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The giant comet 29P/Schwassmann–Wachmann 1 as seen in the thermal infrared by the AKARI space telescope

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Abstract

We present thermal infrared images (15 and 24 μm) and spectra (1.8-12.9 μm) of the giant comet 29P/Schwassmann–Wachmann 1 (29P hereafter), acquired in 2007 with the Japanese AKARI space telescope. Despite orbiting at around 6 AU from the Sun, the comet showed a sustained activity. We investigated its nucleus properties (size, albedo, rotation), as well as its dust and gas production.

1. Introduction

Comet 29P is one of the largest ever discovered and is known to present a recursive activity, with about 6-7 episodes per year [10]. Orbiting the Sun on a low eccentric orbit with an aphelion of 6.25 AU and a perihelion of 5.72 AU, this object gives us the possibility to analyse in a comprehensive way a "far" cometary environment, at heliocentric distances where water sublimation cannot trigger the activity and the sublimation of other surface volatiles, such as CO, is responsible for the presence of a coma. Indeed, carbon monoxide has been detected by several authors in the coma of 29P and is thought to be its primary driver gas (e.g., [3]).

We used the InfraRed Camera (IRC) [7] onboard the AKARI telescope to characterize the physical properties of 29P, as discussed in the following sections.

2. Data reduction

Imaging frames at 15 and 24 μm have been pre-reduced using the calibration files presented in [1]. Further reduction steps included: removal of cosmic rays and instrumental artifacts; image deconvolution (Fig. 1) using the "maximum likelihood" algorithm based on the Lucy-Richardson method [5],[8]; shifting and adding the frames to produce the final 15 and 24 μm images, that have been flux-calibrated taking into account both aperture and color corrections.

Fig. 1: 15-μm image (2.51′′/pixel) of 29P, before (left) and after (right) a "maximum likelihood" deconvolution.

3. Results

After both radial normalization and Angular Differential Imaging (Fig. 2) techniques, the images of 29P show the presence of three dust jets extending up to about 2×10^5 km from the nucleus. Assuming that the curvature of the jets is due to the rotation of the nucleus, and using a dust ejection velocity of 20 m/s, the rotational period is found to be 23±14 h.

Comparing the radial profile of 29P with that of star HD37122, we could discriminate between the nucleus and coma contributions to the detected flux in comet images at 15 and 24 μm. After having combined our measurements with those obtained for 29P at 8 μm by [9], we applied the Standard Thermal Model [4] to derive an estimation of the size and the albedo of the nucleus, finding values of 56.3±3.8 km and 2.3±0.3%, respectively.

Based on [2], we modelled the thermal emission of the coma assuming it is composed of amorphous carbon grains in the 0.1-100 μm size range. Assuming that the grains are ejected with an average velocity of 20 m/s, we derived a dust production rate of about 660 kg/s, in agreement with previous results by [6], who had found a dust loss mass rate in the range of 300-900 kg/s.

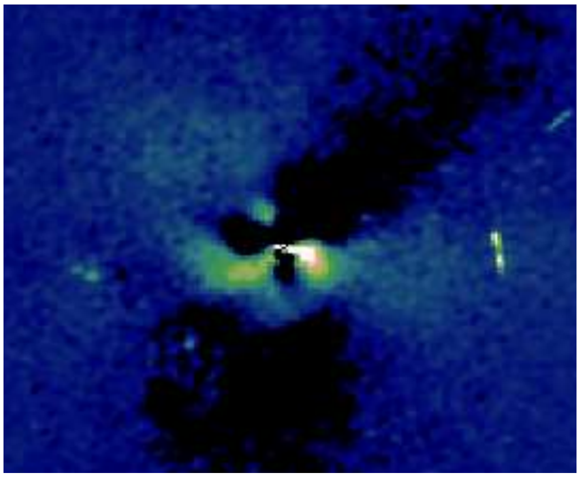

Fig. 2: Angular Differential Imaging applied (45° rotation) to the 24-μm image of 29P. The image resolution is ~10.5×10^3 km/pixel.

4. Summary and work in progress

At the time of writing we are:

- Refining the analysis of the imaging data. In particular we will consider different grain compositions (e.g., olivine and pyroxene) to improve the estimation of the dust production rate.
- Analysing the spectral data. These seem to suggest the presence of both water and carbon monoxide, and possibly also of carbon dioxide.

Our preliminary results will be presented and discussed.

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