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Dust properties in comet 67P/Churyumov-Gerasimenko's coma during its 2008-2009 apparition from polarization observations

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Abstract

Comet 67P/Churyumov-Gerasimenko is the main target of the Rosetta mission. Remote observations from India and France, of the scattered light (and mainly its linear polarization) by the dust allowed us to conclude on different physical properties pre- and post-perihelion. Large dust particles are likely ejected from the surface pre-perihelion and small grains eventually in fluffy aggregates post-perihelion possibly originating from the subsurface.

1. Introduction

The ESA/Rosetta spacecraft will encounter comet 67P/Churyumov-Gerasimenko in 2014. The last observation period to prepare the mission was in 2008-2009. Remote observations of the light scattered by the dust in the coma allow to tentatively determine the physical properties of the particles.

The intensity and linear polarization evolution were followed in the coma from about 2 months pre-perihelion to about 2 months post-perihelion.

2. Observations

In a French-Indian collaboration, two telescopes were used with polarimetric imaging capabilities [1,2]. A 0.80 m telescope at observatoire de Haute-Provence (OHP) in France and a 2 m telescope at Girawali Observatory in India. The observations periods are 25-27 December, 2008, 30 April and 1May, 2009 in India. 17-19 March, 2009 in France. The phase angle ranged from 35.8° to 28.8°.

3. Results

For the two first periods the coma is asymmetric with very steep intensity radial decrease (down to -1.5) mainly in the solar direction in agreement with previous observations in 1982-83 and 1995-96. Two months after perihelion the coma is about isotropic with a radial decrease close to the nominal value -1. Before perihelion and two months after the aperture polarization values are comparable to polarization values measured on other comets at such phase angles. The sharp radial decrease in intensity and the feature in the tailward direction without any difference in polarization in the coma before perihelion suggest the presence of large dark particles. The post-perihelion increase in intensity (about 2 magnitude) and in polarization (1 per cent) is significantly above the error bars and suggests the ejection of dust particles with different physical properties. More polarized structures than in the surrounding coma are noticed on the polarization maps with evolution of the structures in 24 h suggesting small micron or sub-micron-sized grains eventually included in fluffy aggregates. An

important seasonal effect suggests that the different grains originate from different hemispheres of the nucleus.

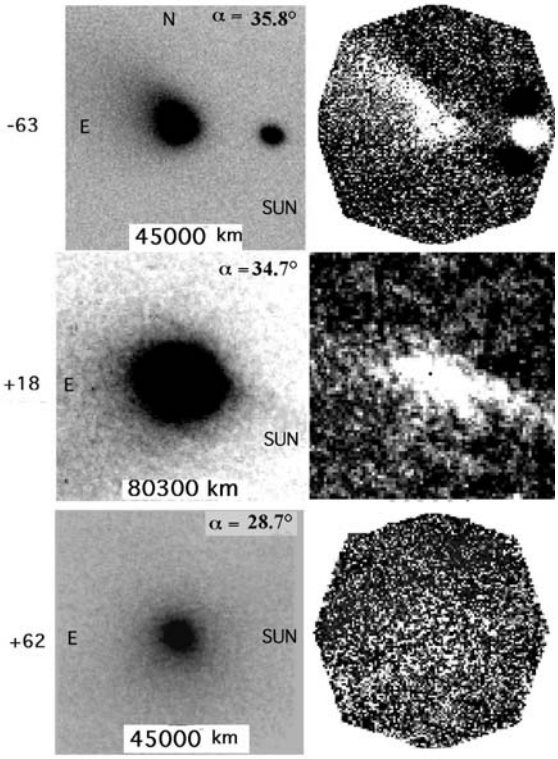

Figure 1: Intensity images of the 3 periods : 1st column in negative, 2nd column treated images to enhance the structures.

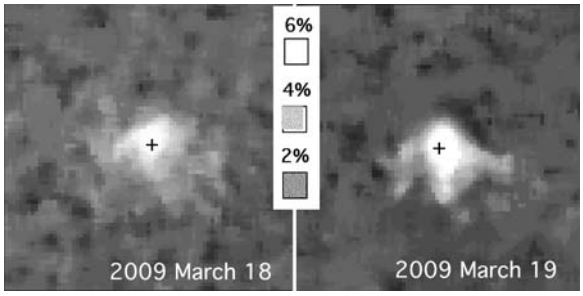

Figure 2: Polarization maps about 3 weeks post-perihelion. FOV 40000 km.

4. Discusssion

As suggested in the present work, [3] from their observations conclude on the presence of large particles pre-perihelion. [4] modeled the dust environment of the comet and found similar conclusions. They suggest a strong seasonal effect due to the obliquity of the spin axis with ejection of small grains after perihelion.

From the study of thermal evolution of the nucleus as a function of its shape and of the obliquity of the axis, [5] discuss the relations between the nucleus activity and the internal structure. Differences in dust mantling depend on the inclination of the axis with a strong influence on the local surface and sub-surface activity and a North-South dichotomy of the nucleus.

Polarization and intensity variations in the coma of 67P/Churyumov-Gerasimenko are reminiscent of those noticed for some comets such as 9P/Tempel 1 and 81P/Wild 2.

5. Summary and Conclusions

The presence of rather large particles can be suggested before and just after perihelion and the ejection of smaller grains eventually in fluffy aggregates post-perihelion. An important seasonal effect related to the obliquity of the comet suggests that the different grains originate from the surface or subsurface and from different hemispheres of the nucleus.

Acknowledgements

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References

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