Radiative-transfer model for simulating VIRTIS/Rosetta molecular spectra

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The VIRTIS (Visible and Infrared Thermal Imaging Spectrometer) instrument onboard the ESA Rosetta probe will measure the infrared spectrum of 67P/Churyumov-Gerasimenko in the nadir and limb geometries. From these measurements, the spatial distribution, production rate, and rotational temperature of several species will be obtained.

We have developed a radiative-transfer model which simulates the excitation of the vibrational bands of H_2O, CO_2, and CO in both optically thin and optically thick regions of the coma. This 3D model treats properly the effect of non-isotropic excitation from solar radiation and allows us to consider any coma geometry. This allows us to compute synthetic spectra in different observation geometries.

The model uses a spatial grid for the gas parameters and the level populations with a directional discretization to treat the ray propagation. The algorithm we propose minimizes the number of rays. This makes the model computationally efficient, which is necessary to compute the excitation of a large (50–100) number of ro-vibrational lines.

We apply the model to 67P/CG to provide predictions for the forecoming 2014–2015 VIRTIS observations and present the results. We also discuss the possibility to derive the gas temperature and density from the measurements.