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Seasonal variation of activity on the nucleus of comet 67P/Churyumov-Gerasimenko

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1. 67P/Churyumov-Gerasimenko

Selected in 2003 as the final target of the Rosetta mission, comet 67P/Churyumov-Gerasimenko has been monitored extensively over the course of several orbits.

Comets often behave in an unpredictable way, sudden outbursts or fragmentation can occur at any time and change completely the period of the nucleus, its spin orientation, or the activity pattern if a region gets suddenly depleted of volatiles, or if a fresh layer becomes exposed to the Sun. Fortunately for the Rosetta mission, comet 67P has behaved consistently for its last three orbits. While this is by no means a guarantee that Rosetta will encounter a similar activity pattern in 2014, odds are high that the comet will continue to display the same kind of activity.

2. Seasonal effects

On a general level, we see the activity of the comet increasing as the nucleus approaches perihelion, and decreasing afterward, with a peak about one month after perihelion. We have monitored this activity closely [2, 1], looking at fine variations such as jets and other structures in the coma. We found a strong difference in behaviour before and after perihelion. Inbound activity is relatively homogeneous. Jets are detected in the dust coma, but rather faint. About one month before perihelion, and continuing outbound, this patterns changes completely. Strong jets are detected in all ground-based images and can be clearly connected to specific regions of the nucleus [4].

According to our understanding of the spin axis orientation, this change of behaviour is directly correlated to the variation of illumination conditions around the orbit. The northern hemisphere of the comet is illuminated most of the time, while the southern one gets most of its illumination around perihelion. Figure 1 shows the latitude of the subsolar point throughout a revolution. The Sun crosses the nucleus equator about two months before perihelion, and soon after starts to trigger the main jets we observed.

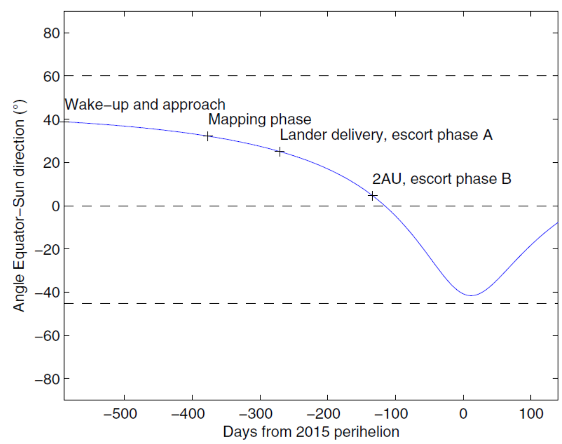

Figure 1: Angle between the comet equator and the Sun direction in the epoch covered by the Rosetta mission (01/01/2014 to 31/12/2015). The dashed lines indicate the estimated latitudes of the three active regions described in [4]. Northern and southern hemisphere are defined as facing the ecliptic north and south. Labels indicate the main different phases of the Rosetta mission.

3. Implications for Rosetta

One of the main goal of the Rosetta mission is to understand how cometary activity works, especially how it starts when the comet is far away from the Sun. Unfortunately, recent observations [3] show that the comet will be already active when we start observing it with Rosetta. However, the strong seasonal variations will allow us to investigate the start of activity anyway during the mission. As the comet gets closer to the Sun, the latitude of the subsolar point decreases, and regions of the southern hemisphere, which have not seen the Sun since the last perihelion passage, will enter the sunlight again. Thanks to all instruments onboard Rosetta, we will be able to monitor the changes in activity and look for variations across hemispheres as seasons pass on the nucleus.

References

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