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Centaurs as seen by Herschel/PACS

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Abstract

The goal of this work is to characterize the sample of Centaurs which have a radiometric size/albedo measurement including 16 new Herschel targets. We study the correlations for a more extended sample of diameter and albedo with each other and with orbital parameters and spectral slopes. We have done three-band photometric observations with Herschel/PACS and we use a consistent method for data reduction and aperture photometry of this sample to obtain monochromatic flux densities at 70, 100 and 160 μm. Additionally, we use Spitzer/MIPS flux densities at 24 and 71 μm when available. We also include the Centaurs sample observed only with Spitzer/MIPS and Scattered Disk Objects presented in a previous work of the team.

1. Introduction

A fundamental question in astrophysics is how planetary systems form and evolve. Accurate physical properties of small Solar System bodies are crucial pieces of information needed to understand the formation processes, and they constrain models of planetary formation and evolution.

Centaurs are a dynamical class of small bodies in our Solar System with orbits in the region between Jupiter and Neptune crossing the orbits of one or more of the giant planets. They are a transitional population between TNOs and Jupiter family comets. Centaurs have a unique physical property among the small body classes: their B-R colour is divided into gray and red populations instead of exhibiting a continuous range of colours [1]. This is a unique property on this population. This bi-modal distribution does not appear in the Scattered Disk Objects (SDOs), the parents (progenitors) of the Centaurs, neither into the Jupiter family comets, their final evolution [2]

2. Observations

Our sample of 16 Centaurs has been observed as part of the Herschel key program "TNOs are Cool!" [3][4] mainly between March, 2010 to June, 2011 by the photometry sub-instrument of PACS. In this work we present the observations from PACS combined with the data from Spitzer when it's possible. The short-wavelength array has a filter wheel to select between two bands: 60-85 μm or 85-125 μm, whereas the long-wavelength band is 125-210 μm. In the PACS photometric system these bands have been assigned the reference wavelength 70, 100 and 160 μm, and they have the names "blue", "green" and "red", respectively.

3. Results

The main objective of this work is to obtain the diameters and albedos for a Centaur sample. From the thermal fluxes obtained we applied a model to fit the 3 fluxes from Herschel-PACS, or the 5 fluxes from Spitzer-MIPS and Herschel-PACS to obtain diameters and albedos. As was done in previous sample publications from the key programme [7,8,9,10] we used a thermal model, either NEATM [13] or hybrid-STM [14 and references cited therein], to fit the measured Spitzer-MIPS, and Herschel-PACS fluxes. The model therefore fits the Herschel (3 data points) or Herschel + Spitzer (5 data points) fluxes in terms of two (diameter "***D***" and albedo "p_V") or three (D, p_V, and η) parameters.

objects with perihelion between 12 and 20 AU and a concentration of objects with an albedo above 7% for objects with a perihelion bellow 17 AU. There is not a clear correlation between albedos and inclinations or eccentricities. All of this together seems to indicate that the albedos of Centaurs are not clearly determined by their orbit.

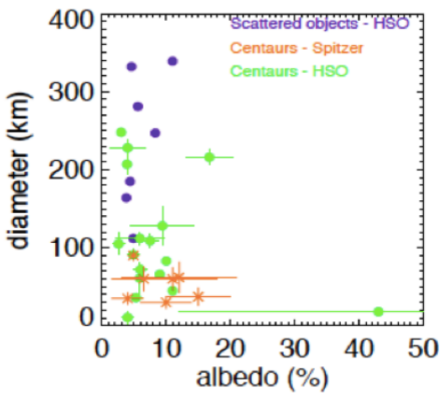

Figure 1: Diameter *vs.* albedo of the studied sample, including Centaurs observed only with Spitzer and also Scattered Disk object from [7]. This image is based on preliminary analysis, updated results will be shown in the Meeting and published in [15].

4. Summary and Conclusions

The p_V for our targets are mainly lower than 10% with two exceptions as for Chiron with 17.6% and $2005UJ_{438}$ with a strange 43%. In the Centaurs sample the biggest object is $2002GZ_{32}$ with a diameter of 248 km, and the smallest is $2005UJ_{438}$ with a diameter of 43 km. It needs to be highlighted that nearly the 75% of all Centaurs are smaller than 120 km. The darkest object is Hylonome with an albedo of 2.6% and the brightest is $2005UJ_{438}$ with an albedo of 43% followed by Chiron with an albedo of 17%, which currently shows a confirmed activity.

[12] showed a tentative correlation (at 2.7σ) between albedo and semimajor axis for Centaurs, with all the objects at $\boldsymbol{a}$ < 20 AU having p_V < 5%. Our data do not show such correlation. Nothing changes when we include the SDOs in the sample. Again, a tentative positive correlation between perihelion and albedo is discussed in [12] which suggests that objects at lower perihelion have a lower albedo. We do not see the same correlation neither for the Centaurs nor for the Centaurs plus SDOs. Otherwise, a pattern arises from the comparison of the albedo in the visible and the perihelion distance with the largest concentration of objects with albedo below 7% in our sample is for

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