VIS-NIR SPECTRAL PROPERTIES OF SATURN'S MINOR ICY MOONS. G. Filacchione[1], A. Coradini[2], F. Capaccioni[1], P. Cerroni[1], G. Bellucci[2], R. H. Brown[3], K. H. Baines[4], J. P. Bibring[5], B. J. Buratti[4], R. N. Clark[6], M. Combes[7], D. P. Cruikshank[8], P. Drossart[7], V. Formisano[2], R. Jaumann[9], Y. Langevin[5], D. L. Matson[4], T. B. McCord[10], V. Mennella[11], R. M. Nelson[4], P. D. Nicholson[12], B. Sicardy[7], C. Sotin[13], A. Adriani[2], M.Moriconi[2], E. D'Aversa[2], F. Tosi[2], F. Colosimo[2], [1]INAF-IASF, via del Fosso del Cavaliere, 100, 00133, Rome, Italy, gianrico.filacchione@rm.iasf.cnr.it , [2]INAF-IFSI, via del Fosso del Cavaliere, 100, Rome, Italy, [3]Lunar and Planetary Lab, University of Arizona, Tucson, AZ, USA, [4]Jet Propulsion Laboratory, Pasadena, CA, USA, [5]Institut d'Astrophisique Spatiale, Orsay, France, [6]US Geological Survey, Denver, CO, USA, [7]Observatoire de Paris, Meudon, France, [8]NASA Ames Research Center, Moffett Field, CA, USA, [9]Institute for Planetary Exploration, DLR, Berlin, Germany, [10], HIGP/SOEST, University of Hawaii, 22 Fiddler's Rd. Winthrop, WA, USA, [11]INAF-OAC, Napoli, Italy, [12]Cornell University, Astronomy Department, Ithaca, NY, USA, [13]Laboratorie de Planetologie et Geodynamique, Universitè de Nantes, Nantes, France.

Introduction: The numerous minor icy moons of Saturn are difficult targets to observe from Earth and very few VIS-NIR spectra were available before Cassini's exploration. Thanks to Cassini-VIMS (Visual and Infrared Mapping Spectrometer) we can unveil the nature of these icy surfaces, compare them with nearby rings and major satellites, and search for possible compositional analogies. These data are of great interest to better define the evolution and dynamics of minor bodies in the Saturn system. Considering their orbital proximities, we have compared Atlas with the outer regions of the A ring; Pandora and Prometheus with the F ring; Janus with the co-orbital Epimetheus; Telesto with Calypso, both Trojan satellites of Tethys. The small dimensions of these objects and the large distances of Cassini from them, allow us to retrieve only full-disk observations. The amount of water ice is estimated from the diagnostic absorption features at 1.5 and 2.0 microns while the abundance of contaminants (dusts, organics) is strongly correlated with the blue spectral slope. From our preliminary results it seems that Janus-Epimetheus and Prometheus-Pandora, both in nearby orbits, have similar spectral properties; on the other hand Atlas is greatly different from the A ring; Telesto and Calypso show different spectral behavior, probably related to their orbital positions with respect to Tethys.

VIS-NIR Reflectance Spectra: Up to the present time only a few observers were able to collect spectrophotometric data on the minor moons of Saturn from terrestrial and HST observations [1, 2, 3]; these datasets are generally limited by poor spatial/spectral resolutions that don't allow a complete characterization of the objects. VIMS spectra, shown in Figures 1 (VIS range, 350-1050 nm) and 2 (IR range, 850-5100 nm), confirm a dominant presence of H_2O ices [4]. All spectra, in fact, are featureless in the visible range while showing the strong and characteristic absorption bands of water ice at 1524, 2050 and 3000 nm. The presence of contaminants (organic tholins and dusts) affects mainly the visible blue region, resulting in a red slope at these wavelengths for all targets, with the exception of the F ring.

VIS spectral slopes: Blue-green and red spectral slopes are evaluated by using the same method explained in [5] and are plotted in Figure 3. In the blue-green range (350-550 nm) Telesto and the F ring have the flatter spectra with a slope equal, respectively, to 4.15E-4 and 4.35E-4. This behavior can be explained by a nearly complete absence of contaminants on water ice. The heavily contaminated regions of the A ring have the steepest slopes in this spectral range (2.73E-3 to 2.80E-3). The 550-1050 nm red slope is sensitive to the freshness and grain sizes of the water ice. The fresh surface of Calypso (-2.05E-4) and the micrometer sized particles of the F ring (-1.88E-4) have negative (blue) slopes while positive values are reached on the A ring regions (1.09E-4 to 1.43E-4) where meter-sized particles are mainly distributed. Prometheus and Pandora show the same spectral slopes: a positive slope in the blue-green range (1.26E-3 and 1.28E-3, respectively) follows a negative slope in the red range (-5.72E-5 and -5.55E-5). By looking at this properties in the visible range it seems that these two object are strongly correlated, thus indicating the same amount of contaminants and grain sizes distribution on their surfaces. Calypso has a negative red slope while Tethys has a slightly positive value; the blue-green slope, sensitive to the presence of contaminants over water ice, is practically flat: this is an evidence of a lower abundance of contaminants, in comparison, for example, with the A ring. The negative red slope in the visible range continues in the 1000-1500 nm range where Calypso spectrum shows an evident blue slope (Figure 2).

Water ice bands: With the exception of Calypso, whose band strength is influenced by a 65 nm wide bump near the band center, the 3000 nm water ice band is almost saturated for all targets. The dispersion of the 1524 and 2050 nm bands (Figure 4) is particularly meaningful as targets are distributed with a linear law: F ring have the faintest features while Calypso, Prometheus and the A ring the strongest. Telesto, Tethys and Calypso have a peculiar behavior: these objects have bands strengths that become more intense moving from the leading Telesto to the trailing Calypso. This effect could be produced or by contamination or by a different grain sizes distribution. Considering the results obtained in the visible, this second effect should be more probable because there aren't evident traces of contamination in the blue range.

Water ice band strengths are strongly dependent on the grain sizes: lower band strengths characterize fine grains while stronger bands correspond to coarse ice. As many studies have demonstrated on Saturn's moons [5, 6], the leading hemispheres are more succeptible to impacts than the trailing hemispheres. By analogy we can affirm that finer icy particles are distributed on Telesto, the leading Trojan of Tethys, while more coarse grains occur on the surface of the trailing Calypso.

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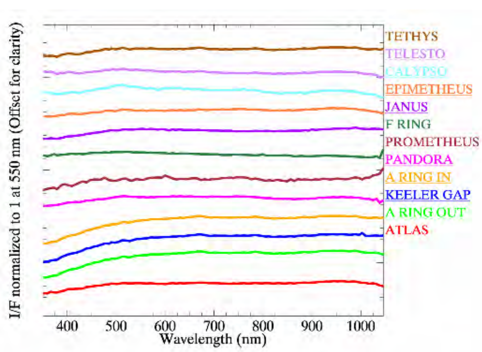

Fig. 1 Saturn's minor icy moons VIS I/F normalized at 550 nm.

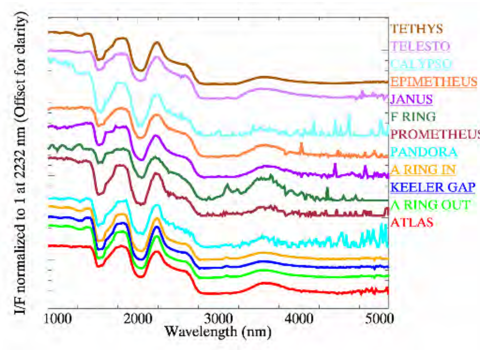

Fig. 2 Saturn's minor icy moons IR I/F normalized at 2232 nm.

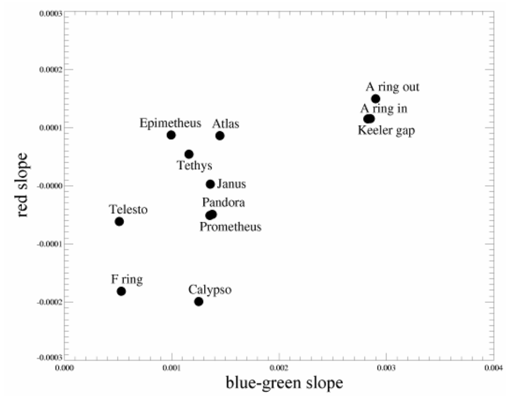

Fig. 3 VIS blue-green vs red slope. Prometheus and Pandora have coincident slopes.

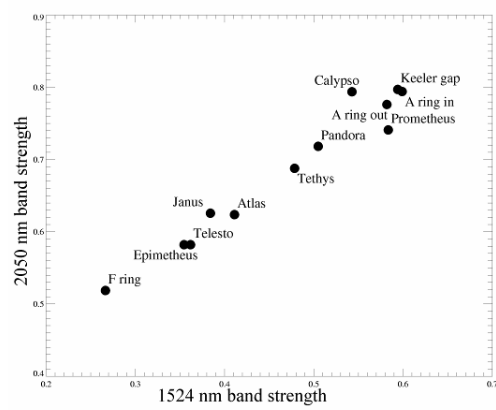

Fig. 4 Water ice 1524 vs 2050 nm bands strengths.