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Automated determination of dust particles trajectories in the coma of comet 67P

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Abstract

During more than two years Rosetta spent at comet 67P, it took thousands of images that contain individual dust particles. To arrive at a statistics of the dust properties, automatic image analysis is required. We present a new methodology for fast-dust identification using a star mask reference system for matching a set of images automatically. The main goal is to derive particle size distributions and to determine if traces of the size distribution of primordial pebbles are still present in today's cometary dust [1].

1. Introduction

During more than 2 years that Rosetta stayed at comet 67P, the OSIRIS camera system monitored the evolution of the dust coma from 4.1 AU inbound to 3.8 AU outbound. One of the intriguing results was the large number of big (cm to dm sized) particles that could be identified visually. We plan to analyze the dust populations to compare measured size distributions to those predicted by formation models.

Many thousand images were obtained by the OSIRIS cameras for different purposes; in many of those observing sequences, 100s of dust particles are identifiable in single images. The dust detected by OSIRIS can be divided into near-spacecraft dust with its apparent motion being dominated by spacecraft motion and near-nucleus dust, moving radially away from the nucleus. In the latter case, the distance is known approximately and the size (with an assumed albedo and phase function) and velocity of the particles can be determined. In addition, the rotational lightcurve of some particles is detectable in the images, providing additional information about spin period and shape [2].

2. The method

We demonstrate the method with a specific series of images as an example: we take a set of 90 images obtained on 11th May of 2015 with the OSIRIS wide angle camera (WAC) at a heliocentric distance of 1.67 AU and a spacecraft-comet distance of 140 km. The phase angle of the nucleus was approximately 70 deg. The spacecraft pointed 9.7 degrees off the nucleus in sunward direction, so that the phase angle of the observed dust grains is about 80 deg.

After processing the set of images, 22 images were chosen in a period of time between 08:37:07 and 09:08:14 hours. We co-register the images on selected stars to derive the inertial motion of the dust particles relative to the spacecraft (Figure 1), defined as reference frame, when 20 stars were used in a subset of 12 images. Tracks of dust particles are identified in Figure 2. This mask is enough for matching the images at first approximation with errors in the pixel match near to R^2=1, as shown in the graph in figure 3.

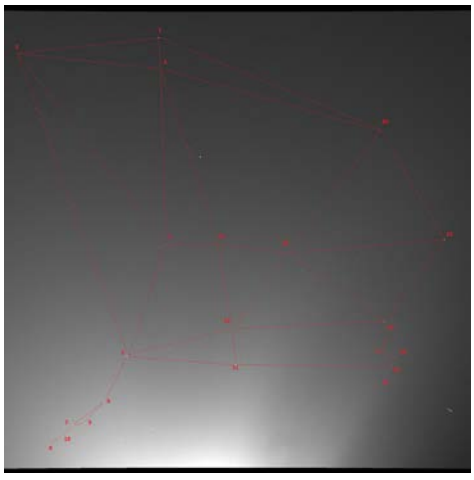

Figure 1: Mask of stars used for this analysis.

Figure 2 shows the processed images to correlate the stars and to distinguish them from dust particles with very low velocity relative to the spacecraft. The motion of the stars can be easily detected.

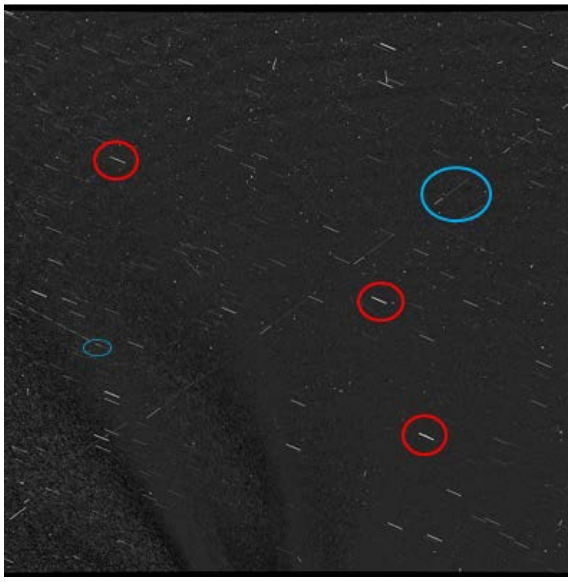

Figure 2: 22 images taken on 11 May 2015 which each image pixel summed up and divided by the median. Red circles show examples of stars , blue circles show examples of dust particles.

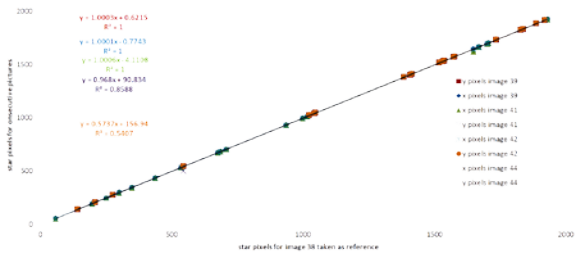

Figure 3: Pixel coord x and pixel coord y set over the field of view. It was found the mask of stars moves with a max velocity of 6 pixels per hour relative to the first image, but the pixel matching along the different images can be settled with relatively low errors.

3. Summary and Conclusions

We present an ongoing study with the goal of describing the evolution of the cometary dust population over the mission, and to search for changes on various timescales. The outcome will be used to evaluate if there is a preferred size range of dust particles and if their measured size distribution is primordial. In terms of methodology, it seems feasible to use stars as reference points.

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