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Analysis of absorption features in TNO and asteroid spectra

S. Erard, D. Despan, F. Merlin (1)
(1) LESIA Observatoire de Paris, France

Modern spectroscopic observations of Trans-Neptunian Objects are providing insights to surface composition and evolution of these objects. However, because TNOs are dark and distant, the data are usually rather noisy and the presence and characteristics of absorption features is often difficult to assess. A similar situation occurs with recent resolved spectra of Main Belt asteroids, where spectral features hardly stand out of the noise.

We present here a new method based on wavelet decomposition and on a multiscale vision model, partly derived from image analysis techniques (e.g., Starck et al. Ap. J. 1997). This method was originally developed to process large imaging spectroscopy data sets from space borne instruments, and to extract the relevant information from highly correlated data, where it only represents a small fraction of the overall variance. The outcome of the analysis is a description of the bands detected, and a quantitative and reliable confidence parameter. The bands can be described either by the most appropriate wavelet scale only (for rapid analyses) or after reconstruction from all scales involved (for more precise measurements). An interesting side effect is the ability to separate even narrow features from random noise, as well as to identify low-frequency variations i.e., wide and shallow bands.

The principle of the method is presented here, and it is tested on laboratory spectra of minerals (controlled olivine / pyroxenes mixtures). The techniques is then applied to NIR spectra of Trans-Neptunian Objects and Main Belt asteroids, including recent observations of Sedna and 1 Ceres. In both cases, the robustness of the method allows to identify and characterize spectral features in these very low signal-to-noise situations.