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Artefacts removal in VIR/DAWN data

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Introduction

VIR is a imaging spectrometer on board Dawn spacecraft acquiring hyperspectral images in the 0.25-5.1 spectral range [1]. After the success of the Dawn mission in the study of the asteroid Vesta, the spacecraft departed toward the dwarf planet Ceres and is currently in its orbit.

All VIR spectra display residual artifacts due to the systematic instrumental uncorrected effects. In order to highlight the spectral bands hidden by spectral artifacts, we propose here a denoising method to remove these artifacts from the VIR spectra. Other authors have studied the denoising of planetary spectra with different approach [2] or similar one [3].

The method that we are applying is in a test phase, but the obtained results are encouraging. We tested this method on various cubes of different mission phases during Vesta observations and the results are presented in this paper.

Method and Results

In general, the method consist of two stages: 1) creation of the artifacts matrix; 2) application of the artifacts matrix to the VIR cubes.

In the VIR spectra we assume that the reflectance (R) of each pixel is a combination of signal due to the surface contribution (S), artifacts (A) and noise (N): R=S+A+N.

In VIR data, detector artifacts change from sample to sample (column dependency). For this reason it is necessary to understand what are the residual artifacts for each sample. In order to study these effects we use the survey mission phase of Vesta to compute the artifacts profiles.

Starting from this dataset we extract a mean spectrum that characterizes the systematic residuals for each sample. The algorithm consists of four steps summarized in the following:

1. one thousand spectra are randomly selected using the data of survey mission phase of Vesta;

2. the median value are computed for each wavelengths;

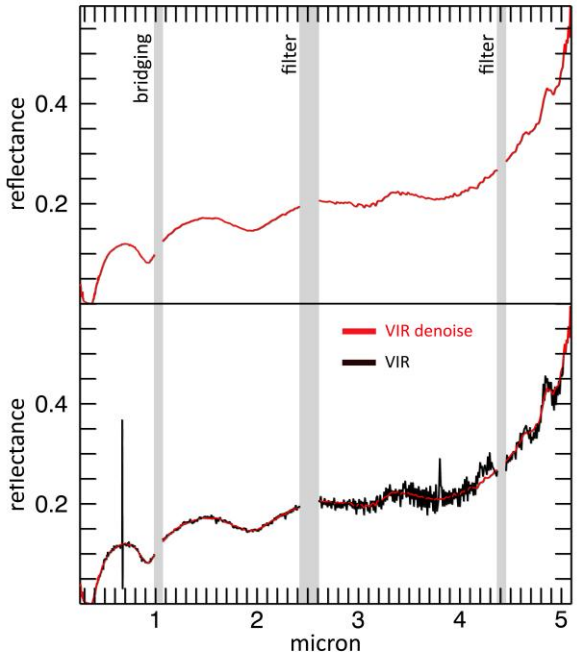

Figure 1. In the bottom panel are displayed a spectrum of Vesta acquired by VIR spectrometer (black curve) and the same spectrum after the denoising (red curve). In the top panel is displayed only the denoised spectrum for clarity.

3. a polynomial function is computed to fit the average spectrum;

4. the artifacts profile is extracted as ratio between the average signal and the fit at each sample.

The output file of this procedure is a 2D-matrix [number of samples, number of wavelengths] that we call “artifacts matrix”. It represents the percentage of signal to remove in the VIR spectra that have a wavelength dependency. In the second and last stage we remove the column-dependent artifacts from the reflectance values applying the artifacts matrix to the VIR reflectance cubes. This algorithm is able to remove the systematic residual artifacts but it cannot include the random spatial frequency residuals. In this last case a despiking procedure is necessary.

We are applying the artifacts matrix to the observations obtained during the various Vesta mission phases. In Figure 1 we show a spectrum of Vesta after the artefacts have been removed.

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