EPSC Abstracts
Vol. 13, EPSC-DPS2019-1410-1, 2019
EPSC-DPS Joint Meeting 2019

EPSC
EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

Clustered ejection of metre-sized boulders on comet 67P

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Abstract

Imaging data of comet 67P/Churyumov-Gerasimenko (hereafter 67P) obtained by OSIRIS cameras on board the Rosetta spacecraft show multiple occasions of large dust aggregates being ejected collectively from the nucleus. We will present physical properties of these boulders, characteristics of their motion, and their inferred source region on the nucleus. We will also discuss about our modeling effort for understanding the possible condition that triggers such events, with further implications on the general picture of cometary activity.

1. Introduction

Dust particles ejected from 67P have been observed and characterized by different instruments on board the Rosetta spacecraft [1 and references therein], and show a broad range of sizes and morphologies [2]. Among them are large boulders, usually decimetres in size [3], even with resolved shape [4]. Dust particles with similar sizes were also found near comet 103P/Hartley 2 [5]. While rocket forces have been suggested to explain the motion of such particles in the coma [5, 3], details on their initial liftoff and acceleration remain unclear.

2. Observation

In January 2016, the shutter of the OSIRIS Wide Angle Camera started operating in the so-called “ballistic” mode, and obtained a large number of multi-exposure images. Each one of these images consists dozens of brief exposures with pauses in between. These images are advantageous for studying slow-moving large particles in the vicinity of the nucleus.

In a handful of observations carried out during March to June 2016, when the comet was on its out-bound journey, we identified groups of individual dust particles moving near the nucleus. These particles, observed shortly after being emitted, appeared not entrained in nominal “jets”. They also appeared to have originated from a certain “radiating point” on the nucleus surface.

3. Data analysis

Photometric analyses were done on the tracks left by the motion of these boulders, showing them to be: 1) large in size, reaching more than one metre in diameter; 2) irregular in shape, as manifested in the brightness variation along the tracks; 3) moving at speeds of decimetres per second; 4) rotating with typical period of a few tens of seconds.

The possible source region of these boulders, as inferred by back tracing of the tracks, lies in the Bes region, close to the rim of the smooth sandy plane of Imhotep on the large lobe. This area has been identified to be one of the most active areas in the southern hemisphere of the nucleus [6].

It is also noticed that such events were not spontaneous, but rather, showing a pattern of diurnal repetition, which might be linked to water ice sublimation at the source.

4. Modelling

We modeled the thermal environment of individual boulders and their immediate surroundings. The gas pressure generated by sublimation of volatile ices is examined in search of possible conditions for lifting the boulder against its own gravity. Results from test cases with different parameters might reveal key factors for the occurrence of such events, and further

shed light on understanding the mechanism behind similar activities.

Acknowledgements

OSIRIS was built by a consortium led by the Max-Planck-Institut für Sonnensystemforschung, Göttingen, Germany, in collaboration with CISAS, University of Padova, Italy, the Laboratoire d'Astrophysique de Marseille, France, the Instituto de Astrofìsica de Andalucia, CSIC, Granada, Spain, the Scientific Support Office of the European Space Agency, Noordwijk, The Netherlands, the Instituto Nacional de Técnica Aeroespacial, Madrid, Spain, the Universidad Politéchnica de Madrid, Spain, the Department of Physics and Astronomy of Uppsala University, Sweden, and the Institut für Datentechnik und Kommunikationsnetze der Technischen Universität Braunschweig, Germany. The support of the national funding agencies of Germany (DLR), France (CNES), Italy (ASI), Spain (MEC), Sweden (SNSB) and the ESA Technical Directorate is gratefully acknowledged.

References

[1] Fulle, M., Altobelli, N., Buratti, B., et al.: Unexpected and significant findings in comet 67P/Churyumov–Gerasimenko: an interdisciplinary view. Monthly Notices of the Royal Astronomical Society, 462(Suppl_1), pp.S2-S8, 2016.

[2] Güttler, C. Mannel, T., Rotundi, A., et al.: Synthesis of the morphological description of cometary dust at comet 67P, Astronomy and Astrophysics, 2019, in press.

[3] Agarwal, J., A'Hearn, M., Vincent, J. B., et al.: Acceleration of individual, decimetre-sized aggregates in the lower coma of comet 67P/Churyumov–Gerasimenko, Monthly Notices of the Royal Astronomical Society, 462, no. Suppl_1, pp. S78-S88, 2016.

[4] Fulle, M., Marzari, F., Della Corte, V., et al.: Evolution of the dust size distribution of comet 67P/Churyumov–Gerasimenko from 2.2 AU to perihelion, The Astrophysical Journal, 821(1), pp. 19, 2016.

[5] Kelley, M.S., Lindler, D.J., Bodewits, D., et al.: A distribution of large particles in the coma of Comet 103P/Hartley 2. Icarus, 222(2), pp.634-652, 2013.

[6] Läuter, M., Kramer, T., Rubin, M. and Altwegg, K.: Surface localization of gas sources on comet 67P/Churyumov–Gerasimenko based on DFMS/COPS data. Monthly Notices of the Royal Astronomical Society, 483(1), pp. 852-861, 2018.