Publication Year	2016
Acceptance in OA	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, Érard, Stéphane, Leyrat, Cedric, Combi, Michael R., Fougere, Nicolas, RINALDI, GIOVANNA, VIRTIS Team
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 Rinaldi[2], Dominique Bockelee-Morvan[3], Cedric Leyrat[3], Fabrizio Capaccioni[2], Gianrico Filacchione[2], Stéphane Érard[3], Jordan Steckloff[5], Gian-Paolo Tozzi[4], Uwe Fink[6], Lyn Doose[6], Giuseppe Piccioni[2], Maria Teresa Capria[2], Michael R. Combi[7], Maria Cristina De Sanctis[2], David Kappel[1], Andrea Longobardo[2], Alessandra Migliorini[2], Ernesto Palomba[2], Fredric W. Taylor[8], Federico Tosi[2]
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 outgasing 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 Steckloff[1], H. Jay Melosh[2]
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 electrodynamics 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 Nilsson[5], James L. Burch[4], Christopher M. Carr[1], Anders I. Eriksson[6], Karl-Heinz Glassmeier[2], Pierre Henri[3]
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 H_2O and CO_2 at 2.67 and 4.27 µm, respectively, were identified by the VIRTIS spectrometer (Bockelée-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 H_2O 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 H_2O 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 H_2O 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 Migliorini[1], Gianrico Filacchione[1], Fabrizio Capaccioni[1], Giuseppe Piccioni[1], Dominique Bockelee-Morvan[2], Stéphane Érard[2], Cedric Leyrat[2], Michael R. Combi[3], Nicolas Fougere[3], Giovanna Rinaldi[1]
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 CO_2 and H_2O outgassing for comet 67P

We present an investigation of the emission intensity of CO_2 and H_2O 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, CO_2 outgasses mostly in local regions or spots. Furthermore for the data on April 27, the CO_2 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 CO_2 and H_2O have such disparate origins, deriving mixing ratios from local column density measurements cannot provide a meaningful measurement of the CO_2/H_2O ratio in the coma of the comet. We obtain total production rates of H_2O and CO_2 by integrating the band intensity in an annulus surrounding the nucleus and obtain pro-forma production rate CO_2/H_2O mixing ratios of ~5.0% and ~2.5% for Feb. 28 and April 27 respectively. Because of the highly variable nature of the CO_2 evolution we do not believe that these numbers are diagnostic of the comets bulk CO_2/H_2O composition. We believe that our investigation provides an explanation for the large observed variations reported in the literature for the CO_2/H_2O 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 2.5×10^{26} molecules/s while for April 27 at 1.76 AU it is 4.65×10^{26}. We find that about 83% of the H_2O 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 5×10^{19} molecules/s m^2.
Author(s): Uwe Fink[3], Lyn Doose[3], Giovanna Rinaldi[1], Fabrizio Capaccioni[1], Dominique Bockelee-Morvan[2]
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 Muñoz[1]
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. Stevenson[1]
Institution(s): *1. University of Chicago*
Contributing team(s): "Enabling Transiting Exoplanet Science with JWST" workshop attendees