BIGGER EYES IN A WIDER UNIVERSE:

THE AMERICAN UNDERSTANDING OF EARTH IN OUTER SPACE,

1893-1941

A Dissertation

by

JODICUS WAYNE PROSSER

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

May 2009

Major Subject: Geography

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Approved by:

Chair of Committee,	Peter J. Hugill
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ABSTRACT

Bigger Eyes in a Wider Universe:

The American Understanding of Earth in Outer Space, 1893-1941.

(May 2009)

Jodicus Wayne Prosser, B.S., Austin Peay State University;

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Chair of Advisory Committee: Dr. Peter J. Hugill

Between 1893 and 1941, the understanding of the Milky Way galaxy within the American culture changed from a sphere to a spiral and Earth's location within it changed from the center to the periphery. These changes were based primarily upon scientific theories developed at Mount Wilson Observatory near Pasadena, California. This dissertation is an "astrosophy" that traces the history of changing depictions of the Milky Way in selected published sources and identifies key individuals, theories and technologies involved. It also demonstrates why the accepted depictions of the universe envisioned at Mount Wilson were cultural-scientific products created, in part, as the result of place.

Southern California became the hearth of a culture that justified its superiority based upon its unique climate. Clear skies, remarkable visibility, and a perceived existence of intense natural light became the basis for the promotion of Mount Wilson as the premier location for astronomical observations. Conservation, *en plein air* paintings, and the concept of *paysage moralisé* are Southern Californian cultural products of the

early 1900s that promoted an idealized society capable of exceptional intellectual endeavors and scientific accomplishments.

The efforts of astronomers Hale, Shapley, Adams, Hubble and Ritchey resulted in the changing American understanding of the universe. This dissertation reveals how the diverse social interactions of these astronomers intersected Arroyo Seco meetings, women's organizations, the Valley Hunt Club elites, and philanthropic groups that comprised the schizophrenic culture of Pasadena. Their astronomical theories are compared to other aspects of the Southern Californian culture revealed in the writings of Raymond Chandler, Nathanael West and John Fante. The desire of astronomers to gain prestige from their discoveries is compared to competition in the creative processes of Hollywood. The theories created by astronomers and the films of the motion picture industry relied upon establishing an accepted second space within the minds of their audiences. By the end of the study period, the universe accepted by most Americans was a "California Universe". It was not a discovery of pure science, but rather a cultural-scientific product of the Mount Wilson astronomers, the Pasadena community and the landscape and culture of Southern California.

DEDICATION

This dissertation is dedicated to my wife, Ruth. Her love has changed the meaning of my universe and her companionship has made it endlessly more fascinating.

ACKNOWLEDGMENTS

The completion of this dissertation would not have been possible without the help of many people. Most are anonymous librarians and research staff who have gathered and sent information to me from various libraries and collections throughout the United States. These dedicated individuals also maintain and improve the on-line research tools and data bases upon which virtually every modern researcher has come to depend. Such tools, along with technological advances such as word processing, on-line dictionaries, and spell-checkers have made this academic endeavor achievable for a mind such as mine. I am thankful for these conveniences, the people who have made them a reality, and those that have taken the time to teach me their most efficient and effective applications.

Fortunately, many who have assisted me are not among the anonymous and have left an indelible mark upon my memory. I would like to acknowledge just a few of these very special people, starting with the members of my dissertation committee. My committee chair, Dr. Hugill, introduced me to the vast array of possibilities within the field of geography. He has guided my interests but has never limited them. Dr. Jonathan Smith exposed me to the concept of geosophy. He could not have known at the time, what I would choose to do with this knowledge. But, without such a framework the idea for this dissertation would have never been hatched. Dr. Jonathan Coopersmith instilled within me a deep conviction that the relationships between history, technology, science, and geography merited additional research and study. Dr. Christian Brannstrom has been my academic voice of reason. He pushed when I needed a start, poked when I needed to

adjust course, and sometimes made me aware I was going the wrong direction just when I was picking up speed. It is my sincerest wish that each of my committee members identifies the evidence of their handiwork in the pages of this dissertation and appreciates my level of indebtedness to their teachings.

Next, I would like to thank Don Nicholson and the volunteers of the Mount Wilson Society. Don is the son of a Mount Wilson Astronomer who lived and worked in Pasadena during the period of this study. Not only did Mr. Nicholson provide access to the sixty-inch and one-hundred-inch telescopes on Mount Wilson. His memories of the era in Southern California, the personalities of the astronomers, and the technicalities of their work greatly enriched this effort.

A portion of the research conducted for this dissertation was funded by Embry-Riddle Aeronautical University Extended Campus Research Reward Program. I owe a debt of gratitude to Dr. Alan Bender of Embry Riddle who encouraged me to apply for this grant to cover the cost of research at the Library of Congress and Huntington Library in Pasadena. The reference librarians in the Geography and Maps Department of the Library of Congress were extraordinarily helpful.

Finally, I would like to thank my wife, Ruth Ann Minkus Prosser. Her support during this project has been more than any husband deserves. Now it is her turn.

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CHAPTER I

INTRODUCTION

Between the Chicago World's Fair in 1893 and the entry of the United States into World War II, the understanding of Earth's physical location in the cosmos changed from being at the center of a modest and spherical stellar system that comprised the entire universe to being at the edge of a large and remote spiral galaxy in a nearly endless sea of similar galaxies. In terms of physical magnitude, this change was by far the largest shift in spatial perception and location awareness in human history. Yet, the history of new astronomical equipment and techniques employed in Southern California during the early 1900s and how they served as a catalyst for this change has been largely ignored by geographers. Instead, it has been left to historians of astronomy, such as Marcia Bartusiak and Allan Sandage, biographers of astronomers, such as Helen Wright and William Hoyt, or the astronomers themselves to interpret how the understanding of Earth's location in the universe changed. The result is a decidedly positivist and whiggish interpretation that fails to account for culture or place in its description.

This dissertation will trace the changes in cartographic representations of the Milky Way with the aim of determining some of the human impacts that helped guide the use of new technology and influence the interpretation of astronomical discoveries. In order to accomplish this, I will attempt to answer two primary research questions. First, in what ways did the culturally-accepted cartographic representation of the Milky Way change between 1893 and 1941? Second, what were the scientific, technologic, historic,

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This dissertation follows the style of the *Annals of the Association of American Geographers*.

and cultural conditions that served as catalysts or influenced the changes? The specific aims of the research needed to answer these questions are threefold: the identification of key technologies, techniques, and scientific theories that led directly to the altered image of the Milky Way; the identification of key people that made significant contributions to the change; and the comparison of the selected key people with other producers of cultural products within the same cultural region.

My hypothesis is that culture, as well as technology and astronomical theory, played a key role in the changing cartographic depiction of the Milky Way. I hypothesize that the invention of the modern catadioptric telescope, advances in astrophotography, and the incorporation of unifying theories of science such as Einstein's relativity were the root technological causes of the changes in the way the Milky Way was understood and cartographically depicted during the study period. The astronomers, who lived and worked at Mount Wilson Observatory and in Pasadena, California, were the key individuals that led this change. And, that these astronomers and the theories they developed were not shielded by the scientific method from the influences of their local and regional cultures. It is hoped that this dissertation will effectively apply the craft of cultural geography to the growing body of work aimed at understanding the intertwined nature of technology, culture, and science.

Background

J. K. Wright coined the term "geosophy" in his 1947 presidential address to the Association of American Geographers entitled "Terrae Incognitae: The Place of Imagination in Geography". He defined geosophy as: "The study of geographical knowledge from any or all points of view. To geography what historiography is to

history, it deals with the nature and expression of geographical knowledge." He further explained: "The historical approach to geosophy implies the study of the history of geographical knowledge, or what we customarily call 'the history of geography'" (Wright 1947, 14). While geosophy and its parent science historical geography deal with the Earth, this study's first research question considers only depictions and knowledge of outer space. Therefore, it may be more appropriate to refer to the first part of this study as an "astrosophy" or a history of astrographical knowledge. It will remain close to Wright's classic definition of geosophy and seek to understand how the cartographic representation and scientific explanation of the Milky Way changed during the study period.

The second research question employs a more modern geosophic method by considering the meanings assigned to place within the culture of California during the study period. It borrows techniques from the contemporary geosopher, Patrick McGreevy. His book, *Imagining Niagara: The Meaning and Making of Niagara Falls* (1994) provides an example of the methodology necessary to extract geographic meaning from a landscape in order to understand how a place might be developed and used by humans. Such a method is required to understand how and why California came to be considered the most valuable and preferred site for astronomical studies. "The Geography of Utopia" by Philip W. Porter and Fred E. Lukermann, published in *Geographies of the Mind* (1976), serves as a model regarding how public understandings reflect one's surroundings and projects them into the creation of an idealized future. Such a method is required in order to understand how living and working in California

may have influenced the astronomers who redrew the Milky Way during the study period.

Since the dawn of the post-modern era, historians have been examining the relationship between culture and the development of science and the advent of technology. The Society for the History of Technology (SHOT), founded in 1958, is one example of a group of historians dedicated to uncovering clues regarding why the advent and diffusion of technologies vary based on culture and, by extension, place. SHOT is focused upon "the relationship of technology to politics, economics, science, the arts, and the organization of production, and with the role it plays in the differentiation of individuals in society" (SHOT 2008, 1). An early example of this type of analysis is Dirk J. Struik's, *Yankee Science in the Making* (1948). Struik states in the book's preface:

> Scientists, scholars, engineers are citizens, not only in the sense that they can vote, but in the wider sense that their work contributes materially to the welfare and the ideas of society. Each of them, in his own professional way, expresses tendencies, desires and ideals which exist among his fellow men. Understanding the science, the learning and the technology of an age means not only a knowledge of the content of the individual professions and techniques, but also an insight into the ways in which they are related to the social structure, the cultural aspirations and the traditions of this age. And so we begin to understand that the history of an epoch includes the history of its science and technology. We must also understand that this history must combine a study of their social relations

> with a study of theories and techniques. History of science, if taken in the fullest meaning of the term, must include its sociology. (Struik 1948, vii)

Sociologists, since the writing of *The Structure of Scientific Revolutions* (1962) by Thomas Kuhn, have accepted changing scientific paradigms as proof that "Science was not one thing – conceptually and methodologically unified, as the seventeenth-century moderns and their followers proclaimed; it was a variety of practices whose conceptual identities were the outcomes of local patterns of training and socialization" (Shapin 1998, 6). Steven Shapin, a sociologist at the University of Southern California, asserts that "geographical sensibilities" are a paramount consideration when studying the development of scientific thought. The idea that science is an unbiased "view from nowhere" is unsustainable when the effect of place is granted a full hearing. While many sociologists contend that despite localized spatial influences science remains a largely universal endeavor, Shapin finds that even universal truths are subject to the vagrancies of place due to dissemination challenges and interpretation errors. Shapin asserts: "The problem here is not that the geographical sensibility has been taken too far but that it has not been taken far enough" (Shapin 1998, 6).

While historians and sociologists have been willing to embrace the intermingled nature of science, technology, and culture; geographers have been slow to accept that place plays a significant role in the development of scientific understandings. This irony is likely related to the fragmented nature of the field of geography; whose economic benefit and standing within universities is often related to partnerships with the hard sciences. For example: beyond the simple and obvious relationship between atmospheric conditions and the location of observatories, geographers have not been willing to

consider the theories developed by modern astronomers as cultural products produced by the occupants of a cultural region. Internationally renowned historical geographer, Alan R. H. Baker, acknowledges in his book, *Geography and History: Bridging the Divide* (2003) that over the last few decades "a renewed emphasis on the cultural significance of area, of place and of region…has given geography a rejuvenated relevance to the social sciences and humanities" (Baker 2003, 158). However, Baker stops short of including the direct impact of place upon the physical sciences, such as astronomy, in his consideration of geography's relevance. Still, Baker recognizes that such studies, sometimes called "historical geographies of knowledge" are "giving rise to some exciting work by geographers" (Baker 2003, 67). Baker identifies the work of David Livingstone in the mid-1990s as an example of geography's potential contributions to the history of science.

David Livingstone, a professor of geography and intellectual history at Queen's University in Belfast, is among a small group of geographers who have been challenging the preconceived notion that science is exempt from the influences of place. While Livingstone has not investigated the field of astronomy, he has used it as an illustration of the predominant intellectual mindset regarding science and place. He states: "Even geographers, despite their professional stake in matters of place and location, have been inclined to exempt science from the imperatives of spatial significance…To suggest that the methods of astronomy, or the theories astronomers devised, might be influenced by their spatial settings was little short of absurd" (Livingstone 2003, 2). This dissertation has directly examined and dispatched this absurdity. It joins with geography's renewed interest in area, place, and region and builds upon a growing number of studies focused

upon “science as a cultural formation, embedded in wider networks of social relations and political power, and shaped by the local environments in which its practitioners carry out their tasks” (Livingstone 2002, 236).

Simon Naylor, a geographer at the University of Exeter, has identified several contexts in which place impacts the development of science. To Naylor, contexts are cultural settings within which science is developed and are directly related to geographic scale. The laboratory, the city or town, the region, and the global scientific community are the contexts within which geographers may choose to study science. Furthermore, Naylor finds local contexts to be more influential than overarching scientific communities and their paradigms. He states: “Beyond the intimacy of the laboratory, the lecture hall or the public house, perhaps the most immediately relevant context is the town or city, the urban, to which we might add the more abstract concept of the public or civic sphere” (Naylor 2005, 6). This dissertation has followed Naylor’s outline. It considered all four contexts while focusing primarily upon the local influences of the Mount Wilson Observatory, the city of Pasadena, and the Southern California region.

Robert A. Dodgshon, a respected human geographer, emphatically asserts, “geography matters precisely because it embodies the materiality of social life” (Dodgshon 1998, 183). In seeking to determine the location of new understandings and innovations within societies, Dodgshon contrasts the society’s core with its peripheral regions. He finds that while members positioned near the society’s spatial and intellectual core have much invested in the status quo, those near the periphery have “greater resources of flexibility” and “unused freedom”. These attributes are often invested in novel ideas and some of these ideas eventually result in change within the

entire society. The resulting changes can be mapped as a "geography of change" (Dodgshon 1998, 183-184). This study has examined the changing understanding of the Milky Way within the context of Southern California as a peripheral location of change.

Additionally, the works of historical and humanistic geographers, such as Sir Peter Hall's *Cities in Civilization* (1998), David Lowenthal's *The Past is a Foreign Country* (1985) and Yi-Fu Tuan's *Topophilia* (1974) will inform this dissertation by providing examples of how the meaning of place changes over time and forms deep emotional ties that influence individuals. The study overlaps with the history of technology. When completed, excerpts of its findings will be similar to articles published in the journal *Technology and Culture*. Therefore, articles published in *Technology and Culture* will serve as examples of how to conduct research and relate findings. While none of the above mentioned sources will serve directly as research material, they do establish the boundaries of the larger context in which this dissertation exists. In summary, although the present study deals with depictions of outer space, it can be classified under the sub-field of geosophy. It is associated with and relies upon humanistic and historical geography and is part of the larger field of cultural geography. It will be appropriate for publication within the fields of cultural geography and the history of technology.

Donald Meinig's description and analysis of the emergence of California's cultural regions in *The Shaping of America: A Geographical Perspective on 500 Years of History: Volume 3: Transcontinental America, 1850-1915* (1998) and his description of California's rise to the status of a regional powerhouse within the American domain in *The Shaping of America: A Geographical Perspective on 500 Years of History: Volume*

4: Global America, 1915-2000 (2004) provide an excellent source for beginning an examination of California as a cultural region. However, Meinig does not examine the role of science, astronomers, or the products of their labor in his analysis. Meanwhile, outstanding accounts of scientific history, such as *Centennial History of the Carnegie Institute of Washington: Volume I: The Mount Wilson Observatory* (2004) by Allan Sandage or Marcia Bartusiak's *Archives of the Universe: A Treasury of Astronomy's Historic Works of Discovery* (2004) fail to address the social component of science and therefore do not analyze the astronomical discoveries made in the context of culture, region, or place. This dissertation will attempt to partially bridge the gap between these two diverse fields of study by drawing upon both sets of sources and thereby placing the astronomers within the fabric of the cultural regions to which they belong.

Biographies of key astronomers, such as Helen Wright's *Explorer of the Universe: A Biography of George Ellery Hale* (1966), Harlow Shapley's autobiography, *Through Rugged Ways to the Stars* (1969), and Gale E. Christianson's *Edwin Hubble: Mariner of the Nebulae* (1995) provide a better account of the astronomers' interactions with the environment and culture surrounding their workplaces. However, even the most personal accounts tend to separate the astronomer's cultural surroundings from his observations, discoveries, theories, and conclusions. One geographer who has recently begun to examine such a relationship between culture and the science of astronomy is Maria D. Lane. Her chapter entitled "Astronomers at Altitude: Mountain Geography and the Cultivation of Scientific Legitimacy" in Dennis Cosgrove and Veronica della Dora's (editors) book, *High Places: Geographies of Mountains and Ice* (2008) looks at the way astronomers used the unique characteristics of remote mountaintops as a means to secure

professional respect and promote their theories. Lane shows that the place of observation was important to the acceptance of an astronomer's work. This dissertation will build upon her work by examining how the local setting and regional culture surrounding the Mount Wilson Observatory served as inspiration for new astronomical concepts and aided the acceptance of new discoveries.

Regional histories such as Kevin Starr's *Inventing the Dream: California through the Progressive Era* (1985) and Carey McWilliams' *Southern California: An Island on the Land* (1983) are excellent sources for understanding the people, conditions, and circumstances in California during the study period. However, these broad histories often fail to address the contributions made by astronomers. In order to address this gap, period pieces such as "A Californian's Gift to Science" (1886) by Taliesin Evans and "Interviewing the Stars" (1925) by William J. Showalter will be referenced. Additionally, many histories of the primary observatories and the astronomers who worked at them can be found online. For example, Florence M. Kelleher's article "George Ellery Hale: The Yerkes Years, 1892-1904" (1997) is one of many related links on the Astronomy Department of the University of Chicago's website.

Finally, outer space itself is not outside the venue of the larger field of geography. Understanding the Earth does not stop at the edge of the atmosphere. For example, as we grapple with the causes of global warming, geographers should be asking about the external forces that effect the human condition on Earth. Additionally, there is plenty of terra incognita on the planets of our solar system and beyond. The fabric of space itself is not uninteresting. It has contours, gravity wells, and points of equilibrium. Recently in an article called "The Geographical Pivot of Outer Space" (2005) Everett C. Dolman has

suggested that near-Earth orbit is the new geographic pivot of history. The consideration of outer space by geographers is not new. William Morris Davis's 1900 article, "Practical Exercises in Geography" addressed the need for geographers to understand Earth's position in the universe as a precondition for understanding the processes, physical and human, that occur upon the surface of the planet. More recently, Dennis Cosgrove's book, *Apollo's Eye: A Cartographic Genealogy of the Earth in the Western Imagination* (2001) has demonstrated how our understanding of Earth, its environmental frailty, and the need for human unity have been altered by our ability to see Earth as a body floating in space. This dissertation utilizes these works as guides and sometimes as source material to ensure that it remains rooted in the science of geography.

Research Design and Methods

This study is a subjective analysis of the changing astrography of the Milky Way galaxy. In particular, the study aims to understand the popular view of the structure, size and shape of the Milky Way, and Earth's location within it, as explained by leading astronomers between 1893 and 1941. It does not include all influences upon the popular conception of outer space such as science fiction, religion, or dreams. It does, however, look for similarities in the creation of other cultural products such as art, literature, and motion pictures. Science fiction, religion, and dreams are topics that may help create a more complete understanding Americans had regarding outer space. However, this study focuses upon the influence professional astronomers had upon Americans' vision of the universe. When considering art, literature, and motion pictures, the topics are limited to analysis of works created in Southern California during the study period. They are examined for the purpose of establishing the cultural setting within which the Mount

Wilson astronomers worked and to assess their impact upon the creation and acceptance of the changing astrosophy.

Chapter II focuses upon the astrosophy of the Milky Way as a cultural product of science. The emphasis of this chapter is to answer the dissertation's first research question: in what ways did the culturally-accepted cartographic representation of the Milky Way change between 1893 and 1941? The changes in the accepted cartographic representation of Earth's place in the cosmos, the Milky Way Galaxy, and the Universe are traced using four different mediums commonly used by astronomers to relay their visions to the general public. The first three mediums represent key devices through which astronomers directly influence and inform the general public. They include academic textbooks, popular scientific journals, and maps and atlases with astronomical sections. The fourth medium is newspapers. While astronomers were not able to control the substance of the accounts published in newspapers, they did make comments to and were cited by journalists. By examining changes (or lack there of) in each of these four mediums an understanding is achieved regarding the changing character of the conceptions of outer space by leading astronomers. Because the explanations, illustrations, photographs, and theories presented by astronomers are scientifically privileged and considered more accurate than representations from other sources, it can be inferred that changing views of outer space in these narratives led the general public and strongly influenced the popular understanding of outer space.

Academic textbooks represent an amalgamation of accepted facts and current theories. Many prominent astronomers authored textbooks during the study period, but only three series of textbooks were chosen for inclusion in the study. To be selected the

text had to be authored by a well-known astronomer and published prior to 1925. It must have a subsequent version published at least once prior to 1945 and at least a decade must have elapsed between selected versions of the textbook. The selection period for textbooks is extended beyond the study window to allow for the delay in revising and publishing. Textbooks published prior to 1945 generally reflect the knowledge base that existed in 1940. Each textbook must contain a detailed discussion along with cartographic representations of Earth's location in outer space. The following textbooks met the selection criteria: Series 1: *The Elements of Astronomy* (1897) by Charles A. Young and *Astronomy: A Revision of Young's Manual of Astronomy: Volume I and II* (1926, 1938, and 1945) by Henry Russell, Raymond Dugan, and John Stewart. Series 2: *A New Astronomy* (1906 and 1926) and *The Story of the Starry Universe* (1941) by David P. Todd. Series 3: *The Elements of Astronomy* (1928 and 1944) by Edward A. Fath.

The primary popular scientific journal that was used is *Popular Astronomy*.[1] This journal was the only major American magazine dedicated to astronomy that was also published for the entire study period. It was edited by some of the leading astronomers of the period and was published ten times each year. The majority of the articles written for *Popular Astronomy* were authored by the astronomers who conducted the observations, but were written in plain, non-technical language. *Science* is a journal that appeals to a broader audience than *Popular Astronomy* and is useful for determining the astronomical issues that rose to the attention of the greater scientific community. It was available

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[1] *Popular Astronomy* was published at the Goodsell Observatory of Carleton College in Northfield, Minnesota. Despite its remote location, the reputation of this publication attracted several well-known and influential astronomers to assume the role of editor or co-editor. The list of *Popular Astronomy* editors during the study period includes: Curvin H. Gingrich, William Wallace Payne, Herbert C. Wilson, and Edward A. Fath.

monthly during the entire study period and covered many scientific topics including astronomy. Astronomers who conducted the observations wrote some of the astronomy articles in *Science*, but staff writers wrote many. Finally, occasionally *National Geographic* publishes astronomy articles. Three such articles were published during the study period (1900, 1925, and 1939). The articles were included in the study because they reflect the broad interdisciplinary and geographic interest that existed for astronomic topics. Furthermore, the transformation of *National Geographic* from an academic journal at the beginning of the study period to a popular magazine by the end reflects the growing interest the American public had for scientific matters including astronomy.

Rand McNally's World Atlas series, *Cram's Universal Atlas* series, *Hammond's Modern Atlas of the World*, *Collier's World Atlas and Gazetteer*, *The New Pictorial Atlas of the World* by James, *The Columbian Atlas of the World We Live In* by Hunt and Eaton and *The Graphic Atlas and Gazetteer of the World* by Bartholomew have each been selected for inclusion in the study. The criteria for inclusion of atlases required the atlas to be published at least twice during the study period, once before and once after 1920, include a section on outer space, and have at least one cartographic representation of outer space displayed within the book. The cartographic representation of space did not have to be displayed in every yearly edition of the atlas.

The Columbian Atlas of the World We Live In and *The Graphic Atlas and Gazetteer of the World* were not published after 1920, but will be included in the study because of their relationship to the Chicago Columbian Exposition of 1893, a key event in the popularization of astronomy. James' *Pictorial Atlas of the World* will be included due to its popularity in the early 1920s and *Collier's World Atlas and Gazetteer* is

included due to its popularity beginning in the late 1930s. All maps depicting the solar system, the Milky Way, or the universe published during the study period and stored in the map room of the Library of Congress were viewed and many were included as subjective examples. Finally, the *New York Times* and *Los Angeles Times* were selected as the large city newspapers that best covered astronomy prior to 1941. Any articles published between 1893 and 1941 in the *New York Times* or the *Los Angeles Times* dealing with astronomy were screened for possible inclusion.

Each of the above sources have been thoroughly reviewed and key material pertaining to the size, structure, or shape of the Milky Way or to the location of Earth in the cosmos was identified and compared. Examples that best typified the handling of the subject during similar years were identified and general trends in information inclusion, exclusion, and display were noted and used to inform the astrography. The examples and trends were then analyzed and compared to better understand the changing nature of how Americans understood the Milky Way galaxy and Earth's location within it. A synopsis and breakdown of this analysis is available in Appendix B and is summarized in the dissertation's conclusion.

The majority of the observations that led to the fundamental reshaping of the Milky Way during the study period occurred at Mount Wilson Observatory and the observatory's offices in Pasadena, California. Lowell Observatory in Arizona and Allegheny Observatory in Pennsylvania also made contributions. Travel to Mount Wilson, California and examination of the equipment used by the astronomers and the cultural settings in which they lived and worked was conducted. Don Nicholson, the son of a Mount Wilson astronomer, Seth Nicholson, who worked at the observatory for a

majority of the study period was interviewed. Mr. Nicholson provided access to the observatory telescopes, buildings, and grounds. He also supplied first hand accounts regarding his childhood in Pasadena. Much of the original equipment still exists but its direct use was limited to the 60-inch telescope and required permission and the help of expert volunteers from the Mount Wilson Society. The passage of time has limited the availability of individuals with direct experience using the equipment in the manner it was used in the early 1900s. At the time of this research, Mr. Nicholson was eighty-eight years old and one of the few surviving individuals who can relate stories regarding the astronomers, understand how the equipment was used during study period, and recall stories regarding how the astronomers lived and worked in Pasadena. For this reason, in addition to findings made during the above field work, similarities and differences were identified between the perceptions and attitudes of leading Mount Wilson astronomers in their published writings, biographies, and historical accounts.

It is the key premise of this dissertation that scientific observations are not excluded from classification as cultural products. Knowledge of the universe is a combination of technology, theory, opportunity, and the existing cultural influences upon astronomers and the public. Therefore, the selected examples are embedded within a historical narrative to provide a context for understanding the causes of changes in the representation of the Milky Way. This required research into cultural venues typically disassociated with hard science. Theses cultural venues are discussed in Chapters III, IV, and V.

Chapter III examines the cultural setting of Pasadena, California that surrounded the establishment of Mount Wilson Observatory and other local scientific institutions by

George Ellory Hale. It also explores the artists and paintings of the *en plein air* art movement popular in California during the 1910s and 1920s. Edgar Payne, Maurice Braun, Benjamin Brown, and William Wendt are three of the *en plein air* artists that were examined. Ruth Lilly Westphal highlights each of these Californian painters in her comprehensive book, *Plein Air Painters of California; the Southland* (1982). The works of Payne and Wendt are examined by Jean Stern is his 2001 article in *American Art Review* entitled "Masters of California Landscape" and a recent report found that the value of these artists' work is rising rapidly due to an increased awareness of their importance (Bryant, 2006). Brown was a contemporary of the Mount Wilson astronomers and fellow resident of Pasadena. The movement to paint outdoors in a natural light with an emphasis upon landscape is compared to the astronomers' accounts of California's beneficial environment for observing the stars. Additionally, the related topic of conservationism and John Muir's influence upon the Californian appreciation of the environment and natural landscape is compared to the astronomers' desire for clear skies and their belief in the beneficial attributes of raw nature upon humans.

Chapter IV examines the experiences of Harlow Shapley, Edwin Hubble, and the etiquette of the observatory staff while at work and in Pasadena. This examination is set against the analysis of three works of literature about Southern California and produced by writers living in Southern California near the end of the study period. Raymond Chandler's *The Big Sleep* (1939), John Fante's *Ask the Dust* (1939), and Nathaniel West's *The Day of the Locust* (1939) are analyzed in an effort to reveal distinguishing features representative of the Southern Californian culture during the study period. The Northern Californian Independent Bookseller's Association considers each

of these works “significant” and each has been made into a motion picture. The characters portrayed in these books have taken on iconic status and represent a wide range of Southern Californian culture. In this portion of the analysis, emphasis is placed on the attitudes and life experiences of the fictional characters as opposed to the authors. Common beliefs and cultural attitudes held by these literary representations of members of various classes and stations were compared to the biographies of Mount Wilson astronomers. In this way, the Mount Wilson astronomers can be situated within the cultural milieu of Southern California. Additionally, an understanding of the local cultural forces and customs placed upon them as members of the community can be estimated.

Chapter V concentrates upon the life of the second Director of the Mount Wilson Observatory, Walter Adams. It examines the relationships between Adams and other notable Mount Wilson astronomers in the context of the emerging Southern Californian culture. Next, related cultural and geographic aspects of the Southern California film industry are discussed. Like astronomy, the film industry was the result of a visual and intellectual product dependant upon new technologies that used lenses and light. Each product was also highly portable, distributed internationally, and subject to the interpretation and control of a select few Southern Californian industry pioneers. The study compares the employment conditions, actions, and methods of one key motion picture industry leader with those of the leading astronomers at Mount Wilson. The goal of this comparison will be aimed at detecting similarities in the entrepreneurial attributes, work habits, and relationships with their co-workers, superiors, and representatives distantly located in the Eastern States. In order to accomplish this task, I concentrated

upon the life and experiences of David O. Selznick. Selznick is ideal because he fits the mainstream of Hollywood producers and also created his own studio. The biographies and writings of David O. Selznick have been examined and relevant passages selected for comparison with the biographies of key Mount Wilson astronomers.

Finally, through each chapter, the history of Southern California and its cultural landscape are examined. Donald Meinig's model of the cultural region and various California histories are used as a guide to understand the larger social changes occurring in the region during the study period. The contributions made by Mount Wilson astronomers are continuously set within the broad and changing social patterns of Southern California. During the study period, California emerged as a politically and economically powerful region within the United States and the world. The discoveries made within the field of astronomy are viewed as one of many cultural products that were simultaneously the product and cause of this rise in regional power. Understanding the role Southern Californian culture had upon the changing depiction of the Milky Way requires an intertwined history of Southern California's emergence as a culturally dominant region within the American domain. In this way, Chapters III, IV, and V seek to answer the dissertation's second research question: what were the scientific, technologic, historic, and cultural conditions that served as catalysts or influenced the changes in the culturally-accepted cartographic representation of the Milky Way between 1893 and 1941?

CHAPTER II

THE SCIENCE OF CHANGING THE UNIVERSE

> If it be true that in nature nothing is great but man, in man nothing is great but mind, then may knowledge of the universe be regarded as the true measure of progress.
>
> - Simon Newcomb[2]

The Chicago World's Fair of 1893 was a watershed event in American history. It inspired a profound fascination with the world and an interest in science among the general population. Over one hundred academic congresses brought the best and brightest scholars of their day together at the fair to present new theories and to provide accounts of the academic status of their respective fields. The most influential paper delivered during this event was Fredrick Jackson Turner's "The Significance of the Frontier in American History."[3] Turner concludes: "And now, four centuries from the discovery of America, at the end of a hundred years of life under the Constitution, the frontier has gone, and with its going has closed the first period of American history" (Turner 1893, 88). The burgeoning cities, towns, and suburbs of California stood as proof that Manifest Destiny had achieved its goal. However, philosophical and imagined frontiers soon replaced the original expansion of the physical frontier that fueled American growth. One such frontier was contemplation and study of outer space. During the half-century following the Chicago World's Fair, America took the lead in the science of Astronomy. Using the most advanced telescopes, American astronomers

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[2] Simon Newcomb was a renowned planetary scientist and considered by some the "most distinguished astronomer of the age" (Osterbrock 23). This passage comes from his dedication speech for the 40-inch Yerkes telescope at the University of Chicago in 1897 (Aitken 1923, 381).

[3] American Historical Association in Chicago, July 12, 1893.

developed and debated new theories regarding the plurality of worlds and sought to determine Earth's place in the cosmos.

Among the many Americans destined to play a role in the opening of these new mental frontiers was a young astronomer and public entrepreneur, George Ellery Hale (1868-1938). Hale was a dedicated astronomer who had earned his Ph.D. from Yale at the age of eighteen. He was also the son of a well-connected Chicago businessman with ties to Chicago's elite businessmen and investors. In October of 1892, as the director of the University of Chicago's Kenwood Observatory, Hale and the University's president, William Rainey Harper (1856-1906), convinced millionaire and Chicago native, Charles T. Yerkes (1837-1905), to finance the largest refracting telescope ever built. The project would cost over $500,000. Yerkes, known as "the Boodler" in local papers, was a manipulator of streetcar and railroad companies, and had spent time in prison for stealing assets following the Great Chicago Fire of 1871. Anxious to establish a more positive legacy, Hale urged Yerkes to follow the example of James Lick (1796-1876), who financed a thirty-six-inch telescope for the University of California and thereby had his name attached to several recent astronomical discoveries. The pitch at his vanity succeeded and Yerkes was soon heralded in Chicago newspapers as the man who would "lick the Lick" (Osterbrock 1997, 6).

Four years before the completion of the telescope's forty-inch lens, Hale and Yerkes arranged for the tube, frame, base, and operational drive to be displayed in the Manufacturer's Building on Columbus Avenue during the World's Fair. The telescope was an imposing piece of equipment and many times visitors were able to "behold the operator putting the telescope through all its motions" (Ives 1893, 128). Recently a

historian of astronomy noted: "Large telescopes evoke a unique response in most people. They symbolize pure science, our urge to understand our world, in a way that nothing else does. They are tools that expand not just our visual horizons but our mental horizons as well. In a sense they are the grandest monuments of our technical civilization" (Zirker 2005, 1). The inspiring nature of such a remarkable display was not lost on Hale, who had been appointed to the World Fair's Special Committee on Astronomy. On Wednesday, August 23rd, the astronomy committee proceeded to the base of the telescope where Hale, Worcester R. Warner (1846-1929), a wealthy manufacturer and amateur astronomer, and telescope mirror designer, Alvan G. Clark (1804-1887), gave speeches (Osterbrock 1997, 14). In contrast to Turner's view of the closing of the American frontier, this display was choreographed to invoke the opposite conclusion. In the minds of many, America was poised to discover endless frontiers in outer space and lead humanity into a new age of discovery some 400 years after Columbus discovered the New World. Astronomer C. A. Young (1835-1908) expressed this sentiment after viewing the telescope at the World's Fair. He stated: "One felt justly some stirrings of patriotic pride in the noble instrument…its benefits are for the most part purely intellectual; in the widening of the range of thought; in the stimulus of grappling with problems that tax to the utmost our highest faculties" (Young 1896, 215).

In terms of geography, the new frontiers in space are related to three basic inquisitive desires of human cultures. First, the desire to understand where the Earth is located in the cosmos drives the search for order, structure, and the boundaries of the universe. Second, the desire to find resources and frontiers drives the search for suitable places to extend the cultures of Earth. Third, the desire to find other cultures drives the

search for extraterrestrial life and the search for climates on other worlds that will support it. Each of these desires is largely the product of speculation, fantasies, and dreams. How Americans understand the vast reaches of outer space, the suitability of other planets for human consumption, or the likelihood of alien life is largely in the hands of the astronomers who have access to our largest telescopes. Those with the biggest eyes have a privileged position in the public understanding of outer space. Their theories, drawings, photos, and interpretations shape the accepted view of the universe within our culture. Their work and findings inspire science fiction and challenge many of the truths we hold as certainties.

This part of the dissertation begins with an account of how scientists understood the universe in 1893 and follows the evolution of this understanding until the beginning of World War II. During this period, the creation of extremely large optical telescopes, the advent of new ways to measure interstellar distances, and the acceptance of radical new theories that could only be understood in the mind's eye, allowed for fundamental changes in the way Americans understood outer space. Another era in the understanding of outer space followed World War II. Additional instruments, such as the development of radio astronomy, the advent of rockets that could transport humans beyond the atmosphere of Earth, and extremely complex theories that often extended beyond the human mind's ability to imagine, further reshaped our understanding of the cosmos. This paper will not attempt to understand all of the subjects and changes that have occurred in the popular understanding of outer space. Instead, it will focus on the half-century prior to World War II (the age of the first giant optical telescopes) and will be limited to the investigation of the popular understanding of the size and structure of the universe.

Using Lenses and Trigonometry to Chart Earth's Place in the Heavens

> When any person untaught in astronomy is told that the many stars he sees, on any clear and moonless night, are suns, like our own, scattered through space, the next question likely to be asked is, How far are the stars away?
>
> - William W. Payne[4]

In late 1893, editor William W. Payne wrote an article in his newly established *Popular Astronomy* magazine entitled "The Distances to the Stars." This article attempted to explain the difficulty astronomers had in the late 1800s trying to answer the question posed in the above quote. Payne states: "Though scholars have thought on this question for centuries, astronomy cannot answer it very well, chiefly because the instruments now in use are too coarse to make the measures needed" (Payne 1893, 129). The primary limitation facing astronomers was the use of motion parallax as a device to measure stellar distances. This method used the relative motion of close stars compared against more distant background stars. As the Earth moves around the Sun, closer stars appear to move at a faster speed. The more movement observed in six months, the closer the star. Additionally, because the approximate size of Earth's orbit was known, trigonometry could be employed to more accurately estimate the distance of the closest stars. Payne included a diagram based on A. C. Ranyard's observations originally published in *Knowledge* (an English science journal) in 1890. The diagram showed the distance from the Sun to the twenty-nine brightest stars in the sky. The diagram shown in Figure 1 (See Appendix A for all figures) also depicts the known universe as round with cardinal directions based on observations from the Earth. The Sun's position is

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[4] William Wallace Payne and Charlotte R. Willard were the first editors of *Popular Astronomy* beginning in September of 1893.

conceptually located at the center of the diagram. This is one of the first attempts to depict the Earth's location in the cosmos beyond our solar system by an American astronomer in a popular journal.

Payne's explanation of motion parallax and the equipment used to measure it borrowed heavily from the astronomy textbooks published by Charles A. Young. A leading astronomer at Princeton, Young was an expert on the Sun and had served a term as president of the American Association for the Advancement of Science in 1883. His textbooks were among the most popular of the time and included a series called: *The Elements of Astronomy*. These textbooks were intended for students of science and for the general population. In 1897, Young was careful to describe the stellar system as a "celestial sphere" and asked the reader to conceive of its enormity by imagining that "the whole material universe lies in its center like a few grains of sand in the middle of the dome of the Capitol" (Young 1897, 5). Young also recommends the use of celestial globes to teach the location of stars in the night sky. This tool depicts the stars on the surface of a globe that can be rotated to align stars with their correct visual position over the surface of the Earth based on time and date. In order to understand the Earth's place in the cosmos, the user must invert the image, seeing the Earth at its center and the stars displayed upon a shell around the planet. Young provided his readers an appendix with directions on how to use the Celestial globes available at most colleges with astronomy programs since the early 1860s.[5]

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[5] The Library of Congress has preserved several early Celestial Globes including the 24-inch Celestial Globe made by Malby and Son Company in 1860.

In 1900, the conception of Earth's place in the Universe as a whole remained vague. However, the understanding of Earth's place within the solar system was well established. The understanding of the Earth's size, rotation, and revolution around the Sun were considered crucial understandings that could be applied to various other studies. William Morris Davis (1850-1934), the founder of the Association of American Geographers, published an article in *National Geographic* in 1900 explaining why this knowledge needed to be taught to students of geography and how this task could be accomplished using interactive practical exercises based on observations. Davis wanted scholars of geography to understand Earth's situation in space so that they could understand phenomena that affect physical geography as well as the cultures of humans. However, he also intended to assure students that such understandings were based on and could be verified with scientific observations. Davis states: "It is well that the scholar should know that it is entirely on the basis of such agreements between hypothesis and fact that text-books make statements about the inclination of the Earth's axis, the duration of its annual revolution, and so on" (Davis 1900, 78).

Depictions of the Earth in the solar system can be found in various sources beyond astronomy textbooks. Many world atlases published throughout the duration of this study (1893-1941) contain a verbal section on astronomy or a visual depiction of the solar system. Most of these sources use diagrams to explain the seasons, the phases of the moon, and Earth's size and location relative to the other planets and the sun. These depictions remained remarkably consistent from the early 1890s through the early 1940s. Specific facts, such as the size and distance of planets changed, but the general

understanding of the solar system, the seasons, and the phases of the Moon remained consistent.

Figures 2 and 3 are taken from *The Columbian Atlas of the World We Live In* published in 1893 by Hunt and Eaton publishers. In figure 2, the comparative sizes of the planets are shown in the upper left, the relative size the Sun would appear if viewed from each planet is displayed in the upper right. The main illustration is a view of the solar system from directly above the elliptic plane of the planets. This view includes planets out to Neptune, the asteroid belt, and several comets. At the bottom of the illustration is a depiction of the Earth's orbit around the Sun and a graph demonstrating the relative distances of the planets. Figure 3 explains the season, eclipses, tides, and phases of the Moon. Each of these depictions has a ring surrounding the Earth or solar system that contains the names of the constellations of the zodiac. In this way, the relative position of the Earth and solar system within the greater cosmos is displayed. The Earth and solar system, for all practical purposes, are shown as situated in the center of the cosmos. The page also includes a compass rose reflecting the practical use of astronomy as a navigation tool. *The Columbian Atlas of the World We Live In* was published to coincide with the Columbian Exposition and the depictions are typical of atlases that included astronomical information in the late 1800s.

Figure 4, was taken from the *Rand McNally World Atlas* published in 1939. Almost all of the information contained in *The Columbian Atlas of the World We Live In* (1893) appears in similar fashion within the *Rand McNally World Atlas* (1939). The top of the illustration features a depiction of the solar system as viewed from along the elliptic plane beyond the orbit of Saturn. Once again the names of the constellations of

zodiac appear along the edge of this depiction. Below the depiction of the solar system is an explanation of the tides, eclipses, relative sizes and distances of the planets, and an illustration explaining the seasons. This example is a common depiction of the solar system from a vantage point along the elliptic plane beyond the orbit of Saturn. Such a vantage point requires the viewer to peer back upon the inner solar system and the position of Earth from an imaginary location in space. This example demonstrates the popular conception of the solar system throughout the entire study period. A nearly identical depiction of the solar system was used in George F. Cram's *Universal Atlas* as early as 1896.

The only piece of information that was no longer commonly depicted in atlases by the end of the study period was the compass rose. This omission can be attributed to the displacement of astronomy from navigation resulting from improvements in the magnetic compass. Yet, astronomy remained linked to navigation in the public perception and remained a secondary means of navigation for ships and aircraft as late as WWII. For example, an Air France travel poster published in 1939 entitled, "*Air France: Principales Lignes Exploitees en 1938-1939*" painted by Lucien Boucher depicts trans-Atlantic air routes following a course from star to star across the ocean and continents. Nevertheless, the absence of compass roses from solar system maps in the later part of the study window demonstrates a separation of astronomy from the study of planet Earth.

Despite the intentions of William Morris Davis, by the early 1940s, astronomy was no longer associated with geography or considered essential knowledge of the geographer. This change occurred not just because of improved methods of navigation, but also because of fundamental changes in the way astronomers began to explain the

Earth's position and status within the cosmos. While the popular understanding of the solar system remained relatively unchanged, ideas about the rest of the universe changed greatly. This change was the result of many sociological factors including: improved telescopes, new astronomical theories, and the repositioning of major observatories from the east and mid-west to the American southwest.

In 1906, David Peck Todd, the director of the Amherst College Observatory, published the second edition of his astronomy textbook, *A New Astronomy*. Todd, well respected in the fields of astronomy and mathematics, had worked at the U.S. Naval Observatory for three years in the late 1870s, and had been a renowned planetary astronomer for over 30 years when the textbook was published. A decade after Young's *The Elements of Astronomy* (1896) and nine years after the original *A New Astronomy* (1897), Todd's textbook repeated and reinforced many of the same teachings about Earth's place in the cosmos. At the beginning of the twentieth century, after decades of observations with refracting telescopes, a lasting understanding of the cosmos was established in the minds of many Americans. Todd captures that image in his textbook just before the development of large reflecting telescopes, theories by Einstein, and the establishment of Mount Wilson Observatory by George Ellery Hale forever changed the way Americans understood the universe.

On page 436 of *A New Astronomy* (1906), Todd provides the reader with a model for better understanding the use of motion parallax, also called the differential method, to determine stellar distances. A similar diagram is provided in Figure 5. The use of motion parallax resulted in a common understanding of the universe as a set of two rings of stars. The group of stars close enough to the Earth to be measured with the differential

method formed the inner ring while the background stars formed the outer ring. As a result of stellar distance measurements with motion parallax, Americans living in the first decade of the twentieth century understood the Sun to be located near the center of the universe. A band of stars extended out to roughly 300 light-years, the maximum measurable distance using motion parallax. A second, larger band of stars formed an outer ring estimated at a distance of 1200 to 1800 light-years away from Earth. Such an understanding of the structure of the universe was illustrated by Alfred Russel Wallace in *Man's Place in the Universe* (1903) (Wallace 1903, 296). A similar diagram is provided in Figure 6.

Todd updates Young's 1897 depiction of the closest stars contained within the inner ring (see Figure 7). He also clarifies that the differential method determines a star's distance using "not the star's absolute parallax, but the difference between its parallax and that of the remotest star, assumed to be zero" (Todd 1906, 437). This minor change in terminology did not represent a change in the method astronomers used to determine stellar distances, but it does show the improved method by which this information was conveyed to students of astronomy and the general public. During the early 1900s, astronomers were beginning to realize their role as shapers of the accepted public pictorial understanding of outer space. The number of illustrations and photographs in astronomy textbooks and astronomy related journal and newspaper articles increased. Additionally, authors invested more effort in the explanation and interpretation of these images. Todd's textbook is an example of this trend.

Using the Rules of Science to Understand the Nature of Celestial Phenomena

Perhaps the phenomenon most responsible for changing the way Americans understood the universe was the nature of spiral galaxies. Todd's textbook captures the popular understanding of these objects in 1906. First, it is important to clarify that in the early 1900s there were no "spiral galaxies" in the popular understanding of outer space. These objects were known instead as spiral nebulae and thought to exist at the far edges of the Milky Way celestial system. One of the "proofs" used by astronomers to conclude that spiral nebulae were indeed part of the Milky Way was the direct negative correlation between visible stars and visible nebulae. Todd states: "It may be said that the nebulae are distributed over the sky in just the opposite manner from the stars; for their number has a definite relation to the Milky Way" (Todd 1906, 465). Todd demonstrated this relationship by plotting the location of known nebulae on a map of the night sky as seen from Earth (Todd 1906, 464).

Additionally, the prevailing theory in 1906 was that "spiral nebulae" were planetary systems in the early stages of development. The photos of spirals such as Andromeda seemed to support this concept. Today, we see these same objects as collections of billions of individual stars at extragalactic distances. But, in the early 1900s, astronomers educated the public to see swirling masses of dust clumping together to form stars and planets like our own. Todd states: "Thousands of stellar systems, then (probably also our planetary system), came into being, not from rings left behind as the nebular disk contracted, but by condensation into knots of nebulosity, here and there detached from the whirling nebulous mass, each knot subsequently contracting into a separate star (or planet)" (Todd 1906, 471). A photo of the Andromeda Galaxy and an

artist's rendition of the genesis of a solar system were presented by Todd and effectively made this understanding plausible to the reader (see Figure 8).

However, just because astronomers in the 1900s did not conceive of spiral nebulae, as spiral galaxies did not mean that they were incapable of understanding a larger universe. Todd speculates:

> Are, then, the inconceivable vastnesses of space tenanted with other universes than the one our telescopes unfold? We are driven to conclude that in all probability they are. Just as our planetary system is everywhere surrounded by a roomy, starless void, so doubtless our huge sidereal cluster rests deep in an outer space everywhere enveloping illimitably. So remote must be these external galaxies that unextinguished light from them, although it speeds eight times round the earth in a single second, cannot reach us in millions of years. Verily, infinite space transcends apprehension by finite intelligence. (Todd 1906, 472)

Understanding of spiral nebulae and the size of the observable universe would begin to be challenged around 1920. By 1933, the popular understanding of these objects, the size, shape, and lifespan of the universe, and the location of the Earth within the cosmos would be radically different from the visions presented by astronomers such as Young and Todd in the late 1890s and early 1900s.

The structure of the universe is a grand theory that is nearly impossible to prove. Throughout the study period, as it is today, this subject has attracted numerous competing theories. During the late 1890s, the "rules" for this competition became more clearly defined. In order to be respected, an astronomer's depictions of the universe must be

verifiable. The scientific method would be strictly applied and all suppositions would be subject to challenge by the greater community of scientists.

Prior to 1900, cartographic representations of the Milky Way presented the scientific method a dilemma because astronomers drew by hand the objects they viewed through their telescopes. Pannekoek's 1897 article in *Popular Astronomy* entitled: "On the Necessity of further researches on the Milky Way" addresses this problem. In this article, Pannekoek compares comprehensive drawings of the Milky Way made by several noted astronomers in the early 1890s. He finds many discrepancies between the work and drawings made by each. Pannekoek uses the words of infamous astronomer Professor E. E. Barnard who stated in 1890: "Eyes differ so much and astronomers as a rule are such very poor artists, that we may never expect to get anything like a fair delineation of the Milky Way by the human hand alone" (Pannekoek 1897, 397). As a part of this study, a star chart in *The Graphic Atlas and Gazetteer of the World*, was compared to a similar depiction found in the *Andree Allgemeiner Handatlas* published during the same year (Bartholomew 1893, 2; Andree 1893, 5). Each example illustrated the Milky Way as a light area traversing the star field from north to south. The only noticeable differences in the illustrations were the outlines, or extents, of the Milky Way. Such variation is the result of stellar magnitude selection criteria and artist preference. Pannekoek found such discrepancies prevalent and problematic. In an 1897 article, he called for an agreed upon universal depiction of the Milky Way. Pannekoek also uses the words of W. H. Wesley, who had compared two star charts showing the Milky Way drawn in 1892, concluding: "It can only be by the accumulation of independent drawings

that personality can be eliminated and a representation obtained sufficiently certain and satisfactory to be used with confidence" (Pannekoek 1897, 398).

A solution to this problem was found in the application of astrophotography. By photographing objects instead of drawing them, astronomers could obtain more scientific consensus regarding their conclusions. However, this method is best applied to singular objects and less suited for depiction of the entire sky. Additionally, the amount of light gathered significantly altered the appearance of many celestial objects. In particular, the appearance of spiral nebulae changed radically with increased light gathering capability. Large telescopes with clock-driven drives, capable of tracking stars by countering the rotation of Earth, became required equipment for astronomers seeking to influence the field. By 1900, astrophotography had replaced simple observation as the means by which most astronomers gathered and shared information about the cosmos. The ability to expose film to light from stars for hours on end altered the way humans understood the universe. No longer was the mind limited to the information that human senses could gather. For example, the Andromeda Nebulae had been drawn for centuries, but its true shape was not known until Isaac Robert exposed it for four hours using a 20-inch reflector in 1888 (Wilson 1899, 508).

Prior to 1908, the 40-inch Yerkes telescope located in the town of Williams Bay on the shore of Geneva Lake, Wisconsin, remained the largest refracting telescope in the world. However, a 72-inch reflecting telescope, constructed by William Parsons (The Earl of Rosse), had been in operation since 1842. Lord William Parsons, using this telescope was responsible for identifying the spiral nature of some twenty nebulae in the mid-1800s (Zirker 2005, 15). However, the design of reflecting telescopes required the

astronomer to be located near the top of the scope's 58-foot focal length. Plus, the telescope had no mount that could support its weight and had to be suspended between two giant walls. Without a mount, the telescope could not be outfitted with a clock drive. Attempts to make larger refracting telescopes had failed due to the light bending nature of the lens. The larger a telescope's lens, the more blue light it absorbs. Photographic plates are most sensitive to blue light. This meant that beyond roughly 40-inches, the value of a refracting telescope was limited.

Due to relatively poor environmental conditions at its location, the Yerkes telescope never managed to outperform the smaller 36-inch refractor at Lick Observatory, near San Jose, California. J.E. Keeler, while working at Lick around 1898, began to systematically photograph images of nebulae and to discern and catalog those with a spiral appearance (Bartusiak 2004, 383). No such efforts were undertaken at the Yerkes Observatory. Both telescopes had been designed and built by Alvan Clark and there was no reason to suspect the skill of the astronomers varied substantially between the two locations (Zirker 2005, 20). The reason for the smaller scope's superior performance was based solely on the clear, stable, and dark skies of the Sierra Nevada Mountains.

Using Mirrors, Mountains, and Relativity to Expose Outer Space

George Hale had anticipated the need to build a large reflector equipped with a clock drive in order to exceed the 40-inch achromatic limit. In 1897, he persuaded his father to purchase a 60-inch mirror blank from the St. Gobain Glassworks in Paris. Hale had already employed George W. Ritchey as an assistant. Ritchey was the son of master woodworkers from Ireland and an expert in telescope design and mirror grinding (Osterbrock 1997, 11). Hale was able to obtain the blank and have it prepared for a total

cost of $25,000. Hale then offered the disk to the University of Chicago "on condition that a suitable building, with dome and telescope, mounting and all auxiliary apparatus be provided and that arrangements be made to keep the optical parts of the instrument in good condition." (Kelleher 1997, 1).

The university did not raise the money and informed Hale that if he wanted such a structure that he would need to raise the money himself. Attempts to pursue local financing also failed. Hale's father died in 1898 and his mother the following year. He no longer had any reason to remain in Chicago. Hale's opportunity to build the 60-inch reflector came in 1903. Hale was a member of the Andrew Carnegie Institute's advisory committee on astronomy. When the institute offered $10 million for grants supporting science, Hale quickly demonstrated the value of building a large reflector, capable of astrophotography. Such a reflector would require a complex catadioptric design using a series of mirrors to redirect and concentrate light while enabling the astronomer to remain closer to the ground than a typical reflector would facilitate. By keeping the astronomer away from the upper portion of the telescopes frame, clock drives could be used to counter the Earth's rotation and allow for long photographic exposures.

Within a year, Hale determined the first such telescope should be built in the mountains of Southern California as opposed to Wisconsin and completed an expedition to and observations from Mount Wilson, near Los Angeles (Osterbrock 1997, 44). Hale knew that such a project would require massive funds. He proposed the idea to the President of the University of Chicago and gained his academic support. Next, Hale sought funding from Carnegie Institute. His pitch for funding, despite being buttressed by the support of a major university, fell far short of his expectations. Instead of the

$30,000 of front money he requested, the Carnegie Institute initially appropriated only $10,000. Furthermore, Hale had also requested two yearly payments of $150,000 to start construction. Based on the lowered amount of the front money, these appropriations seemed unlikely to be realized. Undaunted, Hale proceeded with the planned observatory by financing the remainder himself and gambling that the funding would be approved. Hale's gamble paid off in December 1903 when the Carnegie Institute awarded the entire $310,000 for the building of the observatory. (Eklund 2004, 28; Wright 1966, 195).

Hale used the additional funds to "steal" Ritchey, and two other Yerkes astronomers, Ferdinand Ellerman and Walter Adams to form an observatory staff for the University of Southern California (Osterbrock 1997, 45). Within six months, Hale had signed a 99-year lease with the Mount Wilson Toll Road Company for use of the land near Mt. Wilson's summit. Within a year, he had already commissioned the construction of a 100-inch mirror. The 60-inch "Hale" catadioptric telescope was completed in 1908 and was immediately put to use photographing nebulae. The 100-inch "Hooker" catadioptric telescope, named after the financier of its mirror, was completed in 1917 and was used primarily to study deep sky objects including spiral nebulae.

Hale's relocation to Mount Wilson marked a key shift in the study of astronomy within the United States. This shift corresponds with the rising influence of California within the United States. Cultural geographer Donald W. Meinig described the new culture that Californians brought to the American landscape noting that "Californians had taken the lead in formal scientific study of their land and resources…a new society, something closer to what America might – ought – to become" (Meinig 1998, 55). This

new society's focus on science and nature was a perfect environment for the development of a generation of astronomers who would produce a new model of the cosmos.

Helen Wright, in her biography of Hale, described the astronomer as active and respected within the community. She details accounts of Hale climbing the mountain with George Jones (who was later known as Paul Bunyan) and speaking at the house of Mrs. Burdette, the cultural leader of Pasadena. The combination of nature and culture was inspiring to scientists like Hale. Additionally, investment in research and development by philanthropy through the California university system provided a constant stream of funds.[6] By 1918, the major observatories of California had supplanted the college observatories of the American core (shaded area in Figure 9). During the years between the two world wars, Californians, not Ivy Leaguers or east-coast publishers, led the shaping of the American understanding of deep space. Figure 9 depicts the locations of the ten largest telescopes built in the United States between 1873 and 1918. The shift of astronomy's greatest physical assets, large telescopes, away from the American core and into the Southern California region is apparent and significant. The influence of Southern California upon the practices of individual astronomers will be explored in later chapters. However, at this point, it is important to note that social factors resulting from living and working in the periphery of a young city, Los Angeles, that was located on the edge of the emerging American nation, may have allowed the California astronomers to have a more optimistic, experimental, and ambitious outlook.

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[6] David Harvey, a renowned economic geographer, refers to such investments as the "tertiary circuit of capital" and attributes America's rise to hegemonic status in the world after WWII to investments made in the American south and west during the first half of the twentieth century (Harvey 2003, 111). The Carnegie Institute led investment in the Mt. Wilson observatory. This organization invested $10,000 in 1904, $150,000 in 1905, and $150,000 in 1906 (Eklund 2004, 28).

This outlook may have served to further increase their influence.

At some point prior to 1920, the myriad of individual astronomical projects being conducted in California, the American core, and throughout the world, began to be understood as a larger scientific project seeking to "solve" the universe. As early as 1903, Simon Newcomb, a noted economist and astronomer, recognized this greater pursuit as one of the results of massive institutionalized investment in science. Newcomb states: "In recent times what we may regard as a new branch of astronomical science is being developed, showing a tendency toward unity of structure throughout the whole domain of the stars" (Newcomb 1903, 122).

The scientific need to connect individual discoveries with overarching theories became even more pronounced after the introduction of the theory of relativity by Albert Einstein in 1905. Einstein, a patent clerk in Bern, desired to solve a discrepancy in the paradox of two mathematical equations. The first equation was used to calculate the magnetic energy amassed from a fixed coil moving over a bar magnet. The second equation was used to calculate the magnetic energy amassed from a bar magnet moving within a fixed coil. Why the two equations were mutually exclusive was troubling to Einstein. His solution to this dilemma would forever alter the understanding of the universe!

In the words of Brian Greene, a popular modern day cosmologist and author, Einstein simply concluded, "observers in relative motion will have different perceptions of distance and of time." However, despite the simplicity of this concept, it causes serious problems for the human imagination. Greene states: "It has been almost a century since Einstein informed the world of his dramatic discovery, yet most of us still

see space and time in absolute terms. Special relativity is not in our bones – we do not feel it. Its implications are not a central part of our intuition" (Greene 2003, 25). It is also difficult to construct an astrographical depiction of a universe that is "relative". Suddenly, a tool that made the universe more understandable to astronomers made it harder to explain to the general population.

Einstein would expand the special case of relativity to a general theory of relativity in 1915. The general theory allowed for the change in velocity and direction of all objects in the universe (not just those moving in a straight line and at a constant speed) and could be tested by demonstrating that light will bend due to gravity. An international team of astronomers acquired the measurements necessary to confirm Einstein's theory by photographing a star as it passed by the limb of a solar eclipse on May 29, 1919. Their results left "little doubt that a deflection of light takes place in the neighborhood of the Sun and that it is of the amount demanded by Einstein's general theory of relativity" (Dyson et al 1920, 332). The impact of this confirmation upon astronomy and the understanding of the universe cannot be overstated. Marcia Bartusiak, a modern historian of astronomy, concluded that general relativity "allowed cosmology, once the province of philosophy alone, to become a bona fide science. By applying the equations of general relativity to the cosmos at large, astrophysicists started predicting the ultimate geometric structure of the universe" (Bartusiak 2004, 294). Yet, the path of scientific discourse may be far less removed from the effects of human interaction, culture, and place than her whiggish conclusion suggests.

Using Debate to Measure the Galaxy

The concept of relativity allowed Mount Wilson astronomer, Harlow Shapley, to question the position of the Sun within the Milky Way. Using a system of measurement that did not depend upon motion parallax, Shapley determined that the Sun was located near the edge of an exceedingly large stellar system as opposed to near or at the center of a more modest galaxy. Because motion parallax was only effective to about 300 light years, the vast majority of objects in the heavens remained beyond measurement and assumed to have distances generally associated with their brightness. However, instead of using motion parallax, Shapley based his findings upon the properties of Cepheid variables.

Cepheid variables are stars that exhibit a regular pattern of change in their brightness.[7] Henrietta Leavitt, an astronomer at Harvard, was able to calculate and compare the periods of twenty-five Cepheid variables in 1912. She found a "simple relation between the brightness of the variables and their periods" (Leavitt 1912, 2). Brighter Cepheids have longer periods than dim ones. However, Leavitt's work went to expand the use of motion parallax and the real importance of her discovery was not initially realized.

However, starting in 1914, Harrow Shapley began using the 60-inch reflector at Mount Wilson to identify Cepheid variables in clusters of stars throughout the Milky Way. He painstakingly collected data and applied Leavitt's relationship to determine the distance of sixty-nine globular clusters until he "clearly saw that our Sun was not situated

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[7] Cepheid variables obtained their name from Edward Pigott and John Goodricke who discovered a regular pattern in the variation of the star, Delta Cephei, in 1784 (Bartusiak 2004, 136).

in the galaxy's center but off to one side of the flat disk of stars" (Bartusiak 2004, 391). He also used this data to estimate the size of the galaxy, finding it to be 100,000 parsecs (300,000 light-years) in diameter (Figure 10) (Shapley 1919, 314). Shapley's findings did not go unchallenged and a fierce debate began among astronomers regarding the size of the galaxy and the Sun's location within it. The argument reached its zenith following the National Academy of Sciences meeting in 1920.

At the root of the debate was the acceptance of Shapley's method for measuring distance in deep space. The use of Cepheid variables threatened to dismantle completely the dominance of refractors in determining extra-stellar distances. As expected, the majority of astronomers who accepted Shapley's measurements were users of reflectors while the majority who opposed them worked with refractors. George Ellery Hale persuaded the National Academy of Sciences (NAS) Secretary, C. G. Abbot, to host a formal debate on the subject. Hale's father's NAS lecture series endowment was used as a platform and the debate took place in Washington, D.C. on the April 26, 1920 (Trimble 1995, 1). Harlow Shapley, of Mount Wilson Observatory, and Heber D. Curtis, of Lick Observatory, were selected as the discussants. The selection of Curtis to represent the opposition to Shapley foreshadowed the academic clout that California would establish in astronomy by the mid-1920s. Regardless of the outcome, the accepted understandings of the size and structure of the universe would have a decidedly Californian influence.

The actual debate was little more than back-to-back prepared remarks. Shapley used the forum to impress his future employers at Harvard Observatory by reading a simplified summary of his findings while Curtis provided a slide show and a series of

technical accounts. Neither astronomer was interested in risking their professional reputation in such a forum. Consequently, there were no questions or interaction between the two astronomers beyond the exchange of greetings and polite gestures. The mystique of "the great debate" developed only after the written version was published in the *Bulletin of the National Research Council* in the following year (Hoskin 1997, 329).

In the written version of the debate (Shapley and Curtis 1921, 171-217), each astronomer presented a more spirited, academically supported, and distinct view of the universe. Shapley determined that the Milky Way was a very large disk (roughly 300,000 light years across), the solar system was located near its edge, and spiral nebulae were collections of gas and stars closely associated with it. Curtis offered an opposing view where the solar system was located very near the center of a smaller Milky Way (roughly 30,000 light years across) and spiral nebulae were actually "island universes" of undetermined size and not associated with the Milky Way. A diagram of Curtis' concept is provided in Figure 11 for graphical comparison with Figure 10.

Both conceptions were based upon the acceptance of a separate and different set of measurements. As expected, Shapley placed the most emphasis upon the use of Cepheid variables to determine the distance to close star clusters. He further suggested that this method could be used to determine the distance to spiral nebulae by using a larger telescope than the 60-inch reflector he employed at Mount Wilson. Curtis dismissed the Cepheid argument by concluding that Shapley had too few confirmed examples upon which to base his analysis. However, both astronomers agreed that if Cepheid measurements could be confirmed that their use would be the best method to determine distances in deep space.

Each astronomer used several other methods to support their view of the size and structure of the universe. Shapley assumed that stars with spectral types F, G, and K visible in clusters (beyond measurement by parallax) were giants with absolute magnitudes of –3 or greater. Curtis, on the other hand, assumed these same stars were dwarfs with absolute magnitudes of roughly +7. The absolute magnitude of a star is equal to its apparent magnitude at a standard distance of 10 parsecs (32.26 light-years).[8] Since the apparent magnitudes of the stars were known, the brighter the star's actual absolute magnitude the further away it must be located. Most stars have absolute magnitudes of between –5 and +15. For example, the Sun has an absolute magnitude of +4.8. Therefore, the difference between –3 and +7 absolute magnitude is immense. By using these different estimates the size of the galaxy varies by a factor of ten.

Shapley reinforced his estimate by comparing the apparent brightness of blue giant stars visible in clusters with the known absolute brightness of some local blue giants. He determined that if the clusters were only 3,600 light-years away, as proposed by Curtis, they would shine brighter than the Sun. Curtis did not dispute this point, but he questioned why the brightest blue stars outshine the brightest red stars in the local area while the opposite is true in distant clusters. Curtis concluded that something must be wrong with using such a comparison and insisted this method could not be used until the reason for this discrepancy was explained. In similar fashion, Shapley determined that the absolute brightness of nova (stellar explosions) recently viewed in spiral nebulae

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[8] The spectral classification of stars is based on the heat and light generated by each star. Seven main-sequence categories exist: O, B, A, F, G, K, and M. Each of these star types could also appear as giants or dwarfs. F, G, and K stars are yellow or orange and thought to be similar in temperature to the Sun (3,500-7,500 degrees Kelvin).

would be a million times too bright if spirals were indeed separate galaxies. Again, Curtis did not dispute Shapley's analysis, but instead suggested that two separate classes of nova may exist. In Curtis' view, most nova in other galaxies are too faint to be seen, but occasionally a super-nova will occur and cause a single star to shine as bright as the entire Milky Way.

The debate remained unresolved for the next five years. One historian of astronomy notes: "The Shapley-Curtis debate makes interesting reading even today. It is important, not only as a historical document, but also as a glimpse into the reasoning processes of eminent scientists engaged in a great controversy for which the evidence on both sides is fragmentary and partly faulty. This debate illustrates forcefully how tricky it is to pick one's way through the treacherous ground that characterizes research at the frontiers of science" (Shu 1982, 286). In the absence of a scientific consensus, astronomers, philosophers, laymen, and skeptics offered many different theories with wide-ranging estimates regarding the size and nature of the Milky Way and the cosmos. Radical visions of the universe by amateur astronomers and philosophers began to compete with the interpretation of scientific observations conducted at the leading observatories. Additionally, skeptics who openly challenged assumptions made by scientists gained added respect and popularity.

Using Non-Scientific Techniques to Comprehend the Cosmos

Skeptics, such as Charles Hoy Fort (1874-1932), capitalized upon the rift in the scientific explanations of the Milky Way and the authoritative vacuum it opened. In his book, *New Lands* (1923), Fort challenged the vision of the universe proposed by leading astronomers. He lamented the respect granted to astronomers and argued against an

implied “general supposition that the science of astronomy represents all that is most accurate, most exacting, painstaking, semi-religious in human thought, and is therefore authoritative” (Fort 1923, 10). Instead, Fort offered a description of the universe that he claimed required “extra-geographic thought” to understand.

In his vision of the cosmos the solar-system was “an egg-like organism that is shelled away from external light and life – this central and stationary Earth its nucleus – around it a revolving shell, in which the stars are pores, or functioning channels, through some of which spray irradiating fountains…and that the stars are not trillions or even millions of miles away” (Fort 1923, 86). He backed his analysis with numerous reports of rocks and other objects repeatedly falling from the sky over certain locations on Earth. He ascertained that the Earth must be stationary for such events to reoccur at the same location. Fort surmised that astronomers dismissed these events because they did not fit the “well-established conventional doctrine that has spun like a cocoon around mind upon this earth, shutting off research and stifling even speculation” (Fort 1923, 127).

Several factors likely played a role in the public’s willingness to entertain Fort’s non-scientific view of the cosmos. First, for decades astronomers had been using equipment far beyond the means of average citizens to acquire. By the early 1920s, the technology gap between professional astronomers and amateurs had grown exponentially. The professionals had extremely large telescopes, equipped with advanced clock drives and cameras. Second, the most significant recent contributions made in astronomy came from three of the largest telescopes in the world. These telescopes were remotely located upon mountaintops in California far away from the majority of Americans. Third, theories proposed by astronomers required adherence to general relativity, quantum

mechanics, and a host of other mathematical and theoretical concepts not generally understood by the public. Therefore, the new conceptions of the universe described by astronomers beginning in the 1920s no longer matched the realities of the world experienced by humans. Finally, the well-publicized disagreement among leading astronomers over the basic structure of the universe undermined the hope that astronomers and their telescopes could solve the riddles of the universe, find suitable worlds for human use, and discover extraterrestrial life.

The vast distances described by astronomers and the new structure of the universe challenged the frontier spirit inspired by the great telescopes and the advance of astronomy. Large telescopes served to provide more accurate (although disputed) measurements of distances to the planets and the stars. But, the realization that the distances were beyond comprehension was disheartening. Further, the apparent motion of all heavenly bodies, including the Earth and the solar system, made space travel nearly impossible to comprehend. How could a being navigate if all reference points were relative in nature? Fort reacted against the astronomers' conclusions by stating: "The doctrines of great distances among heavenly bodies, and of a moving earth are the strongest elements of exclusionism: the mere idea of separations by millions of miles discourages thoughts of communication with other worlds" (Fort 1923, 155). However, despite alternate visions, astronomers still held a dominant position from which to influence the understandings of the majority of Americans regarding the character of outer space. When astronomers found agreement, Americans would accept their findings and seek other venues to satisfy their desire for attainable frontiers.

During the late 1920s through the 1930s, despite the mounting evidence provided by astronomers, Americans found many ways to reconcile their desire for a central role for humanity in the universe, the existence of a usable plurality of worlds, and the possibility of extraterrestrial life. Amateur philosophers and astrologers had sought to define and prove a relationship between man and the cosmos for centuries. In the wake of astronomy's intellectual dispute, these visions increased in popularity and the production of individually copyrighted maps, charts, and diagrams of the universe dramatically increased.

Often these representations of the universe attempted to establish a theory that would explain geography and human history with astronomic phenomena. One such example is Hahn Brooks' "Map of the Planetary Man" (1929) (see Figure 12). Brooks sought to connect religion, astronomy, astrology, biology, and geography into a unified theory of history.[9] Often, this type of amateur philosophical analysis seems to consider existence as a riddle to be solved. The map or chart used could be considered a key to solving the puzzle as well as a depiction of reality. Precise astronomic calculation was typically not required to understand the overarching plan of God in such representations of the universe.

Astrologers, on the other hand, used increasingly sophisticated astronomical data to persuade clients that the location of planets and stars relative to locations and times on Earth could reveal insights about a client's life. Paul Counsil took this analysis further and built a model similar to the environmental determinism of American geographer

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[9] The "Map of the Planetary Man" by Hahn Brooks was originally published in San Francisco in 1906. It was revised and updated in 1918 and again in 1929. By the late 1920s, it had achieved at least some national exposure and was sold by stores as far away as The Playhouse Shops in Washington, D.C.

Ellsworth Huntington in order to present a cosmic theory of determinism. According to Counsil's "Outline of the World and the Heavens" (1933) (Figure 13) the Sun's movement through the zodiac could be used to explain the rise and fall of human civilizations. His analysis concluded that, as the Sun's precession moved its path in front of the constellation Aquarius, the United States would become the world's most powerful nation.

In 1913, Cassius J. Keyser published an article in *Science* entitled "Concerning the Figure and the Dimensions of the Universe of Space." In this article, Keyser recounts an adage from Blaise Pascal's treatise on geometry written in the mid-1600s: "Space is an infinite sphere whose center is everywhere and whose surface is nowhere" (Keyser 1913, 889). This statement gained popularity as Einstein's general relativity became somewhat better understood by the public. Astronomers fell short of graphically depicting earth in the center of an infinite and relative universe. But mathematicians such as H. P. Robertson concluded that since the extra-galactic nebulae are "fairly uniformly spaced" and "the more distant the nebular the greater its velocity of recession" each position in space-time would appear equivalent (or centered) (Robertson 1932, 222). James M. McDade's "In the Nature of the Universe Organized System, an Infinite Globe" (1936), attempts to display such a universe (Figure 14). McDade uses mostly accurate astronomical data in his graphical representation of the universe. The one obvious exception is the inclusion of planets around prominent stars. The inclusion of this pseudo-scientific information on an otherwise comprehensive and scientifically accurate map suggests the presence of the human desire for a plurality of worlds.

Americans were not completely deterred by the seemingly endless void that astronomers described as existing between the Sun and even the closest stars. Beginning in the second half of the nineteenth century, numerous stories of adventures in space captured the fantasies of the American population. By the early 1900s, sophisticated works of science fiction incorporated and challenged scientific tenets, astronomical measures, and developing technologies. Karl Guthke found that science fiction had the capability to provide "a special form of philosophical literature that allows a writer grappling with the philosophical questions thrown up by scientific advances to extrapolate more boldly and give freer reign to his imagination than those who write only as physicists are able to do" (Guthke 1990, 22).

In 1919, Robert Goddard submitted a paper called "A Method of Reaching Extreme Altitudes" in response to a grant he had received from the Smithsonian Institute. In this paper, the moon was established as a likely target for a rocket carrying a small payload of explosives. Goddard proposed that the explosion on the surface of the moon could be seen through large telescopes to verify that the rocket had reached its destination (Burrows 1998, 45). Goddard's paper was ridiculed in newspapers and caused him embarrassment within the scientific community. However, such thinking, combined with the allure of science fiction, would inspire the creation of American rocket societies. Within a decade these rocket enthusiasts coined the term "astronautics" to describe navigation among the stars and proclaimed that humans would "carry out expeditions of discovery in space as ambitious as those of earlier explorers on Earth, maintaining the spirit of adventure and discovery they had inspired" (McCurdy 1997, 20). Later in his life, even Harlow Shapley would agree that a stage of "cosmic fantasies" was necessary

to fill the gap between the public's desires for technological advancements and the actual capabilities of science (Shapley 1958, 156).

Using Light to Explain and Expand the Known Universe

While theologians, astrologers, amateur philosophers, science fiction buffs, and members of rocket societies promoted the concept of an accessible outer space, professional astronomers continued to attempt to ascertain the true size and nature of the universe. Between 1920 and 1925, the status of spiral nebulae remained undetermined despite improved photographs taken with the 30-inch refractor at Allegheny Observatory and the 100-inch reflector at Mount Wilson. However, beginning in the fall of 1923, a Mount Wilson astronomer, Edwin P. Hubble, began looking at photographic plates of the Andromeda nebula taken with the Mount Wilson 60-inch scope. Hubble was looking for nova and hoping to use these objects to confirm Curtis' measurements from 1920.

Instead, Hubble detected what he thought might be a Cepheid variable. It took only six nights of observation with the 100-inch telescope, in February of 1924, to verify the existence of the Cepheid and to establish its period and relative magnitude.[10] The star's period corresponded with a very large and bright star, but its visual magnitude was a mere 18.2. Using Henrietta Leavitt's formula, along with the calibrations made by Harlow Shapley, Hubble determined that the star was nearly one million light-years away (Bartusiak 2004, 409). By the end of 1924, Hubble had found eleven additional Cepheids in the Andromeda nebulae, twenty-two in Messier object eighty-one (the only other spiral

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[10] The first Cepheid variable found in the Andromeda Nebulae had a period of 31-days and a visual magnitude of 18.2. This placed the star roughly one-million miles from Earth (Hubble 1925, 263).

nebulae visible to the naked eye), and fourteen in other less well-known spirals (Hubble 1925, 265). All of the measurements confirmed that the stars were at extra-galactic distances.

Hubble was reluctant to publish his findings until he was certain that they would not embarrass Shapley or Curtis. He sent advance word to each of the leads in the great debate to let them know his results. A student, who was in Shapley's office when he read the news from Hubble, would later recall that Shapley held out the note and stated: "Here is the letter that destroyed my universe!" (Trimble 1995, 1142). Curtis' views were less threatened by Hubble's findings. Curtis would write a response stating: "I have always held this view, and the results by Hubble on variables and spirals seem to make the theory doubly certain" (Berendzen et.al. 1976, 138). Prior to submitting it for publication, Hubble released the findings of his paper to the American Astronomical Society in Washington, D.C. His paper was read by Henry Norris Russell of Princeton to a group of astronomers on New Year's Day, 1925. Although Hubble never mentioned it in his paper, the official report of the meeting noted that Hubble had confirmed the island universe theory (Bartusiak 2004, 410). From this point forward, the long-standing belief that the Milky Way contained the entire physical universe was replaced by the nearly ubiquitous scientific understanding that the Milky Way was just one of many galaxies in a tremendously large super-universe.

However, the structure, size, and centrality of the Milky Way in the greater universe were still open for debate. As early as 1900, Cornelis Easton, a Dutch amateur astronomer, theorized that the Milky Way was a spiral formation of stars. Easton made this assumption based on the angle and declination of various features of the Milky Way

as viewed from Earth (Hoskin 1997, 311). Shapley's argument for a large Milky Way was still relevant because the apparent size of the other spiral galaxies had become larger as improved techniques in astrophotography revealed that they contained more stars. In his 1928 textbook, *Elements of Astronomy*, American astronomer Edward Arthur Fath, conceded the distribution of spiral galaxies still appeared associated with the Milky Way. Fath stated: "It is evident that these nebulae avoid the Milky Way and show a tendency to cluster around its poles." He later added, "There is no satisfactory explanation of this lack of uniformity in distribution" (Fath 1928, 284). Fath, like many scientists, was uncomfortable with a privileged status for the Milky Way. The recent findings by Hubble and scientists' desire to formulate unified theories required that the Milky Way be an average galaxy just as the Sun was an average star.

The confirmation of a single theory in 1930 resolved each of these three questions. In the late 1890s and early 1900s, Edward E. Barnard used the 36-inch telescope at Lick and then the 40-inch telescope at Yerkes to photograph dark clouds of gas and dust floating in space (Barnard 1907, 218). Later in 1919, Barnard published a catalog of these objects in an attempt to demonstrate their significance in the debate regarding the size of the Milky Way. Very few astronomers found his case compelling. However, in 1926, Sir Arthur Eddington, England's most renowned astrophysicist, lent support to the idea that large amounts of dark matter exist throughout the galaxy (Bartusiak 2004, 400). Eddington's acceptance of the theory was based on mathematical principles related to gravity and inspired further research into the issue of dark nebulae by American astronomers.

In 1930, another Lick astronomer named Robert Trumpler published a paper on the distances to open star clusters that included the effect of dark matter. Trumpler measured the absorption of light by evaluating the color change in stars as they are obscured by interstellar gas and dust. By comparing the apparent sizes of open clusters he was able to estimate their relative distances and then determine the change in color. His findings confirmed the existence of large amounts of dark matter in the galaxy and also determined its distribution. Trumpler found that obscuring gas and dust "is very much concentrated toward the galactic plane…thinning out very rapidly at greater distances from the galactic plane and forming so to speak a thin sheet" (Trumpler 1930, 186).

Trumpler's findings explained why spiral galaxies could not be seen near the galactic plane of the Milky Way. No longer was the Milky Way considered a central object in the universe. Additionally, when the obscuring nature of portions of space was included in calculations of distance, a more reliable estimate of the size and shape of the Milky Way could be determined. Slowly, a consensus formed among astronomers regarding the size and structure of the Milky Way. By the late 1930s, it was an accepted fact that the Milky Way was a spiral galaxy roughly 100,000 light-years across and some 16,000 light-years thick at its core. The Earth was located in what would later be known as "the Orion Arm" some 30,000 light-years from the galaxy's center and about 20,000 light years from its edge (Ferris 1977, 21). J. S. Plaskett's description and diagram of the Milky Way, published in 1938, summarizes the popular conception of "our galaxy" in the decade prior to the start of WWII (Figure 15).

But what about the size, shape, and structure of the universe? Now that the Milky Way was just one of many galaxies, how were all the galaxies arranged and how many were there? In 1910, Vesto Slipher was working at the Lowell Observatory in Flagstaff, Arizona. Most of the work accomplished at this observatory was dedicated to the study of Mars and the canals that were believed to exist upon it. However, some of the 24-inch reflector's time was spent examining spiral nebulae. Percival Lowell was convinced that spiral nebula were solar systems in the early stages of forming and assigned Slipher to collect data that would measure the speed at which the system was spinning.[11] Lowell hoped that Slipher could employ the "Doppler effect" to confirm that one side of the system was moving toward the Earth while the other side was moving away.[12] Lowell wanted the data to demonstrate planetary evolution in support of his claim that Mars was an old planet. The vast majority of astronomers felt this theory was unlikely to be proven by examining the spectral lines of spirals and therefore wanted little to do with such an investigation. Slipher had this field of inquiry "virtually to himself for more than a decade and by 1925 he had obtained Doppler shifts for 45 spirals" (Ferris 1977, 47). Hubble put this data to use by combining it with the estimated distances to the spiral galaxies that he obtained using Cepheids. Using the 100-inch telescope at Mount Wilson, Hubble found and verified a direct relationship between the distance of galaxies and the

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[11] Lowell includes such hypothesis in his book, *Evolution of Worlds* (1910, 213-238).

[12] In the 1840s, Christian Doppler, an Austrian physicist, had theorized a way to measure the speed a star was moving based on shifts in its spectral properties. He believed that the faster a star was receding from Earth the redder it would appear. This proved incorrect because as the light shifts toward the red end of the spectrum, the reddest hues shift beyond the visual into the infra-red region of the electromagnetic spectrum. The result is that the star's appearance remains the same. However, Hippolyte Fizeau of France soon realized that dark absorption lines in the spectrum, first observed by Joseph Fraunhofer in the early 1800s, could be used and would accurately depict the star's movement (Bartusiak 2004, 226).

rate at which they were moving away from Earth. The impact of this discovery upon the modern conception of the Universe cannot be overstated. One author states: "In doing this, Hubble established the very foundation of modern-day cosmology" (Bartusiak 2004, 416). Philosophers and cosmologists soon developed theories based on these findings. The most popular theory envisioned the universe expanding from a single point of concentrated matter and time known as a "singularity". Furthermore, by incorporating general relativity, the system was seen as a closed and finite sphere. The further one looked out into space, the further back in time and the closer to the single point from which all matter originated was observed.

Hubble's theory would be challenged in the 1940s, by the "steady-state" theory, but it would prevail and remains the basis of the accepted scientific explanation of the beginning and structure of the universe today. Acceptance of this theory brings with it a common, although seldom stated, set of astrographical understandings. First, the universe is understood as a sphere. If all matter is expanding from a single point and there is nothing in existence prior to its arrival, then it will expand in all directions at the same speed and form an ever-expanding sphere. Eddington aptly pointed out that mathematically the universe could "be pear-shaped or sausage shaped…we are not in a position to dogmatise as to the actual shape" but he also concedes: "For the purpose of discussion this closed space is generally taken to be spherical" (Eddington 1933, 48-49). Second, the equal expansion of the universe imposes order upon the location of large concentrations of matter. From the mid-1930s until the end of the study period, when the advent of radio-astronomy would alter it, most scientifically informed Americans were exposed to an understanding of a simplistic and orderly distribution of galaxies and

clusters of galaxies. Edward A. Fath depicts such a view in his 1944 version of *The Elements of Astronomy* (Figure 16). He describes the universe as centered on our galactic system (the center could be anywhere) with "other galaxies and clusters separated by distances of approximately 2,000,000 light-years on the average in all directions…This structure continues to the present limit of the space-penetration of our instruments" (Fath 1944, 355).[13] Finally, once the expanding universe theory was accepted, the universe was seen as a closed system. Anything that existed outside of the advance of the edge of the universe was no longer part of "our universe". This is perhaps the most fundamental change in the understanding of the universe that occurred during the study period. It altered the definition of "universe" and allowed Americans to conceive of multiple alternate universes that could exist beyond the boundaries of our own reality.

Changes in Cartographic Representations of the Milky Way

Illustrations and descriptions of outer space found in atlases, astronomy textbooks, popular journals, and newspaper articles reveal general trends in the American popular understanding of outer space. In particular, when the above sources of information are separated from popular non-scientific sources, such as science fiction, religion, and art, an understanding of the impact astronomers had on the American population's knowledge of outer space can be realized. One hundred and one separate sources were examined in this analysis and are listed by category within the tables of Appendix B. Tables 1 through 6 examine the treatment of the structure of the universe. These tables focus upon the information the American public received regarding whether

[13] Fath concluded the grid of evenly spaced galaxies extend at least 500-million light-years in all directions (Fath 1944, 355).

the Milky Way galaxy comprised the entire universe or if it was presented as one of many galaxies within the universe. The second group of tables, 7 through 12, examines the treatment of Earth's location in the cosmos. These tables focus upon the information the American public received regarding whether or not Earth, or the Solar System, was located in the center of the Milky Way galaxy. Tables record information found in textbooks, atlases, *Science* and *National Geographic* journals, *Popular Astronomy* journal, *New York Times*, and *Los Angeles Times*. In order to be selected for entry into one of the tables, the source had to have information that described the structure of the universe as it relates to the number of galaxies or Earth's location within the galaxy or universe and be published between 1893 and 1941.[14] Finally, each table lists the selected entries by the year of publication to reveal the historical development of the treatment of each topic within each medium.

The discussion of the structure of the universe and the location of Earth in the cosmos was further divided into three time periods on each table. The first period begins in 1893 and ends with Harlow Shapley's use of Cepheid variables to calculate the distance to globular nebulae in 1919. The second period covers the intense debate among astronomers that took place between Shapley's work and Edwin Hubble's published discovery of Cepheid variables in extra-galactic nebulae on New Year's Day in 1925. The final period extends from Hubble's publication to the start of American combat in World War II.

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[14] The selection period for textbooks is extended beyond the study window to allow for the delay in revising and publishing. Textbooks published prior to 1945 generally reflect the knowledge base that existed in 1940. Therefore, Fath's *The Elements of Astronomy* (1944) has been included to complete the *Elements of Astronomy* series.

From the one hundred and one sources selected for this study, Table 13 provides a composite of the descriptions of the structure of the universe and Table 14 provides a composite of descriptions of Earth's place in the cosmos. The composites reveal several findings. First, the accepted understanding of the universe is subject to change. Both composites reveal a dramatic alteration in the understanding of outer space during the period of study. Second, when an understanding changed, the new understanding was almost universally accepted and the old understanding was almost completely discarded. Both the description of the structure of the universe and the understanding of the Earth's location in the cosmos underwent complete or near complete revision during the study period. Third, both composites reflect a transitional period where multiple scientific views were presented to the public.

The structure of the universe and how Americans understood it can be analyzed using the status of the Milky Way as a guide. Prior to 1919, eleven sources used in this study described the Milky Way as the entire universe. Only three sources, all of which were published in the *Los Angeles Times*, described the Milky Way as one of many galaxies. Between 1919 and 1924 the publicly available description of the universe reflected the debate within the scientific community, with sources split between opposing views. After 1925, until the end of the study period in 1941, the public was left with no doubt that the debate had been resolved. No sources described the Milky Way as the entire universe while fifty-five described it as one of many galaxies.

The location of the Earth in the cosmos as understood by Americans can be analyzed using descriptions and illustrations of the Sun in relation to the zodiac, the Milky Way, or the location of the Milky Way in the universe. Prior to 1919, all but two

of the sources used in this analysis that addressed the location of the Sun, described the Sun at the center of the Milky Way. Harlow Shapley's measurement of the distance to Cepheid variables in globular clusters was responsible for casting doubt on the popular understanding of the Sun's location. His unequal measurements to globular clusters supported previous theories, such as Easton's vision of a spiral Milky Way with its center located far from the Sun. The fact that Shapley gathered his measurements from the nation's largest telescope helped the debate finally achieve public notice. During this period of debate between 1919 and 1924 sources were split on the location of the Earth in the cosmos. After 1925 only four sources described the Sun/Earth as the center of the universe, while twenty-six sources touted a new understanding of the location of the Earth in the cosmos. This new understanding described the Sun as located in the arm of the Milky Way, the zodiac as an arbitrary view of the heavens based on the relative position of the Earth, and the Milky Way as one of many galaxies strewn throughout an expanding universe.

Newspaper articles containing a detailed description of the structure of the universe or the Sun's location in the Milky Way were exceedingly rare prior to 1925. A review of the *New York Times* revealed only four and the *Los Angeles Times* published only six. Table 15 compares descriptions of the structure of the universe that appeared in the *New York Times* with the descriptions in the *Los Angeles Times* between 1893 and 1924. Two articles published in the *New York Times* clearly stated that the Milky Way comprised the entire universe while no articles proposed the existence of other galaxies. In contrast, four of the six articles in the *Los Angeles Times* promoted the idea that other galaxies may exist. No articles challenging the theory that the Earth was located at or

very near the center of the universe were published in the *New York Times* prior to 1925. The *Los Angeles Times*, on the other hand, published an article that reported that Canopus, as opposed to the Sun, was the center of the Milky Way galaxy. Such theories appeared in the *Los Angeles Times* far before they were published nationwide in astronomy textbooks, atlases, and scientific journals. Therefore, while rare, the *Los Angeles Times* articles and editorial process may reflect a general willingness of Southern Californians to consider alternative scientific viewpoints. If the articles were widely read and discussed, they may have predisposed the Southern California culture to a higher level of acceptance regarding the unconventional theories that would later be developed at Mount Wilson.

Summary

From 1893 to 1919, the astrosophy of the Milky Way was based upon trigonometry. By measuring the motion parallax of nearby stars against a background of stars too distant to demonstrate similar motion, astronomers produced a logical mental image of the universe. The universe was understood as a sphere with a radius between 1200 and 1800 light-years. The Milky Way was a dense region of stars that formed a band that traversed the outer shell and the Earth and its sun were located at or near the center of the sphere. This description of the universe matched the other spheres seen in nature in the form of planets, moons, and the sun. Astronomers shared this description with the public by way of textbooks, atlases, journal articles, and newspaper interviews. The instrument relied upon to make improved measurements was the refracting telescope. The larger the telescope, the clearer the atmosphere, and the longer film could be exposed

to starlight, the more precise the stellar distances. But, the size of refracting telescopes was limited to forty inches due to the achromatic limit of the primary lens. This limitation inspired the need to explore reflecting telescopes as a means of building larger telescopes. George Ellory Hale's founding of Mount Wilson observatory in Southern California provided a location where the world's largest reflecting telescopes could be built and used to their maximum potential. In 1908, the sixty-inch reflecting telescope became operational and by 1917 the 100-inch telescope was in use. By 1918, the Mount Wilson Observatory had the two largest telescopes capable of astrophotography in the world and was poised to lead astronomy into a new era.

In 1919, Harlow Shapley completed a study of Cepheid variables using the sixty-inch telescope at Mount Wilson. By painstakingly taking measurements of the fluctuating stellar brightness of Cepheids over a five-year period and applying the relationship of brightness to period length to his data, Shapley was able to calculate the distance to stars far beyond the limits of motion parallax. Shapley's new vision of the Milky Way, found it to be a flat disk instead of a sphere. His universe was roughly 300,000 light-years in diameter as opposed to 3,600 light-years and the Earth occupied a peripheral position instead of a central one. Shapley's use of Cepheid variables threatened the established scientific view and was challenged by many within the astronomical community of scientists. The primary opposition came from the leading observatories that employed the world's largest refractors and continued to improve upon motion parallax measurements. In 1920, the National Academy of Sciences held back-to-back presentations to allow each side to present their findings regarding the size and shape of the Milky Way. Shapley represented the use of reflectors and Cepheid variables

to measure stellar distance while Heber D. Curtis of Lick Observatory represented the use of refractors, motion parallax, and spectral analysis to measure stellar distances. Curtis also presented a controversial theory that found the Milky Way to be just one of many galaxies within the universe. Shapley's revised Milky Way and Curtis' island universes where both Californian conceptions produced and supported by astronomers who lived and worked in California. These challenges to the status-quo opened a five year period where a predominant theory regarding the structure of the universe or Earth's place within it did not exist within the American scientific community. Without a predominant theory, other non-scientific views, such as those of Fort, Brooks, Council, and McDade, had a temporary window in which to gain some measure of acceptability.

The window closed on January 1st, 1925 when Edwin Hubble released the findings of an eleven month-long study using the 100-inch telescope on Mount Wilson to find and determine the distances to variables located in various spiral nebulae. The measurements verified the distance to these variable stars as extra-galactic and confirmed the island universe theory. Once the spiral galaxies were confirmed as separate entities it was easier to envision and diagram the Milky Way galaxy as a similar spiral system. The Andromeda Nebula, now called a galaxy, was used as an example of how the Milky Way looked from outside its boundaries. Also, since when viewed from Earth, the bulk of stars appeared in one portion of the sky, the solar system had to be located in one of the arms as opposed to its center. From 1925 through the late 1930s, debate ensued regarding the relationship of the island universes and the Milky Way and about the exact size and shape of the Milky Way. The confirmation that dark matter in the form of gas and dust obscured the view of remote galaxies along the Milky Way's centerline

dispelled the notion that all extra-galactic nebulae were an associated part of the Milky Way system. It also helped refine the measurement of distances to stars within the Milky Way. J.S. Plaskett's diagram of the Milky Way galaxy, published in 1938, became the accepted popular conception of our galaxy.

By the early 1940s, the Milky Way was commonly described in textbooks, popular science journals, and newspaper articles as a spiral galaxy roughly 100,000 light-years across and 16,000 light-years thick at its core. The Earth was envisioned as existing within an arm of the galaxy some 30,000 light-years from its center. Additionally, the Milky Way galaxy was viewed as part of an expanding universe due to Hubble's Doppler measurements of remote galaxies and the attempt to fit his findings within Einstein's Theory of Relativity. By the end of the study period, a vision of an expanding space-time bubble with evenly distributed galaxies, of which the Milky Way was one, became the popularly accepted account of the structure of the universe.

CHAPTER III

FINDING ONE'S PLACE IN THE WORLD (1893-1917)

Los Angeles, Pasadena, and the entire Southern California region experienced rapid population growth during the last decades of the nineteenth century and first decades of the twentieth century. The influx of new residents to towns such as Pasadena was comprised of mostly white, middle-class settlers from the American mid-west. These settlers were so numerous and influential that they displaced the previous occupants and established a new "first effective settlement" (Zelinsky 1973). Migratory self-selection and exposure to a peripheral setting far from the American core, yet still within the American sphere, allowed for the development of a unique and new hybrid of American culture. This hybrid American culture rapidly established new mores and reprioritized the importance of others while simultaneously maturing a unique set of attributes that identified it as Southern Californian. Chief among the new attributes was an increased respect for the value and use of nature. Preservation of pre-urbanized settings and conditions amidst rapid population growth and new technologies required an appreciation for the aesthetics of the Californian landscape and an increased understanding of natural science. It was within this developing and expanding hybrid American culture that Mount Wilson Observatory was founded.[15]

On December 20, 1903, George Ellery Hale met his family on the train station

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[15] Mount Wilson Observatory was named after its location on Mount Wilson not a scientist or benefactor. The mountain was named after one of twenty-seven original family patriarchs of the California Colony of Indiana, D. "Don Benito" Wilson (Sandage 2004, 13).

platform in Pasadena, California. He had sent his wife and two children ahead of him during the previous month. He had planned to go with them, but had to cancel at the last moment because he had fallen ill. More than just his current illness inspired his decision to send the family ahead. First, Hale had already visited Pasadena when surveying Mount Wilson six months earlier. He obviously felt the town was suitable and safe. Second, his daughter Margaret had bronchial asthma and he felt that California would be a far better climate for her than Chicago during the winter months (Wright 1966, 171). Finally, Hale was waiting to hear the expected news that the Carnegie Institute would be providing the first of two $150,000 yearly grants for the building of the 150-foot solar tower and a 60-inch reflecting telescope on Mount Wilson. Unfortunately, Dr. John S. Billings, the Carnegie Trustee closest to Hale's cause, sent a telegram that arrived on December 8th informing Hale that the grant had been reduced to roughly one-tenth of its original sum (Wright 1966, 172). Having no reason to remain in Chicago and with his future plans uncertain, Hale set off to join his family in Southern California.

Although his plans for a great astronomical observatory upon Mount Wilson may have been extraordinary, Hale and his family moved to Pasadena for the same basic reasons that tens of thousands of mid-westerners migrated to Southern California during the early 1900s. Historical geographer D. W. Meinig finds that many upper and middle class families moved to Southern California on their own terms with a desire to shape their communities in their own image of the ideal society. This was not possible in other parts of the country, including Northern California, because of preexisting social structures. Upon arrival in Southern California, they quickly formed "churches, clubs, and state societies" that served to impress "their strong Protestant, middle-class, Middle

Western mores on every new community and the region as a whole" (Meinig 1998, 68). The lure of a sunny and healthful climate, the potential for economic and professional opportunity, and chance to start fresh with one's own vision of the future brought Hale's family, along with countless others, to Southern California.

When Hale arrived, he found his family in good spirits and dressed in summer clothes suitable for the mild climate. In a letter to his close friend, Harry Goodwin, Hale expressed his immediate fondness for his Californian bungalow home, the town of Pasadena, the warm and sunny climate, and the relief from depression and onset of optimism his new surroundings inspired. Hale stated in the letter:

> I haven't been here long enough to be in the least blasé, and I can't say enough of the beauties of the place and the climate. The orange trees in the yard around us are full of fruit. One of them, so heavily loaded that it seems ready to break, is a mass of oranges and roses, a great rose tree beside it thrusting up bunches of flowers in the midst of the fruit. I would give anything if you could be here to enjoy it all. (Wright 1966, 173; Hale 1904, 1)

Hale's accounts of Pasadena mirrored those of the real estate boosters, land speculators, and railroad tycoons who capitalized upon the terrain and climate surrounding the convergence of the Southern Pacific and Santa Fe railroads in Southern California. David Fine describes the difference between the people, like Hale, who migrated to Southern California in the early 1900s and previous waves of migrants to Northern California. He states:

> California, began filling up not with the kind of hardy adventurers who came to northern California a generation earlier by ship or Conestoga wagon but with a more timid, gentler breed of migrants – largely white, middle class, and Protestant – lured by a national advertising campaign hawking consistently warm weather, open land, healthful dry air, and agricultural opportunity. (Fine 2000, 3)

Hale, of course, could rightly claim professional purpose for moving to Southern California, but his enthusiasm and letters also indicate a profound personal attraction to and satisfaction with the region. California suited Hale and his family as well as his profession.

Lucky Baldwin, a Los Angeles land developer, once boasted that he "threw the land in and sold'em the climate" (Fine 2000, 1). Many referred to California real estate agents and developers such as Baldwin as "boosters". But many tourists, migrants, and residents with little direct financial benefit to gain by promoting southern California's climate also echoed these sentiments. George W. James defended the positive attitude of Californians toward their environment in his book, *California: Romantic and Beautiful* (1914). He states: "This is the fact that every Californian is a 'booster'. I do not like the word booster, but the idea is indisputable. Why is it? Is every man a liar when he boasts about California?" (James 1914, xviii). James finds much to admire about the climate and life in Southern California. Chief among the attributes identified by James is the apparent and unique nature of light within the region. James finds the whole country to be "flooded with a vivid, clear, intense, striking light that reveals the sweetness, the glory, the beauty of Nature such as is seldom seen in a less vividly lighted land." He

continues: "the clear, cloudless, turquoise sky, the pellucid atmosphere, the illumination that enables one to see vast spaces, that enlarges one's vision and gives a hold upon scenes a hundred or more miles away" (James 1914, 25).

Such a phenomenon, whether real or imagined, was an experience shared by many visitors and migrants to California. It had many effects upon the social development of the region. In 1914, James declared, "California has naturally won to itself institutions that rely upon climate and clear atmosphere." He specifically refers to the efforts of Hale stating: "Situated at an elevation of 5, 890 feet on the eastern end of the Mount Wilson ridge, the Mount Wilson Solar Observatory of the Carnegie Institution of Washington is above four-fifths of the fog and the imperceptible haze and smoke of the valley below. The record of an average of close to three hundred days and nights a year that the instruments are in use shows how well chosen the location is" (James 1914, 355-356). Prior to James' account, the popular reporting of the clarity of the air and brightness of the sun were the primary catalyst that Hale used to justify building the world's largest telescopes in the region. The bright and clear atmosphere also inspired the work of the *en plein air* art movement, and likely enabled the public to more sympathetically embrace the ideas of conservation championed by John Muir.

Muir's California of Landscape and Light

When John Muir visited the Chicago World's Fair in 1893, he was impressed by the grandeur of the "White City" and particularly the effort of fellow conservationist and landscape architect, Frederick Law Olmsted (1822-1903), in designing the layout for the fair grounds. Muir was most attracted to the myriad of art galleries, although he was

clearly disappointed in the lack of representation and attention paid to Californian landscape artists. In a letter to his wife, Muir recounts:

> I most enjoyed the art galleries. There are about eighteen acres of paintings by every nation under the sun, and I *wandered* and *gazed* until I was ready to fall down with utter exhaustion. The Art Gallery of the California building is quite small and of little significance, not more than a dozen or two of paintings all told four by Keith, not best, and four by Hill, not his best, and a few others of no special character by others, except a good small one by Yelland. (Muir 1893, 1)

All three artists mentioned by Muir were landscape artists from San Francisco who emphasized the use of light in their landscape portrayals. Raymond Dabb Yelland (1848-1900) was known for painting coastal sunsets (Jones 1996, 41). Thomas Hill (1829-1908) helped found the San Francisco Art Association in the early 1870s and served as interim director of California School of Design in the mid-1880s. He was best known for the 5,000 paintings of Yosemite he produced during his lifetime. Hill's first trip to Yosemite in 1862 was with Muir's good friend and the first artist mentioned by Muir above, William Keith (1838-1911) (Hughes 1986, 213).

Keith and Muir became close friends after Keith arrived unannounced, but with a letter of introduction in-hand, at Muir's Yosemite Valley cabin in 1872. Both men were Scottish and thirty-four years old. They each had a profound admiration for nature and likely advanced each other's philosophy and careers during their long friendship. Muir referred to Keith as a "poet-painter", a homage that reflected nineteenth-century critical use of the term "poetry" to describe landscape art. By the time of the Chicago World's

Fair, Keith was one of the most popular Californian landscape artists and by the end of the century he had become the leading artist in San Francisco (Saint Mary's 2007, 1).

Muir's tepid description of Keith's work on display in Chicago was likely due to the stylistic changes occurring in Californian landscape art at the time. Keith was part of a vanguard of landscape artists who were experimenting with a more impressionistic form of Barbizon (based on direct observation of nature) paintings. These paintings featured individual aspects of the natural landscape and often masked a portion of the scene in shadow or brightness. In a speech presented to the Longfellow Society in 1888, Keith described the reason he developed the style, stating:

> When I began to paint, I could not get mountains high enough nor sunsets gorgeous enough for my brush and colors. After a considerable number of years experience, I am contented with very slight material - a clump of trees, a hillside and sky; I find these hard enough, and varied enough to express any feeling I may have about them. (Keith 1888, 1; Wilson 1986, 9)

Muir would have almost certainly preferred the totality of a natural scene, as God created it, without the selective bias of the artist. But many of the San Francisco elite were purchasing the newer style. For example, Collis P. Huntington (1821-1900), a San Francisco resident and railroad tycoon, owned an art collection that featured paintings of dimly-lit forest interiors by Narcisse Virgilio Díaz (1807-1876) (Wilson, 1986, 9). Additionally, another Californian artist, Arthur Frank Mathews (1860-1945), had recently returned from studies at the Académie Julian in Paris with knowledge of the Barbizon style of painting and a significant level of clout to influence others, having recently studied in France. Mathews rapidly rose to prominence within the world of Californian

art and eventually became the director of the California School of Design (Wilson 1986, 9-10).

Keith was among the Californian artists that were ushering in a new school of American landscape painting called "*en plein air*", a school which had its roots within French Impressionism. However, instead of seeking to capture a fleeting moment of societal activity, such as a woman walking down the Champs d'Elysee, *en plein air* artists sought to capture a specific moment when natural light illuminated a landscape. Their philosophy was based on the belief that the light in California had distinct properties not found anywhere else and that these properties served to create and expose the Californian landscape. Art historian, Jean Stern, describes the artistic goal of *en plein air* art this way:

> The clear and intense light of California that appears so often in these paintings is, in fact, the true subject matter of these paintings. To the artists, it was the light that defined the landscape. The biblical analogy of light as the creative instrument is appropriate to the California landscape and the way artists addressed it, for without that unique light and the divine energy it represented, the land would not exist. (Stern 2001, 96)

Muir may have been somewhat disappointed by the artistic move away from the direct depiction of the subject of his conservation efforts and towards the force of nature that illuminated them. However, Muir also had an affinity for the power of light. He may have even considered it a divine presence. Muir recounts his journey from a carriage factory accident he endured in 1872 to his life at Yosemite, stating: 'I died to light, I lived again, and God who is Light has led me tenderly from light to light to the shoreless

ocean of rayless, beamless Spirit Light that bathes these holy mountains" (Williams 2002, 44-45). In *Mountains of California* (1894) Muir proclaimed the Sierras should be called the "Range of Light" and declared them "so gloriously colored, and so luminous, it seems to be not clothed with light, but wholly composed of it, like the wall of some celestial city" (Muir 1894, 1). In 1901, he urged his readers to climb into the mountains of California proclaiming: "Nature's peace will flow into you as sunshine flows into trees" (Muir 1901, 56).

The Land of Sunshine and the Arroyo Culture

Around the turn of the century the expression "land of sunshine" was becoming a ubiquitous description of California. This was largely due to the influence of the popular magazine *Land of Sunshine* that began publication in 1894. Within the first year of publication the magazine had 8,000 subscribers and by the end of 1896, 12,000 copies "proved too small to meet demand" (Bingham 1955, 63). The editor of *Land of Sunshine*, Charles Fletcher Lummis (1859-1928), placed the readership at roughly 50,000 based on the belief that each subscriber would share the magazine with family and friends (Staples 2004, 21; Bingham 1955, 64). Additionally, the magazine's influence may also have been magnified by the development of a modern mass culture based largely on the ability of magazines to market their audience to advertisers. The success of this method of finance allowed magazines to be sold well below production and delivery costs.

Richard Ohmann, a noted expert on culture and literature, examined how this method enabled magazines to become significant intellectual forces in the early 1900s. He identifies *Munsey's Magazine* as the prototype that lowered its price to ten cents per issue in 1893 (just one year before *Land of Sunshine* premiered). This price was low

enough to expose its contents to a vastly larger middle-class audience. Subscriptions to the magazine exploded to over 50,000 within the first year and advertisers gladly filled the issues with products designed for the average consumer (Ohmann 1996, 25). At the same time, middle-class consumers could achieve the appearance of intellectual respectability and cultural education previously reserved for the "leisured and affluent, with culture given by birth and education" (Ohmann 1996, 6).

Land of Sunshine also sold for ten cents per issue and included inside most back covers an item titled "A Pointer to Advertisers". In at least one issue, G. H. Paine, a well known California land booster who operated in Arizona, held a long list of *Land of Sunshine* subscribers. The ad was clearly intended for potential advertisers stating, "Let us make the connection for you." Joseph Staples, a scholar of English at Arizona University, states in his dissertation:

> This important shift in the magazine industry emphasizes the commercial nature of cultural exchange; even the production and consumption of art and literature, formerly the proprietary domains of the upper classes, became more accessible to members of all classes, not because of some egalitarian social consciousness or *noblesse oblige* but because those classes wielded great power as a potential purchasing body. (Staples 2004, 22)

In this way, *Land of Sunshine*, published in Los Angeles, became a powerful cultural force that focused popular attention upon Southern California and established the region as an important hub of cultural and intellectual expression.

Charles Lummis was “probably the most ardent and effective booster of Southern California's attractions” (Gerdts 2002, 29). His magazine highlighted the natural beauty of Southern California and frequently published works by local poets, landscape artists, and photographers of nature. Lummis’ status as first city editor of *The Los Angeles Times* and the *Land of Sunshine* attracted the friendship of social elites and artisans, and he soon became the center of a social clique known as the “Arroyo Seco”. The group took its name from the Arroyo Seco, a streambed that flows from Red Box, a location very near the summit of Mount Wilson, through Pasadena to just north of Los Angeles where it joins the Los Angeles River. Lummis’ home was built beside the Arroyo Seco between Los Angeles and Pasadena from local river stones fashioned to resemble a cross between a cliff dwelling and a Spanish mission. He called his home “El Alisal”, meaning place of the sycamores, and frequently hosted wild social gatherings, called “noises”, of writers, poets, artists, and intellectuals. The combination of his unique social status and wide-reaching publications had a dramatic effect upon the American public’s understanding of Southern California. Thomas F. Andrews, executive director of the Historical Society of Southern California, considers Lummis “the impresario of the Arroyo Culture," and concludes that "he had a major impact on what the West became in people's minds" (Jaffe 2004, 1).

Each issue of *Land of Sunshine* states above the title banner: “THE LANDS OF THE SUN EXPAND THE SOUL.” The implication of this statement and the contents of the magazine repeatedly expose the center of Lummis’ philosophy. Lummis believed and convinced many others of the cultural superiority Southern California afforded to residents who exposed themselves to its environment. One historian of Californian

literature comments: “Lummis ranted euphorically about the God-given natural wealth of the region” (Fine 2000, 42). One of many examples is Lummis’ claim that “One thing makes Southern California unique…its wealth is intrinsic and not epiphytic (dependent upon another). Its future rests on the guarantee of the almighty” (Lummis 1895, 81).

An article entitled “Race and Climate” written by Charles Dudley Warner (1829-1900) and published by Lummis in *Land of Sunshine* in 1895 finds a synergetic effect when the Anglo Saxon race is exposed to the Southern Californian climate. Warner predicts: “The Anglo Saxon energy and spirit in the setting of the particular climate of Southern California will produce a new sort of community, in which the vital forces of modern life are not enervated, but have added to them something of the charm of a less anxious and more contented spirit” (Warner 1895, 106). Warner’s analysis predates the influence of Ellsworth Huntington’s *Civilization and Climate* (1915). However, it certainly shares some of the tenets of both Ratzel’s environmental determinism and Spencer’s theory of social evolution. Huntington, and many intellectuals of the time, would likely have agreed with Warner that an Anglo Saxon culture, evolved through millennia of exposure to harsh environments, would thrive within the relatively mild climate of Southern California. Although rarely supported by scientific evidence, such justifications were common within intellectual circles and Southern California society appeared to epitomize such thinking.

Such theories supported Lummis’ desire to use his *Land of Sunshine* magazine as a medium to show that the region “grows brains as well as oranges” (Fine 2000, 41). The assessment of environmental impacts upon racial performance also served to rationalize and lend merit to the perceived moral and intellectual capacity of Southern California’s

social elites. Wide distribution of Lummis' *Land of Sunshine* enabled this thinking to be extended through the middle class. Instead of access to larger social circles, libraries, and institutions of the East, Southern California's intellectuals had a better climate in which to think, artists had better light in which to paint, astronomers had clearer skies under which to observe, and the middle class had a better environment in which to learn.

Hale and the Pasadena Community

The "noises" that took place at Lummis' home were widely reported and the appetite to experience similar intellectual discussions spread throughout Southern California. Many groups formed and had regular meetings to discuss topics ranging from politics to hobbies. Sometimes guests from lower social strata would be invited, but usually the meetings took place through the invitation of women's clubs in wealthy communities such as Pasadena. The meetings often featured notable personalities from the arts and sciences. George Ellery Hale was invited to speak at several meetings of this nature during his first year in Pasadena. Even before the building of the observatory on Mount Wilson was financed, Hale had given a talk "on the work of an astronomer" at the home of Mrs. Robert J. Burdette on February 29, 1904. Mrs. Burdette was considered the "cultural leader" of the Pasadena community in the early 1900s and would remain influential and active in Southern Californian women's groups for decades (Wright 1966, 176; Vickroy, et.al. 1922, 100).

Hale's speech at Mrs. Burdette's home likely led to a second and more significant meeting with another local women's group. In May of 1904, Hale gave a talk he called "Stellar Evolution in the Light of Recent Research" to the Friday Morning Club in Los Angeles. The talk was accompanied by stereopticon slides showing photographs of spiral

nebulae, described as “wheeling, circular bodies of fiery vapor from which stars are emanating” (*Los Angeles Times* 1904, 7). The Friday Morning Club was one of several women’s groups that predate the popularity of Lummis’ *Land of Sunshine*. It officially formed in 1891 and was substantial enough to send delegates to the Woman’s Congress at the Chicago Fair in 1893 (Vickroy, et.al. 1922, 55). Hale’s name recognition within the circles of Los Angeles’ social elites was immediately enhanced when the President of the Friday Morning Club, Mrs. Jones was quoted in *The Los Angeles Times*, saying: “the community was to be congratulated in having Prof. Hale as a resident even for a short time”, and she “sincerely hoped that it might result in his becoming a fixed star in the California firmament” (*Los Angeles Times* 1904, 7).

One of the members of the Friday Morning Club was Katherine Putnam Hooker. Mrs. Hooker was the young wife of an elderly Los Angeles hardware magnate, John D. Hooker (1838-1911). Hooker had been recommended to Hale in 1903 by fellow astronomer W.W. Campbell as a potential source of funding and needed supplies for building large telescopes on Mount Wilson (Wright 1966, 197; Sandage 2004, 170). Hooker was interested in astronomy and was intrigued by Yerkes having a telescope named in his honor (Christianson 1995, 115-116). Hale’s reception by the Friday Morning Club earned an invitation to the Hooker’s Los Angeles home. The Hookers soon “added Hale and his wife, Evelina, to the regular dinner guests” (Sandage 2004, 170). The friendship that developed with the Hookers would lead to Hale’s exposure to an influential set of Southern Californian intellectuals: other frequent dinner guests included John Muir and William James.

But Hale's strongest social ties within this group developed with a few attractive women who became his personal friends and admirers. First, Hale was drawn to Mrs. Hooker. He would spend many hours accompanying her in the Hooker's Italian garden behind their house on West Adams Street. "Here she would read some of her favorite Italian poems aloud" and "Hale would spend some of his happiest hours" (Wright 1966, 198). While at the Hookers he met another woman, Alicia Mosgrove: her "keen wit, her humor, her insatiable curiosity, her whimsical imagination attracted him strongly, and soon he was calling her, as did everyone else, 'Ellie'" and "acting quite differently with her than with anyone else" (Wright 1966, 198). One published photo captures Ellie and Hale in the Hooker's garden acting out a scene from a play they had written together (Wright 1972, 70). Another young and attractive woman, Maude Thomas, joined the group and Hale found the Hooker house "took on an added glamour. In these stimulating surroundings he became, as a young girl who met him there recalls, 'the charming center of a great deal of admiration'" (Wright 1966, 199).

Hale's relations with this group of women were by all published accounts platonic. However, the son of a Mount Wilson astronomer, Don Nicholson, disagrees and attributes Hale's naming the astronomer's quarters on Mount Wilson "the Monastery" as proof of Hale's personal failings. He states: "I think he was protecting himself. He was a womanizer and he knew it! He wanted a place where he could go where he wouldn't be distracted and also his staff wouldn't be distracted" (Interview by author June 17, 2007). As late as 1920, Hale refused to allow a wife of a newly-hired astronomer to seek employment at Mount Wilson. In a letter to Edison Pettit, Hale states: "No Quarters for women have been provided on Mount Wilson, and it would be

impracticable for Mrs. Pettit to take part in observational work. It is probable, however, that we could give her regular employment at our Pasadena office in the Computing Division" (Hale 1920, 1). Vera Rubin, a Carnegie Institute employee and the first female astronomer to be offered telescope time for her own studies at Mount Wilson, discovered that Andrew Carnegie originally asked for a facility where astronomers would not be bothered by family members. But she finds it was Hale that named the living quarters the "Monastery" and used this as an excuse to refuse female astronomers access (Rubin 1997, 167; Nichols 1998, 1). In any event, Hale clearly enjoyed the company of women when not on the mountain and used them to acquire social status, promote public interest in astronomy, and gain financial support for his activities. Hale's relationships with women in Southern California demonstrate that even though women were barred from many intellectual endeavors, such as astronomical observations, they nevertheless functioned as key conduits within the Southern California culture for spreading artistic, scientific, and intellectual ideas.

Southern California as *Paysage Moralisé* and the home of *En Plein Air* Artists

Women were also important literary figures who, along with Muir and Lummis, were respected within the Arroyo Seco community for their vision of an idealized California. One woman in particular, Mary Hunter Austin (1868-1934), helped to establish a *paysage moralisé* regarding the Californian landscape that conflicted with the vision of boosters, industry leaders, and developers. The term "*paysage moralisé*" is used in this study as a term that refers to the use and observation of the landscape as intended by God. The original use of the word by art critic and historian, Erwin Panofsky, was intended to denote a moral choice or dilemma faced by the human subject

within a painting. The moral choice was sometimes suggested by the lighting of the landscape within the painting. For example: Panofsky compares the dimly lit fortified town with the brightly lit rustic and rural landscape in the painting "Sacred and Profane Love" by Titian (Emison 1995, 126). In California, such a moral landscape was considered remote, beautiful, misunderstood, and threatened by modern society. In this usage, paysage *moralisé* is often expressed by the absence of human presence entirely, as seen in the works of *en plein air* artists, or in the promotion of native-American culture, such as the literary works of Mary Austin.

Mary Austin first met Lummis in the summer of 1899 during a trial separation from her husband, a civil servant who worked on irrigation projects in the Owens valley. Despite her rugged and worn appearance, Lummis welcomed her as a regular attendee at his "noises", published several of her poems and stories in *The Land of Sunshine*, and even helped to find her a house near the Arroyo Seco (Starr 1985, 115). Austin's literature built upon the intended legacy of Helen Hunt Jackson's (1830-1885) portrayal of the injustice, oppression, and disregard for Native American culture in her tragic fictional account of an interracial love story. Jackson's *Ramona: A Story* (1884) created a mythical heroine, whose story inspired tourism of old Spanish ranches, and a desire to replicate and preserve these settings within the Anglo community of Southern California. Dydia DeLyser's book, *Ramona Memories: Tourism and the Shaping of Southern California* (2005) addresses the impact of Jackson's *Ramona* upon the cultural landscape. She states: "elements from a work of fiction became factual through the landscape and came to influence the way residents and visitors in southern California thought about their past – which is to say, they became part of southern California social memory"

(DeLyser 2005, xvi). This constructed social memory, in turn, influenced a wide range of cultural understandings and products. By the early 1900s, this included Austin's works which championed Native American values and understandings of the natural world and landscape.

Austin has been described as a "literary landscapist" who created "poetic portraits of California and the Southwest" (Starr 1985, 117). Her seminal work, *The Land of Little Rain* (1903) is a geographical description of a region east and south of the Sierra Nevada range comprised primarily of the Mojave Desert. She uses the Native American name for the region as her title and for other more specific locations because they "always beautifully fit" and do not merely "originate in the poor human desire for perpetuity" (Austin 1903, viii). Austin contends the remoteness of the desert reveals the relative unimportance of human ambitions; an understanding clear to Native American desert cultures but lost on modern American society. She states:

> For all the toll the desert takes of a man it gives compensations, deep breaths, deep sleep, and communion of the stars. It comes upon one with new force in the pauses of the night that the Chaldeans were a desert-bred people. It is hard to escape the sense of mastery as the stars move in the wide clear heavens to risings and settings unobscured. They look large and palpitant; as if they moved on some stately service not needful to declare. Wheeling to their stations in the sky, they make the poor world-fret of no account. (Austin 1903, 21)

Austin also believed geography informed even modern persons, shaping their manners, dress, beliefs, arts, and understandings. This theme resonates through all of her

works, but was perhaps best stated in her book, *Land of Journey's Ending* (1924) when she describes a man as "the land, the lift of its mountain lines, the reach of its valleys…he takes it in and gives it forth again in directions and occasions least suspected by himself, as a manner, as music, as a prevailing tone of thought" (Austin, 1924, 437).

The concept that individuals and cultures were products of their environment fit the viewpoints of naturalists like Thoreau, boosters like Lummis, and conservationists like Muir. It also struck a chord within a Californian branch of The Universal Brotherhood and Theosophical Society established by Katherine Tingley (1847-1929) in 1900 on San Diego's Point Loma.

Among the philosophies taught by the Theosophical Society was a belief in interconnectedness between all things within the natural world. This interconnectedness was based on a central tenet of Theosophical doctrine that holds: "Light is the first begotten, and the first emanation of the Supreme, and Light is Life…From its swelling, electric bosom, spring *matter* and *spirit*" (Blavatsky 1928, 579; Smith 1990, 88-89; Fort 2000, 36). The Theosophical Society at Point Loma had an active art community within its ranks. These artists "attempted to capture the invisible, but somehow still noticeable, aspects of whatever they were depicting" and "believed that since every object has innumerable aspects, so-called realism in art was not at all real, being concerned with external appearances and not inner qualities" (Kamerling 1980, 1).

The most successful of the Point Loma artists was Maurice Braun (1877-1941). Braun found worldwide success painting California's natural settings at a time when international critics complained: "American artists paint nothing but landscapes" (Hartmann 1901, 107). His works won gold medals at both the San Francisco and

San Diego International Art Expositions in 1915 (Kamerling 1980, 1). Braun's landscapes were easily identified by their impressionistic interpretations based on the artist's close study of natural light and his frequent use of Eucalyptus trees as subjects (Petersen 1977, 1).[16]

Eucalyptus trees were frequently featured by *en plein air* artists to emphasize the *paysage moralisé* of Southern California. Eventually their use would become the basis for the sometimes derogatory term, "Eucalyptus School", to describe these *en plein air* artists.[17] Once the Eucalyptus became a popular feature, critics attempted to interpret why they were so loved by the artists, the public, and landscape art connoisseurs. One critic of Braun speculated: "Where a tree appears in his landscape it is nearly always characteristically the Eucalyptus…like the Oak in New England and English landscape, the Eucalyptus will endear itself as typically California" (*San Diego Evening Tribune* 1911, C4). Another concluded: "just as Italians painted saints when they were popular and Dutchmen painted the people in the streets and taverns – the sights their public knew and enjoyed, so it is natural that Southern California painters should paint the eucalyptus" (*Los Angeles Times* 1928, C17). However, it is likely that artists seeking evidence of divinity within a moral landscape would have had a deeper rationale for using Eucalyptus trees than these assessments suggest.

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[16] Maurice Braun was a devout Theosophist and remained actively involved with the Point Loma community but never became a resident. Braun founded the San Diego Academy of Art in downtown San Diego in 1912. He operated his studio from inside the Isis Theater building and held frequent exhibits and auctions. Katherine Tingley financed this effort and felt that Braun could better serve the Theosophist community by raising funds and interest through exposing and selling his *en plein air* painting to the public. Paintings were signed "Maurice Braun, Universal Brotherhood and Theosophical Society" (Petersen, 1977, 1; Kamerling, 1980, 1).

[17] The term, "Eucalyptus School" was first used by art critic, Merle Armitage in *The West Coaster*. The idea was to disparage the art form as simplistic, harmless, and uncreative (Los Angeles Times 1928, C17).

Perhaps the deeper artistic rationale rests with the alien nature of the Eucalyptus in California. The Eucalyptus tree is a very adaptable species that originated in Australia. Its use in California was promoted by Ellwood Cooper (1829-1918) who planted over two-hundred acres of Eucalyptus groves in 1870 near Santa Barbara. In 1875, Cooper, then President of the Santa Barbara College, argued in an address to the school that "California, and alas, the world, needed the eucalyptus for the planet's well-being" (Santos 1997, 2). Cooper's plea was largely heeded by the local population and in the early 1900s the Eucalyptus became a common feature of the Californian landscape, providing the population shade and relief from the Santa Ana winds.

En plein air artists may have used this history as an example, within the natural world, of the synergetic effect Warner espoused in "Race and Climate" (1895). In this way, the Eucalyptus represented Anglo-culture within the Californian natural landscape. Instead of impressions of people walking the streets of Paris, Californian impressionists featured stately Eucalyptus trees thriving amid the light and landscape of Southern California. Harry Noyes Pratt (1879-1944), a curator of *en plein air* art, expressed this idea when he wrote the following poem for *Overland Monthly and Out West Magazine*:

The Eucalyptus

I love these trees which hesitant stand
Afraid to enter on a land
Which is not theirs, however kind-
These alien trees, which never find
Kinship among the trees which grow

Where golden poppies flaming flow;
But stand aloof, their ragged cloaks
Slight covering – while valley oaks
Flaunt velvet green above the field,
Their arrogance but half concealed.
I hold it is a princely tree
Which still may stand in dignity. (Pratt 1924, 316)

Braun, like all *en plein air* artists in California, was influenced by the style's most recognized formative master, William Wendt (1865-1946). Wendt, a self-taught painter who was born in Germany and spent his teenage years in Chicago, began painting Californian landscapes after he visited the region in 1894 (Millier 1930, B12). By the time he moved permanently to Los Angeles in 1906, he was already a famous and respected artist. But, it was Wendt's chosen lifestyle and work ethic that made him a valued member of Lummis' Arroyo Seco group. During the summers, Wendt would venture into the Californian Mountains and reemerge months later with new impressions of unique landscapes for his fall exhibitions. A *Los Angeles Times* art critic, Fred Hogue, described these yearly excursions: "Every summer Wendt disappears. He goes into temporary seclusion for his intimate communion with the mountains, the canyons and the valleys of Southern California. The voices of the mountain and desert solitudes whisper to him; and he records his impressions in harmonies of tone and color" (Hogue 1929, A4).

Wendt's yearly communion with nature was particularly respected among members of the Arroyo Seco group because it harkened images of Native American vision quests, the journeys of solitude undertaken by Thoreau and Muir, and Lummis's own walking journey to California.[18] Wendt's art was physical proof of the benefits, knowledge and insights gained by immersion into the natural world, solitude, and intense study of nature. Hogue offered a challenge to his readers to confirm that Wendt had achieved a superior understanding of nature: "If you would know how art transcends nature, ride down on the transcontinental highway to Fullerton; then turn to the north to Santa Ana Canyon; symbolize all you see; return to the city, go out to the Stendahl Galleries and look upon the canyon as William Wendt envisioned it" (Hogue 1929, A4).

Wendt was not a Theosophist, but even before the movement took hold in California, and while he was still living in Chicago, he was positioning himself as "the primary representative of the *paysage moralisé* in California" (Gerdts 2002, 32). Wendt used the Californian landscape as a "prophetic New Canaan paradise realm" and drew an equivalency between the word of God in scripture and the existence of natural beauty (Walker 1992, 35-36). In 1898, he described the remote Southern Californian landscape as "holy ground" and "Nature's Temple" (Griffith 1939, i). By the turn of the century, some of the titles of his paintings, such as "The Earth Yields its Gold" (1899), began to "suggest the moralistic, even spiritual implications of the goodness and bounty of nature"

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[18] Part of Lummis' mystique was based on his being the only known migrant to come to California on foot. Lummis completed a 3,705 mile journey through seven states and two territories which lasted 143 days in the winter of 1884-1885 (Fine 2000, 36).

and the "spirit of California" (Gerdts 2002, 32; McLouth 1926, 54).[19] As his art progressed, Wendt began to move away from an impressionist style to more solid, blocky forms that hinted of cubism. But, his unique forms always emphasized intense light, undisturbed nature, and a spiritual essence that was "more fully realized in his art than in the paintings of any of his contemporaries except, perhaps, for Maurice Braun" (Gerdts 2002, 33). By the late 1920s, Wendt had become an "institution" and ownership of a Wendt painting implied a "very real appreciation of painting" that was understood "in all classes of society" (Millier 1930, B12).

Wendt's status afforded him the opportunity to display his art as a single artist, but most *en plein air* artists needed to form groups and pool their works in order to entice interest from the public. One such group, the "Ten Painters Club", displayed their work at the Kanst Art Gallery in Los Angeles in 1919 (Petersen 1977, 1). This event effectively centered the *en plein air* art movement in Los Angeles by uniting key artists from the major Californian cities. The "Ten Painters Club" brought Braun, a San Diego Theosophist, into contact with Pasadena's Benjamin Brown (1865-1942), a member of Lummis's Arroyo Seco group, and Edgar Alwyn Payne (1882-1947), founder of the Laguna Beach Art Association in San Francisco (Petersen 1979, 54; Gerdts 2002, 44). The result was a unified demonstration of appreciation for the superiority of the Californian landscape and the opportunity it provides for artists to commune with nature and enhance their skills.

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[19] Other paintings by William Wendt include: "I Lifted Mine Eyes unto the Hills" (1912), "The Mantle of Spring" (1917), "Where Nature's God hath wrought" (1925), and "Trees They are My Friends" (1931). (Walker 1992, 155, 165, 204, 195).

Edgar Payne was a source of pride among Southern Californian art connoisseurs who considered him one of the most important figures within the *en plein air* school (Moure 1987, 10). Payne was a strong proponent of California and emphasized the values of solitude and accessibility to landscapes not corrupted by human activities. He traveled a lot and often compared the natural aspects of the California landscape to locations elsewhere in the world. An example can be found in an interview he granted the *Los Angeles Times* in 1927. Payne states:

> When one goes into the Swiss Alps he does not get the feeling of communion with nature that one experiences here in California. Even on the peaks, one finds there shelter huts. The slopes are cultivated to the snow line. The hotels follow you everywhere. Here it is different. The California Sierras are not yet fully explored. I have stood on the banks of fifty mountain lakes that are neither charted nor named. I have sketched in the shadow of mountains that would be famous in Europe, but that are known here only as units of the Sierra range. (Hogue 1927, B4)

Late in his career, Payne published *Composition of Outdoor Painting* (1941), an attempt to explain some of the science behind *en-plein air* techniques. He emphasizes the need for artists to apply individual thought based on the knowledge of previous works and the intense study of nature. Payne attests that "all fine creative work is built upon previous thought and accomplishment, proven truths and principles, coupled with new ideas, theories and mannerisms" (Payne 1941, iii). He also finds: "A well developed knowledge of nature is one of the most important assets in building the picture" (Payne 1941, 14).

Hale expressed the same values when extolling the need for engineering schools like the Throop Institute (later known as California Institute of Technology) in Pasadena in the early 1900s. Hale contended: "The greatest advances, whether in engineering, in pure science, in art, or in any other field, arise as mental pictures…requiring only an application of text-book methods to give them tangible form" (Hale 1907, 468). Hale also agreed with Payne when he found: "cultivating the scientific imagination…is most effectively acquired through reflection and experience" (Hale 1907, 471). The fact that Hale and Payne agree that imagination, knowledge, and experience are fundamental aspects of their chosen professions is not surprising. However, the fact that each man concluded California was the most suitable location to achieve these goals is noteworthy.

Near the sunset of the *en plein air* art movement, Benjamin Brown began conducting weekly receptions on Sunday mornings at his Pasadena art studio. Unlike formal art exhibitions at local galleries, these meetings were more personal and interactive. Because the receptions frequently attracted a loyal group of friends and critics, they are comparable to Lummis's "noises". However, an important difference between Lummis's "noises" and Brown's receptions was that invitations were not required to attend Brown's hour-long discussions. Brown would typically "drag out his canvases in all stages of completion, from sketch to finished painting, for the inspection of his guests" (Berry 1925, 123). Fellow Pasadena artist, Edna Gearhart (1879-1974), described the Sunday morning open studio as "an hour of inspiration and argument, of frank criticism and generous help, of persiflage and fine philosophy" (Gearhart 1924, 314).

Edna Gearhart was familiar with Benjamin Brown through his work as the founder and first President of the Print Makers Society of California. Edna's sister

Frances Gearhart (1869-1958) had joined the Print Makers Society of California in 1919 as a way to promote her unique artwork. Frances was experimenting with the application of Japanese color block prints to representations of Californian landscapes. Her works were prints and more modernistic in style as opposed to freehand *en plein- air* paintings.[20] Her work stood out from the etchings made by Benjamin Brown and the black and white block prints created by Benjamin's brother, Howell. She became a popular artist and an influential member of the Print Makers Society, serving as the organization's secretary, treasurer, and editor of its newsletter. Her studio on West California Street in Pasadena eventually became the headquarters of the Print Makers Society (Leitenberg 2008, 1).

By the time Frances Gearhart's color block prints achieved popularity (c. 1923); the *en plein air* art movement was beginning to fade in importance. The impressionistic style was completely absent from her color block prints. Instead, stark outlines and definite boundaries highlighted the subjects of the print. However, despite the clear difference of style and form, the color block prints retained the most fundamental part of Southern Californian paintings from this era: the dramatic portrayal of the influence of light upon individual aspects of the landscape and the resulting *paysage moralisé*. In sympathy with earlier Californian artists, Frances Gearhart often depicted groves of eucalyptus or "valleys and canyons using wonderful shading and earth colors" (Leitenberg 2008, 1). Her portrayals conveyed the same moralistic tone as the writings of

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[20] "When compared to the *plein air* style, the work of Modernist artists tends to favor overall flatter surface designs instead of portraying realistic three-dimensional effects of natural depth. The forms they create usually follow rhythmic lines that echo or complement each other. Moreover, they tend to intensify colors in larger, simpler brushstrokes and simplify forms such as houses, hills, and trees by using stylized sets of patterns." (Irvine Museum 2006, 1).

Muir and Austin, the philosophy of Lummis, the art of Keith, Braun, Wendt, Payne, and Brown. Her work captivated the observer with a glimpse of nature only visible through the intense use of light and her choice of subjects perpetuated the message that Southern California offered the best location for such observations.

Building a Scientific Community within Nature's Splendor

In the spring of 1904, Hale wrote from Pasadena to his friend and observational assistant at Yerkes Observatory, Walter S. Adams (1876-1956): "I doubt if you could find a better place in the country for philosophical calm, although I confess that the exhilaration of the place is a little more likely to make one work rather than reflect" (Hale 1904, 1). Hale's optimism easily convinced Adams, and three other key members of the Yerkes staff to join him at Mount Wilson despite the "temporary" status of the positions offered them and the need for Hale to pay their salaries "out of his own pocket" until permanent funding could be secured (Sandage 2004, 10).[21] But, Hale was well aware that the building of large telescopes and the enterprise of operating a world-class observatory would require more than solitude and tranquility. He would need to depend upon the local population to build mountaintop structures, maintain astronomical equipment, construct access roads from Pasadena to the observatory, and deliver needed supplies. When reflecting upon and assessing the lessons learned from the first ten years of the Mount Wilson Observatory's operation, Hale determined:

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[21] Telescope designer and mirror specialist, George W. Ritchey (1864-1945) and amateur astronomer, photographer and mechanical engineer, Ferdinand Ellerman (1869-1940) joined Walter Adams in the move from Yerkes Observatory in Wisconsin to Mount Wilson. Francis G. Pease (1881-1938), an expert at optical design joined the group in Pasadena later in the year. Together, Hale, Adams, Ritchey, Ellerman, and Pease comprised the founding staff at Mount Wilson (Sandage 2004, 95-102).

> In departing from accepted standards and in preparing to overcome difficulties, the initiator of new methods almost necessarily becomes an instrument-maker, and hence a machine-shop may be his first requirement. He cannot afford to intrust [sic] construction to instrument-makers thousands of miles away, with whom he is unable to discuss details of the design, necessarily subject to frequent modification in the light of newly acquired ideas. (Hale 1915, 5)

Because of this need to craft new instruments, Hale found that the advantages of Mount Wilson's location extended far beyond altitude and climate. The cultural landscape of the San Gabriel Valley also provided many advantages. The expanding development of Southern California provided the resources for "shops, laboratories, and offices in the city of Pasadena, within easy reach of large foundries, supply houses, sources of electric light and power, and other facilities demanded by the nature of the work" (Hale 1915, 7).

The Mount Wilson Observatory's Pasadena office building, laboratory, and machine shop were, in fact, largely overlooked segments of the process of observation and scientific discovery. The original buildings for these functions were constructed before the observatory was operational in 1904, just one block north of the center of Pasadena. In 1905, the observatory complex moved to a location that provided room for expansion on the town's northern edge. Within a few years the city of Pasadena would envelope this location and eventually the site would again be located just a few blocks from the center of town (Sandage 2004, 167). Astronomers spent the majority of their working hours at the Pasadena complex and most had assignments within the various research support, maintenance, and administrative activities of the organization. The

Pasadena office building also housed a crew of "computers" who worked to measure and categorize the exposure of starlight on photographs. Many of the computers were women which added a social dynamic to the staff and may have brought the cultural influence of the city into the heart of the observatory's operation. Other employees worked in the optical shop, machine shop, precision instrument shop, engineering and design shop, publication office, and drafting office (Sandage 2004, 180). Despite its image as an institution that practiced science on a mountaintop, the Mount Wilson Observatory was actually an organization that completed most of its work in the center of Pasadena.

Hale emphasized the importance of the Pasadena operation, stating: "The interpretation of the varied phenomenon recorded on astronomical photographs is the most important phase of the Observatory's work" (Hale 1915, 74). He also touted the independence and ingenuity of the complex, stating:

> The collection of instruments used in the Pasadena office-building for the study of photographs includes measuring-machines of various types, visual photometers, for determining the density of the image (and hence the brightness of the object); Koch's registering microphotometer; a Zeiss stereocomparator, for the accurate comparison of two photographs of the same object; the heliomicometer, a combined measuring and calculating machine for determining latitude and longitude of objects on the sun; several calculating machines for rapid addition, multiplication, and division; and other devices for special purposes. Most of these instruments were made in our own shop, from working drawings prepared by our draftsmen. (Hale 1915, 78)

Hale's testimony demonstrates the degree to which the observatory's scientific interpretations and discoveries actually took place in Pasadena and not upon the mountain above it. Likewise, Mount Wilson astronomers were not secluded from Southern California's culture. Contrary to their image as mountain hermits, peering through telescopes, astronomers actually spent the vast majority of their working hours in town. They lived and interacted as typical members of the professional community. Don Nicholson emphasizes:

> These guys were humans. They were interested in different things. Dad was a scout master among other stuff. They had families. They lived in Pasadena for the most part. Some of them went to church and some of them didn't. You walked down a street in a neighborhood where there was an astronomer living and you couldn't pick him out from the lawyers, the doctors, and the 'whatevers'. (Interview by author June 17, 2007)

Hale was aware of the Southern Californian culture and its impact upon his work and community. He actively sought to improve it and use it to his advantage by involving himself in various philanthropic projects. One of his most influential efforts involved the transition of the Throop Institute, an underachieving, elementary-level, technical school in Pasadena, into the world-class institution of higher learning known today as the California Institute of Technology. This transition took over a decade and involved the cooperation of many individuals, but Hale was the primary catalyst.

Astronomer and biographer, Helen Wright notes: "Hale has been called the 'master builder' in recognition of his role in the building of large telescopes. But he was

also a builder of institutions" (Wright et.al 1972, 46). Perhaps Hale is best described as "a major statesman of the era – 'one of the first prototypes of the high-pressure, heavy-hardware, big-spending, team-organized scientific entrepreneurs" (Dupree 1967, 1115). Hale's second in command at Mount Wilson, Walter S. Adams, found that life in Southern California had imbued Hale with "the spirit of the pioneer, whose greatest joy is the adventure of starting with little and taking an active personal part in every phase of creation and growth" (Adams 1947, 213). Hale's role and methods employed in shaping the California Institute of Technology were certainly pioneering and visionary, but, like the Mount Wilson Observatory, they were successful because of the personal relationships Hale developed and his ability to enlist philanthropic contributors to donate large sums of revenue.

In January of 1907, Hale made an impassioned plea to the wealthier residents of Pasadena for funding to expand and intensify the engineering program at Throop Institute. Hale made the case for a specialized engineering curriculum that would provide "a broad scheme of education" that would "give proper recognition to all sides of the engineer's life" and enable its graduates to conceive and lead vast engineering projects (Scherer 1908, 23). He repeated this vision in an article entitled "A Plea for the Imaginative Element in Technical Education" published in *Technological Review* in the fall of 1907. In this article, Hale concludes: "It should be the purpose of the Institute to contribute to the world the largest possible proportion of men capable of conceiving great projects and the smallest possible proportion of men whose ambition can be completely satisfied by the work of executing them" (Hale 1907, 469). Hale tapped into the booster mentality of Southern Californian investors and effectively won their financial support.

One historian has noted: "Hale carefully aimed his remarks at the pocketbooks of the doctors, lawyers, and businessmen in the audience, pointing out that southern California couldn't survive, let alone grow, without engineers to bring water and electrical power to the semiarid region" (Goodstein 1991, 47).

Hale was familiar with many of these individuals because of his association with the Pasadena Board of Trade and his participation in civic functions. Hale became a member of the Board of Trade in April of 1905. (Kevles 1967, Roll 63). His civic role continued to enlarge as he lived and integrated into the Pasadena community. His community interests and activities were diverse and influential. Examples include: Hale's appointment as a member of Sierra Madre National Park Committee, his efforts within the Arroyo Seco Highway Club to raise funds to connect Pasadena to Mount Wilson with an improved road, and his work raising money for the Pasadena Hospital (Kevles 1967, Roll 63). Hale also worked with city planners on the design and placement of city hall, the civic auditorium, and the public library. His efforts were rewarded with Pasadena's highest award to a citizen, the Noble medal (Wright et.al. 1972, 89).

Hale also joined the Pasadena Music and Art Association in 1912 and was later appointed to the original board of trustees of the Pasadena Art Institute (Kevles 1967, Roll 63). His interest in art placed him in contact with many of Pasadena's wealthiest residents including the famous railroad magnate, Henry Huntington (1850-1927). Hale and Huntington developed a friendship and when Hale learned that Huntington planned to donate his massive collection of art and literature to the city of Los Angeles, he saw an opportunity to create "a center in the humanities where scholars from the world over might come to do research" in Pasadena (Wright et.al 1972, 88). In 1914, Hale wrote to

Huntington and suggested that Huntington's endowment could "establish a true international center, known throughout Europe and America as a unique attraction to every lover of art or of literature" with an "international board of the greatest living scholars and artists, whose advice and assistance could be obtained whenever required" (Hale 1914, 1). Hale became a Huntington trustee in 1919 and in 1927 Huntington provided the endowment for the Henry E. Huntington library and art gallery located in Pasadena (Wright et al 1972, 88).

Hale's involvement with the community was already quite substantial in 1910 when Andrew Carnegie came to inspect the Mount Wilson facilities. Carnegie's trip was too early in the year to see Halley's Comet in full bloom and during the only night Carnegie spent upon the mountaintop observing through the telescopes was not possible due to a snowstorm (Wright 1966, 258). But, Carnegie left with a permanent vision of the cosmos when the Mount Wilson Staff donated a mahogany cabinet the size of a grand piano that displayed an illuminated series of twenty-five photographs of celestial objects taken from Mount Wilson telescopes (Washington Post 1910, 6). Most of his nine-day trip was spent below the mountaintop, in Pasadena, where Carnegie was exposed to Hale's social connections and high standing in the community. Hale's celebrity among the social elites reflected positively on Carnegie and the mutual respect the two men publicly displayed strengthened their influence within Southern California.

During his visit, Carnegie met with the Washington Heights Women's Club of Pasadena and entertained their idea that he should establish a non-political and non-religious daily newspaper (*New York Times* 1910, 1). Despite a barrage of requests during the Carnegie family's stay in Pasadena, they made only one public donation. In

celebration of her thirteenth birthday, Carnegie's daughter, Miss Margaret Carnegie gave Mrs. Hale a check for $5000 to endow a bed at the Pasadena Hospital (New York Times 1910a, 1). However, Carnegie would later donate significant sums to Throop Institute and Mount Wilson Observatory.[22] The latter donation was used to construct a mount, telescope housing, and dome for the 100-inch mirror that Hooker had previously funded. While contributions of this type were typically made only after lengthy contemplation, the timing and justification for this gift left little doubt that it was made "largely as a result of Andrew Carnegie's visit to Mount Wilson in 1910" (Wright et. al. 1972, 45).

Hale frequently used astronomy and Mount Wilson as a means of attracting scientists, philosophers, and men of wealth to Pasadena. Hale envisioned Pasadena as a cultural center and worked hard to make this a reality. In 1910, Hale hosted the fourth meeting of the International Solar Union; an event described as "one of the world's great gatherings of astronomers and physicists" (Tenn 1992, 100). Once both groups arrived on his turf, Hale could stimulate imaginations and inspire synergetic unions among scientists and industry captains. Sometimes the meetings that occurred in Pasadena were not formal gatherings or intentionally orchestrated by Hale. For example: while staying at the Hotel Maryland in Pasadena, Carnegie had the opportunity to meet John Muir (see Figure 17). Despite their philosophical differences regarding industry and conservation, the two men found common ground regarding a fascination with the cosmos. Muir and Carnegie also shared a common Scottish heritage, and after their

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[22] Carnegie expressed a personal interest in the uncertain yet promising future of Mount Wilson. He commented: "We do not know what we may discover here. Franklin had little idea what would be the result of flying his kite. But we do know that this will mean the increase of our knowledge in regard to this great system of which we are a part" (Wright 1966, 258-259).

meeting, Muir considered Carnegie to be one of the “many fine godly men” that “our stormy, craggy, glacier-sculptured little Scotland [had] given birth, influencing for good every country under the sun!” (Muir 1914, 1). Such unlikely pairings were not uncommon when Hale was involved and one author has noted:

> Hale was raised in an era of optimism influenced by Darwin's great discovery: evolution was destiny, and it would lead to a better, wiser world. It was also an age of altruism. Those who became rich building railroads, steel mills, skyscrapers, and oil companies sought ways to use their wealth for further progress. No one would do more than George Hale to channel this new wealth into scientific research. (Tenn 1992, 94)

Muir also visited Hale and toured Mount Wilson. The effect of this meeting could be seen in his later writings as he began to expand his ideas of conservation to include a reframed understanding of Earth’s tiny, fragile and temporary status within the larger order of the cosmos. In 1915, Muir wrote: “When we contemplate the whole globe as one great dewdrop, striped and dotted with continents and islands, flying through space with other stars all singing and shining together as one, the whole universe appears as an infinite storm of beauty” (Muir 1915, 5).

Hale’s influence upon Southern California’s scientific culture is difficult to overstate. The growth of Mount Wilson into the premier astronomical facility in the world, the expansion of Throop Institute into the California Institute of Technology, and the endowment of the Huntington Library combined to establish Pasadena as a recognized center of scientific knowledge on par with the great universities of the

American core. Each of these accomplishments can be traced to Hale's ideal fit within the cultural template of Southern California. Additionally, the establishment of Pasadena as a recognized center of scientific knowledge was a prerequisite for the acceptance of the "California Universe" that would emerge between 1925 and 1940.

Summary

When Hale arrived in Pasadena in 1904, he was among a large group of white, middle-class settlers from the Mid-West. These settlers created a hybrid American culture within Southern California. One of this culture's primary attributes was an informed appreciation for Nature and a desire to preserve it. Hale, like his contemporaries, had a strong desire to shape his community and form an ideal society not possible in the conservative and established American core. Idealists, from among the Anglo-Saxon immigrant community, established numerous powerful and culturally influential cliques, clubs and groups. These groups discussed and debated numerous political and scientific subjects of importance. But, no subject garnered more attention than the Californian environment, landscape, and lifestyle. Muir's conservationist ideals were championed amid a rapidly developing cultural landscape that threatened the core of these values. Meanwhile, business investors and real estate boosters also promoted California's climate. They emphasized the value of sunlight to crops and the beauty and health benefits that a clear atmosphere and mild climate provided. Southern California soon became known for its quality of life based primarily upon its superior climate and clear skies.

Works of art by early Californian landscape artists further promoted the unique qualities of the region and simultaneously proselytized the need to preserve it. In the

1890s, artists such as Keith began to apply the Barbizon style to Californian landscapes. This style required the artist to directly observe nature and highlight particular aspects with shadow and light. By the early 1900s light became the primary subject of Californian landscape art. Impressionism de-emphasized objects and instead focused upon the effects of light on the landscape. This application was uniquely Californian and became known as the *en plein air* art movement. *En plein air* artist and Theosophist, Maurice Braun, emphasized the use of eucalyptus trees as a primary subject. In the context of the paintings, eucalyptus trees can be interpreted as symbols of Anglo-Saxon racial health amid the ideal climate of California. Other *en plein air* artists, such as William Wendt spanned the gap of theosophy and conservation by seeking seclusion and communion with Nature. The popularity of *en plein air* works was further advanced by the claims of environmentalists and theosophists that light was divine. By the late 1910s, the "Ten Painters Club" effectively centered the waning *en plein air* movement in Los Angeles, near the Arroyo Seco, and elevated the form's association with Pasadena and artists such as Benjamin Brown.

The influence of Lummis' *Land of Sunshine* upon the Southern Californian culture is difficult to overstate. Lummis used mass marketing strategies to influence a receptive middle class regarding the superiority of Southern California's environment and culture. *Land of Sunshine* became a powerful cultural force. Its stories, photos, poetry and landscape art promoted a Californian lifestyle made possible by the ideal setting for Anglo-Saxon settlement. The magazine also included the lessons that could be learned from previous cultures who had occupied the region. Helen Hunt Jackson's Ramona and Mary Austin's accounts of Native Americans provided readers with an appreciation of a

paysage moralisé. The promotion of Mary Austin's works also served to elevate the status of women as intellectuals and made their inclusion within Social cliques such as Lummis's "noises" more acceptable. Additionally, women's clubs provided conduits for the transfer of intellectual ideas and access to social elites.

Hale became an expert at navigating these conduits and capitalized upon the opportunities they afforded him. He agreed with and used the prevailing attitude promoting California's ideal atmosphere and light to substantiate Carnegie Institute's initial investment in Mount Wilson and to professionally entice his fellow Yerkes staff members to join him in Pasadena. The fact that the astronomical studies conducted at Mount Wilson were initially dedicated to the study of the Sun, the visual spectrum, and the composition of the universe, made Hale's work particularly complementary to the Southern Californian culture and its infatuation with the understanding of Nature and light. Hale had truly found his place in the world. By the time the 100-inch telescope saw first light in 1917, Mount Wilson Observatory was a source of pride to citizens of Pasadena and a cherished institution within Southern California.

CHAPTER IV

UNDERSTANDING ONE'S PLACE IN THE UNIVERSE (1917-1941)

By the mid-1920s, at least three important and unique elements were firmly rooted in the Southern Californian cultural landscape. First, the dispersed nature of the urban settlement caused Southern Californians to experience urban life without a traditional hub, center, or core. Second, a constant influx of migrants resulted in a culture with fractured and continuously evolving social norms. Third, in the absence of such stabilizing influences, Californians had an increased respect for independence among residents, social leaders, and heroes. Each of these elements would be a substantial cultural influence on its own. When combined, they helped to establish a shared cultural milieu and to foster common perceptions and beliefs within a new American culture. One method to confirm and understand the effect these elements had on the culture of Southern California is to examine the literature produced about Southern California by Southern Californian writers of the time. This chapter uses three prominent novels written near the end of the study period (1939) to examine the Southern Californian culture, compare the lives of the Mount Wilson astronomers to this culture, and determine what effect, if any, the culture may have had upon the acceptance or promotion of new theories and depictions of the Milky Way galaxy produced at Mount Wilson in the 1920s and 1930s. The three novels are: John Fante's *Ask the Dust* (1939), Nathanael West's *The Day of the Locust* (1939), and Raymond Chandler's *The Big Sleep* (1939).

Edwin Hubble joined the staff of Mount Wilson Observatory in early September of 1919. He presented himself as the embodiment of American and English values and accomplishments by touting his past. Hubble had been one of the first Rhodes Scholars

at Oxford and, although his unit never engaged in combat, he rose to the rank of Major in the American army during World War I. He flaunted this persona by arriving in full military dress to include a wound chevron that his official record did not support (Christianson 1995, 108). On his way to Pasadena he had stopped for a short visit at Lick Observatory on Mount Hamilton in August. There, a young PhD candidate named Donald Shane was the first Californian astronomer to meet Edwin Hubble. Hubble's tall stature, military decorum and recognition in the field had preceded him. His stay on Mount Lick lasted less than a day but his first introduction with Shane made a lasting impression. Californian astronomers whose careers overlapped that of Hubble's would forever refer to him as "The Major" (Christianson 1995, 120).

His distinctive persona was juxtaposed to the mythical heroes of Californian culture. These mythical heroes were typically independent, self-reliant, and loners. Hubble in contrast was proud to be a military man and longed to be accepted as part of a team. He didn't even have a driver's license, opting instead to allow others, including his wife, to drive him around town and to work. Yet, Hubble would become one of the most famous astronomers from Mount Wilson. Certainly his fame is associated with his astronomical discovery of Cepheid variable stars in the Andromeda galaxy. But, also important to his success in California, was his distinctive personality. David Fine, writing in his 2000 work, *Imagining Los Angeles: A City in Fiction*, notes how Californian authors such as Nathaniel West used dress as a "way of constructing and performing an identity" (Fine 2000, 158). Hubble's use of military dress exemplified an intentional construction of identity in real life.

In a community such as Southern California, with towns comprised of immigrants, most of whom arrived in the middle or late portions of their lives, one's identity was key in establishing a name for oneself and one's work. Fellow Mount Wilson astronomer Harlow Shapley was particularly annoyed by Hubble's use of phrases such as "Bah Jove!" and "to come a cropper". Hubble had acquired these colloquialisms while earning his Masters Degree at Oxford University. Both Shapley and Hubble were born and raised in Missouri and Shapley found Hubble's adopted accent pretentious. Yet, even Shapley had to accept that the ladies in California liked "that Oxford touch very much." What Shapley most likely failed to grasp is that pretentious or not, Hubble's persona created a certain fame that transcended the quality or quantity of his astronomic study.

Don Nicholson, the son of early Mount Wilson astronomer Seth Nicholson, described the low-key way in which most astronomers conducted their lives in Pasadena. He insisted that the astronomers were very different from "Hollywood people" (Interview by author June 17, 2007). Despite astronomer's professions being highlighted in the Pasadena phone books along with other professional class employees such as doctors, lawyers and professors, Nicholson stated he would be "willing to bet that not a single one of them would have said 'please put that in the phone book.' The phone book people got it somewhere else" (Thurston's Directory of Pasadena 1921, 627; Interview by author June 17, 2007).

Nicholson's observation was almost certainly factual for the vast majority of astronomers who worked at Mount Wilson and at the Solar Lab in Pasadena. Most of the astronomers, including Seth Nicholson, and the computers at the Solar Lab (workers,

usually women, paid roughly twenty-five cents per hour to count and measure the brightness of stars on photographic plates) never became famous. Only three astronomers who worked at Mount Wilson reached a significant level of notoriety – Hale, Shapley, and Hubble. It is also noteworthy that each of these astronomers had flamboyant, albeit dissimilar, personalities. It is beyond the scope of this dissertation to contemplate the characteristics of personality prerequisite to success in the field of Astronomy. Yet, it is important to establish that having a distinguishing persona served as a career enhancer for astronomers in remote locations such as Mount Wilson. Closer to the core - at Yerkes, Harvard and the Naval Observatory - reputation and quality of work were paramount and distinguishing characteristics were more of a liability than an asset.

Evidence exists demonstrating that the positive qualities of an astronomer's personality in Pasadena were different than the assessment made in the American core. For example, George Russell Agassiz of the Harvard College Observatory and head of a visiting committee to the National Research Council of 1920 was assigned to interview Shapley for the position of Director of Harvard University's Observatory. This was one of the most prized traditional positions within the field and Shapley fully expected to be awarded the position based on his notoriety and leading theories on the shape and size of the universe. Agassiz and his committee found Shapley "immature and lacking in force" and further stated, "[Shapley] does not give the impression of being a big enough personality for the position" (Hoskin 1988, 8). Instead Agassiz selected Henry Norris Russell who, "spoke eloquently from the floor" for the directorship. Shapley was offered a consolation position as assistant director. He would eventually be offered the

directorship only after Russell turned down the position and Hale wrote a letter of support (Christianson 1995, 150). It seems apparent that a "big enough personality" in the east meant something much different than it did in California. A "big personality" in the east was one who humbly and meticulously conducted his work without self-aggrandizement. Russell confirmed this notion when he wrote to Hale and expressed his concern that Shapley would be a "bully second" and that he would attempt to "keep Shapley from too righteous an imagination – in print" (Gingrich 1975, 348). Certainly some energetic scientists such as Albert Einstein achieved international fame and respect; however, it seems that ostentatious personality traits were a liability when considering academics for prestigious positions. Vestiges of this attitude can be seen even in the modern era as famous astronomers such as Carl Sagan are frequently shunned by the scientific community and labeled popularists.

Raymond Chandler and the Californian Image of Independence

By the 1920s, Southern California had become a cultural region dominated by the human image. The motion picture industry relied upon the creation of larger-than-life personalities and character roles, many of which had their origin in the local literature of the late 1930s. One such personality was the character of the private detective, Phillip Marlowe, created by author Raymond Chandler. Marlowe is a quick-witted freelance detective who negotiates the streets of Los Angeles using his own resources, street smarts, and moral code. Chandler wrote in the genre of writing known as the "hard-boiled" detective story and its popularity would spread throughout the nation during the 1940s and 1950s. *The Big Sleep* (1939) is the most refined early example of a hard-

boiled crime novel; one of the first full-length novels within the genre, and it is endemic to the region and time period of this study.

The Big Sleep reveals much about the culture of Southern California in its plot, character development, and style of prose. One critic aptly points out: "Chandler's ironic tone and extraordinary metaphors focused readers on individual scenes, which he excelled at writing. Many of these evoke Southern California in the late 1930s so vividly that the setting seems to become part of the plot." He continues: "The prevailing tendency of these metaphors is to compare people to things, positing a mechanistic, post-Einsteinian world of time, space, mass, motion, and inertia" (Marling 2007, 1). Another critic attests to the importance of the novel by stating: "Although it would be years before the novel received the critical recognition it deserved, the publication of *The Big Sleep* was a landmark in the history of the American hard-boiled detective novel. In the years that followed, Chandler's style and technique would be widely admired and imitated; his work would help establish the conventions of the genre that persist (in both detective novels and movies) to this day" (Moss 2007, 1). In order to adequately relate this work to Californian culture, a brief review of its complicated plot is required.

The Big Sleep begins with Marlowe answering the call of an elderly and extremely wealthy client, General Guy Sternwood. General Sternwood informs Marlowe of a scam to blackmail the reputation of his daughter, Carmen, by a man named Arthur Geiger. Sternwood also mentions that his other daughter, Vivian, has a missing husband who previously worked as a bootlegger. However, Sternwood makes it clear that he does not want Marlowe looking into the missing husband. He only wishes to investigate Geiger. Marlowe accepts the case and begins investigating. He finds out that Geiger

runs a pornographic bookstore on Hollywood Boulevard. Later that night, Marlowe follows Geiger to his home, and waits outside. Upon hearing gunshots, Marlowe moves into the house and finds Geiger shot dead and Carmen Sternwood woozy from drugs and completely naked in front of an empty camera. Marlowe drives Carmen home and then returns to the crime scene. He finds that Geiger's body has already been removed from the scene.

The next day, Marlowe learns that the Sternwood family chauffeur, a former lover of Carmen's, has also been murdered during the night. He then stumbles upon a new character, Joe Brody, removing books from Geiger's store and hiding them in his apartment. Additionally, another blackmail threat has been made against the Sternwoods. This threat directly addresses the nude photos taken at Geiger's house. Marlowe returns to Geiger's house to investigate and finds Carmen already looking for the negatives. A tough guy and casino operator named Eddie Mars arrives at the house. Eddie Mars' wife was thought to have run away with Vivian Sternwood's husband and Marlowe narrowly talks his way out of a tense situation when Mars questions them about Geiger's murder. Marlowe then returns to Brody's apartment to press him on his involvement. Brody admits trying to take over the pornography business but denies the murder. At this point, Carmen arrives on the scene with a gun and threatens to kill Brody unless he returns the photographs. Marlowe wrestles the gun from Carmen and sends her home. Then, suddenly, Geiger's gay lover, Carol Lundgren enters the apartment, where he shoots and kills Brody out of revenge. Marlowe manages to capture Lundgren and take him to the police. The police threaten Marlowe with charges relating to covering up Geiger's murder because he delayed reporting it. Finally, when Marlowe agrees to testify that

none of the murders were in any way associated with the Sternwoods, they let him go. The case is technically solved and Sternwood pays Marlowe.

However, Marlowe is not content and continues the investigation on his own. This time he focuses on the disappearance of Vivian Sternwood's husband. He finds Vivian at Eddie Mars' casino and is baffled that the tough guy allows her to gamble until she wins a huge sum of his money. Later when she leaves the casino with the money, she is ambushed by one of Mars' thugs. Marlowe rescues her and then refuses her sexual advances on the drive to her place. Later when he returns home, he finds Carmen waiting for him in his bed. He refuses her also. The next day Marlowe is inexplicably summoned to the Sternwood mansion and officially assigned the case of finding Vivian's husband. While there, Carmen insists that Marlowe teach her to use a gun so she can defend herself. She takes him to the oil fields below the mansion and brazenly attempts to shoot him with his own gun. Fortunately, Marlowe had the foresight to unload the weapon before handing it to her. Marlowe manhandles her back to the mansion and confronts Vivian who confesses that she and Eddie Mars covered-up her husband's murder at the hands of Carmen by hiding his body in one of the old oil sumps. Carmen had killed Vivian's husband the same way she attempted to kill Marlowe and for the same reason: he refused to have sex with her.

The solution of the crime is necessary to the development of the story, but the real genius of *The Big Sleep* lies in the depiction of the cultural setting. As one critic notes: "Despite the complicated and sometimes confusing plot, the heart of *The Big Sleep* is not the solution of the murders--the whodunit--but rather the world the story depicts and the movement of Marlowe within that world" (Moss 2007, 1). Marlowe serves as a vehicle

to allow the reader to enter the lives of characters from all social classes. As a private detective, he is afforded access to the rich and famous who occupy the mansions on the hills of Southern California as well as the criminals and thugs that walk the mean streets of its cities. The various settings Chandler reveals through Marlowe's investigations document many of the cultural myths and understandings of place, social class and moral standards in Southern Californians during the 1930s. Moreover, Chandler designed the character to "exist complete and entire and unchanged by anything that happens, that he is, as detective, outside the story and above it, and always will be" (MacShane 1986, 39).

In similar fashion, the role of the scientist is often thought to exist beyond the realm of social influence. Also, like the private detective and unlike many other scientific occupations, astronomers were able to promote their activities as manly endeavors. Astronomers working in the American west, in particular, were able to tout their mountain top locations as serene laboratories amidst rugged terrain. Maria Lane, a cultural geographer at the University of New Mexico finds:

> Astronomers' aggressive and strategic representations of their mountain experiences combined two extremely powerful tropes in support of their claims and reputations. On one level, astronomers succeeded in aligning themselves with popular heroic endeavors like mountaineering and polar exploration. At the same time, however, they relied on a popular reverence for sublime mountains as the foundation for their claims. (Lane 2006, 32)

In this way, Mount Wilson astronomers were occasionally presented as manly figures that followed a professional code similar to that of a noble private detective. In 1925,

National Geographic published a lengthy article about the scientific work being conducted at Mount Wilson. The article was laced with language that equated the work of the astronomers with that of a criminal investigation. The article discussed how astronomers were "inducing the heavens to reveal their secrets", "cross-examining the atom", solving "the mystery of the composition of stars" and "interviewing" speeding objects in the heavens (Showalter 1925).

But, even in this account, the astronomer is depicted just as is Phillip Marlowe: not tempted by greed, desire for notoriety, or lust. The astronomer's remote working locations form a natural barrier to the seedier side of the social world. Instead, the immediate manly challenge presented the astronomer is the requirement to overcome intense forces of nature in order to continue his investigations. A depiction of an astronomer braving sub-freezing conditions at Yerkes Observatory is provided in the *National Geographic* article along with the passage: "There is a standing rule that astronomers must stop work in the unheated dome of the big telescope when the thermometer reaches 25^{o} below zero: but if the 'seeing' is good the observers break the rule" (Showalter 1925, 106). Therefore, while Marlowe and the astronomers may share the manly aspect of breaking rules for the sake of a greater and noble result, the portrayal of an astronomer's manliness remains more closely related to a pioneer or an adventurer than it is to an independent agent or detective.

One of the cultural understandings revealed by Marlowe's investigations is that wealthy Californians escaped from the lowlands and cities of the Los Angeles basin to the hills. David Fine notes: "To move up the hill in Chandler's fiction is to move away from the scene of the crime. Living in the hills is living with a 'prospect', which taken

literally means living with a *view* and metaphorically with a *future*" (Fine 2000, 125). Chandler describes this situation when Marlowe makes his first visit to the Sternwood estate and looks down at the valley below the mansion. He states: "The Sternwoods, having moved up the hill, could no longer smell the stale sump water or the oil, but they could still look out of their front windows and see what had made them rich" (Chandler 1939, 602). Fine further interprets the social geography of elevation within Southern California by differentiating the attributes of looking out over the Los Angeles basin and looking down upon the city proper and its inhabitants: "To look out is to enjoy a prospect, a rustic mountain view; to look back down the hill is to see the past, to see where one has come from" (Fine 2000, 126).

Astronomers, of course, are most often visualized working at the top of mountains. Despite the fact that they lived and worked the majority of their days in the cities and towns below, the depiction of astronomers braving the elements and peering from mountaintops into the thin skies above was ubiquitous. In nearly all accounts of the lives of Mount Wilson astronomers, they are closely associated with the telescopes they used and therefore the mountain itself. In actuality, the telescopes on Mount Wilson were not designed for direct viewing and most of the discoveries made from Mount Wilson occurred as the result of the meticulous reading of photographic plates in the Mount Wilson Offices and Solar Laboratory in downtown Pasadena. Hale had designed and built the Pasadena complex for the accomplishment of tasks "not directly involved in day-to-day mountain operations" in an effort to reduce "mountain fever" (Sandage 2004, 180). Nevertheless, the perception of astronomers peering into the base of a telescope on the mountain persisted and was fostered by nearly all media accounts. Astronomers, by

nature of the public's perception of their work, and the notoriety that came from their findings, were considered people with a prospect.

In addition, nearly all of the Mount Wilson astronomers lived in the attractive upper-middle-class neighborhoods of Pasadena. They were able to afford nice homes due to a consistent, albeit modest, income. Astronomers were not rich; but they crossed paths with wealthy investors and donors and had far more contact with the wealthy than most average citizens of Southern California. Don Nicholson describes the typical Mount Wilson astronomer's economic status by stating:

> What they had that a lot of other people didn't have during the Depression was a steady income. That was a huge advantage. They had a job. They had tenure so there wasn't fear of losing it. Of course, Adams was a little upset about paying them that much – but anyway I tell people that during my lifetime I've known a lot of astronomers. I've known four wealthy astronomers and three of them inherited it and one of them married it. (Interview by author June 17, 2007)

Hale was one of the three astronomers known by Nicholson who inherited his wealth and Hubble was the one who married into it.

Harlow Shapley

Shapley, on the other hand, had no such fortune. He was born and raised in the Ozark Mountains of Southwestern Missouri during the late 1800s. His hometown, Nashville, was just thirty miles north of the coal-mining town of Joplin, through which Route 66 would one-day carry many ambitious and adventurous souls to California (Sandage 2004, 307). At age fifteen, Shapley had only a fifth-grade education and the

merit of even this modest education was suspect in the eyes of many urbanites. In fact, Shapley and his brother were both refused admission to a public high school in Carthage, Missouri due to their lack of formal education. Shapley describes his early educational surroundings in his autobiography *Through Rugged Ways to the Stars*: "We went to a one-room country schoolhouse on the edge of the farm. One year the teacher was our sister" (Shapley 1969, 4). Shapley would emerge from these humble beginnings to eventually stand as an academic peer of Hubble and Hale, but like many Midwestern transplants to Southern California, Shapley harbored a mild resentment toward his wealthier colleagues and fellow citizens of Pasadena.

Hale had built a Solar Lab and his new home near the expensive center of town and Hubble was working on the construction of a large English-style home in the woods just south of Pasadena when Shapley moved into his new, but very average, California bungalow on North Los Robles Avenue (Thurston's Directory of Pasadena 1921, 627). A current picture of the home is provided in Figure 18. Most of the second-generation Mount Wilson astronomers including Seth Nicholson, Ritchey, Humason, Joy and many others lived in similar or lesser homes in the northern part of Pasadena.[23] This suburban landscape was situated above the center of town and below the Mount Wilson.

Observatory visible on the mountain to the north (see Figure 19). Shapley was financially sound due to his employment at the observatory, well situated within Southern

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[23] Allan Sandage, astronomer and author of the *Centennial History of the Carnegie Institute of Washington: Volume I: The Mount Wilson Observatory: Breaking the Code of Cosmic Evolution* (2004), lists Adams, Babcock, Seares, St. John, Ritchey, Pease, King, and Ellerman as the first generation patriarchs that were hired by the observatory's founder, Hale, between 1904 and 1910. Sandage's list of second-generation astronomers, hired between 1915 and 1920 at Mount Wilson, includes Anderson, Merrill, Joy, Pettit, Shapley, Nicholson, Hubble, Sanford, and Humason. Sandage also mentions a third generation of Mount Wilson astronomers, such as Olin C. Wilson, that were hired in the mid 1930's. (Sandage 2004, 470).

California and living the middle-class lifestyle of a highly respected astronomer. Yet, Shapley did not consider himself merely an ordinary, albeit highly respected astronomer. In his mind, and perhaps in reality, he was an exceptional scientist and observer.

But, throughout his tenure at Mount Wilson, Shapley must have known he could never earn through scientific achievement the fortune and fame of Hale or Hubble. Hale had the advantage of a wealthy and well-connected father. Plus, as the undisputed founder of Mount Wilson Observatory he was loved as a pillar of the Pasadena community. Hubble was a man who transformed his accomplishments and scientific endeavors into a celebrity persona. Further, Hubble's marriage in 1924 to Grace Burke-Lieb, the daughter of a wealthy Southern Californian, completed his self-driven transformation into an Oxford mannered elitist. Grace enjoyed Hubble's invented persona and the couple "would parlay his image, charisma, and legitimate scientific celebrity into an active Hollywood and international social calendar" (Cloer 2007, 1).

Shapley's wife, in contrast, was an unpaid volunteer of Mount Wilson. She would help Shapley as an assistant, confidant, and professional colleague while they lived in Pasadena. Astronomy became part of the foundation of the Shapleys' marriage when upon their honeymoon; they "worked on the orbits of eclipsing binaries" (Shapley 1969, 49). While living in Pasadena, the Shapleys tried to match the fame of the Hubbles through publication and professional grandstanding. This method seemed to fit Shapley's personality well. By most accounts, Shapley was very charming when he wanted to be, but was frequently blatantly arrogant when it came to his scientific achievements. One example of Shapley's arrogance can be seen in his recounting of his hiring by Hale for duties at Mount Wilson. In his autobiography, Shapley describes Hale as "the founder of

almost everything astronomical". But later on the same page, he recounts how Frederick Seares, his former astronomy professor at Princeton who was already working at Mount Wilson, described his hiring. According to Seares' account, Hale was willing to hire him despite knowing that Shapley "knew more astronomy" than Hale did (Shapley 1969, 44).

Shapley was professionally driven and desired a large amount of recognition, pay, and position. His words seem ironically like Phillip Marlowe's when he describes his salary at Mount Wilson in his autobiography. Shapley states: "Hale did not like my approach, and I did not like having to mention the subject. But nobody else was going to look after me, and I wanted three meals a day. They played fair with me after that – very fair" (Shapley 1969, 50). Shapley's insistence upon being paid every bit of a high salary was juxtaposed to the atmosphere of frugality present throughout the Mount Wilson operation.

Mount Wilson astronomers were expected to harbor resources, use telescope time wisely, and seek low-cost solutions. This attitude was so entrenched that it extended beyond business matters and into the fabric of the social interactions upon the mountain. One example can be seen in the tradition of the midnight lunch. A break area was established midway between the 60-inch and 100-inch telescopes. Typically, one astronomer and one assistant occupied each of the telescopes. Around midnight, after setting the telescope for a long exposure, the assistants would take a break and meet at the break area. They would prepare a small snack, eat, socialize, and then return to the telescopes, whereupon the astronomers would take their turn in the break area. No food was allowed to be stored in the break area due to animals, so the midnight snack needed to be carried up each day and suspended above the ground in a small sack. But these

requirements did little to explain the “pathological frugality” of the observatory’s second director, Walter Adams, who “decreed that each person’s midnight lunch allotment would be two pieces of bread, two eggs, some butter and jam, and enough tea or coffee to make a single cup” (Sandage 2004, 192). The limitation probably had more to do with limiting the length of astronomer’s breaks than it did with saving food or not attracting animals.

The senior night astronomers, such as Shapley, only endured the “hardship” of the frugal midnight lunch roughly four nights per month when the new moon provided the darkest possible skies for the observatory’s most important work (Shapley 1969, 49). Other astronomers who conducted solar, planetary, or other observations that did not require absolute darkness occupied the mountaintop during the remainder of the month. Another mealtime tradition was a formal lunch conducted each time the crews changed. This meal took place in the Monastery dining area and all enforced a strict protocol regarding seating arrangements. The head of the table was reserved for the astronomer completing duties with the 100-inch telescope. To his right sat the 60-inch lead astronomer and to his left sat the 150-foot solar tower astronomer. At the foot of the table sat the oncoming shift and the assistants and visitors sat down the sides of the long table (Sandage 2004, 524). This type of arrangement reflected the deference that the Mount Wilson astronomers placed on the value of one’s work as opposed to one’s social or economic status. In contrast to the Californian culture in the valleys below, on the mountain, one’s position was determined by the value of the work being accomplished. The most important work, for symbolic and practical reasons, used the most expensive pieces of equipment during the best available times for observation.

This arrangement likely appealed to many of the astronomers. It appeased Hubble's sensitivity to rank (Sandage 2004, 524). It also confirmed the cherished tradition of the self-made man on Mount Wilson. However, Shapley's journey from an uneducated farm boy in Missouri to a lead astronomer at Mount Wilson pales in comparison with the ascendancy of Milton Humason. Humason was a native of Pasadena who "progressed from pack-mule driver (1915) to observatory janitor (1917-18) to night assistant (1919) to assistant astronomer on the research staff (also 1919) to cosmologist, working in the latter capacity alongside Hubble from 1929 to 1953" (Sandage, 2004, 192). On the mountain, you were as important as your scientific contributions. However, the majority of even a professional astronomer's life is not spent on mountain tops.[24] In the valley below, and the greater scientific community to the east, scientific standing depended as much on social status and wealth as it did upon merit.

Nevertheless, it was the professional standing afforded accomplished scientists in the American core that attracted Shapley. Most astronomers who moved to Southern California to work at Mount Wilson stayed for the remainder of their careers. Shapley, on the other hand, used his Mount Wilson notoriety, derived from calculating the size of the Milky Way, to land a job at Harvard University. In his own account of the hiring one can easily interpret his professional priorities and desires: "When I was finally called to Harvard, after an interval of some years, I was the highest paid astronomer in America.

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[24] One notable exception is Joseph Hickox. Hickox was a solar assistant and bachelor who lived in the Monastery upon Mount Wilson for an entire year (1922-1923) and then returned for good in 1929 after a five-year attempt at braving "the turbulent world of the valley." He remained a permanent resident of the mountain until 1962. Among his extracurricular accomplishments was the photographic documentation of the spread of metropolitan lights within the San Gabriel Valley (Sandage 2004 182).

I was getting about twice what the Astronomer Royal was paid. Astronomers came cheap in those days" (Shapley 1969, 50). In this account, Shapley dismisses his years at Mount Wilson and instead emphasizes his reward for enduring them; an eventual appointment as the Director of Harvard Observatory. Yet the seven years (April 1914 to April 1921) that Shapley spent at Mount Wilson clearly shaped him into the visionary he was at Harvard.

Shapley was responsible for the first seventeen doctoral degrees in astronomy issued at Harvard. The first was awarded to a woman, Cecilia Payne (Shapley 1969, 95). His willingness to entrust a woman with his academic legacy was likely the result of his respect for Miss Henrietta Leavitt. Miss Leavitt's work as a computer led her to develop the relationship between period and luminosity of Cepheid variables. Shapley would build upon this relationship in order to support his measurements of the galaxy while at Mount Wilson (Johnson 2005, 67). Shapley would eventually visit Miss Leavitt on her deathbed and in his autobiography he declared that she "was one of the most important women ever to touch astronomy" (Shapley 1969, 91). He would later contend that his findings at Mount Wilson resulted in a "Third Adjustment" during which mankind accepted a peripheral position of the sun in the cosmos. Shapley argued that the "First Adjustment" (the realization that the Earth was a sphere) and the "Second Adjustment" (the scientific understanding that the Earth revolved around the Sun) were not as challenging to the human ego as was his third adjustment. Shapley was also the first scientist to suggest a "Fourth Adjustment" was needed wherein mankind renounced its claim as the top life form in the universe (Shapley 1958, 109). He attributes at least some of this philosophy to a hobby of studying the effect of temperature on the speed of ants

while passing time on Mount Wilson. Shapley states: "I can go on and on about ants; it is rather amusing to find an ancient civilization such as ants have had for fifty million years, whereas primates have been around for only a few hundred thousand years. Any entomologist will tell you that the insects are far beyond us in social development." (Shapley 1969, 72)

Perhaps unnoticed by Shapley was the effect the cultural geography of Southern California may have had upon his own ability to conceive of such "adjustments." Unlike the cities of the east, the Los Angeles basin lacked a traditional center. Additionally, California was on the periphery of the American nation. While Shapley would be drawn back to the center of his academic universe, Harvard, he likely understood that other ambitions, such as the use of the largest telescopes, could keep great scientists on the periphery. Shapley was living within a cultural milieu that in some ways resembled the galaxy he ultimately conceived. Shapley's reasoning was certainly influenced by his cultural geography and one can ascertain that his experiences in Pasadena and upon Mount Wilson were important influences upon his professional career. Additionally, the combination of Shapley's mind and his experiences in Southern California ultimately resulted in a new conception of the galaxy and the position of humans within it. Without the geographic and cultural conditions of Mount Wilson, Pasadena, and greater Southern California the outcome of his conceptions may have been altered.

Nathanael West, Automobiles, and Californian Fantasies

A key component of Chandler's writing that paralleled real life in Southern California was the prominence of the automobile. By the early 1930s, tourists and migrants from the eastern United States had flooded the streets and boulevards of the Los

Angeles basin. California was a compelling destination for an American culture that was increasingly fond of automobile travel. California real estate boosters and the beginnings of a national highway system in the early 1920s made such trips increasingly convenient (Meinig 2004, 31). The climate and topography of Southern California combined to provide a setting where numerous smaller cities and towns could be tied together by the automobile into a single urban community. David Fine describes how Southern California in the early 1900s was ready-made for the automobile in his 2004 book, *Imagining Los Angeles: A City in Fiction*. He writes:

> The coming of the automobile was not in itself responsible for the sprawl within and beyond the expanding city limits. Horizontality was already in place, the product of the checkerboard pattern of town buildings established by real estate subdividers even before the turn of the century. Los Angeles emerged as a vast semiurban region…simultaneous development of widely separated towns linked by the Pacific Electric rail lines. When the automobile came the city was clearly positioned for its arrival. (Fine 2004, 9)

Roads within such a setting were easy to justify, build and maintain. The increasing number of roads made travel by automobile very popular. The popularity of the automobile then re-combined with the climate and topography of the region to have even greater effect upon Southern Californian culture in the 1930s. Suburbs filled with new subdivisions of small homes with attached garages. These homes featured a rearward focused domestic setting with pools and gardens in the backyard and a driveway connecting the garage to the urban grid in the front. Donald William Meinig points out:

"By 1930 Los Angeles was notable as having the highest proportion of single-family dwellings of any city in America (93.7 percent compared with barely 50 percent in big Eastern cities), and its vast 'sprawl' across the plains and foothills had become a cliché in visitors' commentary" (Meinig 2004, 31).

The ties between the automobile and the developing and distinctive culture of Southern California run very deep and are difficult to overstate. Meinig points out that even decades before the dramatic cultural changes mentioned above, Los Angeles County "had the highest ratio of cars to population in the United States" (Meinig 2004, 31). By 1925, there were nearly as many cars as people in Los Angeles County, approximately one car for every 1.6 residents, a far higher ratio than anywhere else in the country (Fine, 2004, 9). The Automobile Club of Southern California was formed by ten people in 1900 and quickly grew in membership and clout. By the 1920s the club wielded enough political power to persuade the state to build a highway linking Northern and Southern California. This massive project may have kept California from splitting into two separate states (Pace 1990, 393). Not only did the government spend a good portion of its budget on road travel, so did Los Angeles residents. By 1940, wage earners in Los Angeles spent more on cars than on clothing (McWilliams 1973, 236). Toll roads, license fees, and parking fines added to the cost of owning a car but did nothing to slow its growing use.

When asked about the automobile use by Mount Wilson astronomers in the 1920s and 1930s, Don Nicholson recalled his childhood, stating: "Everybody had a car. It was really necessary. There was a public transportation network but it wasn't really that close in so people who wanted to go downtown got in their car and went downtown. I never

remember a time when my family did not own at least one car" (Interview by author June 17, 2007) Automobiles allowed astronomers, as well as all the region's citizens wealthy enough to own one, to experience the entire Los Angeles basin as their home. It is therefore important to include other groups and types of people within the Los Angeles basin, not typically associated with the Pasadena or scientific communities, when examining the cultural influences upon the Mount Wilson astronomers. The works of Nathaniel West and John Fante provide an opportunity for such comparison and contrast.

Unlike Chandler's Phillip Marlowe, characters in Nathaniel West's *The Day of the Locust* (1939) lack street smarts, independence, self-assuredness, morality and control. While the Mount Wilson astronomers certainly lived a much different life than the characters portrayed by either West or Chandler, the contrast reveals the place of the astronomers within the social strata of the region. By comparing the lives, goals, and actions of Mount Wilson astronomers to the lives of West's fictional characters a better understanding of where the astronomers fit within the perceived social strata of Southern California can be determined. David M. Fine, a professor of American Studies at California State University in Long Beach, finds *The Day of the Locust* to be a work that "stands securely as the most powerful and evocative novel about the film capital" ever written (Fine 1978, 60). Literary and cultural critic, Algis Valiunas agrees, noting: "*The Day of the Locust* is widely regarded as the best novel ever written about Hollywood and it probably is, although one wishes one could think of a better" (Valiunas 1997, 64). Valiunas provides the caveat because the novel fails to capture the experiences of the Hollywood upper classes. Instead, this fictional novel focuses solely on the plight of the lonely, economically depressed, and disheartened masses that consume the social

products created by the upper classes. For a cultural geographer or historian seeking to understand the unrecorded attributes of the lower tiers of the Southern California cultural milieu, *The Day of the Locust* serves as a well-regarded period piece of fiction that contains clues to the cultural attitudes and beliefs of the common people.

The novel's plot follows the experiences of a Yale-educated painter named Tod Hackett who migrates to California seeking the opportunity to paint his Opus Magnus. While employed as a set and costume designer, Tod targets the lowly and displaced people that occupied the streets, apartments, and bungalows of the Los Angeles basin as the subjects of the painting. West describes these unfortunate and angry people as "people who come to California to die" (West 1939, 201). Hackett becomes entangled in their world as he pursues, along with nearly all the book's other male characters, an attractive young woman who remains perpetually just out of his sexual reach. He consequently becomes the victim of the same false expectations regarding life's possibilities as the people he is studying. The novel portrays a tier of society that is simultaneously bored with their current lives and constantly exposed to images and fantasies of more thrilling possibilities. Tod envisions a painting he plans to title "The Burning of Los Angeles." The painting captures the beginning of a civil war based on the rage and frustrations of the disillusioned lower economic classes. By the end of the story, Tod finds himself buried in the middle of an angry and frustrated mob. Fighting for his own survival while hopelessly seeing his friend, Homer Simpson, and others dragged down into the growing violent upheaval, he realizes he is living the painting he had envisioned.

The frustrations of West's characters demonstrate their ability to imagine a more rewarding life. One aspect of these characters that certainly matched the experience of many Los Angeles area natives in the 1920s and 1930s was the frequent exposure to Hollywood props, costumes, sets, movie stars, successful producers, directors, and other people associated with the film industry (Gordon 1987, 68). Witnessing the exotic, bizarre, and fantastic motion pictures these elements combined to form was becoming a normalized part of social life within the region. Additionally, West captures the constant masquerade of images that did not conform to the expected or known reality in which they existed. One day while walking on Vine Street, Tod Hackett observes: "The fat lady in the yachting cap was going shopping, not boating; the man in the Norfolk jacket and Tyrolean hat was returning, not from a mountain, but an insurance office; and the girl in the slacks and sneaks with the bandanna around her head had just left a switchboard, not a tennis court" (West 1939, 22). Had West's fictional character encountered the female computers at Hale's Solar Laboratory in Pasadena he would have found them dressed in similar fashion to the switchboard girl and if he did encounter an astronomer fresh from the top of the mountain, he would likely be dressed in a formal suit and tie as opposed to a Norfolk jacket and Tyrolean hat (Sandage 2004, 217).

The landscape of surreal facades extended well beyond the movie sets in Hollywood. West presents a suburban setting for his novel that is filled with annoyingly eclectic and overly designed homes, apartments, and buildings. West claims: "Only dynamite would be of any use against the Mexican ranch houses, Samoan huts, Mediterranean villas, Egyptian and Japanese temples, Swiss chalets, Tudor cottages, and every possible combination of these styles that lined the slopes of the canyon" (West

1939, 24). West spends an entire chapter describing the small suburban house purchased by the character, Homer Simpson. The outside of the house is described as "Irish" with a gumwood door painted to appear like it was actually oak, the living room is "Spanish" in design, and the home's two small bedrooms were of "New England" style (West 1939, 54). The point of these descriptions is to establish a setting in which everything is a fabrication and subject to alteration or reinterpretation. However, as Fine aptly points out, Homer's house was "no figment of the surrealist imagination, but typical of many bungalows in the hills above Hollywood" (Fine 1978, 59).

The homes of the Mount Wilson astronomers in Pasadena were equally eclectic. Shapley's bungalow home resembled a mid-western farmhouse, Ritchey occupied one of a four-plex of bungalows squeezed onto a single lot but built to resemble the old-Spanish ranch villa, Hubble, the only astronomer who didn't drive, ironically lived the farthest from the workplace in a large modern Spanish revival style home (see Figure 20). He commissioned the construction of his modern suburban home in woods south of Pasadena with a distant view of Mount Wilson. Hale constructed his Pasadena Solar Lab in a style that resembled a Spanish Mission with open, spacious rooms fitting of a public library. It was adorned with ancient symbols of Middle-eastern sun worshippers (see Figure 21).

It is unlikely that the class of people portrayed by West's primary characters would spend their idle time contemplating the cosmos. But, one of the cultural results of the influences of the film industry may have been a population that was predisposed to accepting that the world could be "redesigned." To a Californian of the 1930s, it made sense that the whole understanding of the cosmos could change based upon the lens through which one chose to view it. Radical and new visions of the cosmos simply found

a more receptive audience within the culture of Southern California than in other parts of the world. Migratory self-selection of the 1900s and 1910s created a majority within the upper classes who were capable of understanding and willing to accept the findings of the Mount Wilson astronomers. Later, in the 1920s and 1930s, the motion picture industry enabled the lower classes to accept new scientific interpretations without the need for in-depth scrutiny. Additionally, popular newspaper and journal articles elaborated upon the concepts related to the immensity of astronomical findings. These articles dramatized the impact of the findings and made minor celebrities of the astronomers. Mount Wilson astronomers were promoted as community leaders and described as explorers or intellectual adventurers. Such scientific missionaries appealed to the majority of Californians. They were not threatened by their findings because they had become accustomed to and desirous of a changing reality.

The new understandings of the cosmos did not challenge the cultural norms within California as they did in other parts of the world. Instead, the new depictions of the Milky Way and the universe fit perfectly within a constantly changing cultural landscape. Finally, the changing view of the universe suggested the possibility of a new order on Earth as well. Many who shared the discontent expressed by West through his characters desired such a new order. Alfred Kazin states in his introduction to the 1966 reprint of *The Day of the Locust*: "like all good Hollywood novelists, West saw the place as a symbol of whatever is most extravagant, spoiled, and uncontrolled in American life" (Kazin 1966, xvii). West expressed this most directly through his protagonist, Tod Hackett's desire to paint the burning of Los Angeles as a representation of the beginning

of a needed and rapidly approaching American Revolution. Fine relates West's fiction to the reality of a changing American culture and concludes that everywhere West looked:

> …he found the images of unreality and deception which were to fill his book. The fantastic architecture which he discovered both on and off the lot offered itself as the key metaphor for the disparity between illusion and reality, the breakdown of traditional values and artistry in the face of an industry that mass-produced dreams, the confusion of roles and identity, and the loss of wholeness, integrity, and a sense of community. Hollywood, West believed, epitomized America: 'The Angelinos would be first,' Tod realizes, "but their comrades all over the country would follow. (Fine 1978, 61)

In similar fashion, much of the wider American culture was also ready for a new universe. California contained a thick concentration of such souls and provided a cultural hearth (Sauer 1925) for new aspects of the American society. Among the cultural aspects was a willingness to accept a new understanding of the universe. As the Californian culture spread its influence eastward through literature, motion pictures, and economic power, it also spread another cultural product, the Californian Universe.

John Fante and the Eclectic California Culture

In a forward to an anthology of critics on California writers Kevin Starr wrote: "California is in the throes of a massive eclecticism of culture that almost defies either conceptual or symbolic understanding. Its titanic energies are scattered in a hundred different directions. Its thought is vigorous, but of bewildering pluralism" (Crow 1978, xi). This observation has been true of Southern California since the 1920s. Many walks

of life and subjects of interest seem so remote from the field of astronomy that any comparison would be rendered instantly useless. Yet, one underlying narrative seems to permeate vastly disparate genres of Southern Californian cultural products. In literature, the ubiquitous narrative involves the "outsider" who comes to accept his position as "one of the many" who occupy Southern California.

The vast majority of Mount Wilson astronomers migrated from white, middle-class homes in the American Mid-West and chose to make Pasadena their permanent residence. Although many astronomers were creative, their work ethic and ordered lifestyle categorized them as "Babbitts" as opposed to "Bohemians." Babbitts and Bohemians were two of the most significant stereotype labels applied to people in the United States during the 1920s. The term "Babbitt" was inspired by Sinclair Lewis' portrayal of the American middle class in *Babbitt* (1922) (Garner et al. 2007, 1). It quickly came to be associated with the philistine tastes and mores of businessmen. Babbitts were often civic minded and desired to recreate the social order of their original mid-western homes in the suburbs of Southern California. Bohemians, on the other hand, were non-conformists who held disdain for the social orders of their previous lives and sought a new and transformative existence within the migrant culture of Southern California.

John Fante's novel *Ask the Dust* (1939) explores the life of a young bohemian writer who migrates to California seeking a life worthy of literary documentation. This story serves as an example of a part of Southern Californian culture seemingly far removed from the life Mount Wilson astronomers experienced in Pasadena. Yet, the contrast in ambitions and lifestyles between the astronomers and Fante's characters

reveals important clues regarding the larger Southern Californian culture in which the astronomers were living. It may also suggest some universal beliefs and attitudes that crossed cultural lines and enabled the widespread acceptance of the new vision of the galaxy proposed by Mount Wilson astronomers.

Ask the Dust is the second in a series of three stories that depicts the life of a young writer of Italian descent in Los Angeles during the Depression era. The writer's name is Arturo Bandini and *Ask the Dust* focuses around his relationship with a Mexican immigrant waitress, Camilla Lopez. Bandini meets Lopez in a local bar and a love/hate relationship instantly ensues. Their relationship is powered by sexual lust but retarded by their desires to respond to a socially determined regime of success. Bandini is seeking a Californian blonde to prove he has achieved status as a man and a writer. Meanwhile, Lopez desires a man with a typical American last name to demonstrate that she belongs in America. Adding to the complexity of the relationship is Bandini's narcissism and Lopez's addiction to marijuana. Additionally, Lopez has a preexisting love affair with another struggling writer who is dying but has a more American sounding name. Bandini seeks sexual relief in the arms of an older woman who has been scarred and deformed by a fire. Her husband could no longer look at her body and left her. Bandini, seeking his first sexual experience, is willing to overlook the injuries. However, the affair ends when the woman is killed in the 1933 Los Angeles earthquake. Bandini successfully publishes his first autobiographical story about his relationship with Camilla and his eventual first sexual encounter. However, he is left empty without the ability to impress Camilla. This leaves Bandini desperately searching for Camilla who has disappeared into the desert and

has most likely died. *Ask the Dust* ends with a frustrated Bandini throwing his recently published book out into the empty desert.

One important aspect of Southern California's cultural geography vividly portrayed by Fante is its fragmentation. The region is not only fragmented horizontally by multiple city centers and vertically by economic class, but also, each community is further divided by race. Fante's Bunker Hill is populated by "an assortment of immigrants and ethnics – blacks, Filipinos, Portuguese, Mexican – crowded together with poor whites in a few square blocks in the center of the city" (Fine 2000, 187). The region's fragmentation was intensified at the individual level and mitigated within the larger society by the border region mixing of cultures within the lower-class communities. As one critic of Fante's worked expressed: "The border residents of Depression-era L.A. operated outside the WASP mainstream of L.A. but their existence was informed by numerous cultures including the Anglo one" (Kordich 1995, 18).

Additionally, as migrants continued to swell the population and fuel the economic base of the region, displacement of communities and the adaptation of old ways of life to new realities became commonplace. One historical geographer explains: "In the early decades of the twentieth century a 'growth machine' spurred local development that rapidly transformed the city's physical environment while helping to establish a culture and an economy that continued to thrive upon artistic, scientific, industrial and personal invention and re-invention" (Davidson 2007, 56). Another key change that impacted the various migrant cultures was the extension of the credit system to the poor. The possibility of acquiring imitations of items previously reserved for the elite led to overarching cultural values and a blending of desires among individuals of disparate

cultural groups. Melissa Ryan, a critic of Fante's work, sums up the impact of the consumer culture upon poor neighborhoods such as Bunker Hill:

> For twentieth century America, taking possession of an identity means participation in consumer culture. The twentieth-century American, in short, is an owning self. The rise of credit during the post-World War I years brought about an explosion of consumer potential for a new kind of middle class, and in a context of subsequent economic crisis, things became a particularly potent index, a way of measuring oneself. (Ryan 2004, 189)

Such economic expansion often meant the physical destruction of poor communities to make room for new industry and profits. Self-reinvention often resulted in the dismantling of the pre-existing cultural norms of the group. Therefore, the individual segments of the fragmented communities of Southern California were simultaneously subject to upheaval from within and without.

Social upheaval was not unique to Los Angeles, but as "a young, far-western American city…it has become a high-profile symbol of urban-based modernity" (Davidson 2007, 59). David Fine notes: "Like the characters in all immigrant and migrant literature, those in Los Angeles fiction are poised between imagined futures and remembered pasts" (Fine 2000, 134). However, the rapid pace of physical and financial changes, fragmentation of society, and intermingling of cultures within the border atmosphere of the Los Angeles basin may have led to a more individualistic interpretation of one's history while at the same time resulting in a more universal

acceptance of an idealized future than experienced in any other cultural region of the nation.

Fine ultimately concludes: “The irony in *Ask the Dust* is not directed so much outward at the city as failed paradise as it is inward toward its narrator Bandini’s own self-deception” (Fine 2000, 187). Bandini’s self-deception revolves around his desire to accept what he wants to believe as real despite his knowledge that it is a fabrication. For example: Fante describes the multitudes of middle-aged mid-westerners who migrated to California in search of a new opportunity but were “doomed to die in the sun” with just enough money to “keep alive the illusion that this was paradise” and that “their little papier-mâché homes were castles.” Fante’s protagonist alter ego, Bandini, identifies with these mid-westerners, stating: “These were my countrymen, they were the new Californians” (Fante 1939, 45). Bandini is also acutely aware of the “tens of thousands of others” who occupy the city of Los Angeles who cannot afford a polo shirt and sunglasses. However, despite his awareness of the plight of each of these groups, Bandini still believes his dreams are possible in California. The images and stereotypes of California as paradise and a place where anything is achievable prove too pervasive to be vanquished by reality.

Fante presents Bandini’s delusions of California as a widespread cultural phenomenon that impacted the entire nation. The “picture magazines glutting the newsstands of every corner in America” did not address California’s faults and the plight of the masses (Fante 1939, 46). In Fante’s vision of California, the prospect of possessing a sleek woman or living in a luxurious home was a convenient lie that everyone wanted to believe. In particular, “the folks back home” wanted to believe in

California because “soon or late, they want to come to paradise, too” (Fante 1939, 46). In this way, Fante masterfully depicts Americans as desirous to believe in California as a land of opportunity and as prospect for their own future. It is possible that a similar attitude was conjured regarding the work of Californian scientists in general and the astronomers of Mount Wilson specifically. Americans wanted to believe that humans could solve the mysteries of the universe, and Mount Wilson seemingly provided the ideal combination of people, technology, and geography to make it happen. Just as newsstands across America sold the belief in California as a paradise, dramatic images of celestial objects helped sell a new understanding of humanity’s place in the cosmos. In such a new universe, an average star in a remote region of a typical galaxy could be remarkable enough to harbor a planet such as Earth. Such a concept could appeal to all walks of life.

Summary

When Edwin Hubble arrived at Mount Wilson in 1917, the universe was understood to be a celestial sphere with the Sun located near its center. By the end of the 1930s, American society had accepted Plaskett’s diagram of the spiral Milky Way Galaxy and mankind’s peripheral position in the cosmos. The cultural hearth of this American understanding of the universe was Mount Wilson Observatory in Southern California. The advent of the automobile may have been a significant culturally intertwined technological factor in the creation and acceptance of this radically new understanding. The automobile’s ability to horizontally traverse the fragmented and diverse cultural segments of Southern California and to vertically scale the elevations that separated the social classes allowed the region to be understood as a single cultural

region. Additionally, the extension of credit to the lower classes and the exposure to Hollywood productions enabled and encouraged Southern Californians to imagine a level of social mobility that was unattainable by the vast majority of people from all walks of life. This led to a high-level of social discontent and a desire for a new ordering of society. The resulting Southern Californian culture was therefore ready to accept new ideas that challenged accepted orthodoxies.

Additionally, the public generally held astronomers in high regard because of their public persona. Astronomers were pictured working in high, remote places that challenged their physical manhood while freeing their mental abilities; were considered independent thinkers; often were influential community members despite middle class backgrounds; and, despite being cosmic historians, their work was associated with the future. Their theories appealed to many disillusioned Californians who desired a reordering of society. Key literature of the time depicts people of all backgrounds and classes coming to grips with their place as members of a greater Californian culture. In most cases, their self-image is reduced from lofty, unique, and special to ordinary or just one of the masses. This restructuring of individual prospects parallels the declining significance of the solar system and the heliocentric astronomical theories of the day.

Finally, the urban geography of Southern California matches and possibly inspired the new structure of the Milky Way as theorized by Mount Wilson astronomers. Unlike other cities with strong centers the Los Angeles basin was a sprawling and growing metropolis, located on the periphery of the American sphere with no central core. The galaxy conceived by Shapley placed human civilization on the periphery of a great swirling mass of stars. Ultimately, the universe described by Hubble was

comprised of millions of similar galaxies with no discernable center. Of course, all evidence for a direct correlation between place and the development of scientific theory is destined to be circumstantial. Nevertheless, the degree to which the new universe conceived at Mount Wilson parallels the physical, social, and cultural geographies of the region of its birth are striking and worthy of further examination.

CHAPTER V

ESTABLISHING ONE'S PLACE IN THE MINDS OF OTHERS

In the mid-1920s, California began asserting itself as a dominant American "regional civilization" and Los Angeles' society became the "matrix of the California Dream for the rest of the country" (Starr 1973, 415; Starr 1990, 392-394). This unique culture became an influential catalyst for change throughout America. Chief among its cultural products were the motion pictures and images of a Californian lifestyle created by the Hollywood studio system. Biographies and historical accounts of the astronomers at Mount Wilson and members of the motion picture industry conclusively indicate that the two groups belonged to different social networks with no meaningful contact. They had different aims, interests, and values, and seemingly little in common. Yet, the Mount Wilson astronomers' influence upon the American scientific community expanded at the same time as Hollywood's influence upon the American culture. Astronomers and motion picture producers were each responsible for unique cultural products. They often used similar tools, methods of production, and had similar personal motivations. Both groups were immersed in a rapidly growing urban region that "thrived on a set of new or expanded industries" including oil fields, automobile assembly plants, airplane manufacture, sportswear, and tourism (Meinig 2004, 170). While the motion picture industry and its glamor is rightfully considered the most influential industry of Southern California, the "California Universe" produced by the Mount Wilson astronomers ultimately resulted in a new understanding of Earth's place in the cosmos and may prove to be the region's most enduring, substantial, and important cultural product.

Walter Adams

Walter S. Adams (1876-1956) succeeded Hale as director of the Mount Wilson Observatory two months after Hale submitted a letter of resignation and recommendation of Adams to John C. Merriam, president of the Carnegie Institution, in late March 1923 (Christianson 1995, 169; Sandage, 2004, 94). True to his nature and out of respect for his longtime friend, Adams initially rejected the offer and insisted that Hale remain the director. Adams accepted the position only after Hale convinced Merriam that his health had deteriorated to the point where managing the observatory would be untenable (Hale 1923, 1). Even then, Adams insisted that Hale remain as an Honorary Director and that they both receive the same $8000 annual compensation (Christianson 1995, 170; Merriam 1923, 1). Although Adams had been with the observatory since its founding, served as its Assistant Director since 1910, and often served as Acting Director during Hale's many absences, he preferred to avoid lofty titles, self-promotion, and the spotlight of leadership. Nevertheless, once he took the reins, he successfully led the observatory for the next 23 years (Stratton 1956, 140).

After his retirement, Adams wrote that the history of the Mount Wilson Observatory was "the story of the insight, enthusiasm, and courage of a single individual", George Hale (Adams 1947, 213). He was wrong. Adams spent most of his life working on Mount Wilson and in Pasadena with the aim of advancing science. He had accompanied Hale on the early scouting visits to Mount Wilson, he was among the original staff, and he kept the observatory running when Hale was sick, on vacation, or representing the scientific community in Washington and abroad. He was there when the Snow solar telescope, the Mount Wilson 60-inch telescope, and the Hooker 100-inch

telescope saw first light. Adams was involved in the hiring of nearly all of Mount Wilson's key astronomers during the first four decades of its existence. He managed the observatory's budget, wrote more than 250 astronomical publications, and "prepared the *Annual Reports of the Director of the Mount Wilson Observatory* for the Yearbook of the Carnegie Institute of Washington for nearly thirty-five years" (Joy 1956, 291).[25]

The initial Carnegie funding for the Mount Wilson Observatory was approved on Adam's twenty-seventh birthday. Fifty-two years later, his memorial service was held in the observatory's library just weeks after his final publication: "Notes on the Shell Lines and the Radial Velocity of Alpha Orionis" appeared in the *Astrophysical Journal* (Stratton 1956, 139). Adams had dedicated his life to the work of the observatory. Hale may have been the visionary whose energy brought about the existence of the observatory and its giant telescopes, but ultimately it was Adams who became the institution's heart and soul.

Adams was born in Kessab, Syria in 1876. His parents were missionaries of "old Puritan stock from New Hampshire, to which they returned" when Adams was nine years old (Joy 1956, 285; Sandage 2004, 93). Adams retained many memories of his childhood in Syria and retold the stories throughout his life. Greek and Roman ruins dotted the landscape around his father's home and the remains of an ancient Crusader castle lay in his back yard. Distractions and opportunities for entertainment were rare in such an

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[25] The average length of the *Annual Reports of the Director of the Mount Wilson Observatory* was thirty-five pages. It included a very detailed account of all work accomplished at the observatory, major publications by astronomers at the observatory, and a resume of each astronomers' accomplishments. Adams also prepared abbreviated accounts for distribution to the greater scientific community through the Astronomical Society of the Pacific and the American Astronomical Society. Mount Wilson astronomer, Alfred Joy states: "These reports were prepared with great care and constitute a fair and unvarnished record…to the best of my knowledge no member of the staff ever took exception to the description of his work recorded in the *Annual Reports*" (Joy 1956, 291).

isolated location, so Adams took to reading the numerous histories, classical texts, and treatises collected in his father's theological library. Hale had a personal fascination with the Middle-East and Arabic cultures and likely found a kindred spirit in Adams. Hale would come to consider Adams his "closest astronomical friend" (Wright 1966, 137). Hale also respected Adam's "New Englander's dedication to work and duty" and his seeming delight in the highly demanding daily routine required of an astronomer involved in long-range projects (Sandage 2004, 94).

Regarding his leadership style, Harlow Shapley states: "Adams was not a slave driver; he was an operator – an inspirer, in a way. He drove himself and he expected others to do the same thing" (Shapley 1969, 51). This statement is high praise from a man who often did not get along with Adams. Adams thought Shapley's measurements of the size of the Milky Way were flawed and based on very limited data. The dispute became personal when Shapley and his ally, Adrian van Maanen (1884-1946), continued to flaunt their theory that the Sun was located in the arm of a single large galaxy that comprised the universe. Shapley went so far as to compare the importance of his observations to Copernicus' revelation that Earth was not the center of the Universe. Even after his measurements were proven inaccurate, Shapley considered his own work to be "revolutionary" thinking that "opened up a part of the universe that had not been known before" (Shapley 1969, 59). Meanwhile, van Maanen had a wide circle of friends that included the social elites of the Pasadena community. Like Hale, van Maanen used his work at the observatory to attract new friends who offered him invitations to events, clubs, and "venues for the city's movers and shakers" (Sandage 2004, 129). However, unlike Hale, van Maanen's primary objective was purely social as opposed to raising

money for the observatory. Because of such attitudes, Adams thought Shapley was a "prima donna" and that van Maanen was a "playboy" and an example of "a reprobate masquerading as a serious scientist" (Christianson 1995, 170).

As early as 1917, Adams complained about Shapley's propensity toward grandstanding his accomplishments. In a letter to Hale, Adams states that Shapley has talent but: "has never given credit where it belongs" (Adams 1917, 1). Shapley was aware of Adams' image of him and unintentionally demonstrated why it had merit when he expressed: "no opportunity will be given me…so long as Adams has the deciding voice…[v]an Maanen and I are in ill-favor because we try to do too much" (Smith, 1982, 77). Later, Adams would have similar misgivings about Hubble's intentions regarding his extended trips in 1922 to England, France, and Germany. Adams also had concerns about Hubble's use of his attractive, wealthy, and well-connected wife, Grace, to attract and host some of the world's most prominent scientists including Sir Arthur Eddington and James Jeans (Christianson 1995, 171).

At the center of the animosity between Adams and many of the astronomers who worked at Mount Wilson was Adams' interest in the success of the institution juxtaposed with the astronomers' desire for individual recognition and fame. Adams watched as Hale successfully lobbied for the inclusion of a formal debate on the measurement of stellar distances to be presented to the 1920 meeting of the National Academy of Sciences (Trimble 1995, 1). Hale and Adams hoped that this event would establish Mount Wilson and its large reflecting telescopes as the premiere center of modern cosmological theory. Hale had set aside a fund in the name of his father to support such events (Shapley 1969, 81). The observatory financed Shapley's trip to the meeting in

order to gather scientific consensus behind the use of Cepheid variables as measuring tools. Shapley did a fine job and the effort was largely successful. However, Shapley also used the event to promote his own agenda and ultimately secure a position as the Director of the Harvard College Observatory. Years later, Adams was appalled at the successful request made by Hubble to the Carnegie Institute that he be paid travel expenses and his regular salary while he and his wife undertook a lecture tour in Europe. In a candid letter to Carnegie Institute President Merriam, Adams states:

> In Dr. Hubble's case I find very great difficulty in understanding his attitude toward the organization which has made his scientific work possible. I do not think it in any way deliberate but results from an extreme form of individualism and personal ambition, together with a type of obtuseness regarding his relations to the institution and other scientific men. (Adams 1935, 2; Christianson 1995, 254)

Adams was notoriously frugal. He implemented a midnight-lunch basket program that effectively limited food consumption by the astronomers and according to observatory assistants he required the use of nothing greater that 25-watt light bulbs to save the observatory money (Sandage 2004, 192). Adams was roughly a decade older than Shapley, van Maanen, and Hubble. He had spent the extra years working at Mount Wilson and living in Pasadena. Adams had moved to Pasadena when it was a "town of about fifteen thousand inhabitants spread widely over a large area" with "orange groves intersected by rambling dirt roads" some of which were not even oiled (Adams 1947, 213). The observatory could only be accessed via an arduous journey that usually involved a mule. The business district of Pasadena comprised only a couple of blocks

and at its Southern end had the beginnings of a wooden structure designed to one day allow cyclists to avoid “roads deep in sand and the inconveniences of horse-drawn traffic” when riding to Los Angeles (Adams 1947, 214). By the time the younger men arrived, automotive traffic had replaced bikes, horses, and mules, paved roads extended all the way to the observatory, and the rapidly expanding population of Los Angeles County exceeded a half-million (Hornbeck 1983, 94).

Adams’ earlier experiences in the area resulted in his becoming set in a pattern of life that had little importance to the younger astronomers. One of his only indulgences to image was in smoking a pipe that matched his New England personality. He would read *The New York Times* while walking to the Pasadena office building from his modest bungalow home; a daily routine so regular that “people in the neighborhood set their clocks by his passing” (Christianson 1995, 126). Like the artful simplicity of his bungalow home just blocks from the office, California, Pasadena, and the observatory represented something akin to the “bungalow spirit” (Mattson 1981, 78). His home and life in Southern California stood in contrast to the complicated Victorian mansions of his New England adolescence and his college years in the Mid-West. Most importantly, this environment allowed Adams to focus and simplify his life around a singular overriding purpose, the success of the observatory. To Adams, Mount Wilson Observatory was first and foremost an observing station. Its achievements were the direct result of a commitment to diligent examination and the recording of astronomical phenomenon: a policy Adams “consistently maintained in his own work and in his administration” (Joy 1956, 289). His modest and simple lifestyle suited his personality and may have contributed to his extraordinary health. Adams was an avid sportsman and would often

compete against the younger astronomers in tennis, golf, and billiards (Christianson 1995, 127). Shapley once remarked: "He was not a good loser in anything, but being so good he didn't have to lose very often" (Shapley 1969, 51).

Power and Image in Southern California

Healthful living was an important attribute of the Pasadena culture. Pasadena was a politically conservative, upper-middle-class enclave, with a prohibitionist ethos. It was home to many sporting clubs and attracted many health enthusiasts from various walks of life, but not all were completely welcome. Upton Beall Sinclair (1878-1968), author of *The Jungle* (1906), moved to Pasadena in 1916 where he could do what he most wanted, play tennis in a place that offered "-sunshine, healthfulness, a suggestion of social cachet – from the good life in Southern California" (Starr 1996, 124). Adams, Hubble, and van Maanen, like Sinclair, each played tennis at clubs in Pasadena. Tennis allowed for the social interaction of the community's elite in an environment where all cherished health as a common denominator of good living. In his autobiography, Sinclair, a notorious socialist, recounts how he would play tennis each Sunday at the Valley Hunt Club in South Pasadena despite not being acceptable for membership:

> …on the courts I met some of the prominent young men of my City of Millionaires. I was amused to note that their attitude toward me on the court was cordial and sometimes even gay, but we did not meet elsewhere. …We played at the ultrafashionable Valley Hunt Club, but never once was I invited to enter the doors of that club. When the game was over, I mounted my bicycle and pedaled away. (Sinclair 1963, 23)

Shapley, von Maanen, and Hubble arrived in California amidst a flood of new immigrants each seeking their own agenda and measure of success. They entered the Pasadena social scene to find a somewhat schizophrenic community with two distinct cultural personalities. On the one hand, the Arroyo Seco crowd cherished nature, were mainly progressive liberals, lived in modest homes on wooded lots, and read *Land of Sunshine*. On the other hand, the Valley Hunt Club members cherished social status, were mainly conservative affluent families, lived in mansions along Orange Grove Avenue, and read *The Wall Street Journal* (Starr 1990, 193). The natural aspects and environs of the astronomers' work established them as naturalists and made them acceptable to the Arroyo Seco crowd. At the same time, the higher learning required and the social status associated with the publication of their work sometimes afforded them access to the Valley Hunt Club. The liberty to move within the Valley Hunt Crowd was restricted to those with affluent family ties or those perceived to be the most successful. Personal achievement and the fame it engendered was almost certainly more important to the social self-image of the younger astronomers than Adams realized. To men the age of Adams, the first component of the good life may have been health, but to younger men such as Hubble, it was the social connections afforded them because of their individual accomplishments that mattered most.[26]

A hypersensitivity to image and society's recognition of personal accomplishment was widespread throughout Southern California. This attribute of the culture went far beyond individual pride and ego. A unique combination of geography and industry may

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[26] Their differing agendas for playing tennis may also explain why Adams who was in his early 40s could compete successfully with van Maanen, who was in his late 20s (Christianson 1995, 127).

account for why a self-made image seemed to be more important in Los Angeles and its surrounding suburbs than any other location in the United States. First, Southern California, in the early 1900s, had no preexisting industrial base or fixed economic identity. This fact, combined with its peripheral location in relation to the American core, allowed Southern Californians to be less bound by investments in the status quo and more willing to invest capital and personal ambitions in new ideas and industries (Dodgshon 1998, 183-184). Geographer, Sir Peter Hall, describes the Los Angeles region around 1910 as a major center of innovation:

> Los Angeles was the city of novelty, the place that from the start was determined to owe nothing to history. So it was perhaps natural that this city should have become the crucible of new ventures; enterprises that elsewhere, in the gray world of reality, might have seemed frivolous or fanciful, but that here, seen in the preternaturally bright light of California, appeared full of promise and profit. (Hall 1998, 520)

Second, the primary industry that emerged within the region, the motion picture studio system, had at its core individual creative energy and a focus upon marketing the products of this creativity (Schatz 1988, 15). Hall points out that the Jewish immigrants who established the motion picture industry in New York and their sons who moved the industry to Hollywood were “classic Schumpeterian new men” (Hall 1988, 526).

Schumpeter, an early twentieth century economist, challenged the prevailing neoclassical economic theories of his time by focusing upon the entrepreneurial activities of innovative leaders as the primary catalyst for economic growth and accumulation of capital (Ruttan 2003, 136; Schumpeter 1934, 57-94). Schumpeterian theory places great

weight upon the credit awarded to individuals based on entrepreneurial contributions. Ruttan extends the Schumpeterian credit system to include activities outside of private industry. He states: "An even more inclusive interpretation of Schumpeter's thought would find it useful to extend the concept of entrepreneurship to include the engineers and scientists who are the sources of strategic technical and scientific innovations and to the bureaucratic entrepreneurs who are the sources of many innovations in the institutional infrastructure of modern societies" (Ruttan 2003, 137). Therefore, the founding of the observatory, the activities conducted within, and the scientific theories (cultural products) produced at Mount Wilson fill the same role as the Hollywood studio system within the Schumpeterian economic model. Additionally, the assignment of credit for the production of a theory would be just as important to the astronomer as the profit awarded a producer for the successful creation and marketing of a film. This "credit" translated into social status and connections for astronomers and further expanded their access to the elite of the Southern Californian community in which they were embedded.

However, even when profit was the primary goal, proving one's good fortune as "self-made" remained of paramount importance in Southern California. A family name might suffice and garner substantial clout in the American core. However, because nearly everyone was a recent immigrant and there was no established birthright to power or wealth, respect in Southern California had to be earned by individual achievement. The importance of this aspect becomes clear when examined on the personal level. A portion of a letter written by the legendary producer of the famous movie *Gone with the Wind* (1939), David O. Selznick (1902-1965), to his father-in-law, Louis B. Mayer

(1884-1957), majority owner of the Metro-Goldwyn-Mayer Corporation (MGM), is a good example. In this letter, Selznick defends his refusal of a generous employment offer made directly to him by his father-in-law on behalf of MGM. Selznick states:

> I have had a great deal of satisfaction out of a feeling that in a comparatively short space of time, I have advanced my career appreciably; on my own efforts. This sense of accomplishment would be seriously impaired, and much of the fun of life and work gone, if I took my place in an organization in which I would be a relative – an inlaw [sic], what's worse! – of the company's head. I share the opinion of the world about the generality of relatives in business, even conceding that there are exceptions. I know what is thought of them in business generally; what is thought of them within the industry; and, yes, even what is thought of them at MGM. It is not that I care so much what other people say or think as that these opinions must inevitably have a result on the advancement of my career. One doesn't get ahead in business without the esteem of his fellow workers. And, even more than this, I cannot face the prospect of being a relative in business without cringing and without an inevitable subsequent loss of self-respect. (Selznick 1932, 51)

Six weeks after writing his refusal, Selznick would submit to pressure from Mayer, who was looking for a suitable replacement for his protégé and second-in-command, Irving G. Thalberg (1899-1936). Thalberg had gained an extraordinary reputation and was known in Hollywood as "The Boy Wonder" for his uncanny ability to produce successful films (Pawlak 2000, 1). When Thalberg suffered his second heart attack, Mayer seized the

opportunity to replace him with Selznick and another assistant producer (Harvey 2008, 45). Six months after accepting the position, Selznick was begging to be released from his contract:

> I am today regarded, not merely by a few sheets [industry publications]… but by the industry at large as an outstanding example of a nepotism that I must, unfortunately, agree is the curse of the business. Were I on the outside and someone else in my place, I would share the opinions that others have of me today. All past accomplishment is wiped out, because this is a business that forgets yesterday at dawn today; and any appreciation of future accomplishment is impossible because I am not an executive here, as I believe I am, by right of six or seven years of struggle but a relative here by right of marriage…please, please release me from my contract. (Selznick, 1933 71-75)

Selznick was not granted a release from his MGM contract until the summer of 1935 (Behlmer 2000, 75). At that time he initiated his own studio, Selznick International and set about making films his own way. Selznick often used multiple directors to ensure that no single individual could overshadow his role. Selznick used three different directors during the filming of *Gone with the Wind* (1939). Sixty-years after the movie's release, actress Olivia de Haviland, still recalled Selznick's plenary role in its production:

> You would film with one [director] in the morning and the other in the afternoon. Isn't that extraordinary? You would think an actor wouldn't be able to survive that, and that there would be a lack of unity in the film. But that's not the case. It was David Selznick. He just made you feel that this

> was a perfectly all right thing and it was going to turn out splendidly…David was on the set every day. You could feel how much he cared. (de Haviland 1999, 48)

Pride and ambition were certainly not aspects of humanity that were confined to Southern California. However, historian Neal Gabler highlights the key aspect of the existing culture that likely caused additional incentive toward individualism: "unlike in the East, the social structure was primitive and permeable…There was no real aristocracy in place and few social impediments" (Gabler 1988, 105). In his assessment, Gabler is referring to Jewish migration to Hollywood and the growing film industry between 1907 and 1918. But the lack of an established social caste and the seemingly plentiful opportunities to transcend one's current situation could be applied to all walks of life.

The lack of social impediments in Southern California could, however, also cause conflict and stress among colleagues and friends that was detrimental to an organization's goals. One example of conflict that occurred at Mount Wilson during this time period is the subject of historian Donald Osterbrock's book: *Pauper and Prince* (1993). Osterbrock chronicles the deterioration of the relationship between Hale and Ritchey. In 1882, George Willis Ritchey (1864-1945) enrolled in the University of Cincinnati where he studied Astronomy. Unfortunately, his father's furniture company fell on hard times and, lacking the finances to complete his degree, Ritchey withdrew. Five years later he found employment as a woodworking teacher at the Chicago Manual Training School. The school was sponsored by Chicago businessmen, one of whom was Hale's father. This put Hale and Ritchey in contact and by 1894 they began a working relationship. Hale immediately recognized Ritchey's interest and competence in astronomy and his

self-taught ability in mirror grinding and mounting. When Hale became director of the Yerkes Observatory in 1897, he hired Ritchey as his chief optician (Sandage 2004, 96). Four years older than Hale but still lacking a formal degree, Ritchey became an indispensable asset to Hale when he made plans to build an observatory on Mount Wilson.

Ritchey was placed in charge of the five man team preparing the 60-inch mirror, as well as the design of the telescope mount, and even the crew that was building a rudimentary road to the top of Mount Wilson. Ritchey's salary from the initial Carnegie grant was $4000 per year, just $1000 less that Hale and far more than Adams' $1500 per year (Osterbrock 1993, 79). The Ritchey-Hale partnership was by all accounts ideal until the summer of 1908 when Hale was absent due to illness and Adams was on vacation. Ritchey was placed temporarily in charge of the observatory. A question arose regarding insurance for the 60-inch reflector and Ritchey refused to look into the matter. At the time he was intensely making final preparations to the telescope's mirror. Hale was very disturbed by Ritchey's inaction because: "Unlike Adams, Ritchey was unwilling to put aside his immediate technical or scientific concerns" and fill in as an administrator (Osterbrock 1993, 79).

The situation grew much worse when Ritchey used his fame gained with the success of the 60-inch telescope to launch his own business: G. W. Ritchey & Son, Pasadena California, Reflecting Telescopes and Specula.[27] He then solicited Hooker (the financier of the 100-inch mirror) to provide money for a "special photographic

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[27] Ritchey had also bought a plot of land in Azusa, ten miles east of Pasadena, where he was attempting to start a lemon ranch (Osterbrock 1993, 127).

laboratory". Hale lost trust in Ritchey and saw this move as an attempt to usurp money away from the observatory and use it for personal commercial interests (Osterbrock 1993, 111). Hale reduced Ritchey's pay to $3000 per year and placed him on a contract contingent upon the completion of the 100-inch telescope. Then, in January 1911, Adams discovered that Ritchey had ordered and was using stationery that had "Professor G. W. Ritchey" and the Mount Wilson Observatory's address on it. Adams felt Ritchey was using this for his personal gain by boosting his company's association with Mount Wilson (Osterbrock 1993, 125). Hale agreed with Adams and Ritchey's pay was again reduced, this time to $1500 per year, and in November of 1912 he was replaced by Francis G. Pease (1881-1938), his former assistant, as the man in charge of the 100-inch telescope's design.

The loss of income hurt, but Ritchey's business continued to do fairly well and his reputation remained intact. Since Ritchey's reputation was already established as one of the Mount Wilson patriarchs, Hale was unable to thwart his current fortunes and instead focused on his future standing in the legacy of the Mount Wilson Observatory and the field of astronomy. In 1913, Zoeth S. Eldredge (1846-1915) was editing a five volume history of California and personally writing its section on astronomy.[28] Hale had the final review of the material and ensured that Ritchey's name was deleted from the paragraphs describing "excellence" of the optics or "success" of the observatory. Hale also did not support Ritchey's nomination for the prestigious Royal Astronomical Society Medal. Osterbrock concludes: "Hale had succeeded in the beginning of his campaign to make

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[28] Eldredge edited *History of California: The Rise and Progress of an American State*, 5 volumes, New York: The Century History Company, c.1915.

Ritchey an ‘un-person’” (Osterbrock 1993, 134-137). While the basis of this trite battle of personalities cannot be verified, it is likely attributable to the upward mobility and freedom Ritchey experienced in California and to his misperception of the way his ambitions were perceived by his fellow astronomers.

Southern California, Motion Pictures, and Astronomy

The Mount Wilson astronomers and the Hollywood executives were each groups comprised of Schumpeterian new men who had migrated to Southern California in the first two decades of the twentieth century. Beyond their recurring personal conflicts over credit and control, these creative organizations had several additional similarities. Both the movie industry and Mount Wilson Observatory benefited from several geographic and cultural aspects of the region. Among these aspects were clear skies, cheap land, an underdeveloped social structure comprised of self-selected migrants, and the remoteness of Southern California within the American sphere.

Carey McWilliams concludes in his book, *California: The Great Exception* (1974) that California’s “uniqueness and novelty of the environment, coupled with its amazing versatility, operates as a constant challenge to social and technological inventiveness” and that “forces at work in the process of migration bring to the state a population that is not so much a cross-section as a highly selected sample of the population of the world” (McWilliams 1949, 364-365). The human composition of the Mount Wilson Observatory and the Hollywood studio enterprises were each comprised of self-selected entrepreneurial migrants who were attracted to California because of the opportunities its unique environs provided. Each group sought geographical advantages provided by Southern California’s climate, landscape, remoteness, and human

population. The benefits of these factors upon Mount Wilson astronomers have been extensively explored in earlier chapters. This study will now briefly focus upon the geographic catalysts that gave the motion picture industry in Southern California significant advantages over studios in other locations.

Christopher L. Lukinbeal, a historical geographer who specializes in the study of film production, identifies climate, topography, the need for geographic realism in Western films, and economic concerns as the four factors that contributed to the westward migration of the film industry in the early 1900s (Lukinbeal 2002, 252). Movie companies began moving to Southern California as early as 1906.[29] "William Selig shot a film in Santa Monica and then established a studio in Los Angeles two years later" (Gabler, 1988, 105). Selig's film, *The Count of Monte Cristo* (1908) was billed by the Selig Plyscope Company as a full reel feature comprised of 1,000 feet of film. The indoor scenes were shot in Chicago prior to the move to Southern California where a completely different set of actors finished the outdoor shots (Ramsaye 1926, 533). Like the patriarchs of the Mount Wilson Observatory, many of California's large independent film making companies had their roots in Chicago. During this time, Chicago was "the center of the independent movement, the place where the exchange men rebelled against the Trust and began new, independent production companies" (Bowser 1990, 149).

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[29] In 1906, D.W. Griffith, producer for the Biograph Company, established a studio in Los Angeles. Agents from Majestic, IMP, Vitagraph, and many others soon followed. The Nestor film company was the first to set up offices in Hollywood proper in 1910. In 1911, at least ten motion picture companies operated in the vicinity of Los Angeles. By the time Louis B. Mayer moved to Los Angeles in 1918, eighty percent of the world's movies were produced by over seventy companies within the Los Angeles area. (Gabler 1988, 105; Ross 2001, 257).

Southern California's remoteness was particularly appealing to independent producers seeking to avoid the long arm of the Trust.

The Trust, also known as Thomas Edison's Motion Pictures Patent Company, was designed to pool camera, film, and process patents together and have them legally interpreted "in the broadest possible terms" in order to monopolize and control the film industry (Musser 1990, 238). Between 1902 and 1915 an increasing number of New York studios joined Edison in his efforts. The Edison licensing system was supported by the courts as early as 1907 and the Trust became an officially sanctioned organization in 1909. "The Trust regulated film lengths, salaries, admission costs, discouraged feature-length films and required that actresses and actors remain anonymous to keep their salaries low. … Independent film makers were forced to purchase cameras and film from the black market" (Lukinbeal 2002, 251). The actions of the Trust reportedly went far beyond what they could enforce in the courts. Independent picture makers would have their cameras stolen, "mysterious chemical accidents" would destroy costly negatives, and occasionally riots would break out when the Trust would hire thugs to apply as extras in movies in order to disrupt filming (Ramsaye 1926, 533). While Chicago afforded limited safety from the Trust, Southern California's remoteness offered much greater immunity.

In the early 1900s, audiences were more interested in picture quality and film length than subject, plot, or acting (Salt 1983, 51).[30] In some ways, this was analogous to the public's interest in the building and use of the world's large telescopes without regard to the potential scientific merit or purpose. Indeed, the fundamental attributes that

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[30] The Trust was broken up in 1915 by federal legislation.

initially drove investment in each fledgling enterprise was instrument size (length of film) and resolution (picture quality).[31] These attributes were praised in their own right as accomplishments. Only later would subject, plot, celebrity, and quality of acting become driving economic considerations, just as only later did scientific theories produced by using large telescopes become more important than the existence of the telescopes. The notoriously clear skies and bright sunshine of Southern California provided the climate and landscape required to make the production of long films economically viable, just as it offered a suitable location to invest in building the world's largest telescopes.[32] The economic advantages of filming in Southern California continued to expand through the World War I era. "In Southern California one could shoot outdoors in the dead of winter, which was a tremendous advantage" and during the war, coal shortages made it difficult to generate power for the klieg lights always needed to film indoors and needed outside on most days in Chicago or New York (Gabler 1988, 105).[33] Even when scenes were shot "indoors" in Southern California, sunlight was instrumental. Most indoor sets were four walls with no roof, allowing natural light to illuminate the setting.

While cheap labor and cast "extras" were not as plentiful as they were in the east and mid-west, "Los Angeles provided a stable economic base for production while the surrounding areas provided the geographic realism to ground a diverse array of

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[31] Audiences had few demands regarding motion pictures in the first several years of the twentieth century. In this instance, the term "film quality" refers only to sharp focus and correct exposure. Just about any correctly exposed and sharp image would draw an audience (Salt 1983, 51).

[32] "Fordism dominated the Golden Age of American film making. Products became standardized, measured, and sold by the foot rather than by content" (Lukinbeal 2002, 253).

[33] Klieg carbon arc lamps were first used during the filming of the Jeffries-Sharkey fight on November 3, 1899 at the Coney Island Athletic Club Arena (Ramsaye 1926, 408).

narratives" (Lukinbeal 2002, 252). The synergetic relationship between the congruent human and natural landscapes of Southern California in the production of motion pictures is very similar to the advantages of mountaintops and clear skies so close to an industrial base capable of manufacturing, maintaining, and supplying the equipment used at Mount Wilson. However, while the astronomers were seeking the single best location for their work, motion picture producers were seeking a wide variety of landscapes. Fortunately, as early cinema historian Eileen Bowser points out California landscape was:

> …not only spectacular but extraordinarily varied. Summer greenery and winter snow, sunny beaches, barren deserts and rocky mountains were all within a short distance of each other. Florida and Texas could supply the climate for year-round outdoor filming, but they did not have quite the range of scenic choices within a day's trip from the studios. Even the light of California was different, gently diffused by morning mists rolling in from the Pacific or by dust clouds blowing off the sandy hills. (Bowser 1990, 151)

The proximity of a variety of landscapes that provided geographic realism for filming diverse landscapes on location is clearly demonstrated by a Paramount Studios filming location template from 1927 (See Figure 22).

Regardless of the need for a single ideal location or many locations, the overall goal of astronomers and motion picture producers was to create a plausible "second space" within the minds of their audiences. While "first space" is the world we experience or perceive, Lefebvre describes second space as the "conceptual space [of] scientists, planners…social engineers… and philosophers" (Lefebvre 1991, 33). This

concept can be expanded to include almost any mental image, graphic understanding, or shared imaginative state. In the case of film makers, "Second space is constrained by *mise-en-scene*, or the space framed by the camera's visual field" (Lukinbeal 2000, 27). Because movie sets were expensive and lacked details, multiple locations that provide a high-degree of geographic realism were ideal for the motion picture industry to create a continuous supply of varied storylines and the effective second spaces their products needed. The situation in astronomy was entirely about such second spaces. Because the conceptual understanding of the Milky Way as explained by astronomers required only the mental capacity of the reader, geographic realism was not required. In fact, experiencing the Milky Way in first space could detract from its explanation in second space. Astronomers had to overcome the natural perspective of their audience and mentally transport them outside the Milky Way in order for them to peer back upon its entirety and understand the second space they had created. Therefore, astronomers had to rely upon a high level of social esteem and respect, as opposed to geographic realism, for their interpretations of the cosmos to be believed and accepted as real.

It can also be argued that aspects of modernity helped to mentally prepare scientific audiences to comprehend a universe in second space that was far different from the universe they experienced in first space. For example: "Cinema and train travel shared the ability to shrink space and time, which provided a 'perceptual disorientation' that tore the traveler out of the traditional space-time continuum and thrust him/her into a new world of speed, velocity, and diminishing intervals between geographical points" (Kirby 1988, 114). Furthermore, the use of lenses and film processing can reveal "aspects of the original that are unattainable to the naked eye yet accessible to the lens"

and "with the aid of certain processes, such as enlargement or slow motion, can capture images which escape natural vision" (Benjamin 1936, II). Once captured on film, the movie scene, globular cluster, or spiral galaxy can be reproduced in its new representative form and distributed for mass consumption. In dramatic fashion, by applying new lenses, mirrors, photographic techniques, theories, and imaginative ideas, motion picture producers and astronomers could rapidly introduce images that served to recast existing social norms, cultural practices, and even the understanding of humankind's place in the universe. Walter Benjamin (1892-1940) concludes in his collection of essays, *The Work of Art in the Age of Mechanical Reproduction* (1936): "The enlargement of a snapshot does not simply render more precise what in any case was visible, though unclear: it reveals entirely new structural formations of the subject. …Evidently a different nature opens itself to the camera than opens to the naked eye – if only because an unconsciously penetrated space is substituted for a space consciously explored by man" (Benjamin 1936, XIII).

Because of its profound effect upon culture, it can be said: "The American Film Industry represents the archetype of the commodification of culture and the creation of a culture industry" (du Gay 1997). Additionally, the concentration of American film production within Southern California due to geographic advantages has led to the existence of "Hollywood" as a metaphor for America's cinematic space. In this sense, Hollywood is a combination of first and second space.[34] People simultaneously

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[34] The production of any cultural product "involves the social practices of first space and the representational systems associated with narrative creation" (Lukinbeal 2000, 27).

experience second space with the underlying understanding that it is a creation of entities existing within a first space based in Southern California. Hollywood "juxtaposes multiple geographies of economics, production, distribution, consumption and the creation of meaning that reflect an industrial process that is tied to social and cultural histories, customs and practices" of the larger social community (Lukinbeal 2002, 250). In this way, Hollywood is representative of Southern California culture and its impact upon the larger American identity. Likewise, because of its parallel use of technologies, geographic and temporal proximity to the rise of Hollywood and the creation of a new second space that disrupted traditional scientific theories, Mount Wilson Observatory can also be described as part of the Southern California culture industry.

In the early decades of the twentieth century, film production in Hollywood and the development of scientific theories regarding the Milky Way at Mount Wilson were part of a large and influential Southern California cultural industry. Though different in many ways, Mount Wilson and Hollywood were shaped by three common and interrelated influences. The first is geographic proximity. Each grew within the culture, economy, and history of Southern California. The second was the process of negotiation, bargaining, competition and debate within the operation of the respective organizations. In both cases, personal relationships were the basis of the formal institutions of power. The third influence involved a process by which key members of the industry, community, region, and nation had the ability to affect the meaning of their products. In the case of the movie industry the key participants included "script writers, executive producers, production managers, actors, location managers, location scouts, property owners and public officials" (Lukinbeal 2002, 251). In the case of the depiction of the

Milky Way, the process involved astronomers, assistants, telescope designers, computers (female technicians), observatory managers, professional journal editors, publishers, private financiers, public officials, and administrators within institutions of higher learning.

Summary

Few would deny that the culture of Southern California had a significant effect upon the motion picture industry. Even fewer would deny that the motion picture industry has influenced American culture. By association, the argument that Southern California has had a profound effect upon American culture is generally accepted.[35] Yet, when the argument is extended to include products of scientific institutions, specifically the changes in the American understanding of the Milky Way galaxy, the influence of Southern California is given little or no consideration. It is often assumed that the tools, techniques of production, subjects selected for study, and application of the scientific method results in "discoveries" irregardless of place. However, as David N. Livingstone warns: "It is only when the practices and procedures that are mobilized to generate knowledge are located – sited – that scientific inquiry can be made intelligible as a human undertaking. In important ways, scientific knowledge is always the product of specific space. To claim otherwise is to displace science from the culture of which it is profoundly a part" (Livingstone 2003, 86).

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[35] Historian, Steven Ross, notes: "By establishing itself as the center of the movie industry, Los Angeles and its studios exerted a tremendous influence over the political consciousness of the nation's citizens. Throughout the 1920s, figures on the political left and right agreed that movies played a vital role in shaping the ways in which millions of people looked at their world; there were an estimated 90 million admissions a week by 1927, a figure nearly equal to the entire population" (Ross 2001, 256).

As demonstrated in this and previous chapters, a large human factor may have influenced the conduct and results of science at Mount Wilson. Funding had to be obtained through the power of persuasion. Personal motivation had to exist for the completion of long term studies. New concepts and interpretations of data were debated in the nasty realm of personal politics before being approved by the senior scientists at the observatory. Once approved, the observatory's work was shaped by battles over its credibility, the prestige of the astronomers who completed it, determination of who would receive credit, and what revisions would ensue. Finally, the observatory's scientific products had to be accepted by the larger scientific community and prepared in a standardized way suitable to the editors of scholarly journals. Even after astronomical theories had been shaped by this human gauntlet of cultural activity, the general public needed to visualize, understand, and embrace them to assign meaning.

This chapter has briefly examined the social interactions of the early Mount Wilson astronomers within their community of Pasadena and during the conduct of professional scientific business at the observatory. It compared the personal conflicts and actions of selected key astronomers to those experienced by a prominent member of Hollywood film industry. The result was a congruent set of concerns regarding creative license, assignment of credit, and public recognition. Next, the geographic reasons for the development and success of Hollywood and Mount Wilson in Southern California were compared. Several environmental and cultural aspects, such as clear skies, cheap land, an undeveloped social structure comprised of self-selected migrants led by Schumpeterian entrepreneurs, and the remoteness of the region were explored that may have influenced both enterprises. Finally, scientific theories and motion pictures were

compared in terms of their ability to create plausible second spaces within the minds others. These comparisons raise the possibility that the new understanding of the Milky Way galaxy was a cultural “product” of Southern California as well as a “discovery” of a scientific institution.

CHAPTER VI

CONCLUSION

For roughly three thousand years prior to the migration of Spanish, Mexican, and white American settlers into the region, the Gabrieleno tribe occupied the area known today as the Los Angeles basin. This tribe was one of many separate tribes that occupied southern California. The various tribes spoke different languages, practiced different customs, and often held different religious beliefs. But, the tribes also retained many larger cultural similarities and often shared specific customs and practices with their neighboring tribes. The fractured, yet culturally and geographically bonded, nature of this community of tribes is somewhat analogous to the modern collection of migrants that came to populate the Los Angeles basin in the twentieth century. Among the cultural traits shared by the Gabrieleno and neighboring tribes was a practice of mystic astronomy and cosmology. They documented their cosmological beliefs in ground paintings using the symbolic depiction of celestial phenomena. The Milky Way, in particular, held these mystic people entranced and "To the wonder and beauty of the Milky Way they returned again and again in their calendars and in their chants" (Starr 1985, 9). Just as the Mount Wilson astronomers who practiced centuries later, Gabrieleno understanding of the Milky Way was dependent upon the tribe's state of technology, pre-existing scientific and religious beliefs, and the common culture of the larger community of tribes.

This study examined the history of scientific theories and technologies that enabled a new vision of the Milky Way to be born in Southern California in the early 1900s. It considered the personalities and backgrounds of the key astronomers involved in this process. It also identified some of the cultural influences present in Southern

California that may have led to a unique understanding and symbolic depiction of the Milky Way. By doing so, this dissertation challenges the positivistic tendency of modern academia to discount the importance of place and culture in the development of scientific reasoning. Just as the Gabrieleno shamans were influenced by their cultural beliefs and surroundings, the astronomers of Mount Wilson may have been influenced by theirs. The products each group created, although centuries apart, attempted to symbolically represent humanity's place in the cosmos. Certainly, the scientific method offered Mount Wilson astronomers a measure of insulation from cultural influence unavailable to the Gabrieleno Shamans. However, one of the key findings of this study is the assertion that the protection from cultural influences assumed to be provided by modern science may have been overstated.

The most fundamental difference between the symbolic representation of the Milky Way produced by the Mount Wilson astronomers and all previous cultural representations is the perspective from which the Milky Way is viewed. Californian astronomers depicted the Milky Way from a vantage point outside of the galaxy. All other depictions had been from a perspective within the galaxy, specifically from the surface of the Earth, which was presumed to be at or near its center. Instead of standing upon the Earth and viewing phenomena above it, modern representations of the Milky Way transport the viewer outside the galaxy to gaze upon its entirety. Instead of a river or stairway to heaven, the Milky Way is symbolized as a spinning spiral of stars.

This level of symbolic interpretation, unlike earlier cosmologies, is not naturally intuitive. It defies intuitive meaning because "there's no way to have intuition about things one has never experienced" and it is "based upon unfamiliar concepts including

relativity and quantum physics" (Primack and Abrams 2006, 8). The only way one can understand such a non-intuitive representation is to form analogous understandings based on established symbols and experiences. The difficulty in comprehending and sharing non-intuitive knowledge has been known since at least the writings of the early Greeks. Plato's "allegory of the cave" demonstrates the limitations of the human imagination and its dependence upon life experience to recognize and understand new information. Not only were Mount Wilson astronomers able to conceive of the Milky Way as a spiral galaxy where the sun was just an ordinary tenant near its periphery; they were also able to explain this condition to the public who accepted it as a rational explanation. Such acceptance of a non-intuitive explanation of cosmology and its symbolic representations requires a link to life experience in order to be rational. Several attributes of Southern California cultural milieu during the early 1900s may have provided the life experiences necessary for such a theory to be understood, scientifically explored, successfully promoted, and widely accepted.

The main challenge of this study was the need to make logical and comparative judgments about the development of astronomical theories in Southern California. Mount Wilson provided a unique combination of persons, equipment, conditions, and surrounding cultural settings. Without a similar institution located in another place, how could the case be made that resulting theories were uniquely Californian? At its intellectual core, this question is no different from interpreting the meanings the Gabrieleno tribe assigned to their symbolic representations of the Milky Way. Finding the answer required understanding the meanings Californians attached to their other cultural products. By comparing the creation of astronomical theories about the Milky

Way by Mount Wilson astronomers with the paintings of Southern Californian artists, the literature of Californian writers, and other aspects of culture and life in Southern California during the study period, recurring meanings and attributes were identified that define the label, "Southern Californian". David Livingstone states in his book, *Putting Science in its Place: Geographies of Scientific Knowledge* (2003): "Science has borne the stamp of the regional circumstances within which it has been practiced" (Livingstone 2003, 134). This dissertation has been a search for the Californian cultural stamp that was placed upon the American and worldwide scientific understanding of the Milky Way galaxy.

The California Universe

The astrosophy contained in this dissertation reveals that between 1893 and 1941, the understanding of Earth's physical location in the cosmos changed greatly. In 1893, the Earth was understood to orbit the Sun near or at the center of a stellar system, known as the universe. The system consisted of spherical shell roughly 1200 light-years from the Earth that contained the majority of stars and nebulae. The Milky Way, an immense grouping of densely packed stars, formed a band around the center of this outer shell. Closer to the center (about 300 light-years from Earth) was the outer portion of an inner shell of local stars. In contrast, after a period of debate in the early 1920s, by the beginning of World War II, the Earth was understood to orbit the Sun in an arm of a spiral galaxy. The galaxy was known as the Milky Way and measured roughly 100,000 light-years across. Beyond it stretched a virtually endless sea of similar galaxies. These galaxies were evenly distributed across a uniformly expanding sphere of space and time. The expanding sphere was understood to be a closed system. The edge of this

inconceivably immense sphere marked the edge of our universe. What existed beyond the edge was the subject of pure speculation, philosophy, and fantasy.

The new understanding of the Milky Way galaxy and Earth's place within it that developed between 1893 and 1941 may not have been product of application of the scientific method alone. Instead, it likely emerged as a cultural-scientific product created by scientists living and working in Southern California. By examining Mount Wilson Observatory as the cultural hearth of the modern American understanding of the universe, this dissertation has revealed many aspects of place that may have left their mark upon American astronomy within the early twentieth century. Southern California's environment, availability and use of technology, regional culture, and the local community of Pasadena potentially had many profound effects upon the creation and acceptance of new theories regarding the structure of the universe and Earth's place within it. The effects are numerous enough to cast doubt upon the certainty that science would produce the same understanding of the universe in a different location. For this reason, the scientific explanation of the universe developed during this study's period could be described as a cultural-scientific understanding associated with its place of origin.

The invention and use of the reflecting telescope and advanced clock drive systems allowed for long exposure photography and opened a new venue for astronomical observations that exceeded human perception. The 60-inch reflecting telescope that became operational on Mount Wilson in 1908 forever changed the methods by which humans acquire information regarding stellar distances and spatial relationships. Most important of these changes was the use of Cepheid variables as

standard candles that allow a new methodology of measuring distances within the Milky Way and beyond. But these advances alone and their verification through the scientific method could not establish an accepted popular understanding of the galaxy. Other technologies combined to prepare the public to accept alternate realities that transcended their perceptual realities.

The use of mass marketing strategies in the publication and distribution of magazines such as Lummis' *Land of Sunshine* exposed the population of Southern California to a belief that their environment and culture were superior and that the conclusions of scientists within the region would be more insightful. The advent of the automobile allowed Southern Californians to horizontally traverse the fragmented and diverse cultural segments of their region. It also allowed for the vertical separation of social classes within the cultural region as wealthier people built homes in the hills surrounding the Los Angeles basin. Therefore the arrival of the automobile may have accomplished two vital sociological precedents for the acceptance of a radical new vision of the cosmos. First, like Lummis' *Land of Sunshine*, the automobile allowed common citizens exposure to a wider range of lifestyles which made them more likely to accept alternate possibilities of reality. Second, it added prestige to higher places and created a perception of astronomers as forward looking achievers which added credibility to their interpretations of the universe. In similar fashion, the extension of credit to the lower classes and exposure to Hollywood films encouraged an unrealistic vision of social mobility for Southern Californians. This led to a high level of discontent and a desire for a new order within society. The result was that Southern Californians were ready to accept new ideas that challenged previously accepted orthodoxies.

Southern California in the early 1900s was comprised of self-selected migrants willing to take the risk of moving west based on their individual ideas of a better life. Schumpeterian entrepreneurs thrived within an underdeveloped social structure that afforded opportunities not possible within the American core. The majority of migrants were white, middle-class settlers from the Midwest. Hale and the other original astronomers at Mount Wilson fit this description and like their contemporaries had a desire to shape the communities and form an ideal society not possible in the more conservative and established American core. In an attempt to accomplish this they formed and joined clubs, groups and culturally influentially cliques. These groups of social leaders pooled resources and designated common goals for expenditure. Hale tapped into this cultural attribute of Southern California to raise money, promote the status of astronomy, and build consensus for the findings of the Mount Wilson astronomers. In particular, women's clubs provided conduits for the transfer of intellectual ideas and access to people of wealth and influence. Ultimately the commonality that women, Schumpeterian entrepreneurs, the Anglo-Saxon majority of migrants, and others within Southern California shared was a desire for a reordering of society. The new conception of the galaxy and Earth's place within the cosmos was more easily accepted within a culture hungry for revision of the existing reality.

The desire for such reordering can be seen in other cultural products created in the region during the same time period. Literature written near the end of the study period reveals people of varied backgrounds and classes struggling to understand their place as members of a greater California culture. In most cases the characters' self image is reduced from central, lofty, and unique to ordinary and peripheral. This restructuring of

literary characters' individual self-awareness parallels much of what people were experiencing in real life as they assimilated to California culture. The new theories presented by Mount Wilson astronomers presented a similar story as the Sun was reduced from the central feature of the universe to the status of a typical star in the peripheral regions of an average galaxy. The Mount Wilson astronomers developed a new structure of the universe that matched the culture of which they were members. Californians could simultaneously experience incredible grandeur while acknowledging their relatively insignificant role within it.

The unique local culture of Pasadena also contributed to the clout of the Mount Wilson astronomers and led to the funding of their instruments and the acceptance of their theories. Because astronomers studied nature and worked within the mountains of California, they were accepted along with naturalists and conservationists as member of the Arroyo Seco crowd. This group was important in establishing popular opinion regarding the appropriate way for people and nature to interact. *En plein air* artists advanced an appreciation for the *paysage moralisé* and shared with theosophists and conservationists, such as Muir, a belief that light was divine. By the late 1910s the "Ten Painters Club" centered the *en plein air* movement in Los Angeles near the Arroyo Seco and emphasized the form's association with Pasadena. The importance of light within the study of astronomy and the dramatic photos of star clusters, nebula, and spiral galaxies demonstrated a cosmic *paysage moralisé* which was well received by the Arroyo Seco crowd.

The well-educated and published astronomers were accepted as associates, acquaintances, and sometimes friends, by the economic elites who comprised the Valley

Hunt Club of Pasadena. Adding to their prestige was the astronomers' reputations as "self-made" men. Like entrepreneurs within the motion picture industry, astronomers promoted their ideas as products of individualism. They battled for credit and recognition largely because it increased their status and access to community elites.

The relationships between the cultural attributes of Southern California and the vision and theories of Mount Wilson astronomers are important because they challenge the conventional notion that science, through the application of the scientific method, has transcended the influences of culture. The theories developed at Mount Wilson in the early 1900s may tell as much about the people of Southern California as the astronomical theories developed by shamans three thousand years ago tell about the Gabrieleno tribe. How a people describe their universe is a product of their culture. Even today, "the dramatic colours that render the deep space images such as those taken by the Hubble space telescope so aesthetically powerful are as much the product of human imagination and artistic skill as of cold science" (Cosgrove 2008, 47).

Culture, in turn, both shapes and is shaped by place. Therefore the conception of the universe created at Mount Wilson in the first half of the twentieth century may be a reflection of a place and its culture. Additionally, the peripheral location of Los Angeles and the realization by most individuals in Southern California that their lives were not exceptional parallels the new understanding of our solar system's location within the Milky Way galaxy. Harlow Shapley once revealed such a connection when describing the Milky Way galaxy. He stated, "The stars are clumped into groups scattered about like American cities with some great open spaces like the emptiness of the Rockies" (*Los Angeles Times* 1931a, 1). It is doubtful that Shapley would attest to culture or place

influencing his astronomical conclusions, yet the prestige he and others earned working at Mount Wilson and the words they occasionally chose to describe their theories disclose the impact of place.

Direct evidence of the impact of place upon the scientific theories created at Mount Wilson and their subsequent acceptance by their local, regional, and national audiences is rare. Any exploration into the realm of subjectivism depends upon building a preponderance of circumstantial relationships. Sir Peter Hall builds such a case to describe the city of Los Angeles as an "innovative milieu" (Hall 1998, 552). "Like other elements of human culture, science is located. It takes place in highly specific venues; it shapes and is shaped by regional personality" (Livingstone 2003, 179). The theories conceived at the Mount Wilson Observatory are part of the larger innovative milieu of the region and this study adds to the preponderance of evidence that strongly suggests the theories of scientists contain the cultural stamp of the region within which they live and work.

By 1941, the California Universe was accepted by most Americans as a scientific reality. It was a product of the Mount Wilson astronomers, who lived and worked within the Pasadena community and experienced the landscape and culture of Southern California as a part of their daily lives. However, it remains impossible to prove the hypothesis of this dissertation. The scientists, theories, and equipment that had a direct impact upon the changing cartographic depiction of the Milky Way have been identified and found to have had a strong association with Mount Wilson Observatory. Therefore, Mount Wilson Observatory, to include its offices within Pasadena, may safely be identified as the cultural hearth of the new understanding of the Milky Way galaxy and

Earth's location in the cosmos that emerged by the end of the study period. However, without an alternate plausible interpretation of the data by astronomers, scientists, or philosophers at a different location, the effect of culture upon the cartographic representation of outer space is impossible to prove. Nevertheless, this study strongly suggests that the cultural milieu of Southern California played a key role in the changing cartographic depiction of the Milky Way between 1893 and 1941.

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APPENDIX A

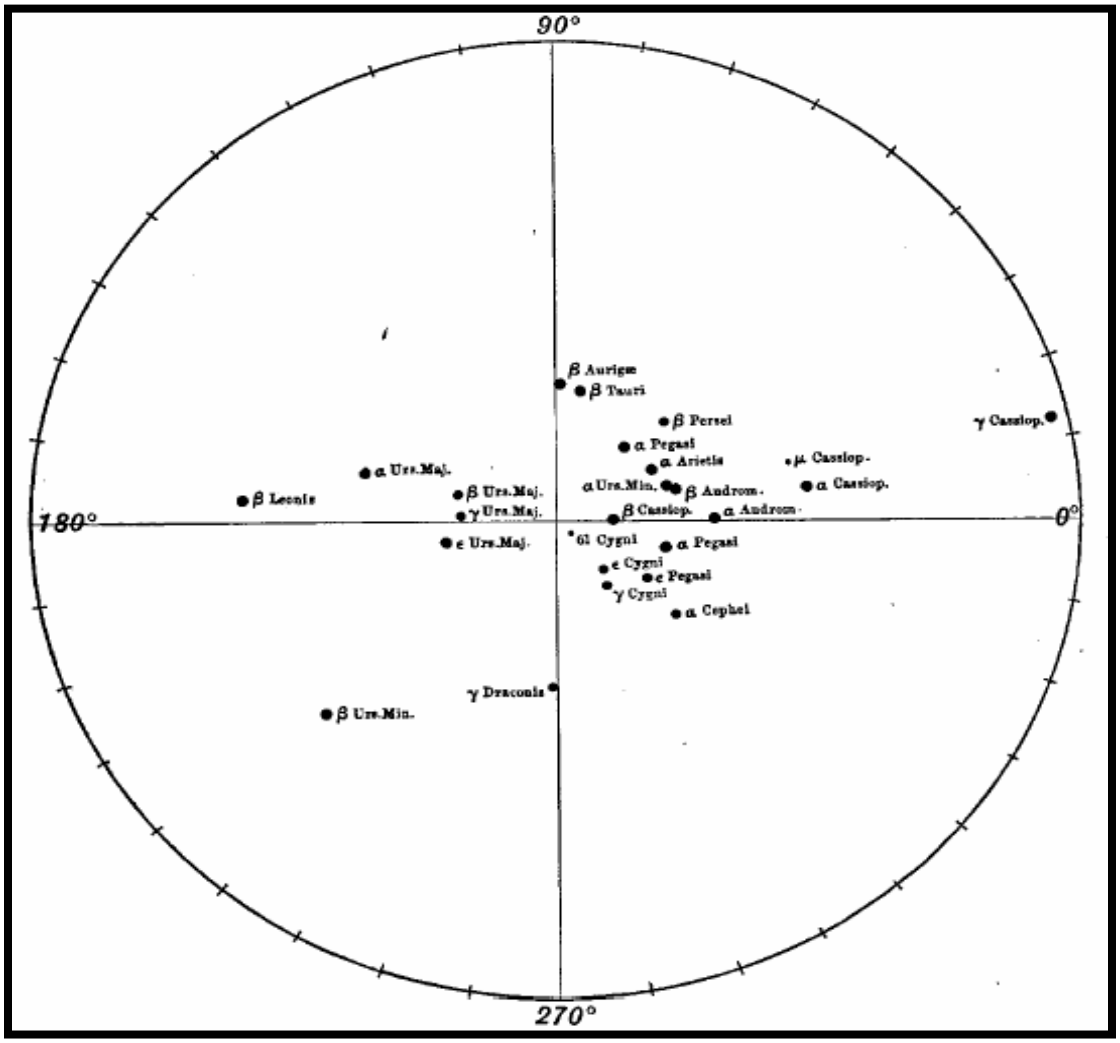


Figure 1. Payne's 1893 Depiction of the Closest 29 stars.

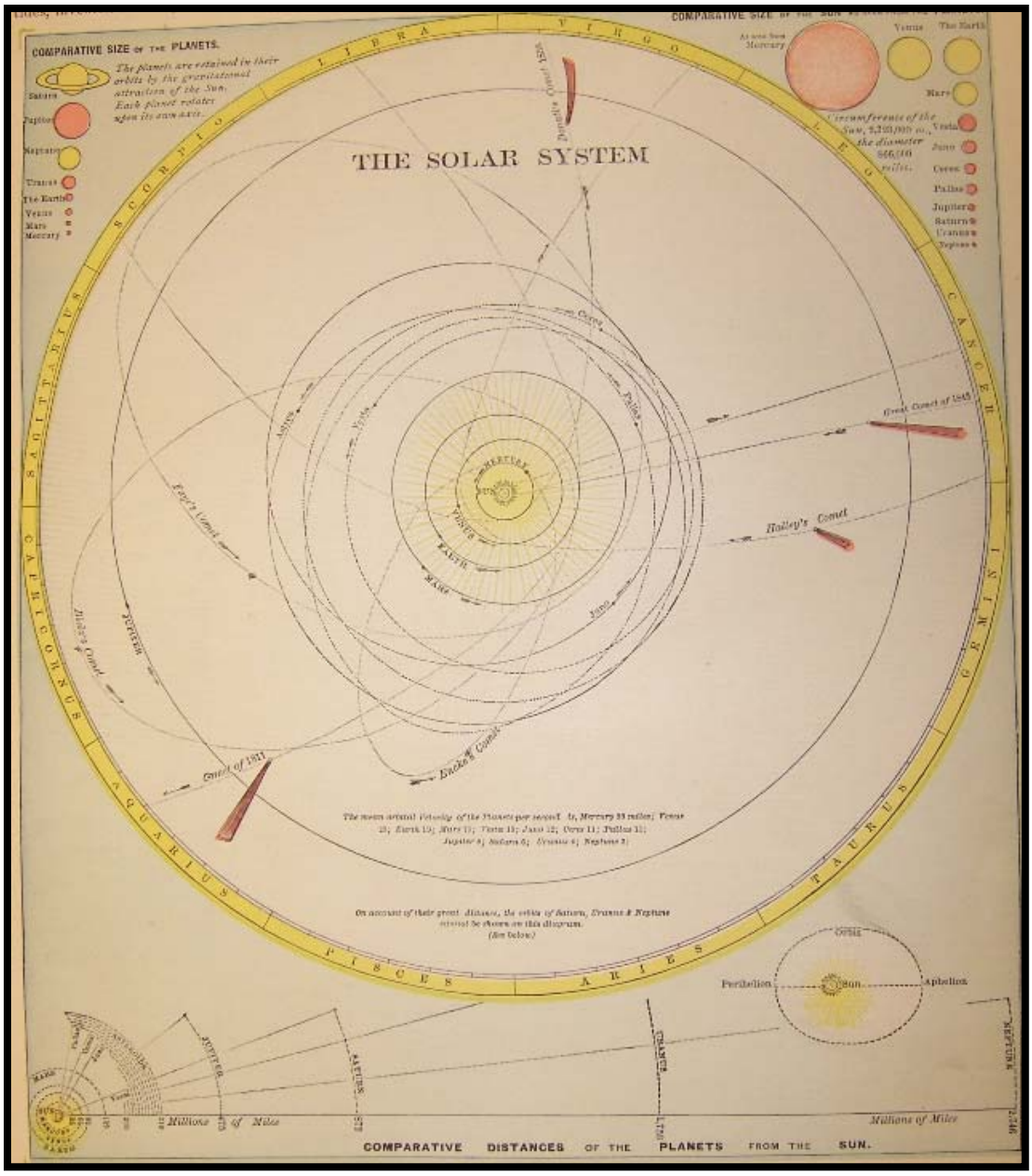


Figure 2. Solar System Depicted in 1893. "The Solar System" located on page 13 of *The Columbian Atlas of the World We Live In* published in 1893 by Hunt and Eaton.

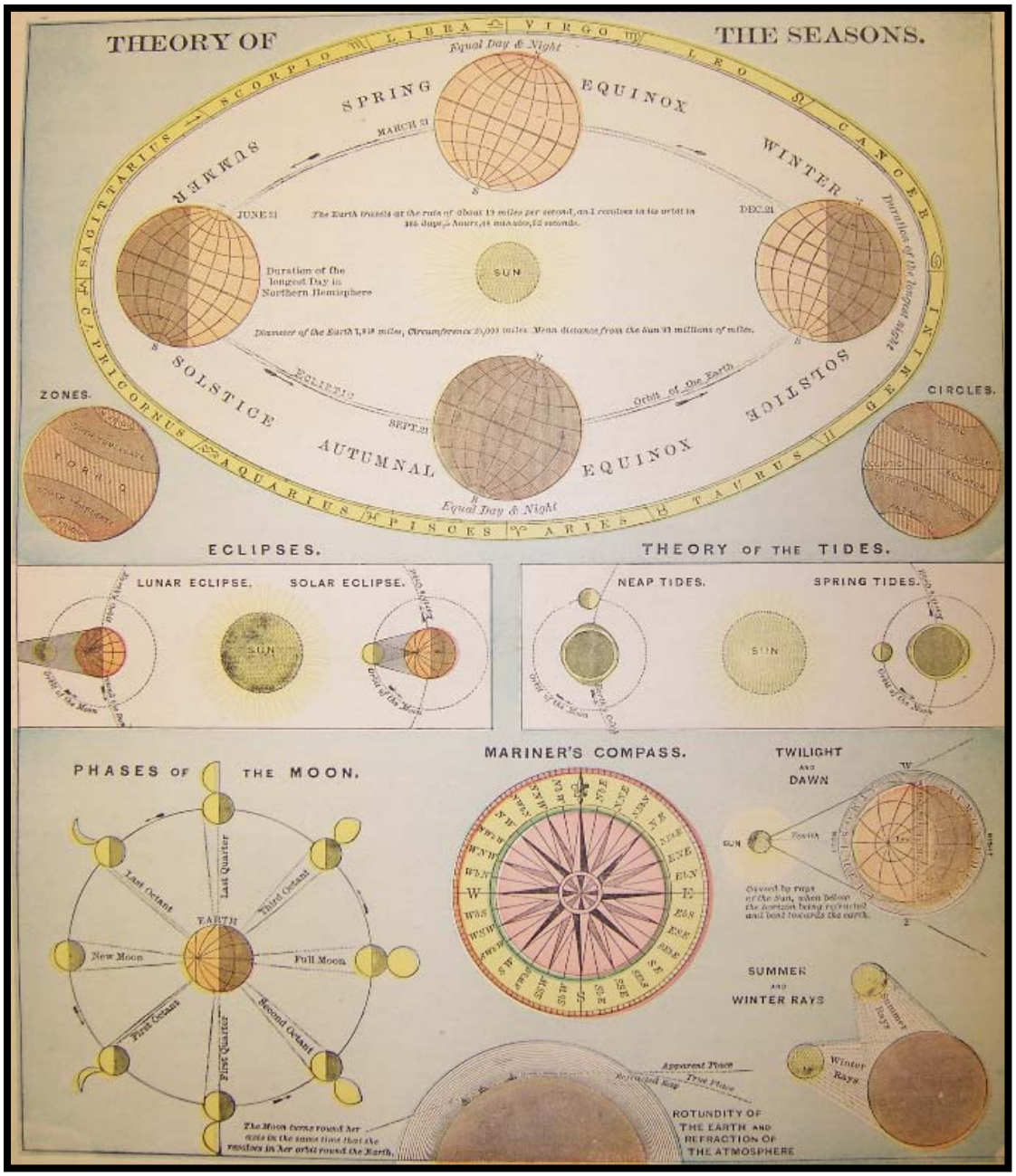


Figure 3. Theory of the Seasons. "Theory of the Seasons" located on page 19 of *The Columbian Atlas of the World We Live In* published in 1893 by Hunt and Eaton.

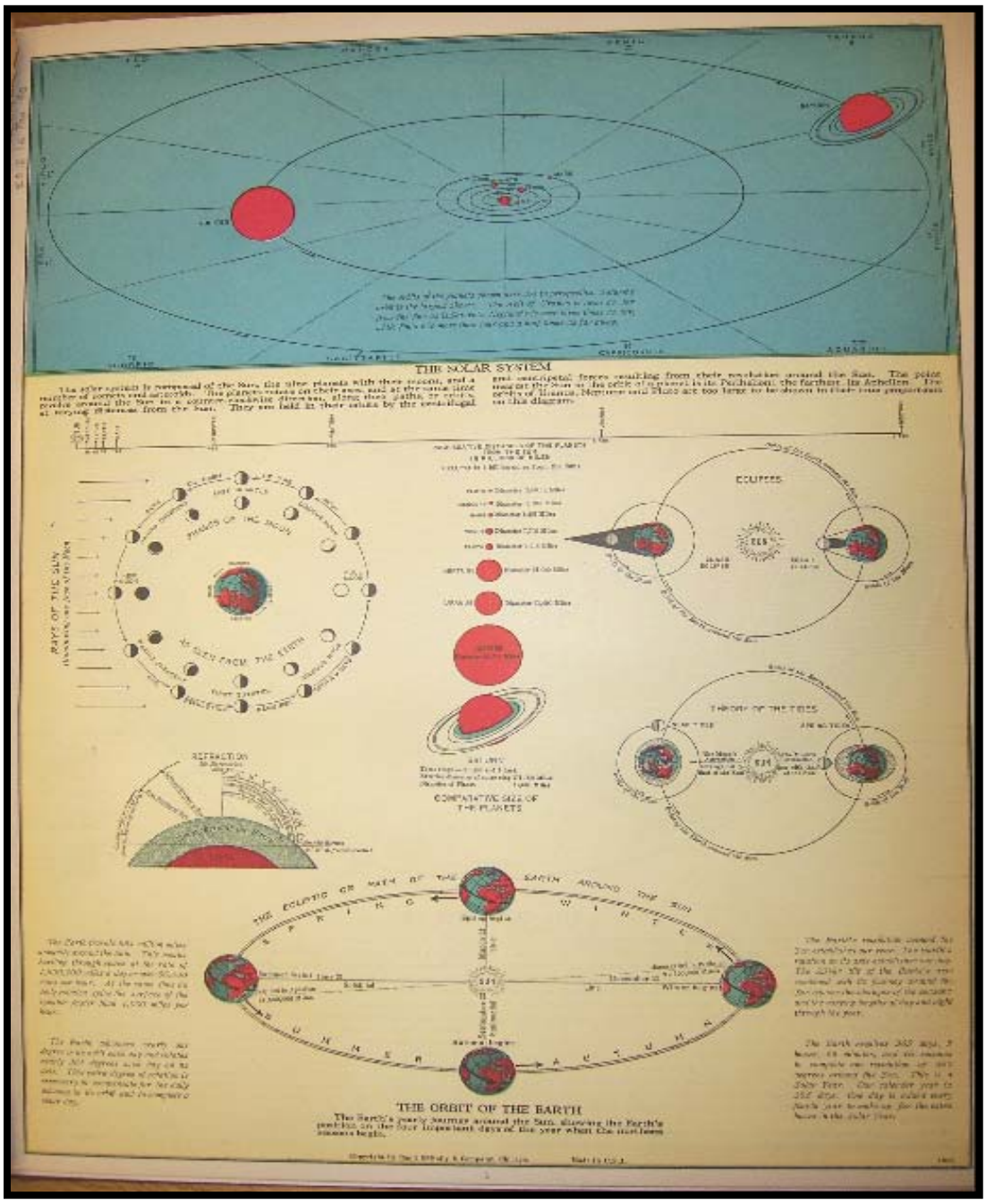


Figure 4. The Solar System and the Orbit of the Earth. "The Solar System" and "The Orbit of the Earth" are located on page 1 of the *Rand McNally World Atlas* published in 1939.

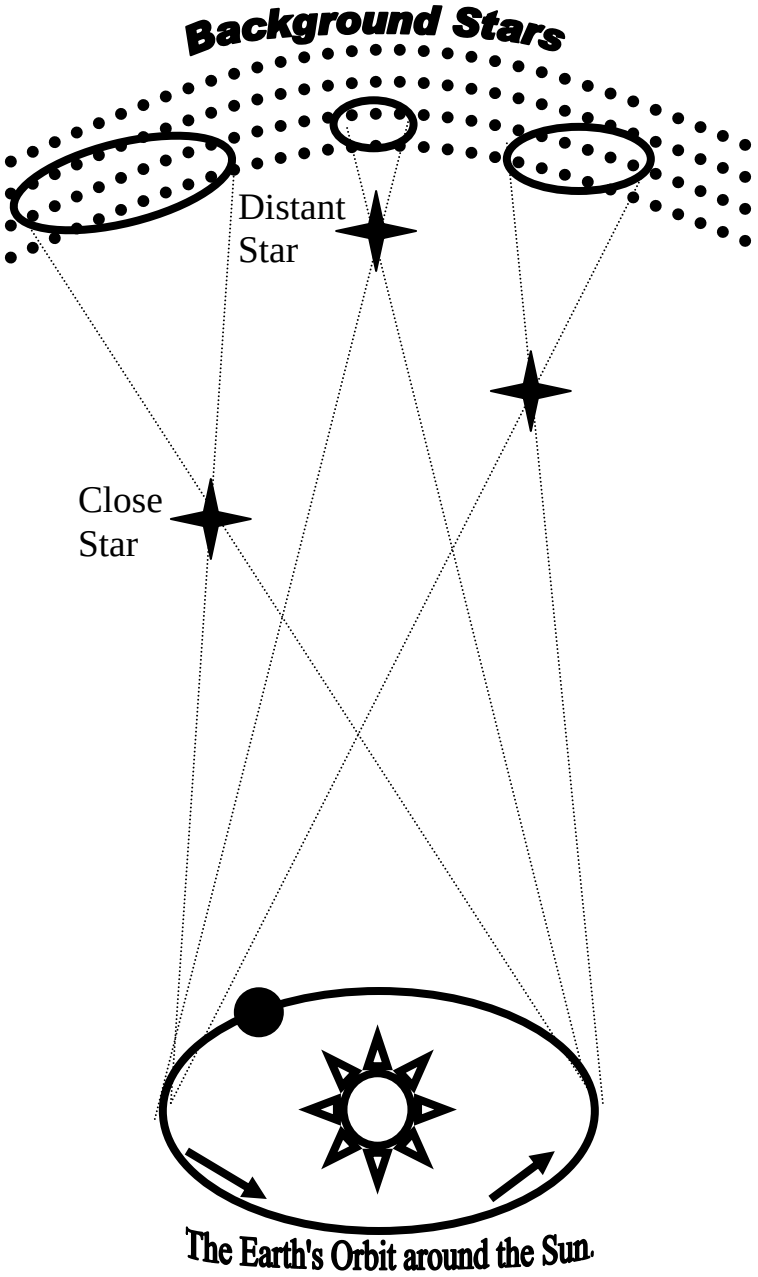


Figure 5. Motion Parallax. Above is a recreation of a diagram commonly used by astronomers to explain the motion parallax method of determining stellar distances. It was first presented in David Todd's *A New Astronomy* (1906, 436).

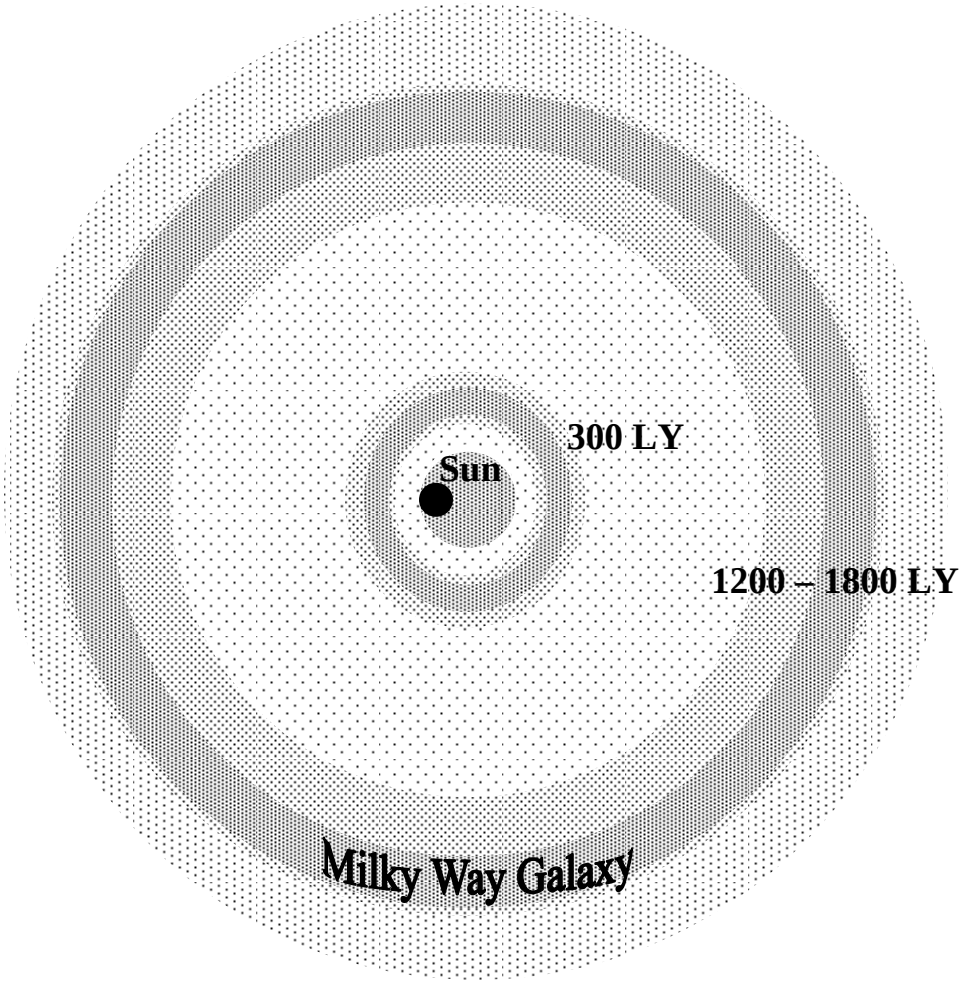
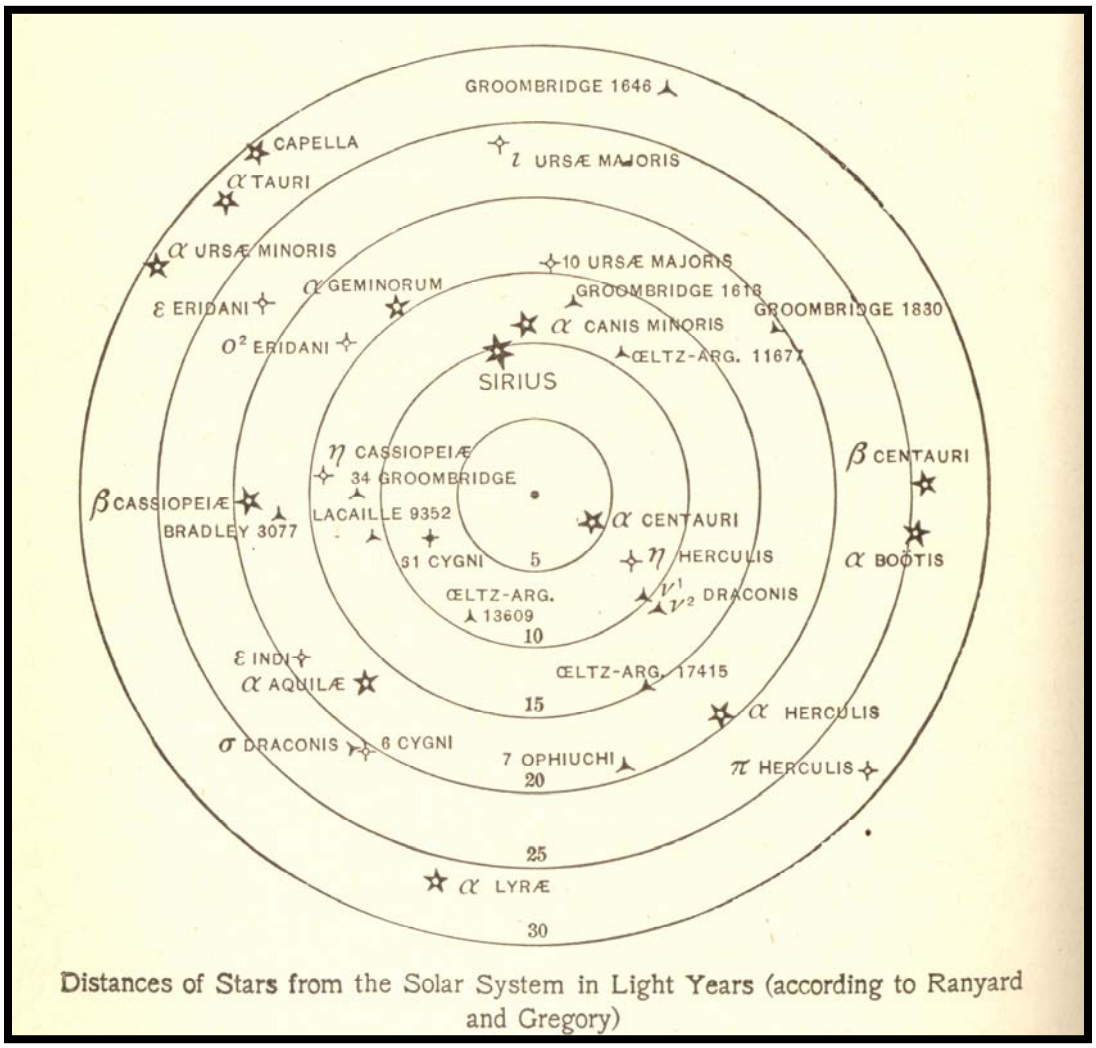


Figure 6. The Spherical Universe. The use of motion parallax resulted in an understanding of the structure of the universe as illustrated above. A similar diagram was first used by Alfred Russell Wallace in *Man's Place in the Universe* (1903, 296).



Distances of Stars from the Solar System in Light Years (according to Ranyard and Gregory)

Figure 7. Illustration of the Nearest Stars. This diagram was presented in David Todd's *A New Astronomy* (1906, 440).

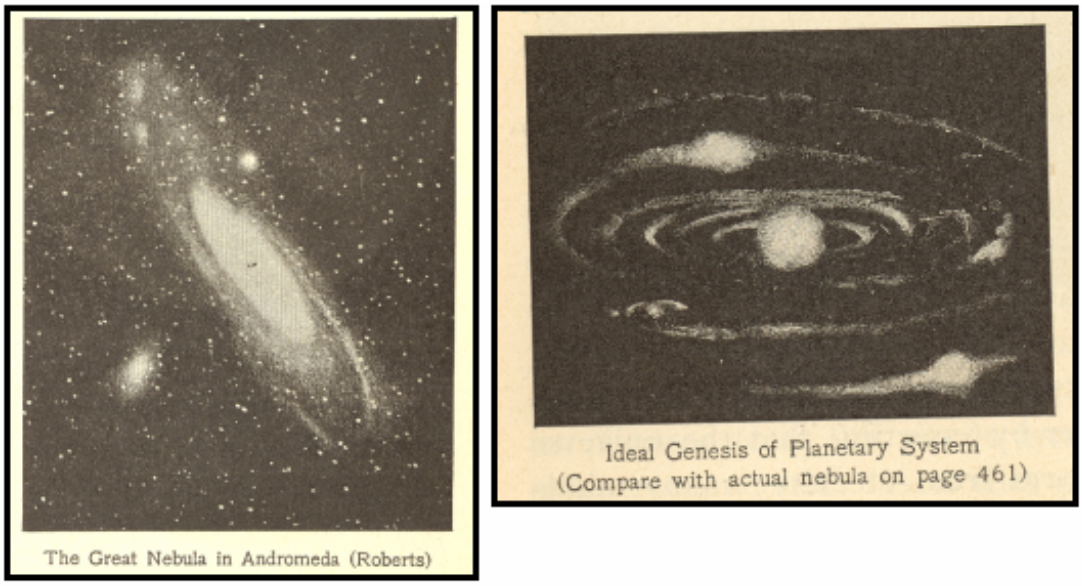


Figure 8. Great Nebulae in Andromeda Compared to the Formation of a Solar System. A photo of the Great Nebulae in Andromeda (left) is compared to an artist's rendition of the formation of a solar system (right) in David Todd's *A New Astronomy* (1906, 461 and 466).

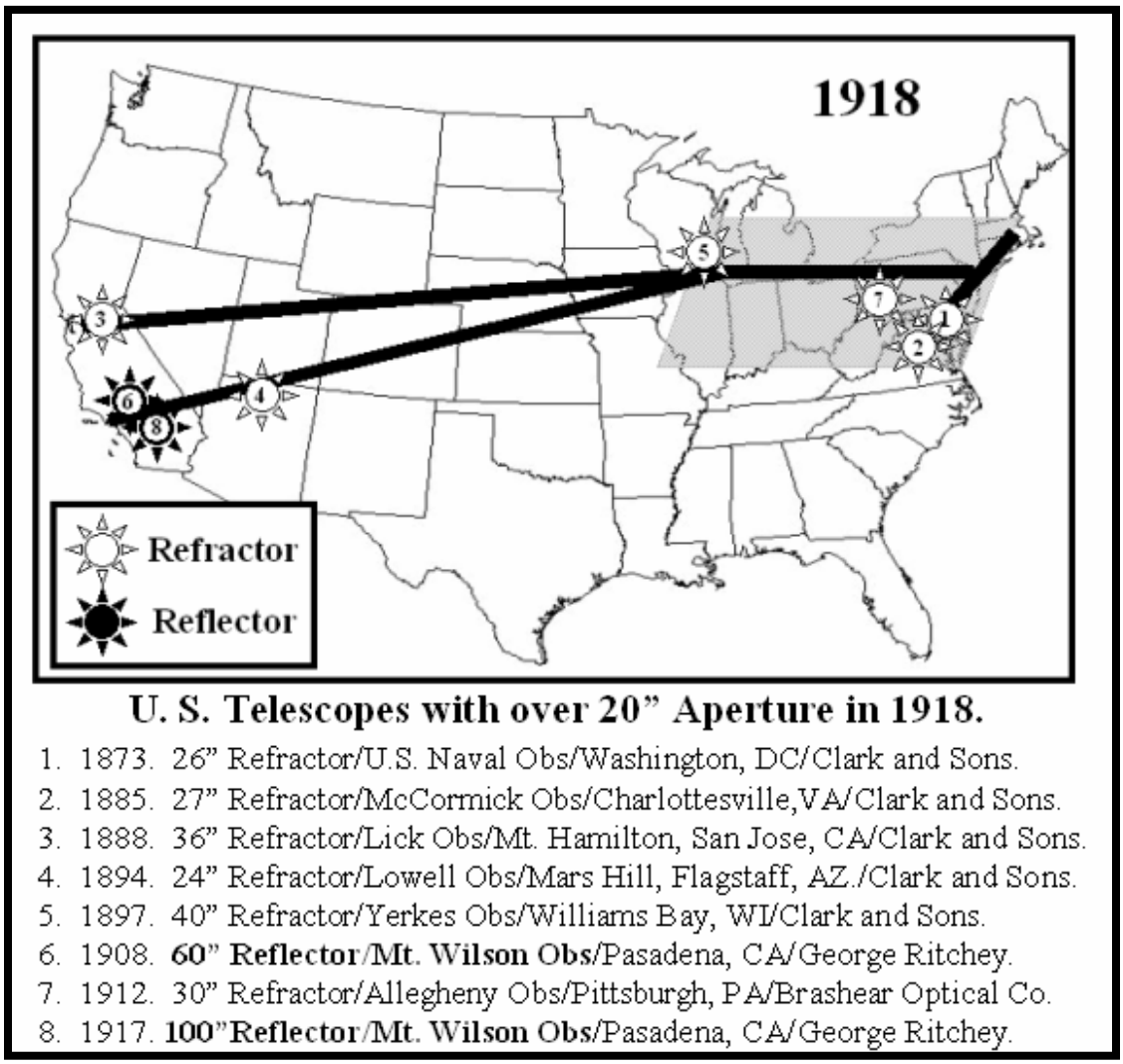


Figure 9. Locations of the Largest American Telescopes in 1918. The gray trapezoid in the north-east portion of the above map is a representation of Donald Meinig's illustration of the American core in 1915 (Meinig 1998, 322). In 1915, the core was primary in establishing the culture of the nation. The thick lines represent Meinig's illustration of the strongest links that exist today when considering the United States as a "system of cities" (Meinig 2004, 282). Each major U.S. city now has a role in defining American culture. The investment in astronomical research as expressed by the location of large telescopes can be seen as one of the many factors that demonstrate this change. By the end of World War I, California dominated the science of outer space based on the strength of the Mount Wilson reflectors.

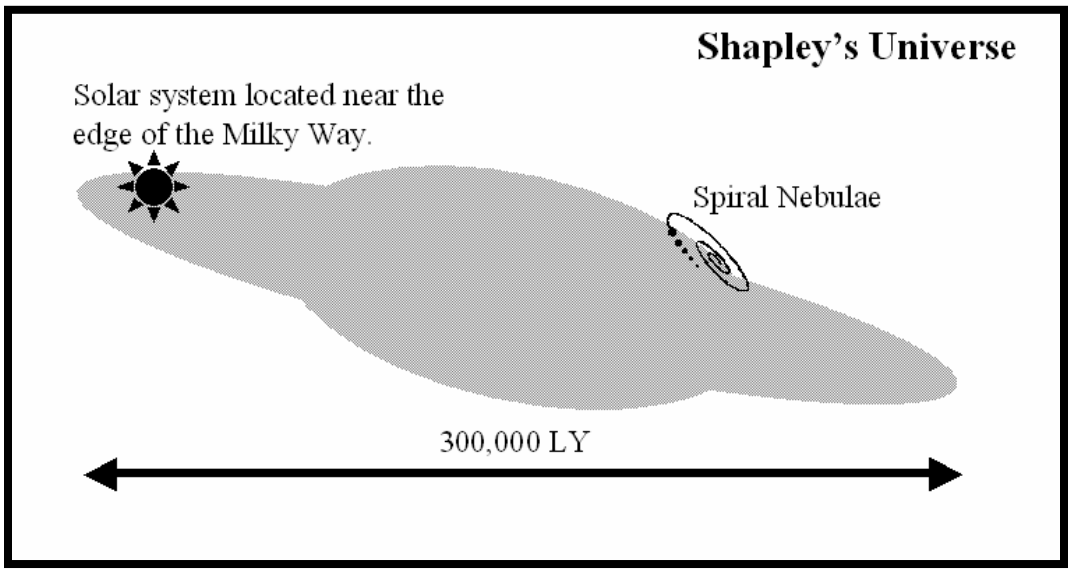


Figure 10. Shapley's Theory of the Structure of the Milky Way.

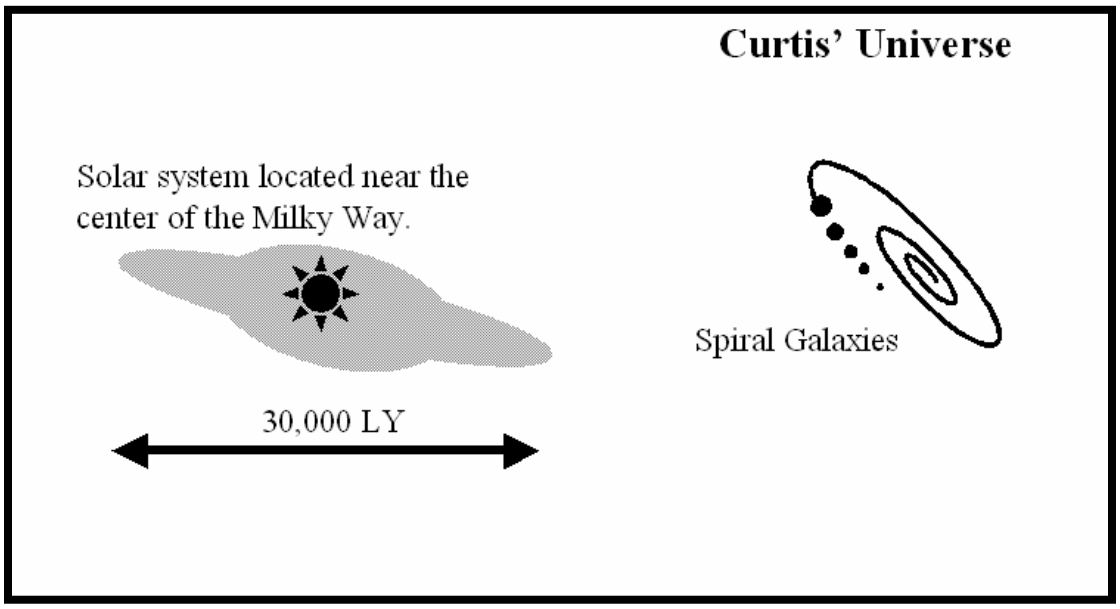


Figure 11. Curtis' Theory of the Structure of the Milky Way.

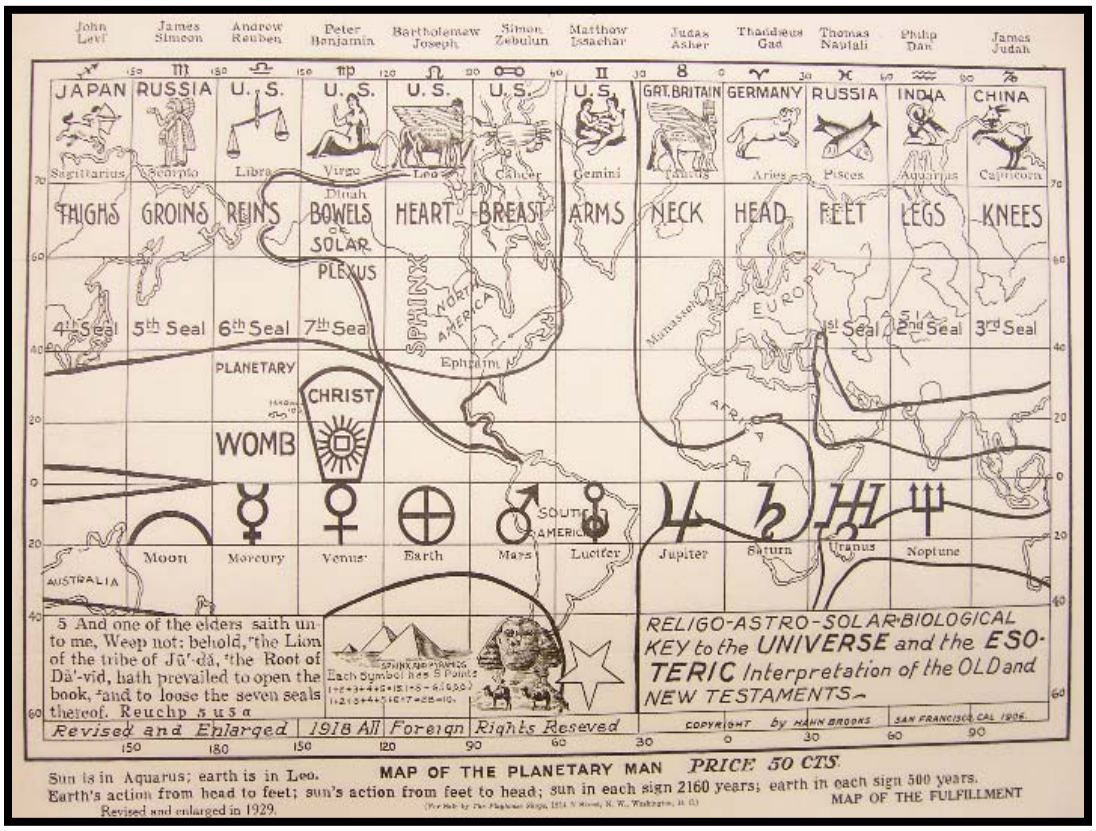


Figure 12. Map of the Planetary Man by Hahn Brooks (1929).

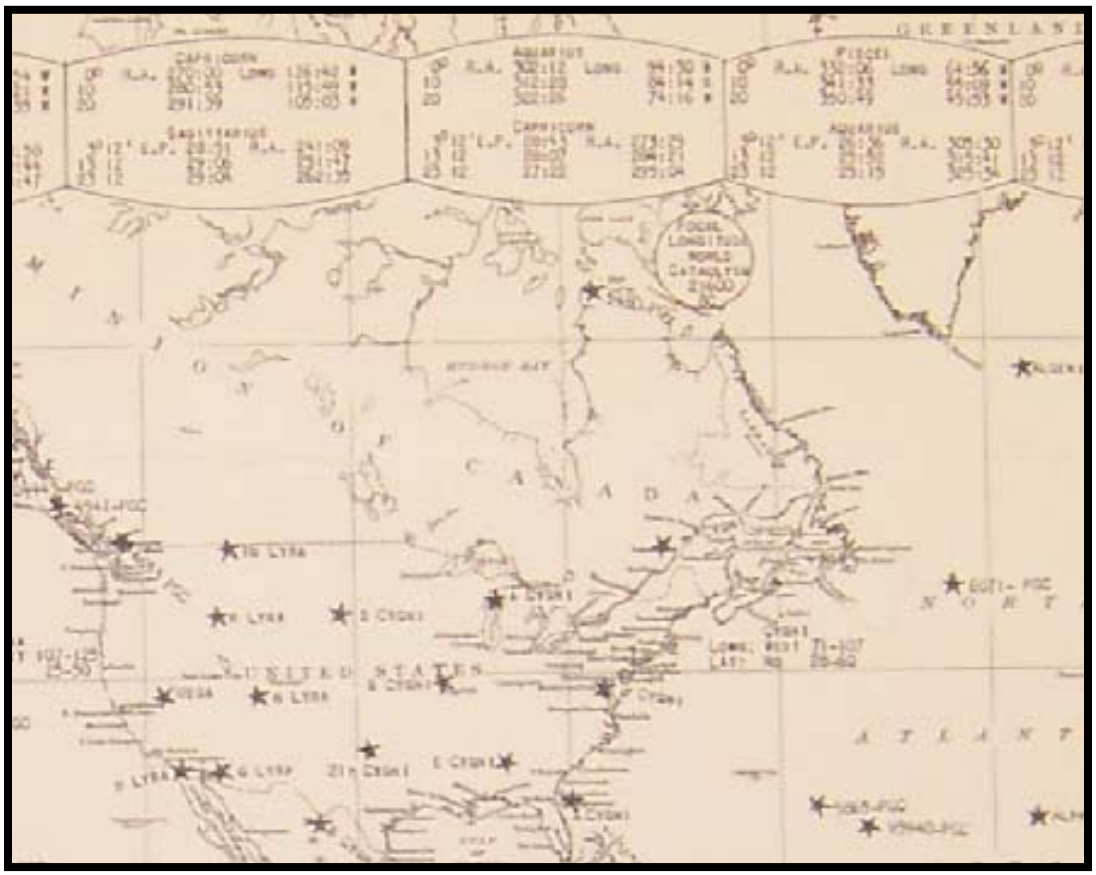


Figure 13. Outline of the World and the Heavens by Paul Counsil (1933). Above is a portion of Paul Counsil's map "Outline of the world and the heavens" (1933) covering North America and the associated stars of the zodiac.

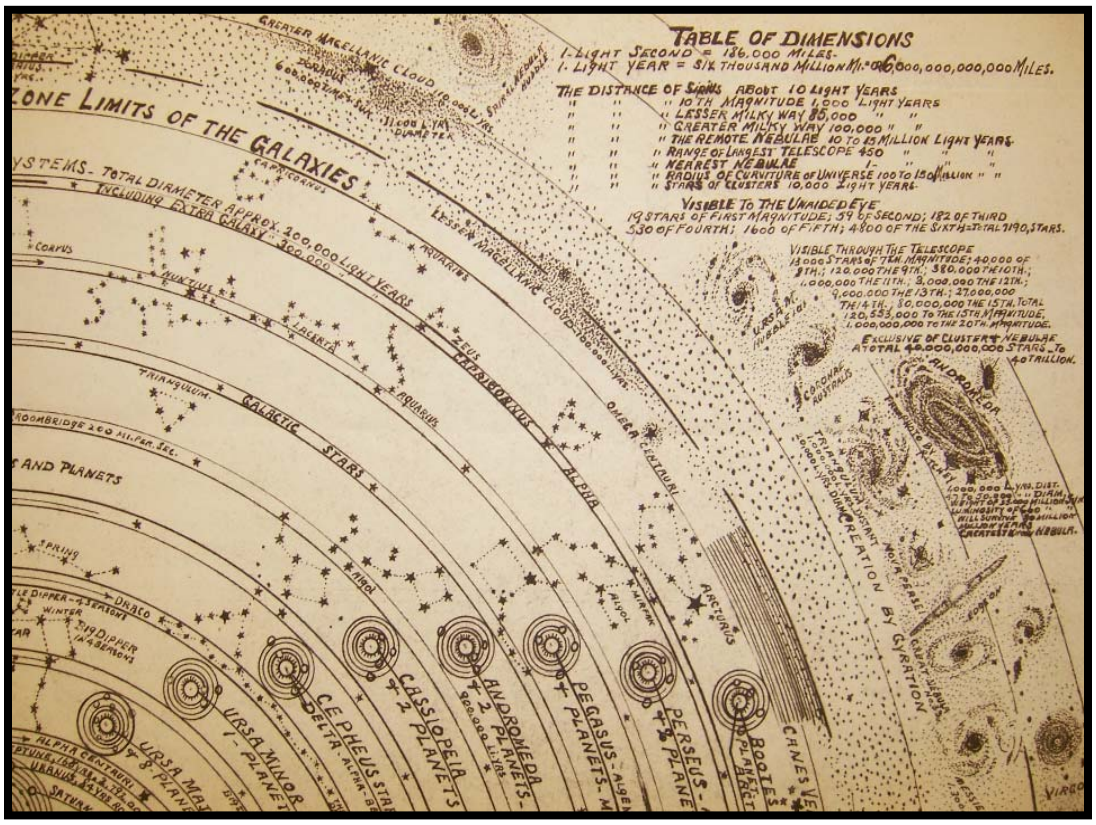


Figure 14. The Universe as an Organized System by James McDade (1936). The full title of this unpublished chart is “In the nature of the universe organized system, an infinite globe.”

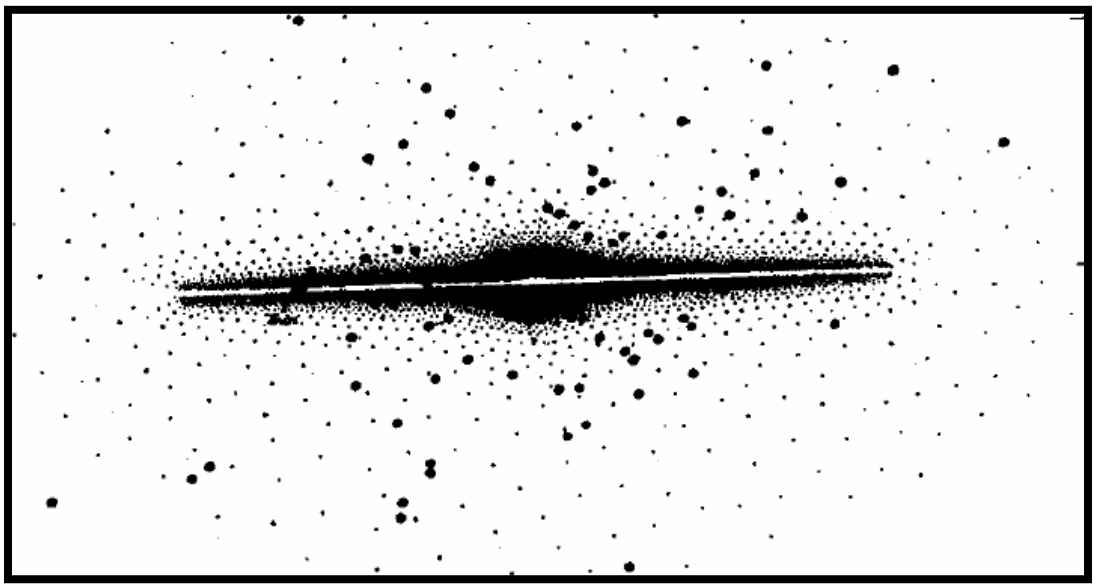


Figure 15. Plaskett's Theory of the Milky Way. The above depiction of Plaskett's theory of the Milky Way shows a flat spiral disk roughly 100,000 light years across and 5,000 light years thick with a central bulge (Plaskett 1939, 255).

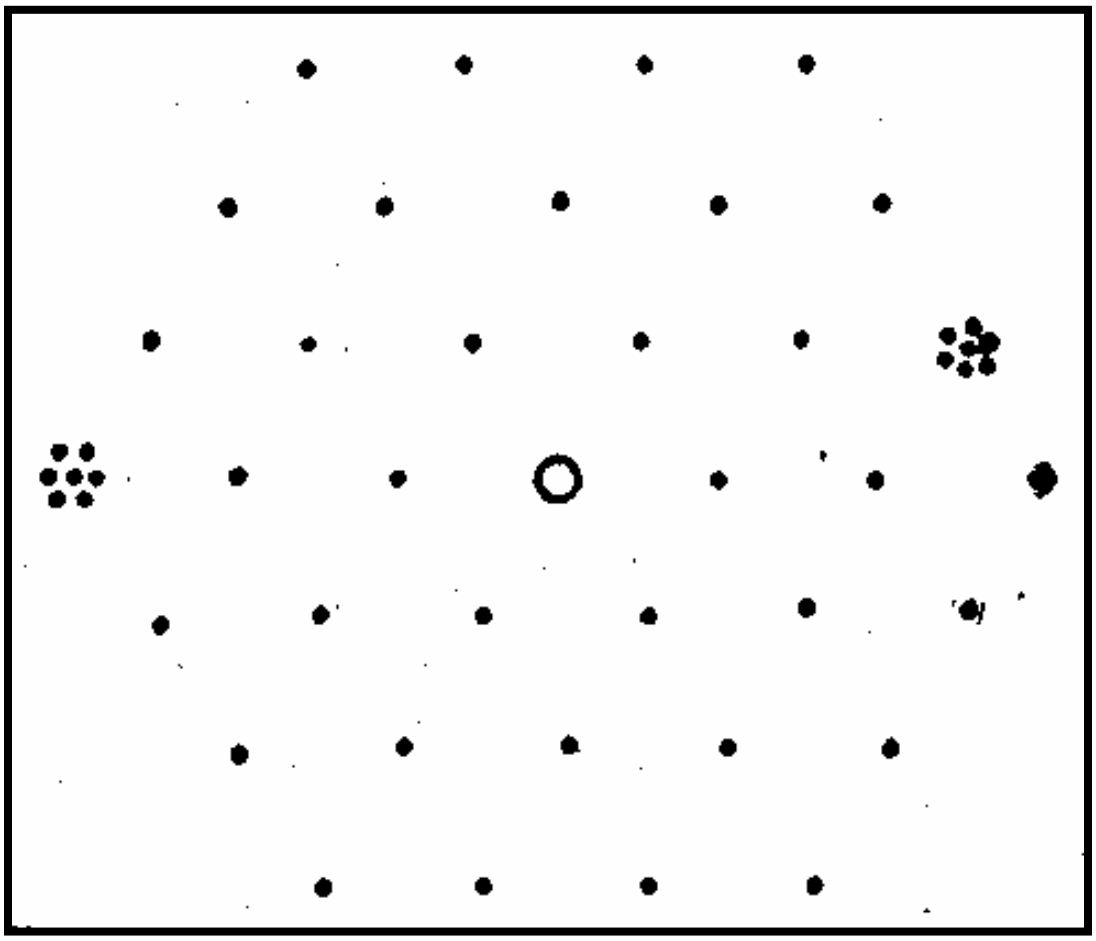


Figure 16. Fath's General Structure of the Visible Universe. Above is a diagram used by Edward A. Fath in astronomy textbooks to illustrate of the structure of the universe (Fath 1944, 328). The circle in the center represents the location of the Milky Way and its associated cluster of galaxies. Other galaxies, outside the local cluster, are represented by dots, some of which are grouped together to represent other clusters of galaxies.

Figure 17. Davidson, Muir, and Carnegie in Pasadena. Photo 2766 Courtesy Huntington Library, Pasadena, California shows Astronomer Anstruther Davidson, John Muir, and Andrew Carnegie at the Hotel Maryland in Pasadena (March, 1910).

Figure 18. Shapley's Pasadena Home. Above is a current photo taken by the author of Harlow Shapley's former house in Pasadena.

Figure 19. Mount Wilson as Seen from Pasadena. Above is a current photo taken by the author of Mount Wilson from the front yard of Mount Wilson astronomer, Seth Nicholson's, former home in Pasadena.

Figure 20. Hubble's Pasadena Home. Above is a current photo taken by the author of Edwin Hubble's former house in Pasadena.

Figure 21. Hale Solar Laboratory in Pasadena. Photo 72 Courtesy Huntington Library, Pasadena, California (4 March 1931).

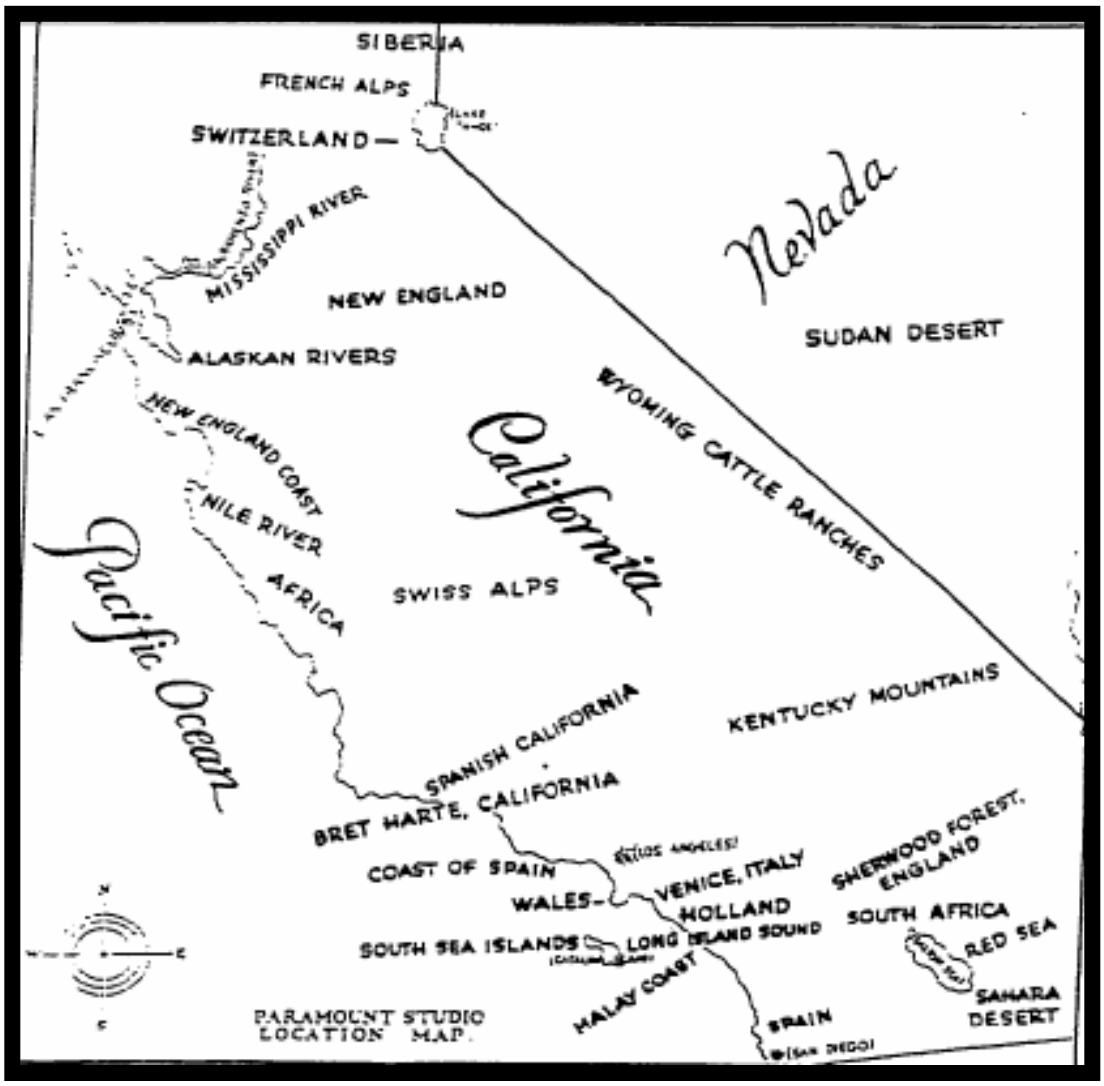


Figure 22. Second Space Filming Locations in Southern California. (Lukinbeal 2000, 73).

APPENDIX B

TABLE 1 Structure of the universe as described in astronomy textbooks between 1893 and 1941

Year Pub.	Title - Author	Milky Way as entire universe	Milky Way one of many galaxies	Not det.
1897	The Elements of Astronomy -Young	x		
1906	A New Astronomy - Todd	x		
1919-1924	No Textbooks Selected			
1926	A New Astronomy - Todd			x
1927	Astronomy Vol. 2 - Russell/Young rev.		x	
1928	The Elements of Astronomy - Fath		x	
1941	The Story of the Starry Universe -Todd		x	
1944	The Elements of Astronomy - Fath		x	

TABLE 2 Structure of the universe as described in leading atlases between 1893 and 1941

Year Pub.	Atlas Publisher	Milky Way as entire universe	Milky Way one of many galaxies	Not det.
1893	Bartholomew	x		
1893	Hunt and Eaton			x
1893	Rand McNally			x
1896	Cram	x		
1921	James	x		
1925	Rand McNally			x
1931	Cram			x
1937	Hammond			x
1938	Collier's		x	
1941	Rand McNally			x

TABLE 3 Structure of the universe as described in selected *Science* and *National Geographic* journal articles between 1893 and 1941

Year Pub.	Journal - Author	Milky Way as entire universe	Milky Way one of many galaxies	Not det.
1900	*National Geographic* - Davis			x
1903	*Science* – Newcomb	x		
1913a	*Science* – Kapteyn	x		
1913b	*Science* – Keyser			x
1917	*Science* – Campbell			x
1920	*Science* – MacMillan		x	
1923a	*Science* – Aitken			x
1923b	*Science* – Henderson		x	
1925	*National Geographic* – Showalter		x	
1932a	*Science* – Robertson		x	
1932b	*Science* - Tolman		x	
1939	*National Geographic* – Colton		x	
1940	*Science* - Russell		x	

TABLE 4 Structure of the universe as described in selected *Popular Astronomy* journal articles between 1893 and 1941

Year Pub.	Author	Milky Way as entire universe	Milky Way one of many galaxies	Not det.
1893	Payne			x
1897	Pannekoek			x
1899	Wilson	x		
1902	Parker			x
1910	Pickering	x		
1918	Holmes			x
1919	MacPherson		x	
1920	Wilson	x		
1922	McLaughlin			x
1931	Harrison		x	
1933	Leonard			x
1934	Gingrich		x	
1937	Stetson		x	
1939	Plaskett		x	
1940	Mowbray		x	

TABLE 5 Structure of the universe as described in selected *New York Times* newspaper articles between 1893 and 1941

Year Pub.	Title - Author	Milky Way as entire universe	Milky Way one of many galaxies	Not det.
1906	Astronomy's high problem – LT	x		
1911	New star is a puzzle - staff			x
1921	Put width of universe at 1M LY - staff			x
1922	New cluster widens universe – staff	x		
1927	Deeper into infinity – Luyten		x	
1928	Theory of limit to space – staff		x	
1931	Shapley depicts universe - Laurence		x	
1931	Astronomy's golden age – staff		x	
1932	MacMillan calls universe endless –staff		x	
1933	Andromeda as big as our galaxy – AP		x	
1934	AZ astronomer finds super galaxy-staff		x	
1939	Einstein sees key to universe -Laurence		x	
1940	Cosmic dent discovered – staff		x	

TABLE 6 Structure of the universe as described in selected *Los Angeles Times* newspaper articles between 1893 and 1941

Year Pub.	Title - Author	Milky Way as entire universe	Milky Way one of many galaxies	Not det.
1896	Photographing skies – Ball		x	
1902	Earth's past and future – staff	x		
1910	Secrets of the heavens – staff	x		
1916a	Gauging sidereal universe – Knight		x	
1916b	Astronomer in present century – Knight		x	
1920	From stars to twins – AP		x	
1925a	Regarding Andromeda – staff		x	
1925b	The heavens – Sutton			x
1926a	Universe in far spaces measured – staff		x	
1926b	Man can never limit universe – staff		x	
1927	Measures universe – staff			x
1928a	The new heavens – staff		x	
1928b	Earth stars' hub depicted – staff		x	
1928c	Space seen as finite – staff		x	
1929a	Our little planet – staff		x	
1929b	Space free of matter – staff		x	
1929c	The universe – staff		x	
1929d	Astronomers feel crowded – staff		x	
1929e	What's new in science (WNIS) –Sutton		x	
1931a	Scientists disputed – staff		x	
1931b	Einstein acclaimed over rival – Sutton		x	
1931c	Space limit pushed back – staff		x	
1931d	The DeSitter universe – Sutton		x	
1931e	Universe held mere bubble – staff		x	
1932a	Savant pictures universe – Sutton		x	
1932b	Star distances held in error – staff		x	
1932c	Sun first stop in sky joyride – Sutton		x	
1932d	WNIS–Close up of Milky Way -Sutton			x
1932e	WNIS–How they measure space-Sutton		x	
1932f	Scientific progress in 1932 – Sutton		x	
1933a	Scientists scale down estimates – staff		x	
1933b	The world's greatest eye - Sutton		x	
1933c	Milky Way likened to sandwich – staff		x	
1934a	Sun believed in dizzy dance – Barton			x
1934b	To unlock secret of creation - staff		x	
1935	Theories facing proof – staff		x	
1937a	Our expanding universe (a) – Barton		x	
1937b	Giant 'eye' discloses boundary –Barton		x	
1939a	Our expanding universe (b) – Barton			x
1939b	Astronomical idea refuted – Barton		x	
1939c	No data on planetary speed – Millard			x
1940	Sky blasts given study – Barton		x	
1941	Nature's power reservoir – staff		x	

TABLE 7 Location of the Earth in the cosmos as described in astronomy textbooks between 1893 and 1941

Year Pub.	Title - Author	Sun/Earth centered in universe	Sun/Earth not centered in universe	Not det.
1897	The Elements of Astronomy -Young	x		
1906	A New Astronomy - Todd	x		
1919-1924	No Textbooks Selected			
1926	A New Astronomy - Todd	x		
1927	Astronomy Vol. 2 - Russell/Young rev.		x	
1928	The Elements of Astronomy - Fath		x	
1941	The Story of the Starry Universe -Todd		x	
1944	The Elements of Astronomy - Fath		x	

TABLE 8 Location of the Earth in the cosmos as described in leading atlases between 1893 and 1941.

Year Pub.	Atlas Publisher	Sun/Earth centered in universe	Sun/Earth not centered in universe	Not det.
1893	Bartholomew	x		
1893	Hunt and Eaton	x		
1893	Rand McNally	x		
1896	Cram			x
1921	James	x		
1925	Rand McNally			x
1931	Cram			x
1937	Hammond			x
1938	Collier's			x
1941	Rand McNally		x	

TABLE 9 Location of the Earth in the cosmos as described in selected *Science* and *National Geographic* journal articles between 1893 and 1941

Year Pub.	Journal - Author	Sun/Earth centered in universe	Sun/Earth not centered in universe	Not det.
1900	*National Geographic* - Davis			x
1903	*Science* – Newcomb	x		
1913a	*Science* – Kapteyn	x		
1913b	*Science* – Keyser	x		
1917	*Science* – Campbell	x		
1920	*Science* – MacMillan			x
1923a	*Science* – Aitken			x
1923b	*Science* – Henderson		x	
1925	*National Geographic* – Showalter		x	
1932a	*Science* – Robertson	x		
1932b	*Science* - Tolman			x
1939	*National Geographic* – Colton		x	
1940	*Science* - Russell			x

TABLE 10 Location of the Earth in the cosmos as described in selected *Popular Astronomy* journal articles between 1893 and 1941

Year Pub.	Author	Sun/Earth centered in universe	Sun/Earth not centered in universe	Not det.
1893	Payne	x		
1897	Pannekoek			x
1899	Wilson		x	
1902	Parker			x
1910	Pickering			x
1918	Holmes			x
1919	MacPherson			x
1920	Wilson	x		
1922	McLaughlin		x	
1931	Harrison		x	
1933	Leonard			x
1934	Gingrich			x
1937	Stetson		x	
1939	Plaskett		x	
1940	Mowbray		x	

TABLE 11 Location of the Earth in the cosmos as described in selected *New York Times* newspaper articles between 1893 and 1941

Year Pub.	Title - Author	Sun/Earth centered in universe	Sun/Earth not centered in universe	Not det.
1906	Astronomy's high problem – LT	x		
1911	New star is a puzzle - staff			x
1921	Put width of universe at 1M LY - staff			x
1922	New cluster widens universe – staff			x
1927	Deeper into infinity – Luyten			x
1928	Theory of limit to space – staff		x	
1931	Shapley depicts universe - Laurence		x	
1931	Astronomy's golden age – staff			x
1932	MacMillan calls universe endless –staff			x
1933	Andromeda as big as our galaxy – AP			x
1934	AZ astronomer finds super galaxy-staff			x
1939	Einstein sees key to universe -Laurence			x
1940	Cosmic dent discovered – staff		x	

TABLE 12 Location of Earth in the cosmos as described in selected *Los Angeles Times* newspaper articles between 1893 and 1941

Year Pub.	Title - Author	Sun/Earth centered in universe	Sun/Earth not centered in universe	Not det.
1896	Photographing skies – Ball	x		
1902	Earth's past and future – staff			x
1910	Secrets of the heavens – staff			x
1916a	Gauging sidereal universe – Knight		x	
1916b	Astronomer in present century – Knight			x
1920	From stars to twins – AP			x
1925a	Regarding Andromeda – staff			x
1925b	The heavens – Sutton		x	
1926a	Universe in far spaces measured – staff			x
1926b	Man can never limit universe – staff			x
1927	Measures universe – staff	x		
1928a	The new heavens – staff			x
1928b	Earth stars' hub depicted – staff		x	
1928c	Space seen as finite – staff			x
1929a	Our little planet – staff			x
1929b	Space free of matter – staff		x	
1929c	The universe – staff			x
1929d	Astronomers feel crowded – staff			x
1929e	What's new in science (WNIS) –Sutton		x	
1931a	Scientists disputed – staff		x	
1931b	Einstein acclaimed over rival – Sutton			x
1931c	Space limit pushed back – staff	x		
1931d	The DeSitter universe – Sutton			x
1931e	Universe held mere bubble – staff			x
1932a	Savant pictures universe – Sutton			x
1932b	Star distances held in error – staff			x
1932c	Sun first stop in sky joyride – Sutton			x
1932d	WNIS–Close up of Milky Way -Sutton		x	
1932e	WNIS–How they measure space-Sutton			x
1932f	Scientific progress in 1932 – Sutton			x
1933a	Scientists scale down estimates – staff			x
1933b	The world's greatest eye - Sutton		x	
1933c	Milky Way likened to sandwich – staff			x
1934a	Sun believed in dizzy dance – Barton		x	
1934b	To unlock secret of creation - staff			x
1935	Theories facing proof – staff			x
1937a	Our expanding universe (a) – Barton		x	
1937b	Giant 'eye' discloses boundary –Barton			x
1939a	Our expanding universe (b) – Barton		x	
1939b	Astronomical idea refuted – Barton			x
1939c	No data on planetary speed – Millard		x	
1940	Sky blasts given study – Barton		x	
1941	Nature's power reservoir – staff			x

TABLE 13 Composite of publicly available descriptions of the structure of the universe between 1893 and 1941.

Years of Publication	Milky Way as entire universe	Milky Way one of many galaxies	Not determined
1893 – 1918	11	3	10
1919 – 1924	3	4	3
1925 – 1941	0	55	12

TABLE 14 Composite of publicly available descriptions of the location of the Earth in the cosmos between 1893 and 1941.

Years of Publication	Sun/Earth centered in universe	Sun/Earth not centered in universe	Not determined
1893 – 1918	12	2	10
1919 – 1924	2	2	6
1925 – 1941	4	26	37

TABLE 15 Comparison of descriptions of the structure of the universe in selected *New York Times* and *Los Angeles Times* newspaper articles between 1893 and 1924.

Years of Publication	Milky Way as entire universe	Milky Way one of many galaxies	Not determined
New York Times	2	0	2
Los Angeles Times	2	4	0

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