



Publication Year	2016
Acceptance in OA @INAF	2020-07-17T09:00:02Z
Title	Investigating the correlations between water coma emissions and active regions in comet 67P/ Churyumov-Gerasimenko
Authors	MIGLIORINI, Alessandra; FILACCHIONE, GIANRICO; CAPACCIONI, FABRIZIO; PICCIONI, GIUSEPPE; Bockelee-Morvan, Dominique; et al.
Handle	http://hdl.handle.net/20.500.12386/26473

on 67P. The data cover the full spectral range of the two channels and allow studying both dust and gas properties to derive information on the underlying physical mechanism driving the outbursts.

The preliminary results of the outburst sequence indicate that they occur on the daylight side of the nucleus. They are characterized by a short duration and decay that lasts typically 15 minutes for the large outburst and 5 minutes for the two mini outbursts. The spatial and temporal distribution of the dust indicates a complex light curve for each event showing internal structures. The large outburst shows a bluer color than the background coma in the range of 2-2.5mm with a value around 1% per 100 nm, which can be interpreted as a change of dust properties and perhaps the presence of icy grains. However, the spectral signature of water ice at 3 mm is not detected in the outburst material, or in the background coma. In the range of 0.45-0.75 mm, the spectral slope shows a redder value in the outburst material (15 % per 100 nm) than in the background (12 % per 100 nm). The dust temperature, measured by fitting the thermal continuum, is much higher for the outburst material than for the background coma. No significant increase in CO₂ or H₂O production is detected. Both the bluer color in the IR and the higher temperature suggest that the outburst material is dominated by small dust particles. Further analysis will be presented during the congress.

Author(s): Giovanna Rinaldi², Dominique Bockelee-Morvan³, Cedric Leyrat³, Fabrizio Capaccioni², Gianrico Filacchione², Stéphane Érard³, Jordan Steckloff⁵, Gian-Paolo Tozzi⁴, Uwe Fink⁶, Lyn Doose⁶, Giuseppe Piccioni², Maria Teresa Capria², Michael R. Combi⁷, Maria Cristina De Sanctis², David Kappel¹, Andrea Longobardo², Alessandra Migliorini², Ernesto Palomba², Fredric W. Taylor⁸, Federico Tosi²

Institution(s): 1. DLR, 2. IAPS-INAF, 3. LESIA-Observatoire de Paris, Meudon, 4. Osservatorio di Arcetri, 5. PSI, 6. Univ. of Arizona, 7. University of Michigan, 8. University of Oxford

Contributing team(s): VIRTIS-Team

206.06 – Are Comet Outbursts the Result of Avalanches?

Recently, Rosetta became the first spacecraft to make high-resolution observations of a comet outburst (a rapid, ephemeral increase in dust production) emerging from the surface of a comet nucleus. These outbursts occurred near perihelion, lasted only a few minutes, and produced a highly collimated outburst plume without any corresponding increase in H₂O or CO₂ gas production (See abstract by Rinaldi et al.). These observations cannot be explained by proposed driving outburst mechanisms (such as crystallization of amorphous ice, cryovolcanic gas exsolution, or explosive outgassing of subsurface chambers), all of which are driven by gas, and would therefore lead to an increase in the gas production.

We propose instead that the observed outbursts on Comet 67P/Churyumov-Gerasimenko (hereafter 67P) are the result of cometary avalanches. The surface of 67P contains many cliffs and scarps, with dusty surface layers blanketing the shallower slopes above and below these steep surfaces. The Rosetta spacecraft returned clear evidence of mass wasting, which form icy talus fields that are the source of much of 67P's cometary activity. Additionally, Rosetta observed morphological changes over time in the shallower, dusty surface layers above these steep slopes, which suggest that avalanches periodically release dusty materials onto these active talus fields.

Here we present the results of a numerical simulation of dusty material avalanching into an active area (active talus field). These simulations show that such avalanches will generate a transient, highly collimated outburst plume that closely matches the observed morphology of the outbursts emanating from the surface of 67P.

This mechanism predicts that cometary outbursting should not be directly associated with any increase in gas production, consistent with observations. Additionally, we show that regions of the nucleus that have sourced outburst plumes contain steep surfaces (above the angle of repose), which is required for the generation of avalanches and the viability of this mechanism.

Author(s): Jordan Steckloff¹, H. Jay Melosh²

Institution(s): 1. Planetary Science Institute, 2. Purdue University

206.07 – Small is different: RPC observations of a small scale comet interacting with the solar wind

Rosetta followed comet 67P from low activity at more than 3 AU heliocentric distance to peak activity at perihelion and then out again. We study the evolution of the dynamic plasma environment using data from the Rosetta Plasma Consortium (RPC). Observations of cometary plasma began in August 2014, at a distance of 100 km from the comet nucleus and at 3.6 AU from the Sun. As the comet approached the Sun, outgassing from the comet increased, as did the density of the cometary plasma. Measurements showed a highly heterogeneous cold ion environment, permeated by the solar wind. The solar wind was deflected due to the mass loading from newly added cometary plasma, with no discernible slowing down. The magnetic field magnitude increased significantly above the background level, and strong low frequency waves were observed in the magnetic field, a.k.a. the "singing comet". Electron temperatures were high, leading to a frequently strongly negative spacecraft potential. In mid to late April 2015 the solar wind started to disappear from the observation region. This was associated with a solar wind deflection reaching nearly 180°, indicating that mass loading became efficient enough to form a solar wind-free region. Accelerated water ions, moving mainly in the anti-sunward direction, kept being observed also after the solar wind disappearance. Plasma boundaries began to form and a collisionopause was tentatively identified in the ion and electron data. At the time around perihelion, a diamagnetic cavity was also observed, at a surprisingly large distance from the comet. In late 2016 the solar wind re-appeared at the location of Rosetta, allowing for studies of asymmetry of the comet ion environment with respect to perihelion. A nightside excursion allowed us to get a glimpse of the electrodynamic of the innermost part of the plasma tail. Most of these phenomena are dependent on the small-scale physics of comet 67P, since for most of the Rosetta mission the solar wind - comet atmosphere interaction region is smaller than the pickup ion gyroradius in the undisturbed solar wind.

Author(s): Hans Nilsson⁵, James L. Burch⁴, Christopher M.

Carr¹, Anders I. Eriksson⁶, Karl-Heinz Glassmeier², Pierre Henri³

Institution(s): 1. Imperial College, 2. Institut für Geophysik und extraterrestrische Physik Technische Universität Braunschweig, 3. LPC2E, CNRS, Université d'Orléans, 4. Southwest Research Institute, 5. Swedish Institute of Space Physics, 6. Swedish Institute of Space Physics

Contributing team(s): Rosetta Plasma Consortium Team

206.08 – Investigating the correlations between water coma emissions and active regions in comet 67P/ Churyumov-Gerasimenko

Vibrational emission lines of H₂O and CO₂ at 2.67 and 4.27 μm, respectively, were identified by the VIRTIS spectrometer (Bockelee-Morvan et al., 2015; Migliorini et al., 2016; Fink et al., 2016) and mapped from the surface up to about 10 km altitude with a spatial resolution on the order of tens of meters per pixel (Migliorini et al., 2016).

Data acquired in April 2015 with the VIRTIS spectrometer on board the Rosetta mission, provided information on the possible

correlation between the H₂O emission in the inner coma and the exposed water deposits detected in the Hapi region on the 67P/Churyumov-Gerasimenko surface (Migliorini et al., 2106; De Sanctis et al., 2015). Further bright spots attributed to exposed water ice have been identified in other regions by OSIRIS at visible wavelengths (Pommerol, et al., 2015) and confirmed in the infrared by VIRTIS-M in the Imothep region (Filacchione et al., 2016). The small dimensions of these icy spots - approximately 100x100 m (Filacchione et al., 2016) – and the relatively small amount of water ice (about 5%) make uncertain the correlation with the strong emissions in the coma.

However, VIRTIS data show that the distribution of jet-like emissions seems to follow the distribution of cliffs and exposed areas identified in the North hemisphere with OSIRIS camera (Vincent et al., 2015). These areas are mainly concentrated in correspondence of comet's rough terrains, while a lack of active regions is observed in the comet's neck. Nevertheless, strong H₂O emission is observed above the neck with VIRTIS. This might be a consequence of gas jets that are originated in the surrounding of the neck but converging towards the neck itself. This gaseous activity is the main driver of the dust upwelling (Migliorini et al, 2016; Rinaldi et al., in preparation) In this paper, we investigate the relationship between H₂O vapour observed with VIRTIS within 5 km from the 67P/C-G nucleus and the exposed regions identified by OSIRIS on the surface (in the timeframe March to April 2015) with an attempt to address possible variations with the heliocentric distance.

Author(s): Alessandra Migliorini¹, Gianrico Filacchione¹, Fabrizio Capaccioni¹, Giuseppe Piccioni¹, Dominique Bockelee-Morvan², Stéphane Érdard², Cedric Leyrat², Michael R. Combi³, Nicolas Fougere³, Giovanna Rinaldi¹

Institution(s): 1. IAPS-INAF, 2. LESIA - Obs de Paris, 3. University of Michigan

Contributing team(s): VIRTIS Team

206.09 – Investigation into the disparate origin of CO₂ and H₂O outgassing for comet 67P

We present an investigation of the emission intensity of CO₂ and H₂O and their distribution in the coma of 67P/ Churyumov-Gerasimenko obtained by the VIRTIS-M imaging spectrometer on the Rosetta mission. We analyze 4 data cubes from Feb. 28, and 7 data cubes from April 27, 2015. For both data sets the spacecraft was at a sufficiently large distance from the comet to allow images of the whole nucleus and the surrounding coma.

We find that unlike water which has a reasonably predictable behavior and correlates well with the solar illumination, CO₂ outgasses mostly in local regions or spots. Furthermore for the data on April 27, the CO₂ evolves almost exclusively from the southern hemisphere, a region of the comet that has not received solar illumination since the comet's last perihelion passage. Because CO₂ and H₂O have such disparate origins, deriving mixing ratios from local column density measurements cannot provide a meaningful measurement of the CO₂/H₂O ratio in the coma of the comet. We obtain total production rates of H₂O and CO₂ by integrating the band intensity in an annulus surrounding the nucleus and obtain pro-forma production rate CO₂/H₂O mixing ratios of ~5.0% and ~2.5% for Feb. 28 and April 27 respectively. Because of the highly variable nature of the CO₂ evolution we do not believe that these numbers are diagnostic of the comets bulk CO₂/H₂O composition. We believe that our investigation provides an explanation for the large observed variations reported in the literature for the CO₂/H₂O production rate ratios. Our mixing ratio maps indicate that, besides the difference in vapor pressure of the two gases, this ratio depends on the comet's geometric shape, illumination and past orbital history. Our annulus measurement for the total water production for Feb. 28

at 2.21AU from the sun is 2.5x10²⁶ molecules/s while for April 27 at 1.76 AU it is 4.65x10²⁶. We find that about 83% of the H₂O resides in the illuminated portion of our annulus and about 17% on the night side. A rough estimate of the water surface evaporation rate of the illuminated nucleus for April 27 yields about 5x10¹⁹ molecules/s m².

Author(s): Uwe Fink³, Lyn Doose³, Giovanna Rinaldi¹, Fabrizio Capaccioni¹, Dominique Bockelee-Morvan²

Institution(s): 1. IAPS-INAF, 2. LESIA, 3. Univ. of Arizona

Contributing team(s): VIRTIS team

207 – Extrasolar Planets: Giant Planet Atmospheres II

207.01 – Optical phase curves of exoplanets at small and large phase angles

Phase curves and secondary eclipses provide key information on exoplanet atmospheres. Indeed, recent work on close-in giant planets observed by Kepler has shown that it is possible to constrain various reflecting, dynamical and thermal properties of their atmospheres from the analysis of the planets' phase curves. This presentation discusses new diagnostic possibilities for the characterization of exoplanet atmospheres with optical phase curves. These possibilities benefit from the fact that at optical wavelengths the signal from the planet is either partly or mostly determined by scattering of starlight within its atmosphere, which entails that the structure of the planet's phase curve mimics to some extent the optical properties of the atmospheric medium. In particular, we will show how cloud properties such as the particle size or the atmospheric scale height might be constrained through observations at small (i.e. near transit) and large (i.e. near occultation) phase angles. We will emphasize how the interpretation of optical phase curves differs from the interpretation of phase curves obtained at longer wavelengths. The conclusions are relevant to the study of Kepler planets, but also to the investigation of phase curves to be delivered by upcoming space missions such as CHEOPS, JWST, PLATO and TESS.

Author(s): Antonio García Muñoz¹

Institution(s): 1. Technische Universität Berlin

207.02 – Transiting Exoplanet Studies and Community Targets for JWST's Early Release Science Program

The James Webb Space Telescope (JWST) will likely revolutionize transiting exoplanet atmospheric science; however, it is unclear precisely how well it will perform and which of its myriad instruments and observing modes will be best suited for transiting exoplanet studies. We will describe a prefatory JWST Early Release Science (ERS) Cycle 1 program that focuses on testing specific observing modes to quickly give the community the data and experience it needs to plan more efficient and successful transiting exoplanet characterization programs in later cycles. We will also present a list of "community targets" that are well suited to achieving these goals. Since most of the community targets do not have well-characterized atmospheres, we have initiated a preparatory HST + Spitzer observing program to determine the presence of obscuring clouds/hazes within their atmospheres. Measurable spectroscopic features are needed to establish the optimal resolution and wavelength regions for exoplanet characterization. We will present preliminary results from this preparatory observing program and discuss their implications on the pending JWST ERS proposal deadline in mid-2017.

Author(s): Kevin B. Stevenson¹

Institution(s): 1. University of Chicago

Contributing team(s): "Enabling Transiting Exoplanet Science with JWST" workshop attendees