**ICY SURFACE PROPERTIES OF THE DWARF PLANET ERIS.** F. Merlin[1], A. Alvarez-Candal[1], A. Delsanti[1], E. Quirico[2], B. Schmitt[2], S. Fornasier[1], M.A. Barucci[1], F. DeMeo[1], C. de Bergh[1] and A. Doressoundiram[1]. [1]Observatoire de Paris-LESIA (frederic.merlin@obspm.fr) , [2]Laboratoire de Planétologie de Grenoble.

**Introduction:** Eris is the largest Trans Neptunian Object (TNO) discovered until now and it is at present the farthest observed. This object is quite similar to Pluto, with a comparable spectrum in the near infrared [1], suggesting large quantities of methane ice, and a similar diameter close to 2400km [2]. Previous observations showed that some of the methane ice absorption bands are shifted compared to laboratory measurements of pure methane ice [3,4] as was also reported for Pluto.

To confirm and explain these results, we performed new spectroscopic observations at ESO-VLT with FORS, ISAAC and SINFONI in the visible and in the near infrared. We will present the different sources of wavelength shifts of the methane absorption bands. With the use of a spectral modeling, we will discuss the surface properties of this TNO.

**Observations:** New observations of Eris were performed in September 2006 and in December 2007 with FORS1 and FORS2 in the 0.36-1.1 µm range, ISAAC in the 1.1-1.35 µm range and SINFONI in the 1.45-2.45 µm wavelength range. The spectral resolution of the instruments (up to 1500) allows us to have a high accuracy of the band centers positions with acceptable signal to noise ratio.

Spectra obtained in 2006 and 2007 are very similar, with differences lower than a few percent. This suggests a homogeneous surface, even if the rotation period of Eris is not yet known. Absorption depths and widths are also similar for both periods. Only methane ice was firmly detected and no other volatile species have been identified, contrary to $N_2$ and CO observed on Pluto [6].

**Spectral modelling:** We ran radiative tranfer models on both complete 0.65-2.45 µm spectra, based on Hapke theory [5]. We used several icy compounds as pure and diluted methane ice, nitrogen and water ice. We also used organic coumpounds and dark materials to better fit the spectra, although no constraint on these compounds can be given.

From the reduced $\chi^2$ (computed between our synthetic spectra and the object spectra), we see that nitrogen ice could be present on the surface but in lower quantities than those reported by Dumas et al.[4], as in the case of water ice. If we compare the absorption bands independently, it appears that the size properties of the methane ice are different. Indeed, the results are different from the spectra obtained in the visible and those obtained in the near infrared, where smaller particle sizes are required. It is possible to use only methane ice in our models to fit the spectra but we need at least three different particle sizes to do it on the entire wavelength range.

**Wavelength shifts of the absorption bands of methane ice:** The methane absorption bands of Eris spectra are blue-shifted by several angstroms in the visible compared to those of the spectral modelling generated with optical constants of pure methane ice. In order to quantify the apparent shifts observed in the visible range and to measure those of the near-infrared part, we performed a cross-correlation experiment [7] on the entire spectra obtained in 2006 and 2007. We find that, within the error bars, the major part of the near infrared absorption bands are not shifted. The error bars take into account spectral resolution of our spectra and accuracy of the numerical methods,

We present several possible sources of wavelength shifts, already found in litterature, as the effects of intimate and geographic mixtures in the spectral modelling [8]; hydration and dilution of the ice in another one, as the case of $CH_4$ component in $N_2$ matrix [9]; the temperature and physical state changes of the methane ice [10]; or the irradiation processes [11,12]. We show that the more realistic scenario to explain these wavelength shifts is the dilution of methane ice in nitrogen. In this case, the diluted methane ice appears stratified on the surface of Eris. We note that the change in the physical state of the methane ice could generate comparable effects in the visible but not completely in the near infrared. Better constraints on the surface temperature are required to conclude on this aspect.

**References:** [1] Brown et al.. (2005) *ApJ, 635*, L97. [2] Brown et al. (2006) *ApJ.,643*, L61. [3] Licandro et al. (2006) *A&A 458*, L5. [4] Dumas et al. (2007) *A&A 471*, 331. [5] Hapke, 1981 *JGR 86*, 3039. [6] Douté et al. (1999) *Icarus 142*, 421. [7] Tegler et al.(2008) *ArXiv:0801.3115*. [8] Merlin et al.(2007) *A&A 466*, 1185. [9] Quirico and Schmitt (1997) *Icarus 127*, 354. [10] Grundy et al.(2002) *Icarus 155*,486. [11] Mastrapa and Brown (2006) *Icarus 183*, 207. [12] Moore and Hudson (1992) *ApJ, 401*, 353.

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