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Stray light in Rosetta/VIRTIS-H

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Abstract

Evidences have been found that the VIRTIS-H spectrometer's signal can be contaminated with stray light in particular geometric conditions. The variability of this stray light with time and geometry was investigated. It is now possible to model the stray light for a given observation, in order to remove it from the signal.

1. Introduction

The Rosetta spacecraft was sent in 2004 and reached its main target comet 67P Churyumov-Gerasimenko in 2014. One of its main objectives was to study the cometary nucleus and to determine its main characteristics. To do this, the probe had a battery of instruments, including the cross-dispersion spectrometer VIRTIS-H [1]. This type of instrument allows, by first dispersing the light in the high orders by two networks, then separating these orders of diffraction by a prism, to simultaneously acquire the entire spectrum on a matrix of detectors, and this at high spectral resolution. VIRTIS-H has a 1300-3000 resolution in the range 1.88-5.03 µm.

2. Stray light in spectra

Figure 1 shows how stray light contaminate the data. It is clear on Figure 1 that stray light is not dispersed as it is present also outside the area where signal is expected (the bright lines that correspond to orders of diffusion). In this case of backup mode data, the complete image on the detector has been conserved, but most of the time, in nominal mode, only the pixel where signal is expected are saved, to save bandwidth. This means that stray light contamination cannot be measured separately from the real signal. Figure 2 shows how stray light affects a measure: in this example, the spectrum correspond to an observation of the black sky, where no signal is expected. The spectrum displayed is then an artifact only due to stray light contamination.

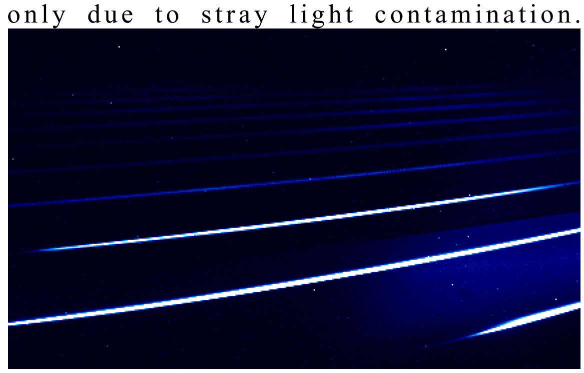

Figure 1: Stray light observed on VIRTIS-H detector in cube H1_00389083498. There should be no signal between the dispersion orders (bright lines)

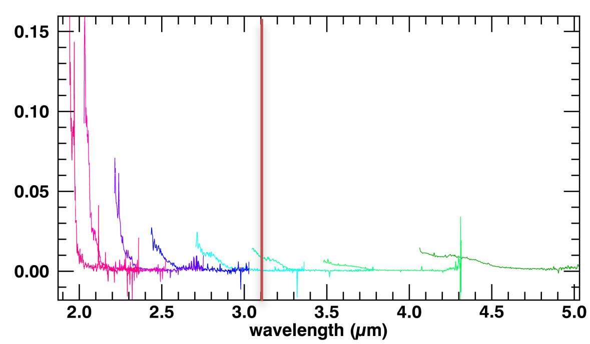

Figure 2: Impact of the stray light on a spectrum: there should be no signal in this example.

3. Variability of stray light

In figure 3 are displayed two images corresponding to the signal at 3.1µm in cube T1_0040235835, but in two different channels in order 2 and 3 (there is an overlap between orders). The red line in Figure 2 shows the locations in a spectrum: in order 3 (image on the left, the 3.1µm channel is never affected by stray light. On the other hand, in order 2, the 3.1µm channel can be contaminated with stray light. When there is no stray light, both channel show the same signal, but when there is stray light, order 2 displays an higher value than order 3. The geometrical region where stray light is contaminating the data is outline in light red in Figure 3 (right).

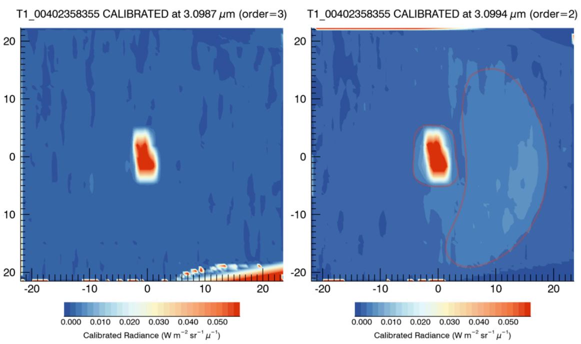

Figure 3: Variability of the stray light with geometry in cube T1_00402358355. Both images show the signal at 3.1µm, but on different orders. Only the canal on the figure on the right is affected by stray light (outlined in light red)

5.Stray light removal

The stray light can be removed from the signal by modeling it and then subtracting its contribution to the original data. As there is a strong variability of the stray light contamination with geometry, different models corresponding to different geometrical condition have been built. They are then scaled using an indicator of stray light in the data, to model empirically the stray light in any observation.

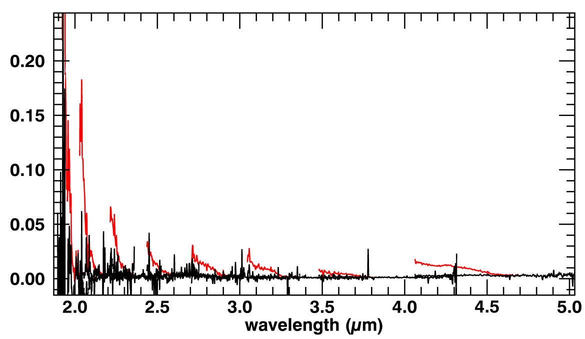

Figure 4: Example of stray light removal: the red curve is the original contaminated data, and the black one is after removal

Figure 4 shows and example of stray light removal in a nominal cube (T1_00396861799). The red spectrum is the original contaminated data, and the black is the corrected spectrum. At first order, the stray light has been removed.

6.Summary and Conclusions

Stray light contaminate a large amount of VIRTIS-H spectral data. It is possible to remove it at first order from the polluted data, by modeling it in different geometrical conditions, scaling it and then subtracting the scaled model to the original data.

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References

[1] Coradini, A. et al., VIRTIS: An Imaging Spectrometer for the Rosetta Mission, Space Science Reviews, 2007, 128, 529-559.