CHARON’S NEAR IR ICE SIGNATURE AS SEEN BY NEW HORIZONS. C. M. Dalle Ore\textsuperscript{1,2}, J. C. Cook\textsuperscript{3}, D. P. Cruikshank\textsuperscript{2}, Kim Ennico\textsuperscript{2}, William M. Grundy\textsuperscript{4}, Cathy B. Olkin\textsuperscript{5}, Silvia Protopapa\textsuperscript{6}, S. Alan Stern\textsuperscript{7}, Harold A. Weaver\textsuperscript{8}, Leslie A. Young\textsuperscript{7} and the New Horizons Surface Composition Theme Team. 1 SETI Institute, 189 Bernardo Ave, Mountain View, CA 95043; 2 NASA Ames Research Center; 3 Southwest Research Institute; 4 Lowell Observatory; 5 University of Maryland; 6 John Hopkins University, Applied Physics Laboratory. (Cristina.M.DalleOre@nasa.gov)

Abstract: Charon, the largest satellite of Pluto, is a gray-colored icy world covered mostly in H$_2$O ice, with spectral evidence for NH$_3$, as previously reported [1, 2, 3]. Images from the New Horizons spacecraft reveal a surface with terrains of seemingly different ages and a moderate degree of localized coloration.

We present results obtained from the analysis of high spatial and moderately high spectral resolution data acquired close to flyby.

Introduction: New Horizons observed Charon at high spatial resolution (better than 10 km/px) with the LEISA imaging spectrometer. LEISA is part of the Ralph instrument [4] and affords a spectral resolving power of 240 in the wavelength range 1.25-2.5 $\mu$m, and 560 in the range 2.1-2.25 $\mu$m.

Charon’s sub and anti-Pluto hemispheres were first observed and modeled by [1]. They attributed the band at ~2.21$\mu$m to hydrated ammonia in varying hydration states over the surface. The presence of ammonia in conjunction with H$_2$O in its crystalline form prompted [1] to suggest cryovolcanism as a favored mechanism of resurfacing.

In their 2010 work [2] modeled the spectrum of Charon and reported presence of ammonia species along with H$_2$O ice both in crystalline and amorphous phase. They introduced a blue component to model the slope present in the observations, which could not be otherwise reproduced without the adoption of an ad hoc component, featureless, and present at the 12% level in their best fit. [2] also reported a strong 1.65$\mu$m band indicative of crystalline H$_2$O ice, ruling out the possibility that H$_2$O ice in its amorphous phase might be causing the observed slope.

Data analysis and modeling: The main goal of our analysis was to map the presence of NH$_3$, already detected on the surface of Charon [1, 2, 3] and identified in localized spots in a preliminary analysis of New Horizons’ LEISA data. For this study, we adopted the equatorial section of Charon’s surface characterized by fault lines and craters, highlighted in red in Figure 1. For the analysis we used an unsupervised clustering technique [5, 6, 7] to highlight variations in spectral signature in the region 2.2-2.33$\mu$m, diagnostic of NH$_3$ ice presence. Clustering of NH$_3$ wavelengths shows presence of this component homogeneously distributed, independently of geography. Figure 2a shows the resulting representative spectral averages and a model of pure NH$_3$ (pink solid line) indicating the position of its bands as a guide for the observations. Figure 2b displays the geographical distribution of the clusters overlain to an orthographic projection of Charon’s geography.

In an effort to quantify the amounts of NH$_3$ we modeled the three main representative spectra shown in Figure 2a. The modeling was done ignoring angle dependencies, which are lost in the averaging of the clustered spectra, making use of the [8] approach. Models were calculated mixing intimately H$_2$O ice both in crystalline and amorphous form, along with amorphous carbon, and pure NH$_3$. Modeling details are listed in Table 1. All spectra present a blue slope that is not reproducible in the models as previously reported by [2].

Results and Conclusions: Our preliminary analysis confirms previous ground-based results with identified materials being comparable in relative amounts. Current mapping of NH$_3$ wavelengths shows presence of this component homogeneously distributed in the region afforded by our preliminary study, independently of geography.

A preliminary simple modeling approach at this time indicates uniformity in amounts and grain sizes of the components, a homogeneity that seems to be the trademark of Charon’s surface.

![Figure 1: Section of Charon’s surface analyzed in this work.](image)


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Table 1. Model parameters for the fits to clusters 1, 2, and 3.

![Reflectance vs Wavelength](image)

**Figure 2a:** Spectral averages representative of the clusters representing Charon’s surface and a model of pure NH₃ (pink solid line) plotted for reference.

![Map of Charon’s Clusters](image)

**Figure 2b:** Map of Charon’s Clusters.