CLOSING THE GAP BETWEEN GROUND BASED AND IN-SITU OBSERVATIONS OF COMETARY DUST ACTIVITY: THE CASE OF COMET 67P.

Introduction: Ground-based data represent the bulk of measurements available for comets. Yet, to date these observations only access a comet’s gas and dust coma at rather large distances from the surface and do not directly observe its surface or even the outgassing layer. In contrast, spacecraft fly-by and rendezvous missions are one of the only tools that gain direct access to surface measurements. However, these missions are limited to roughly one per decade. Combining observations from ground and spacecraft data with the respective models has the potential to link structures from the surface to where they can be observed from the ground.

The Rosetta observations of comet 67P have revealed fine filamentary dust structures [1] that do not appear connected to the large-scale structures from the ground in an obvious way. The ground-based images showed similar jet-like structures with almost the same position angles during the perihelion passage in 2002 [e.g., 2-3], in 2009 [e.g., 4-6], and 2015 [7-8]. Understanding the link between the coma structures on these different scales remains an open question and crucial to ultimately linking the wealth of ground-based data to cometary nuclei properties. Close to the surface the motion of dust particles is dominated by gas drag and nucleus gravity (often referred to the inner coma, extending to roughly 10 nucleus radii [10]). Farther away solar radiation pressure and solar gravity becomes the governing forces (on scales of tens of thousands of km and more). The typical timescales of dust transport through the inner coma is typically on order of seconds to hours, and weeks to months for the outer coma and tail. The different regions of the comae are thus on very different spacial and temporal scales.

Method: In this work we make use of the Rosetta data set and corresponding ground-based campaign of comet 67P. We employ a series of dynamical models of dust particles to track their motion from the nucleus surface to the outer coma. To bridge the different spacial and temporal scales we make use of the fact that we can split the model into an inner coma model, constrained with OSIRIS data, and an outer coma model to predict the coma structures observable from ground. The latter takes as an input the dust fluxes resulting at the outer boundary of the inner coma model.

Results: As expected, the inner coma structures are directly linked to the surface because the dynamical timescale for a dust particle from the surface to tens of nucleus radii is smaller than the rotation period of the nucleus. In contrast, the outer coma structures (Fig. 1), forming on temporal scales much longer than the rotation period and on spatial scales much larger than the nucleus, are a temporal superposition of the smaller scale structures. In this sense the inner coma structures are completely washed out to make way for the new, emergent, outer coma structures. Yet, the large-scale structures retain time-integrated information about the surface emission. We will show in detail the implications for interpreting ground-based observations.

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