MID-IR GROUNDBASED SPECTRAL OBSERVATION OF VESTA. E. Palomba[1,2], E. D'Aversa[1], T. Sato[3], A. Longobardo[1], F. Dirri[1], S. Aoki[4], [1]INAF-IAPS, via del Fosso del Cavaliere 100, 00133 Rome, Italy (ernesto.palomba@iaps.inaf.it),[2] ASI-SSDC, Rome, Italy, [3]ISAS-JAXA,Sagamihara City, Japan,[4]Belgian Institute for Space Aeronomy, Bruxelles, Belgium

Introduction: In this work we present new telescopic observations of the Vesta asteroid made at the Subaru Telescope by using the COMICS IR spectrometer. We obtained 5 different observations in 5 days, at two different epochs, during 2016 and 2017. By applying standard data reduction for this kind of telescopic observations, a thermal model has been applied to retrieve the spectral emissivities. The spectra have a S/N of 100-300 and show weak but definitely real features attributable to residual Reststrahlen bands and a Christiansen peak compatible with the presence of pyroxene minerals.

Vesta Basics: Vesta has been explored and mapped in detail by the Dawn space mission [1]. The measurements obtained by the VIR spectrometer demonstrated that Vesta is the parent body of the HED meteorites [2], in which the pyroxene mineralogy varies locally. Small deposits of olivine were found in the northern hemisphere of the asteroid [3,4]. The regolith grain size has been suggested to be < 45 micron [5]. Nevertheless, plagioclases which are one of the most important mineralogical component of the HED have not been detected on the surface of Vesta yet, since they have not strong spectral features in the NIR. In addition, due to orbital and geometrical constraints, the northern hemisphere was not mapped completely and in large part it is still not explored..

Observations and data reduction: The intent of observing Vesta after the Dawn results, is to try to observe olivine occurrence in the unobserved portion of the northern emisphere, to possibly identify plagioclase presence and finally to discern the Vesta hemispheric difference evidenced by Dawn with a diogenitic rich southern hemisphere and an eucritic rich northern one. Therefore, the observations have been planned in order that the footprints could reflect this strategy. As they are groundbased observations of a distant and relatively small object, the footprints cover practically the entire Vesta surface, with the 2016 observations being centered on the southern hemisphere and the 2017 on the northern ones.

Vesta was observed on 23-24 January 2016 with two consecutive observations of 30 minutes. The HD5112 star was also observed to be used as standard for removing absorptions of Earth's atmosphere and estimating the seeing size. The air mass during the spectroscopic observations of Vesta was 1.205, whereas the exposure time was 0.904 s. Background (sky+telescope) was substracted from target spectra, then flat-field and spectral calibrations were performed. The successive data reduction operations were image transformation, shift-and-add spectra to improve SNR and retrieval of Vesta spectra by means of standard spectra. In order to retrieve the average spectral emissivity of Vesta surface, the observed radiance spectra are modelled integrating the surface thermal emission over the disk, taking into account the actual observing and illumination geometry of each observation. The best fits are obtained by using the sub-solar temperature, an emissivity baseline level and the surface roughness as free parameters (Fig.1).

Previous telescopic observations: Vesta has been already observed in the mid-IR by the ISO telescope with ISO-PHOT instrument [6], the Kuiper Airborne Observatory (KAO) [7] and the Palomar observatory in the framework of the MIDAS project [8]. After a preliminary re-analysis we discarded the KAO data because they are not reliable [Cohen, personal communication].

Analysis: The Subaru spectra have a low spectral contrast and the 2016 spectra are noisier, being the observation geometries less favourable. However, all show few common spectral features, in particular F1 (10.5-10.7 μm) and F2 (11.2-11.5 μm), which are compatible with reststrahlen features of pyroxenes. The Christiansen frequencies obtained with the Subaru and ISO (8.52 and 9.08 μm) are very different, pointing to a pyroxene and olivine composition, respectively. We believe that both the very large spectral contrast and the composition retrieved by the ISO observation make these data not completely reliable. As matter of fact, olivine is very rare on Vesta and its low abundance cannot account for the presence of a Christianesen peak. Nonetheless, the ISO spectrum seems to exhibit the F1 and F2 features. MIDAS observations, similarly to the Subaru spectra, present an emissivity with very low spectral contrast, and show the F1 and F2 features, even though the Christiansen feature is not clear.

Laboratory measurements: The SUBARU spectral analysis has been supported by the comparison with emissivity laboratory spectra of plagioclase and pyroxene minerals already present in the spectral libraries (ASU and PEL). To have a more relevant comparison with material from Vesta we acquired Mid-IR emissivity spectra of 1 Eucrite and 2 Howardites at different grain sizes. The comparison of these emissivity spectra with the ones retrieved by the Subaru observations, confirm the presence of the F1 and F2 features in pyroxenes and in the eucrite sample.

Discussion: Our results are in line with what found by the Dawn space mission. The presence of very weak features such as F1 and F2 and the very low spectral contrast, suggests the presence of a very small grain size regolith, as suggested by some Dawn-VIR analysis. The pyroxene composition is in agreement with the HED mineralogy, as shown by the spectral comparison with the laboratory data. Subaru spectra show subtle differences between the 2016 and the 2017 campaigns. Further analysis is ongoing to understand this spectral behavior in terms of Vesta hemispheric diversities.

References: [1] Russell, C.T., et al. (2011). Springer, ISBN: 978-1-4614-4902-7, [2] De Sanctis, M.C. et al. (2012), *Science* 336, 6082,697, [3] Ammannito, E. et al. (2013), *Nature*, 504, 122-125, [4] Palomba, E. et al. (2015), *Icarus* 258, 120-134, [5] Palomba, E. et al. (2014), *Icarus* 240, 58-72, [6] Dotto, E. et al. (2000), *A&A* 358, 2000/6/1 SP-133EP, [7] Cohen, M. et al. (1998), *The Astronomical Journal* 115, 4, 1671-1679, [8] Lim, L. et al.,(2005), *Icarus* 173, 385-408

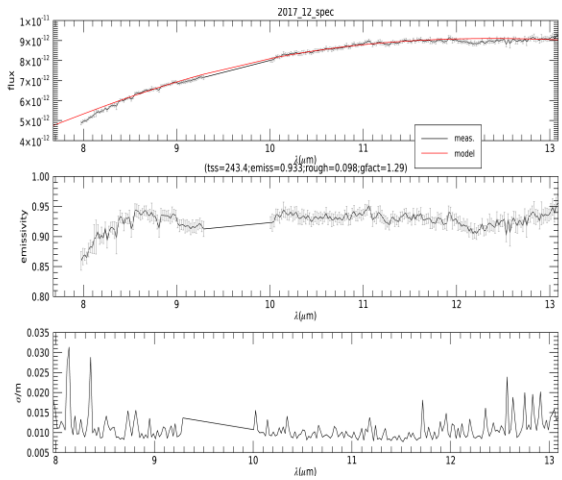

Fig.1. Observation of 12th of December 2017. (Top) Calculated flux and corresponding fit. (Middle) Retrieved emissivity. (Bottom). Emissivity relative error.

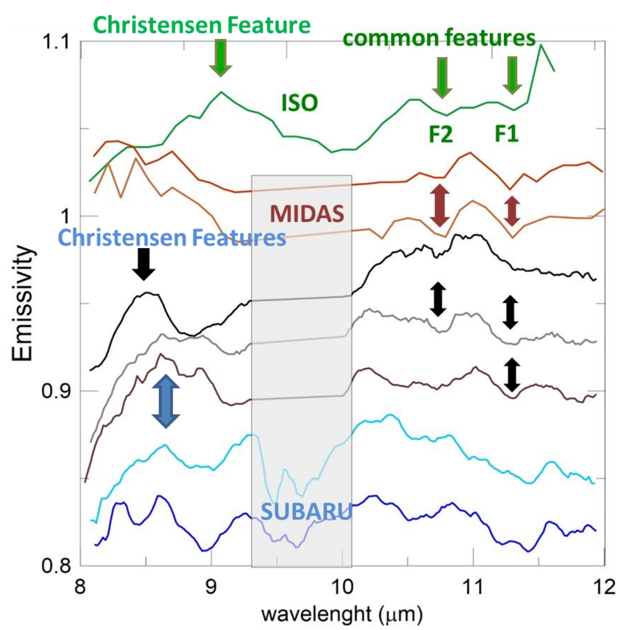

Fig.2. Vesta Emissivity retrieved from different observational campaigns: ISO (green), MIDAS-Palomar (red), Subaru (black, grey, brown, cyan, blue). Common features such as Christiansen features and other residual reststrahlen features (F1and F2) are indicate and marked by arrows. The grey shadowed rectangle is a spectral region where terrestrial atmosphere contribution is strong and the data are not reliable.