TNOs are Cool: A survey of the trans-Neptunian region – Herschel observations and thermal modeling of large samples of Kuiper belt objects. T. Müller[1] (tmueller@mpe.mpg.de), E. Vilenius[1], P. Santos-Sanz[2], M. Mommert[3], C. Kiss, A. Pal, and the TNOs-are-Cool team
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Introduction: Trans-Neptunian objects (TNO) represent the leftovers of the formation of the Solar System [1] and they are analogues to the parent bodies of dust in debris disks around other stars [2,3]. Their physical properties provide constraints to the models of formation and evolution of the various dynamical classes of objects in the outer Solar System.

Observations: In addition to Pluto more than 1400 TNOs have been discovered since the first Kuiper belt object in 1992 [4]. More than 130 of the known objects have been observed as part of our Herschel Open Time Key Programm "TNOs are Cool: A survey of the Transneptunian region" [5]. The results presented here are based on three-band, multi-epoch photometric observations with Herschel/PACS. We use a consistent method for data reduction, background elimination, calibration and aperture photometry for the entire sample to obtain monochromatic flux densities at 70.0, 100.0 and 160.0 μm. Additionally, we use Spitzer/MIPS flux densities at 23.68 and 71.42 μm when available [6]. The observations of targets taken in the Science Demonstration Phase of Herschel have already been presented in a series of papers [7,8,9] and they are included here for the correlation analysis. The data analysis and the interpretation of the remaining targets is currently ongoing.

Thermal model analysis: The samples we present here are composed of dynamically hot and cold classicals, Plutinos, Scattered-disk objects and Detached objects following the Gladman-classification [10], which is based on 10 Myr time-scale orbit calculations. For our samples of TNOs of different dynamic type we derived diameters and albedos via radiometric modeling techniques which have already been used in previous work [6,7,8,9]. As auxiliary data we use re-examined absolute visual magnitudes from the literature and data bases, part of which have been obtained by ground based programmes in support of our Herschel key programme. Correlations between size, albedo, color, composition and orbital parameters may provide diagnostics on the dynamical, collisional and physical history of KBOs. The size distribution of TNOs is also a diagnostic relating to that history. Here we focused mainly on the correlations of diameter and albedo with orbital parameters, spectral slopes and colours.

Results and Discussion: We have determined the sizes and albedos of 19 classical TNOs [11], 18 Plutinos [12], 8 scattered disc objects and 7 detached objects [13]. The effective radiometric sizes range from 100 km to 2400 km. We also determine the bulk densities of 10 binary TNOs with our new effective diameters even though the binary components are not resolved by PACS. We were able to calibrate the Plutino size scale for the first time and find the cumulative Plutino size distribution to be best fit using a cumulative power law with q = 2 at sizes ranging from 120–400 km and q = 3 at larger sizes. There are diverse albedos in these samples and also scatter among the albedos within each dynamical class. The geometric albedos vary from 3.8% to 84.5% (average 11.2% excluding Eris) for the scattered/detached objects, from 4.0% to 28.0% (average 8%, Plutinos with ice signatures in their spectra having higher average) for Plutinos, from 9.0% to 22.0% (average 17%) for dynamically cold classicals and from 3.8% to 20.0% (average 9%) for dynamically hot classicals. The scattered disc objects alone have a low average albedo of 6.9% compared to the detached objects' average of 17% (excluding Eris). In the scattered disk/detached objects population we find a significant correlation between albedo and diameter (more reflective objects being bigger), which is not seen among our samples of Plutinos and classicals. Furthermore, brighter and bigger scattered disk/detached objects have larger perihelia. We discuss possible explanations for these correlations.

References:

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