SPECTRAL DEPENDENCE OF POLARIZATION IN COMETS: RECENT OBSERVATIONS AND INTERPRETATION. L. Kolokolova[1], N. Kiselev[2], V. Rosenbush[2], and H. Kimura[3], [1]University of Maryland, College Park, USA (ludmilla@astro.umd.edu), [2]Main Astronomical Observatory of the UAS, Kiev, Ukraine, [3]Hokkaido University, Sapporo, Japan.

Introduction: In this paper we review recent observations of spectral gradient of polarization (polarimetric color, PC) in comets and provide a tentative explanation of the observations using the model of cometary dust as ensemble of aggregated submicron particles. Comparison with the spectral dependence of asteroid polarization is also provided.

Spectral gradient of polarization in comets: Since the phase dependence of polarization in comets found its explanation [1, 2], the focus of comet polarimetric studies has been shifted to the spectral dependence of comet polarization. In the visual, observations usually show that the spectral gradient of polarization is positive at α >30º, i.e. the values of polarization increase with the wavelength (red PC). However, this regular trend has some exceptions. First, the gradient changes its sign for longer wavelengths (Fig. 1b). Second, some comets show blue PC even in the visible. For a long time the only known comet that demonstrated this peculiarity was 21P/Giacobini-Zinner (GZ) [3]. However, recently we have collected a number of evidences that this is a more common phenomenon [4]. Blue PC in the visible was also measured in comets C/1989 X1 (Austin), C/1999 S4 (LINEAR), 9P/Tempel 1 (Fig. 1b), and 73P/Schwassman-Wachmann 3 (SW3) (Fig. 1a). It might look as the blue PC is typical for the comets that release some material from their interior. However, many disintegrating comets, e.g. C/1975 V1 (West) and D/1996 Q1 (Tabur), did not show a blue PC. Also, we have found that Tempel 1 had blue PC not only after [5] but also before [4] the Deep Impact. Examples of GZ and Austin confirm that comets may be not active and still produce a blue PC in the visible, which may indicate some specific properties of their dust.

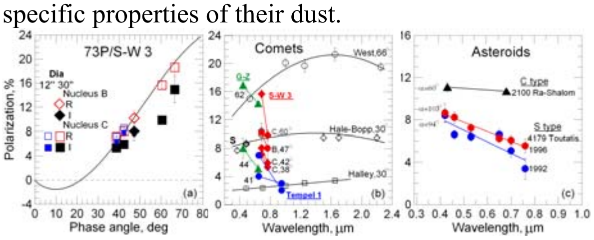

Fig. 1 Polarization for comet SW3 in the R and I bands (a); spectral dependence of polarization for comets (see references in [4]) (b) and for C and S type asteroids [6, 7, 8] (c).

Interpretation of the observations: We use our model of comet dust particles as aggregates successfully applied to examine the phase dependencies of comet brightness and polarization. For ballistic cluster-cluster and particle-cluster aggregates, at α >30º, red PC accompanied by red photometric color is typical in the visible [9]. This may be explained the following way: with increasing wavelength, the monomer size parameter 2πr/λ gets smaller; monomers become "more Rayleigh" particles that increases their positive polarization. However, at some point not properties of individual monomers but interaction between them becomes dominating in light scattering. The strength of the electromagnetic interaction depends on the number of the monomers that the electromagnetic wave covers at a single period (on the light-path equal of one wavelength). This has two consequences. First, the interaction increases with the wavelength: the longer is the wavelength the more particles it covers. The stronger is the interaction the more depolarized becomes the light (similar to multiple-scattering effects) resulting in the negative, blue PC. Second, the transition from individual particle effects (red PC) to the particle interaction effects (blue PC) starts at some specific combination of the size of monomers and the average distance between them (defined by the aggregate porosity). For more compact particles, this effect starts at shorter wavelengths, and they may exhibit blue PC even in the visible. This tells us that GZ, SW3, and Tempel 1 may have more compact aggregates than the comets with red PC (not surprising since all listed comets are short-period, old ones). We may also conclude that asteroids, which show blue PC at all optical wavelengths (Fig. 1c), are covered by rather compact particles. One can see that the wavelength, at which the sign of the PC changes, may be indicative about the porosity of the aggregates. Since the sign of the PC depends on both the size of monomers and the porosity of aggregates, and should also depend on the spectral changes in the refractive index, more serious studies of the interplay between these three characteristics is required.

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