WATER VAPOUR AND CARBON DIOXIDE IR EMISSIONS IN 67P/CG COMA: FIRST DETECTION BY ROSETTA/VIRTIS-M F. Capaccioni[1], D. Bockelée-Morvan[2], G. Filacchione[1], S. Erard[2], C. Leyrat[2], M. C. De Sanctis[1], G. Piccioni[1], J. Crovisier[2], F. Tosi[1], M. T. Capria[1], M. Ciarniello[1], A. Raponi[1], P. Drossart[2], G. Arnold[3] and Rosetta VIRTIS team, [1]IAPS-INAF, via del Fosso del Cavaliere, 100, 00133, Rome, Italy, gianrico.filacchione@iaps.inaf.it, [2]LESIA, Observatoire de Paris/ CNRS/UPMC/Université Paris-Diderot, Meudon, France, [3]German Aerospace Center DLR Berlin, Germany.

Introduction: Taking advantage of Rosetta's terminator orbits around 67P/CG nucleus in December 2014, VIRTIS-M, the mapping channel of the Visible and Infrared Thermal Imaging Spectrometer [1] has carried out systematic observations of the comet limb in the 0.25-5 μm spectral range with the aim to detect fluorescence emissions of gas species like water vapour and carbon dioxide [2]. We report about the first detections of these molecules by VIRTIS-M and correlate them with respect to the nucleus orientation at the time of the observation. These features appear variable in time, depending on numerous parameters like comet's activity state, relative position of the spacecraft with respect to the nucleus, tangent altitude of the line of sight above the limb, heliocentric distance and solar phase. Water vapour emission at 2.7 μm appears considerably more intense in correspondence of the jets emitted by the active regions in the neck while carbon dioxide emission at 4.25 μm increases in limb observations taken above the head and body regions.

Coma observations: In December 2014 VIRTIS has performed an extensive campaign dedicated to 67P/CG coma characterization. These observations consist of repeated limb scans taken on the coma above the illuminated part of the nucleus. From a typical spacecraft altitude above the comet's nucleus of 20 km VIRTIS-M is able to acquire the innermost part of the coma, from the surface up to altitude of about 400-500 m with spatial resolution of about 5 m/pixel. Moreover the 3.7° wide VIRTIS-M field of view allows to image a large region of the sun illuminated coma above the nucleus where the maximum fluorescence emissions of the gasesous species occur. Starting from October 2014, VIRTIS-H channel has detected similar emissions on high-resolution ($\lambda/\Delta\lambda$=1300-3000) point spectra in the 2-5 μm range [3]. In the following we describe the first detection of water vapour and carbon dioxide fluorescence emissions detected by VIRTIS-M in two coma observation campaigns carried out in december 2014: 1) session MTP010-STP033, acquired on 2014-12-14 from a spacecraft-comet distance of about 20 km, solar phase of about 91° and spacecraft offnadir angle of 5.4°; 2) session MTP010-STP034 executed on 2014-12-17 from a distance of about 20 km, solar phase 92.7° and spacecraft offnadir angle of 7.1°. The relative position of VIRTIS-M slit and field of view (FOV) at the time of these observations is shown in Fig. 1. On the first half of STP033 sequence VIRTIS has observed the coma above the night hemisphere of the head region (observations I1_00377200411 and I1_00377202271) while on the second half it was pointing above the neck active region (observations I1_00377208511 and I1_00377210370). In MTP010/STP034 VIRTIS-M FOV was spanning across the coma region extending above the neck active area for all the time. At the time of these observations the comet's heliocentric distance was 2.77 AU.

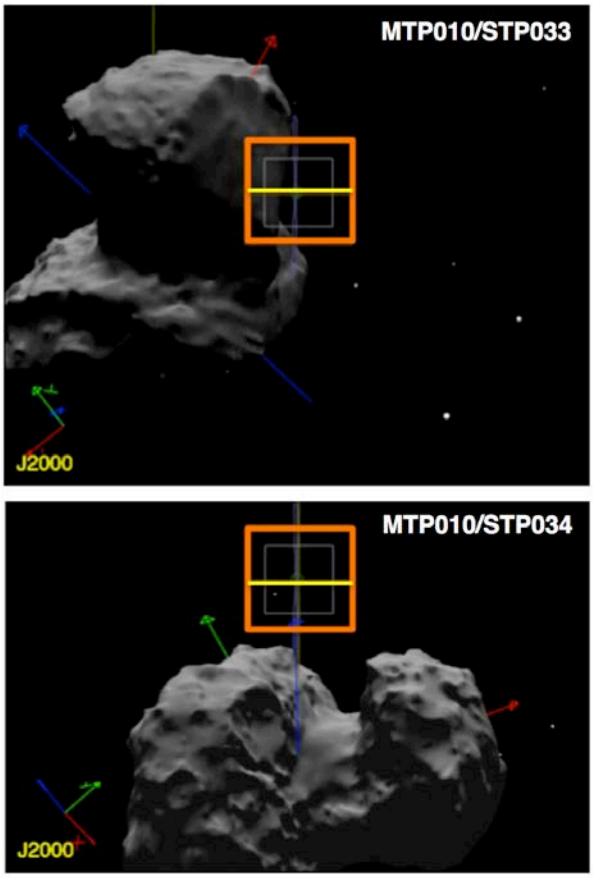

Fig. 1. Renderings of VIRTIS-M full 3.7°×3.7° FOV (orange square) and slit (yellow line) on the CG nucleus at the time of MTP010/STP033 (top panel) and MTP010/034 (bottom panel) observations. Subsolar direction is along the +Y axis.

Integrated radiance: In order to boost signal-to-noise-ratio we have summed the spectral radiance of

all pixels in each VIRTIS-M cube, as listed in Table 1. The resulting averaged radiances are shown in Fig. 2-3 for STP033 and STP034 sessions, respectively.

Observation		Sample × Line	# pixels
STP 033	I1_00377200411	256 × 76	19456
	I1_00377202271	256 × 70	17920
	I1_00377208511	256 × 76	19456
	I1_00377210370	256 × 70	17920
STP 034	I1_00377459611	256 × 76	19456
	I1_00377461470	256 × 70	17920
	I1_00377463271	256 × 76	19456

Table 1: VIRTIS-M cubes dimensions.

Water vapour fluorescence emissions at 2.7 µm are detected by VIRTIS-M on STP033 cubes I1_00377208511 and I1_00377210370 (green and magenta curves in Fig. 2) and in all three observations in STP034 (Fig. 3). These observations were all taken above the active neck regions.

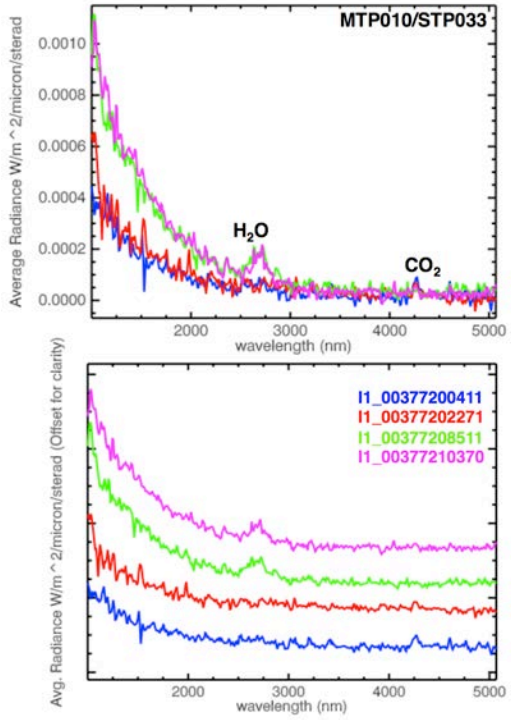

Fig 2: Averaged radiance (over the number of pixels reported in Table I) for coma observations acquired during STP033 above the head region (red and blue lines) and above the neck active region (magenta and green). In the bottom plot the same curves are shifted for sake of clarity.

Carbon dioxide fluorescence at 4.25 µm appears only at the beginning of STP033 session above the head nightside (cubes I1_00377200411, and tentatively I1_00377202271 in Fig. 2). On those spectra the water vapour emissions are not visible.

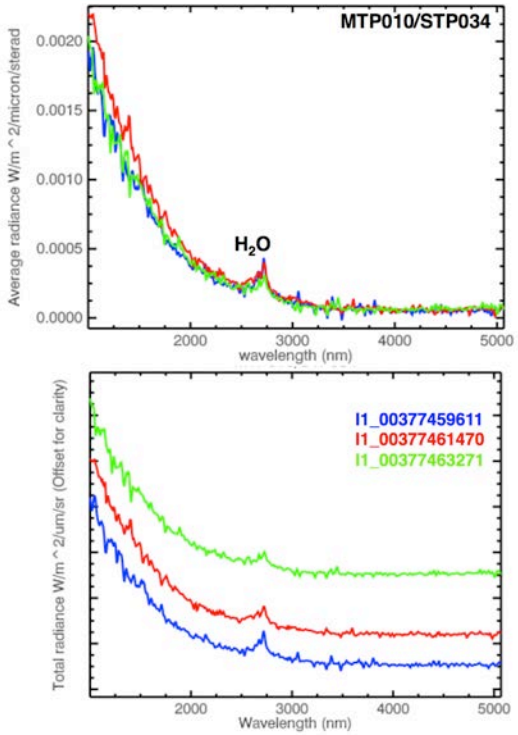

Fig 3: Averaged radiance (over the number of pixels reported in Table I) for coma observations acquired during STP033 above the neck active region. In the bottom plot the curves are shifted for sake of clarity.

Conclusions: VIRTIS-M data are in good agreement with VIRTIS-H data obtained previously [3] and indicate that water vapour is mainly present in the coma above the active areas of the neck region where carbon dioxide emission are not detected. Conversely, the carbon dioxide emission seems to happen preferentially above the head region far from the active areas.

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