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Seasonal evolution of comet 67P's near-nucleus coma: a model interpretation of Rosetta/OSIRIS observations

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Abstract

The near-nucleus coma of a comet, formed by its volatile and dust activities, provides key information for understanding how comets work. Data collected by European Space Agency's Rosetta spacecraft during over two years' rendezvous with 67P/Churyumov-Gerasimenko has revealed the highly complex nature of the comet's coma, with its structure and composition varying both spatially and temporally [1, 2, 3].

Studies have shown the existence of cyclic dust activities driven by water ice sublimation on diurnal and orbital time scales [4, 5]. Correlations are found between the distribution of water gas and dust in the coma [6]. However, it is not straightforward to determine how water and dust activities are distributed over the nucleus and how this distribution is affected by nucleus properties. Inversions using different methods and datasets often lead to different patterns for the distribution of activity [7, 8].

In this work, we combine imaging data with realistic modeling to investigate the changing morphology and intensity of 67P's inner-most coma and its link to the seasonal variation of water activity. We select observations taken by OSIRIS cameras when 67P was at different positions in its orbit. A thermo-physical model is applied to derive the distribution of temperature and water sublimation rate over the nucleus at the epochs of observations [9]. The three-dimensional gas field is then developed using the method of Direct Simulation Monte Carlo. By applying actual observing geometries, we develop synthesized images to be compared with actual observations.

Preliminary results show that, when 67P was at a heliocentric distance of around 2.5 au before perihelion, the column density of water coma modeled with a homogeneous distribution of activity presents similar pattern as that of the observed dust coma. Further analyses will reveal the consistency or variance of this correlation when different areas of the nucleus became illuminated as the comet approached and passed through perihelion.

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