

## CCD NARROWBAND FILTER IMAGING OF MARS DURING THE 1990 OPPOSITION; James F. Bell III, Planetary Geosciences Division, University of Hawaii, Honolulu 96822.

The Charge-Coupled Device (CCD) detector has become a fundamental tool for groundbased astronomy and planetary science over the past decade due to its near-UV to near-IR sensitivity and its ability to accurately map spatial variability of extended sources over this wavelength range. This abstract reports the initial results from 12-color narrowband filter CCD images obtained of Mars during the recent opposition of November 1990.

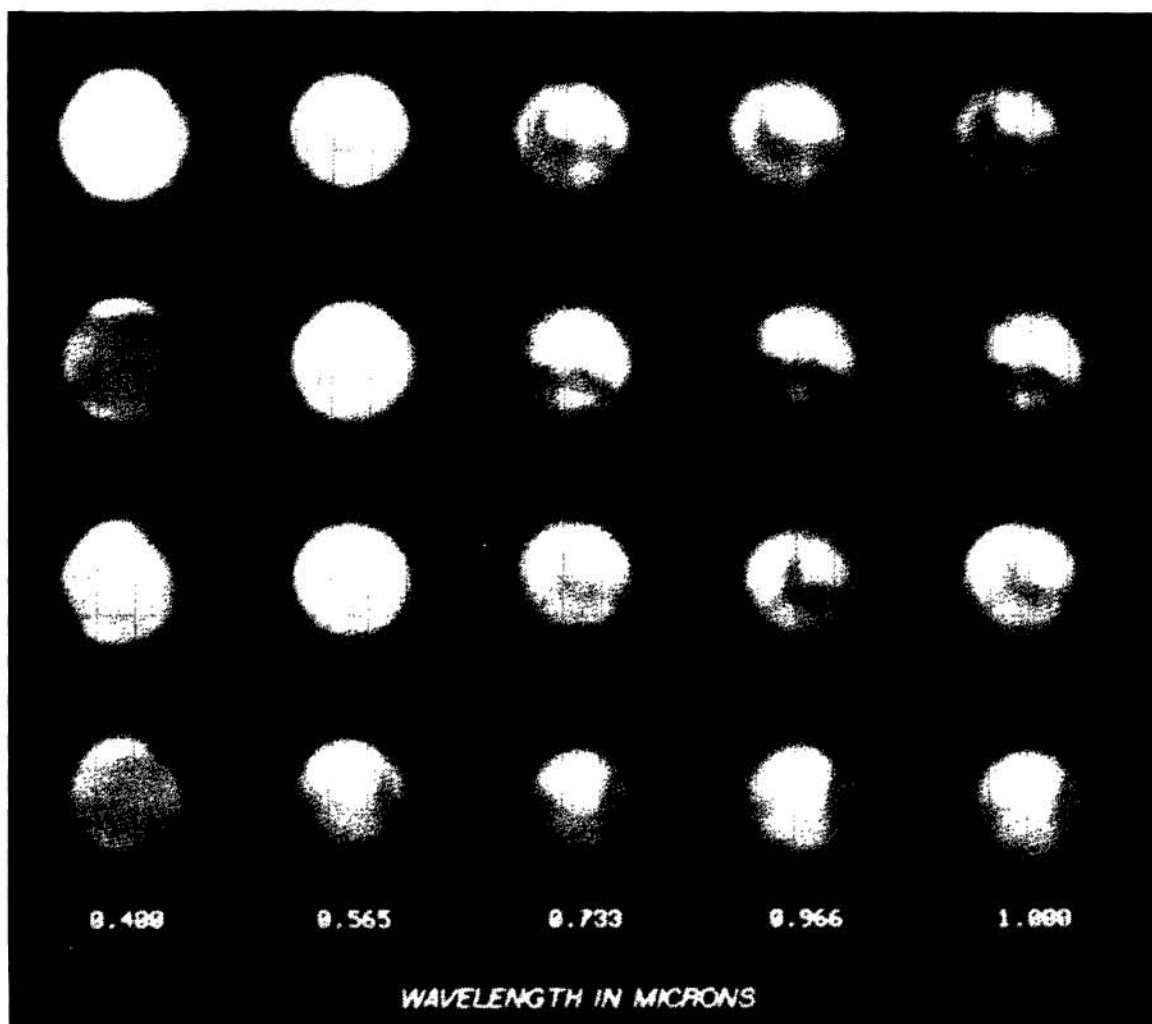
The data were acquired using a STAR 384 X 576 pixel CCD camera (Photometrics Inc., Tucson), cooled to  $-45^{\circ}\text{C}$ . The camera and an uncooled filter wheel were mounted to the Air Force/University of Hawaii 61-cm telescope at Mauna Kea Observatory. Images of Mars, lunar standard areas, and the standard star  $\kappa$  Cetus (G5V) were obtained on November 29 and 30, 1990 UT. Weather at the observatory was fair though not photometric on the 29th (some light cirrus, 60-80% relative humidity, 1" seeing) but was exceptional on the 30th (clear and photometric, 20-30% humidity, 0.5" seeing or better). Mars was at a phase angle of  $1-2^{\circ}$  during these observations, and the northern hemisphere was in late winter ( $L_S=341^{\circ}$ ).

Spectra obtained during the 1988 opposition [Bell *et al.*, 1989; Bell *et al.*, 1990a,b] identified absorption features near 6600 Å and 8600 Å that were interpreted as evidence of crystalline hematite ( $\alpha\text{Fe}_2\text{O}_3$ ) on the martian surface. In addition, a weak absorption centered at 9000-10000 Å was seen in these data, and this band has previously been interpreted as evidence of  $\text{Fe}^{2+}$ -bearing minerals such as clinopyroxene or olivine [see reviews by Singer *et al.*, 1979; Huguenin, 1987]. In an attempt to map possible spatial variability of these absorption features, images were obtained in 12 narrowband filters (300 Å FWHM) at the following wavelengths (Å): 4000, 5650, 6330, 6640, 7330, 7630, 8000, 8660, 9000, 9660, 10000, 10664. The images at 6640 Å and 8660 Å were specifically intended to map variability in ferric oxides in the martian surface and airborne dust, while the images longward of 9000 Å were intended to map ferrous mineral variability. Images at and near 4000 Å have historically been most useful for observing condensates (clouds, ice caps, frost deposits, etc.), since ferric oxides on the surface are spectrally bland in the near-UV while these condensates still have a high reflectance [see Slipher, 1962; Akabane *et al.*, 1990; Beish and Parker, 1990]. The remaining wavelengths were used mostly as "continuum" points for the creation of ratio images in and out of the mineralogic absorption features discussed above.

Data reduction has followed the standard format for CCD image data: dark current (bias) images were obtained for the applicable range of exposure times and subtracted from the raw images. Spatial non-uniformities in the CCD pixel sensitivity and the filter opacity were corrected using flatfield images at each wavelength. Figure 1 presents some of the imaging data at this stage of the reduction. The next, and most difficult step in the data reduction procedure will be to convert these images to absolute albedo using simultaneous imaging data obtained of solar analog star  $\kappa$  Cetus and various assumptions about the surface photometric function.

The images in Figure 1 show that the range of martian longitudes covered was  $130-350^{\circ}$ . Syrtis Major is the dominant dark feature at the longer wavelengths of the images in the first and third rows of Figure 1. As discussed above, the images at 4000 Å ( $0.400\text{ }\mu\text{m}$ ) do not show bright/dark surface feature contrasts similar to those seen at longer wavelengths. Instead, polar "hoods" can be seen over both the north and south poles. As well, a distinct limb brightening can be seen in the November 30 images, particularly along the western limb of the image in the second row of Figure 1.

Further reduction of this data set will concentrate on: calibrating the images to absolute albedo, co-registering and map projecting the data into image cube format (spatial X spatial X spectral), producing "pseudospectra" from these image cubes, and producing ratio images in and out of the absorption bands discussed above in an attempt to map mineralogic variations on the martian surface at 100-200 km spatial resolution. These data may help extend the interpretations of Viking Orbiter narrowband filter imaging data [e.g., Soderblom *et al.*, 1978; McCord *et al.*, 1982; Arvidson *et al.*, 1989].



**Figure 1:** CCD images of Mars obtained on 29-30 November 1990 UT from Mauna Kea Observatory. This figure shows 5 of the 12 wavelengths obtained. Row 1: Data from 0700-0800 UT on 29 November, central meridian (CM) = 260°. Row 2: 0600-0630 UT on 30 November, CM=230°. Row 3: 0900-0930 UT on 30 November, CM=280°. Row 4: 1200-1220 UT on 30 November, CM=330°. Prominent albedo features are Syrtis Major near the central meridian of rows 1 and 3, Tyrrhenum and Cimmerium in row 2, and Sinus Meridiani and Sinus Sabaeus in row 4.

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