CASSINI OBSERVATIONS OF THE OPPOSITION EFFECT OF SATURN'S RINGS-1. R. M. Nelson[1], B. W. Hapke[2], R. H. Brown[3], L. J. Spilker[1], W. D. Smythe[1], L. Kamp[1], M. Boryta [4], F. Leader [1], D. L. Matson[1], S. Edgington [1], P. D. Nicholson [5], G. Filacchione [6], R. N. Clark [7], J-P Bibring [8], K. H. Baines[1], B. Buratti [1], G. Bellucci[6], F. Capaccioni[6], P. Cerroni[6], M. Combes [9], A. Coradini [6], D. P. Cruikshank[10], P. Drossart [11], V. Formisano[6], R. Jaumann [12] Y. Langevin[8], T. B. McCord[13], V. Mennella[14], B. Sicardy[8] and C. Sotin[15]

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On May, 20, 2005 the Cassini spacecraft flew between the sun and Saturn on a trajectory such that the zero phase point passed through the rings. This event was recorded by the Visual and Infrared Mapping Spectrometer (VIMS) aboard the spacecraft and a number of spectral image cubes ($0.4<\lambda<5.2\mu m$) were obtained that showed the opposition point as it transited the rings (Fig1).

Figure 1. The VIMS opposition image of Saturn's B ring.

The zero phase points in the images are surrounded by small, anomalously bright, areas a fraction of a degree wide - the opposition effect (OE). The OE is a spike in the reflected intensity observed near 0^o phase when it is displayed as a function of phase angle. It is known to occur on virtually every object in the solar system whose surface can be seen. It has been observed from the earth on Saturn's rings for over a century (see e.g. [1] for a review), but only for the rings as a whole. This is the first time the OE has been resolved for small areas on the rings.

Theoretical studies and laboratory investigations show that the OE arises from two distinct processes, shadow hiding (SHOE) and coherent backscattering (CBOE). The SHOE process causes an OE by the elimination of shadows cast by regolith grains upon one another as phase angle decreases. The CBOE process causes an OE by constructive interference between photons traveling in opposite directions along the same path within the medium. SHOE is expected to dominate the contribution to the OE in absorbing media where multiple scattering of photons is not significant. CBOE is expected to dominate the contribution to

the OE in highly reflective media with much multiple scattering.

The phase curve of the OE potentially contains information on the structure of the rings and/or the nature of the ring particles. Therefore, we have begun a program of quantitative analysis of the phenomenon. Using the individual image cubes, a total of 32 areas containing 4 pixels each were selected that lay along the same ringlet as the opposition point and bracketed it in phase angle. Figure 2 shows these areas for one image cube in the B ring. For each area the spectral reflectance I/F(λ) averaged over the 4

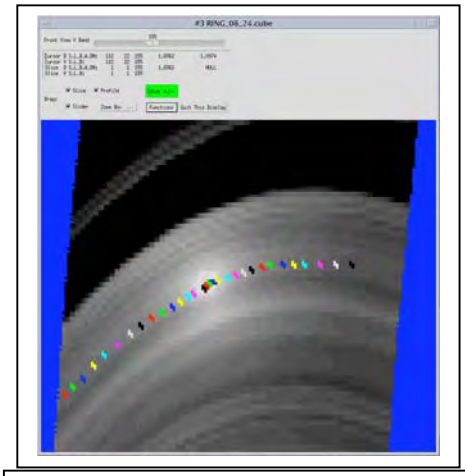


Fig 2. Typical set of photometric measurements encompassing the opposition effect region.

pixels was obtained. Because water ice is a major component of the rings, the spectra are predominantly that of water. Within each spectrum 9 narrow spectral bands were chosen to reflect a variety of wavelengths and reflectance levels. In this way phase curves of the ringlet were obtained for each band. These are shown in Fig 3 where red shows very reflective spectral regions, yellow–very absorbing and green-intermediate. In this way the phase curves for each ringlet were obtained for each band.

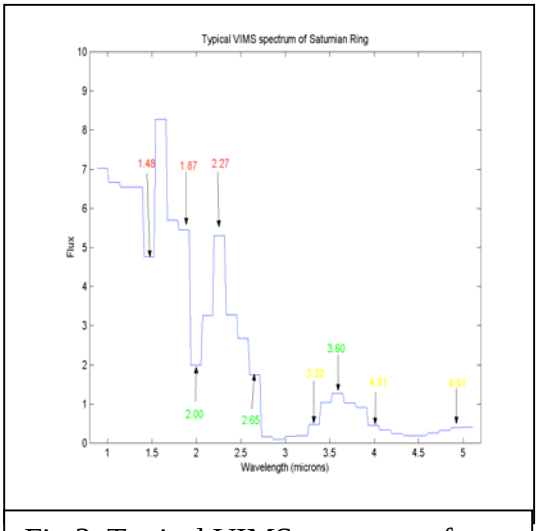
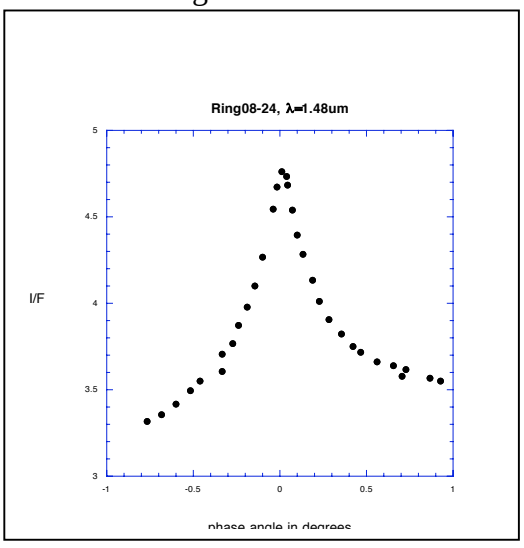


Fig 3. Typical VIMS spectrum of Saturn's ring.

Figure 4 (below) shows one of these phase curves for the ringlet within the B-ring. In a companion paper [2] the results of the analyses of the phase curves will be given.



References: [1] Cuzzi, J. et al (1984) in *Saturn*, ed by Gehrels, T. and Matthews, M., U. of Arizona Press, Tucson. [2] Hapke, B. et al (2006), this conference.