Physical properties of transneptunian objects, Centaurs, and Trojans from thermal observations

M. Mueller[1]

[1]SRON Netherlands Institute for Space Research

The most productive way to measure the size and albedo of small bodies throughout the Solar System is through studies of their thermal emission. This is complicated for the cold bodies in the outer Solar System, whose thermal emission peaks at wavelengths for which the Earth's atmosphere is opaque. While the relatively warm Trojans are marginally accessible from the ground in the Q band, the sizes of only a handful of transneptunian objects (TNOs) and Centaurs were known before Spitzer was launched in 2003. Spitzer/MIPS photometry at wavelengths of 24 and 70 microns allowed size and albedo of tens of TNOs and Centaurs to be measured. Herschel (operational in 2009–2013) allowed photometry of a total of ~ 140 TNOs at wavelengths between 70 and 500 microns using PACS and SPIRE, chiefly in the framework of the Key Programme "TNOs are Cool!". I will present selected results from these surveys and discuss their implications on our knowledge of the origin and evolution of the Solar System, as evidenced by its coldest members.

Of particular interest are the sizes of binary systems. Where their masses are known from spatially resolved observations, diameter measurements allow the bulk mass density to be determined, providing a unique probe of the object's interior.

In the past few years, we have witnessed a remarkable increase in the number of successfully observed stellar occultations by TNOs and other small bodies. They provide an elegant, model-independent, and accurate way of measuring projected TNO dimensions at the time of the event and at the location of the observer(s). Even satellites or ring systems can be detected this way. However, predictable occultations are rare events and will likely stay infrequent, even in the post-Gaia era. Studies of the ensemble properties of the transneptunian populations will continue to rely on thermal observations.

Reliable thermal modeling requires some knowledge of the target's temperature. Optimally, this is obtained through the data themselves, requiring a wavelength coverage straddling the emission peak and including the temperature-sensitive Wien slope. Spitzer covered this range for TNOs and allowed first derivations of the typical thermal inertia: TNO surfaces appear to show the extremely low thermal inertia expected for cold regoliths. Unfortunately, Herschel's wavelength made it largely insensitive to TNO temperatures. The same will hold true for ALMA and for JWST (however useful they will be for TNO science otherwise). If approved, the Japanese-led mission SPICA, with its proposed European camera SAFARI, will be the next observatory to provide sensitive photometric capabilities at the required wavelength range, between some 35 and 210 microns.