THE MEES CCD IMAGING SPECTROGRAPH

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Abstract. The Mees CCD (MCCD) instrument is an imaging spectroscopy device which uses the 25 cm coronagraph telescope and the 3.0 m Coudé spectrograph at Mees Solar Observatory (MSO) on Haleakala, Maui. The instrument works with resolving power up to $R \approx 200000$ with significant throughput from $\lambda 3934 \, \text{Å} \, \, \, \text{(Ca II K)}$ to $\lambda \approx 10000 \, \text{Å}$. A fast guiding active mirror stabilizes the image during observations. A rapidly writing magnetic tape storage system allows observations to be recorded at 256 kbytes s$^{-1}$. Currently, the MCCD is used for imaging spectroscopy of solar flares at $\lambda \approx 6563 \, \text{Å} \, \, \, \text{(H\alpha)}$, and velocity measurements of umbral oscillations; future plans include emission line studies of active region coronae, and photospheric studies of solar oscillations.

1. Introduction

The scientific goals of the MCCD are varied, and range from observing the slow evolution of active region coronae to providing spectroscopic diagnostics during rapid chromospheric flares. At peak performance, over a 10 hour observing day, the MCCD was intended to make 30 ms exposures, each with 0.6 arc sec spatial resolution, and 14 mÅ spectral resolution. These goals placed new demands on the image quality, system throughput, spatial and spectral stability of the coronagraph and spectrograph instrument package.

The coronagraph and spectrograph instruments have been used in many ways since their installation in 1970. Photographic coronal work was done with these instruments (Fisher, 1971a, b; Fisher and Pope, 1971; McCabe, 1973) which was aimed at understanding the spatial and velocity distribution of coronal plasma as observed in several different spectral lines. Various spectrophotometric observations were made with the intention of studying the physical properties of prominences, (Landman, 1976, Landman, Edberg, and Laney, 1977; Landman, Illing, and Mongillo, 1978; Landman, 1981b, 1985; Brickhouse and Landman, 1987) and solar plage (Landman, 1981a; LaBonte, 1986a, b). Photospheric and chromospheric solar oscillations were investigated in two projects, with time series observations of the solar spectrum around $\lambda \approx 5380 \, \text{Å}$ (Lindsey and Landman, 1980) and $\lambda \approx 5876 \, \text{Å}$ (Landman, 1981a). These projects encompass most of the observations made with the coronagraph and spectrograph instrument package.

Although these instruments have been used for many years, there is no comprehensive reference which describes them. For this reason, we review the 25 cm coronagraph telescope and 3.0 m Coudé spectrograph system in Section 2. We describe, in Section 3, the characterization of the instrument package, and the adjustments made to meet MCCD requirements. In Sections 4 and 5, we explain the optical and electronic systems.
that comprise the MCCD instrument. We discuss two current observing programs run with the MCCD in Section 6, and lastly, in Section 7, we list several future observing programs, and discuss potential uses for the MCCD instrument in solar astronomy.

2. The Coronograph-Spectrograph Instruments from 1969 to 1987

The 25 cm coronagraph telescope and 3.0 m Coudé spectrograph instrument package was built by Boller and Chivens in 1967. The installation of the telescope on the 3.7 m solar spar, and the spectrograph in the Coudé room of MSO was completed in 1970. In this section, we describe the design and features of each of these instruments prior to the MCCD project.

The coronagraph telescope (see Figure 1) employs a singlet 25 cm diameter, 355 cm focal length objective lens (L1). At the prime focus of this lens is a two-turret collection of occulting disks, which can occult any section of the solar limb. Light from the photosphere is reflected off these occulting disks and out of the telescope when the solar corona is being observed. A field lens (L2) following the prime focus forms a pupil image on a second objective lens (L3). Two fold mirrors (M1 and M2) fold the beam towards the center of the spar mount. The second objective (L3) is a hyperchromatic lens, and corrects for the chromatic aberration of the coronagraph lenses. After the L3, the beam