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Optical Photometric Observations of GEO Debris

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We report on a continuing program of optical photometric measurements of faint orbital debris at geosynchronous Earth orbit (GEO). These observations can be compared with laboratory studies of actual spacecraft materials in an effort to determine what the faint debris at GEO may be.

We have optical observations from Cerro Tololo Inter-American Observatory (CTIO) in Chile of two samples of debris:

1. GEO objects discovered in a survey with the University of Michigan's 0.6-m aperture Curtis-Schmidt telescope **MODEST** (for **M**ichigan **O**rbital **DE**bris **S**urvey **T**elescope), and then followed up in real-time with the CTIO/SMARTS 0.9-m for orbits and photometry. Our goal is to determine 6 parameter orbits and measure colors for all objects fainter than R = 15th magnitude that are discovered in the MODEST survey.
2. A smaller sample of high area to mass ratio (AMR) objects discovered independently, and acquired using predictions from orbits derived from independent tracking data collected days prior to the observations.

Our optical observations in standard astronomical BVRI filters are done with either telescope, and with the telescope tracking the debris object at the object's angular rate. Observations in different filters are obtained sequentially.

We have obtained 71 calibrated sequences of R-B-V-I-R magnitudes. A total of 66 of these sequences have 3 or more good measurements in all filters (not contaminated by star streaks or in Earth's shadow). Most of these sequences show brightness variations, but a small subset has observed brightness variations consistent with that expected from observational errors alone.

The majority of these stable objects are redder than a solar color in both B-R and R-I. There is no dependence on color with brightness.

For a smaller sample of objects we have observed with synchronized CCD cameras on the two telescopes. The CTIO 0.9-m observes in B, and MODEST in R. The CCD cameras are electronically linked together so that the start time and duration of observations are the same to better than 50 milliseconds. Thus, the B-R color is a true measure of the surface of the debris piece facing the telescopes for that observation. Any change in color reflects a real change in the debris surface.

We will compare our observations with models and laboratory measurements of selected surfaces.

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