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Final Report  
to the  
National Aeronautics and Space Administration  
for Grant NAGW-622 for  
Coordinated Observations in Support of the Solar Maximum Mission

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(NASA-CR-179931) COORDINATED OBSERVATIONS

IN SUPPORT OF THE SOLAR MAXIMUM MISSION

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Abstract. The in-orbit repair of the Solar Maximum Mission satellite has provided an opportunity to continue observations of the Sun's outer corona, transition region, and bolometric flux through the decay phase and minimum of the solar cycle. The coordinated observation of the solar photosphere, chromosphere, and low corona from the ground is a necessary companion to understanding the full range of phenomena seen over the solar cycle by the spacecraft instruments. A program of such observations has been undertaken at the Mees Solar Observatory, and has established a broad database for the analysis of the solar atmosphere and interior.

Regular SMM Coordinated Observations.

A principal activity under this grant was the observation of the Sun at Mees Solar Observatory in coordination with the SMM observing plans. Observer Sherry Thompson was fully supported by the grant to conduct the observations on a regular basis. A computer link to the SMM control center was used to receive the daily SMM observing plans and to direct the Mees observations accordingly. Some specialized observations, particularly those using the Stokes Polarimeter, were made by scientists from the Institute.

The basic count of days with observations from the various instruments at Mees in the calendar year 1985 is as follows:

H $\alpha$ full disk flare patrol	201
Coudé camera (Zeiss H $\alpha$ filter)	77
Red coronagraph (H $\alpha$ )	160
Green coronagraph (Fe XIV 5303Å)	121
Ca II K-line full disk	148

Excluding weekends, holidays, and vacations, a single observer works 226 days in a year. The Coudé Camera was only in operation for 9 months in 1985 because of work on its controller. A detailed listing of the specific hours of observation on each date has been sent to the SMM ground-based data coordinator.

While the level of solar activity has been relatively low during SMM II, research and analysis has continued on SMM data which were obtained under an associated grant. M. McCabe has recently completed studies of several active regions and energetic events. With Z. Svestka and collaborators, she analyzed the coronal mass ejection associated with a well known flare and post-flare arch on May 21 and 22, 1980. X-ray (HXIS), H $\alpha$  (Mees), white light corona (Solwind), and zodiacal light (Helios) images showed the coexistence of coronal mass ejection with a stationary post-flare coronal arch. The mass ejection was seen as a prolongation of a powerful spray, whereas the active region filament did not erupt.

With M. Kundu and collaborators, McCabe is in process of studying and comparing simultaneous VLA observations at 6 and 20 cm with H $\alpha$  data of an active region and flare seen on May 15, 1980 at 20:30 UT.

An active region (2779) of great interest during SMM I transited the solar disk from November 5 to 18, 1980. The earliest H $\alpha$  observations from Mees at 17:25 UT on November 5, 1980 showed large absorption loops with different Doppler shifts that were associated with an earlier (15:26 UT) X1.2 flare. However, another flare (2B) was also developing and reached maximum at 17:28 UT. A number of smaller events with associated Doppler motions then followed. McCabe, Svestka, and S. Martin have begun to examine the HXIS X-ray and H $\alpha$  data. The Mees data is most important because the off-band images during the flare yield data on the velocity distribution among the bright and dark features.

The Ca II K line daily images are an important source of data for studies of the solar irradiance variation, as measured by the ACRIM instrument on SMM. B. LaBonte and graduate student D. Braun have analyzed the Ca images for a short interval of the SMM mission and find that plage and network emission can be readily measured from them. Research fellow D. Chou is beginning a more extensive analysis of the Ca image series, which now extends from the Skylab period.

#### Special Observing Programs.

A number of special programs were also undertaken in 1985.

In June 1985 a filament study program was initiated by K. R. Lang (Tufts University) to assemble SMM data and H- $\alpha$  ground-based observations to complement radio observations from the VLA. On June 7 we were successful in obtaining good H- $\alpha$  coverage of the active region filament. Doppler motions were seen throughout the radio run, followed by a complex two-ribbon flare. A data summary and sample exposures were sent to Drs. Lang and A. Poland (Coronal and Prominence Plasma group coordinator).

The Spacelab II Shuttle flight was well supported, with excellent coverage throughout most of the mission. The data included photographs from all the instruments plus vector magnetograms taken

at 6303Å. A summary was provided to the SMM ground-based data coordinator. M. McCabe has been collaborating with G. Brueckner of Naval Research Laboratory in an investigation of transient line broadenings seen with the NRL instrument on Spacelab II, and the Mees data show that the site of the strongest events was an emerging flux region near a pre-existing active region. This work is being prepared for publication. In addition, during Spacelab II, VLA observations by M. Kundu of an evolving filament on August 3, 1985 were well covered by Mees H $\alpha$  observations and the data are presently being compared.

In late March 1985 a coordinated observing program was conducted in an attempt to obtain magnetic field information on a single sunspot over a wide range of heights. As part of this program D. L. Mickey obtained Stokes spectral rasters of the spot in the lines C I 9112Å, Fe I 6303Å, and Ca II 8542Å, on two consecutive days near the central meridian crossing of the spot. Observations were also obtained by the Marshall Space Flight Center vector magnetograph in Fe I 5250Å line, by the UVSP instrument on the SMM in the C IV 1540Å transition region line, and by the Owens Valley Radio Observatory. The scientific analysis of these data is now in progress, under the leadership of M. J. Hagyard of MSFC.

A second collaboration involving Mickey and E. West of MSFC was directed toward a study of the magneto-optics effects in sunspots.

Data from both the Stokes Polarimeter and the MSFC vector magnetograph were obtained during the period June 6 through 14, 1985. This study will also verify that these two very different instruments do measure comparable polarization signals from the Sun. Data reduction procedures are now being developed.

The second of a series of workshops on Coronal and Prominence Plasmas, organized by A. Poland and sponsored by NASA, was held at Goddard Space Flight Center in April 1985. F. Orrall, D. Landman, D. Mickey, and M. McCabe attended from Hawaii. Three contributions from the Hawaii group appear in the published workshop proceedings.

Other activities.

Refurbishment of the photographic instruments was completed in this grant year, with all new camera controllers for the Red and Green Coronagraphs and the Coudé Camera.

In mid-September 1985, Principal Investigator Dr. Donald Landman resigned from the University of Hawaii to accept an attractive position in industry. He was replaced by Dr. Barry LaBonte.