The Role of the 40 Foot Schaeberle Camera in the Lick Observatory Investigations of the Solar Corona

Thesis submitted by
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STATEMENT ON THE CONTRIBUTION OF OTHERS

Nature of Assistance	**Contribution**	**Names, Titles and Affiliations of Co-Contributors**
Intellectual support	**Proposal writing**	Dr. Wayne Orchiston, Associate Professor of Astronomy, James Cook University, Townsville, Queensland, Australia.
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ABSTRACT

The thesis will present the total solar eclipse expeditions of the Lick Observatory that occurred during the late nineteenth century and continued through the first quarter of the twentieth century. At this period in time, astronomical research centers worldwide, were sending solar eclipse expeditions afar, often under arduous travel and living conditions. The primary goal, of the Lick Observatory's eclipse expeditions, was to collect photographs and spectrograms of the features of the Sun that can only be seen and recorded in the brief moments of a total solar eclipse of the Sun. The scientific focus of this thesis is the Observatory's study of the solar corona using large scale photographic images.

A summary will be given of the science of the solar corona, as it developed through the mid-late nineteenth century up to the period of the Lick Observatory's eclipse expeditions, which began in 1889. It was then that the corona was on an ever-increasing scale being subjected to scientific analysis with the new tools of photography and the spectroscope. This review will define those contributions made by the study of drawings and photographs of the solar corona up to the time of the Observatory's expeditions. This will set the stage for the pioneering photography and coronal research conducted by the Lick Observatory, made possible with the development of a new eclipse camera by Staff Astronomer J.M. Schaeberle. Schaeberle, would in turn use its images in his continued analysis of a new theory regarding the forces within the solar corona that define its structure and form.

Schaeberle's unique 40 foot focal length camera will be presented in detail. This instrument was designed for the sole purpose of making large-scale coronal images at a total eclipse of the Sun. These images would reveal fine structure within the corona never seen before. The individual components, making up this camera, will be described with attention given to the care and precision by which they were manufactured, set up, and operated. The Camera will be described at each eclipse site along with pertinent photographic processes. A brief summary of the plate results will be included.

A general description of each of the Observatory's eclipse expeditions will be detailed. The site geographic specifics, staff and volunteers in attendance, individual duties of the members of the eclipse party, layout of the eclipse camp, range of scientific apparatus and their purpose, interaction with local organizations, and any special circumstances that affected the outcome of the expedition's success or failure are included.

The Observatory's contributions to the knowledge of coronal physics will be presented and subjected to critical analysis. Schaeberle's new coronal theory based solely on Newtonian mechanics will be reviewed and compared to the concurrent mechanical, magnetic and electric coronal theories, then under study by other prominent astronomers at other institutions. Any connections of the new theory with regard to particle makeup, meteor streams, comets, or gas content of the solar corona, will be mentioned. The resulting scientific output generated from the Schaeberle Camera's coronal images will then be fitted within the overall knowledge of the solar corona at that point in history. Major coronal research conducted by J.A. Miller of the Sproul Observatory at Swarthmore College using the Lick's large scale plates will be mentioned as it was an extension in part of the original Schaeberle Mechanical Theory of the Solar Corona.

A brief survey of the Lick Observatory involvement of a test of Einstein's Theory of General Relativity will be presented as it was the principal focus of three of the eclipse expeditions and the Lick Observatory was a chief participant in this paradigm shift of our knowledge of physics.

The coronal imaging program of the Observatory will be compared with that of other institutions at individual eclipse dates. This comparison will include a summary of the cameras used for producing large scale images of the corona by all parties.

The Lick Observatory's solar eclipse program will be discussed in terms of its place in the overall scheme of the general research program of the Observatory. In the same manner, the direct photographic eclipse program will be assigned its level of importance on each of the expeditions when compared to the concurrent spectrographic experiments, Vulcan planet search, and Einstein verification studies, as time progressed. Issues of funding and staff allotment for the expeditions, research, and timely publication of images and scientific results will be discussed. The effectiveness of the Observatory relying on volunteers to conduct a good deal of the eclipse work will be examined.

There will be a discussion of optical design for the production of large sized eclipse images. The study will focus on the advantages and disadvantages of fixed cameras versus clock-driven

movable instruments and refractor versus reflector optical configurations. Optical specifications of aperture and focal length suitable for coronal image making with the photographic emulsions and reproduction methods of the time will be looked at. Within this study, the Schaeberle Camera will receive its classification amongst other eclipse cameras with its performance characteristics being evaluated and compared.

A study will be made to show the level of cooperation present between the Observatory and other national and international institutions. Any major involvement with astronomical organizations and their eclipse committees will be summarized. The educational benefits to the general public and the public relations role of the eclipse expeditions will be noted.

The founding of the Astronomical Society of the Pacific will be discussed because of its intertwinement with the preparations for the first Lick Observatory eclipse expedition in January 1889.

The Observatory faced continuous budget deficiencies and the impact on the publication of eclipse results will be surveyed in this light.

The thesis will conclude with a series of remarks to summarize the findings of the thesis. The advancement in camera design in regards to the Schaeberle Camera and photographic processes for solar eclipse image making will be summarized. A reflection on the modernization of the Lick eclipse expeditions will be given. Advancements in analytical techniques for data reduction will be noted. The key contributions of the Observatory to our knowledge of the solar corona will be summarized. Results of other institutions made latter in the nineteenth century by their use of the plates of the Schaeberle Camera will be briefly noted. The Lick Observatory solar eclipse expeditions and solar eclipse research program will be given its place in the grand scheme of the study of solar physics.

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