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Serendipitous observations of asteroids in Herschel PACS and SPIRE maps

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1. Introduction

The Herschel Space Observatory was an ESA mission in the Horizons 2000 program. The telescope could observe in far infrared and sub-millimetre wavelengths. For imaging, two of its instruments were used: the PACS camera at 70, 100 and 160 μm and the SPIRE photometers at 250, 350 and 500 μm. Amongst its targets there were galaxies, young stars, interstellar clouds and solar system objects. Due to their strong thermal emission solar system bodies, especially main belt asteroids, may contaminate the photometric measurements. Our goal is to find these objects, flag sources contaminated by passing solar system objects, and integrate these results into the PACS and SPIRE point source catalogs.

2. Search for SSOs

2.1 Main steps

We collected all Level 2.5 or Level 3 PACS and SPIRE scan maps from the Herschel Science Archive, and selected one image for every OBSID, because the same area could have two or three map in different wavelengths. In some cases the maps consist of images from very different epochs. To filter this, we selected those maps, where the difference between the start and end date is bigger than one day. In these cases we used the individual sub-maps (OBSIDs) for the search.

In the second step we queried which SSOs could be in the field of view from the Herschel's location at a specific date. We did this for three epochs: the start-, the mid- and the end date of the observation. Then we checked whether these positions were on the image area. If every three points were on the image, the first and the last point was kept as starting and ending coordinates.

In the case, when only one or two pints were on the image area, we calculated an intersection with the edge of the image. The internal point and the intersection was kept for the coordinate pairs.

If none of the three points were on the image area, we checked if the SSO had any intersection with the image, because the maps could have weird edges. If there were any intersections, the first and the last intersection points were used as starting and end points.

In the case of two points from the query we checked if that the SSO trajectory were on the image area or had any intersection with the map.

If we had only one point for an object from the query, we did additional query for two more coordinate pairs with +/- 1 day from the epoch of this one detection. Then we investigated if it could have any intersection with the image and where could it be.

2.2 Problems, exceptions

In some cases the observing time was too short, and the trajectory of the SSOs could not be determined properly. In these cases no intersection with the map was calculated and we used the original coordinates of the SSO from the query.

3. Tools

We used the *ephemd* package to obtain the targets in the actual field of view and *wcstools* for various supplementary tasks and python scripts for spherical geometry calculations. The thermal infrared emission

of the targets are estimated via the Near Earth Asteroid Thermal Model.

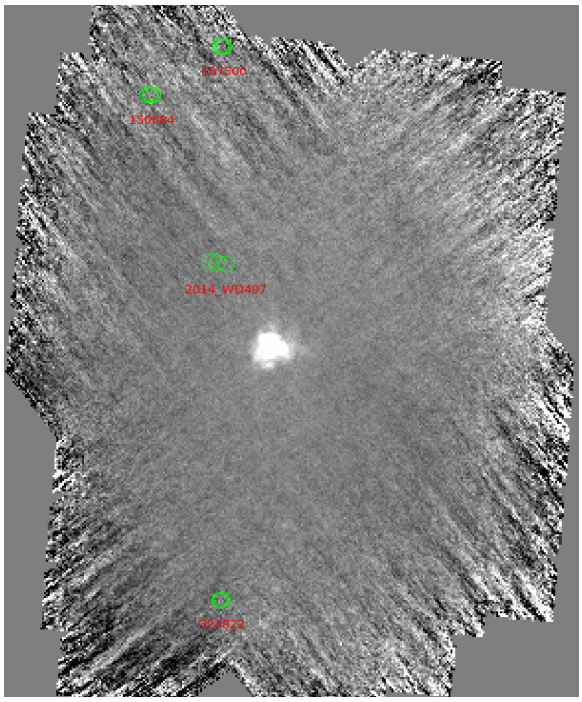

Figure 1: PACS 70 μm map of α Tau (1342183532) with the positions of the contaminating SSOs overlaid

4. Summary and Conclusions

The database developed here will be used as supplementary information in the Herschel PACS and SPIRE point source catalogs. We will also use these results to obtain thermal infrared fluxes from serendipitously observed asteroids supplementing the dedicated Herschel observations of solar system bodies.

https://www.cosmos.esa.int/web/herschel/spire-point-source-catalogue
https://www.cosmos.esa.int/web/herschel/pacs-point-source-catalogue

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