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Saturnian icy satellites: experimental evidence of the narrow component of the photometric opposition effect

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The photopolarimetric observations of Saturn's satellites Enceladus, Tethys, Dione, Rhea, Iapetus, and Titan were taken with the 2-m RC telescope at Rozhen observatory (Bulgarian Academy of Science) during two time periods in the different phase angle intervals (from 0.07˚ and 0.01˚ and from 5.6˚ to 5.2˚). In this paper we present the first results of disk-integrated satellite photometry including mutually consistent solar and rotational phase curves in red and near infrared bands (λ=670nm and λ=890nm). Enceladus, Tethys, Dione, Rhea, and Iapetus demonstrate a sharp brightness increase in the narrow backscattering domain of the phase angles (between 0.7˚ and 0.01˚) reveling presence of narrow components of the opposition effects, which has not been recorded previously except Enceladus. The slopes of the low phase angle portions of moon's phase curves, being especially high for Tethys and Rhea, are at the level or even exceeds that of Europa's at opposition. The shape of the phase curves as well as the strength of the opposition effects, measured as the total increase in moon's reflectance while the phase angle was decreasing from 5.2˚ to 0˚, indicate that the mechanism of constructive wave interference is, probably, a strong contributor to the opposition effects of high albedo saturnian satellites, especially Tethys and Rhea. At the same time, Enceladus' phase curve is somewhat different from those of Tethys and Rhea. It may indicate that despite of the extreme Enceladus' brightness (the albedo at the opposition exceeds 1) there are, possibly, some others physical processes, except the constructive wave interference, which suppress and flatten near opposition intensity peak in comparison with others Saturnian icy moons. The satellite's rotation curves confirm that the leading/training albedo asymmetry known from previous visual observations extends into red and near infrared. The red and near infrared amplitudes of hemispherical asymmetries of the satellite surfaces presented in this study

are quite similar amounting of 4%, 8%, 18%, and 38% for Enceladus, Tethys, Rhea, and Dione respectively. It agrees well with those measured by Buratti et al. (1998) and very similar to the amplitudes recorded at visual wavelengths.

References:

Buratti, B. J., Mosher, J. A., Nicholson, P. D., McGhee, C. A., French, R. G. 1998. Near-infrared photometry of the Saturnian satellites during ring plane crossing. Icarus 136, 223-231.