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Raman Spectroscopy – A Suitable Tool for *in-situ* Planetary Science

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In the last few years Raman spectroscopy has been recognized as a possible method for in situ planetary analysis. The most important fields Raman spectroscopy is addressing are the mineralogical and organic/biological analysis. Some of the advantages and the limitations of Raman spectroscopy as a method of investigation for future planetary missions are discussed here. As an illustration, this method has been used for analysing meteorite material of Martian origin. Point measuring technique was used and mineral maps were afterwards obtained from the Raman spectra. Fig 1. shows the mineral maps for pyroxene, whitlokite, calcite, magnetite and olivine alongside with the white light image of the investigated surface on DAG 735 meteorite sample .
The main advantages that Raman Spectroscopy has to offer for a remote in situ planetary measurement are: i) requires only minimal or no sample preparation, and it can be applied to any optically accessible sample; ii) Easy identification of inorganic, organic, or biological compounds; iii) Measuring configurations which can accommodate target sizes from 1µm^2 up to a few dm^2, at ranges from a few mm up to 1 km.

The characterisation at a micrometer scale is our method of choice. For a complete analysis of the targeted surface there are different measuring scenarios. Point measuring on different spots on the surface (lines, grids) is considered by Haskin & al.[1]. Another approach is imaging by using global illumination and a spectrometer with image preserving capabilities. The main advantage of Raman spectroscopy when combined with an imaging technique is the amount of information that such an investigation is providing in terms of mineral/organic characterisation of the sample. The amount of information produced is on the other hand a disadvantage in terms of data transfer limits for an automated investigation on a remote planet.

The technical developments made possible the design of a new generation of small Raman systems suitable for robotic mineral characterization on planetary surfaces. MIRAS (Mineral Investigation by in situ Raman Spectroscopy) is such a small Raman spectrometer designed for close-up analysis of rocks and soils in planetary surface exploration. Different designs were approached and a breadboard version was built around an acousto-optic tunable filter (AOTF) and an APD point detector. The instrument setup is shown in fig 2. Measurements made with the current breadboard version of the spectrometer are presented. The imaging capabilities for the MIRAS spectrometer equipped with a CCD camera were tested and the possibilities of using it for mineral characterization through global imaging are discussed.

[1] L. A. Haskin, et al. Raman spectroscopy for mineral identification and quantification for in situ planetary surface analysis: a point count method. 1997 *J. Geophys. Res. [Planets]* , 102(E8), 19293-19306.

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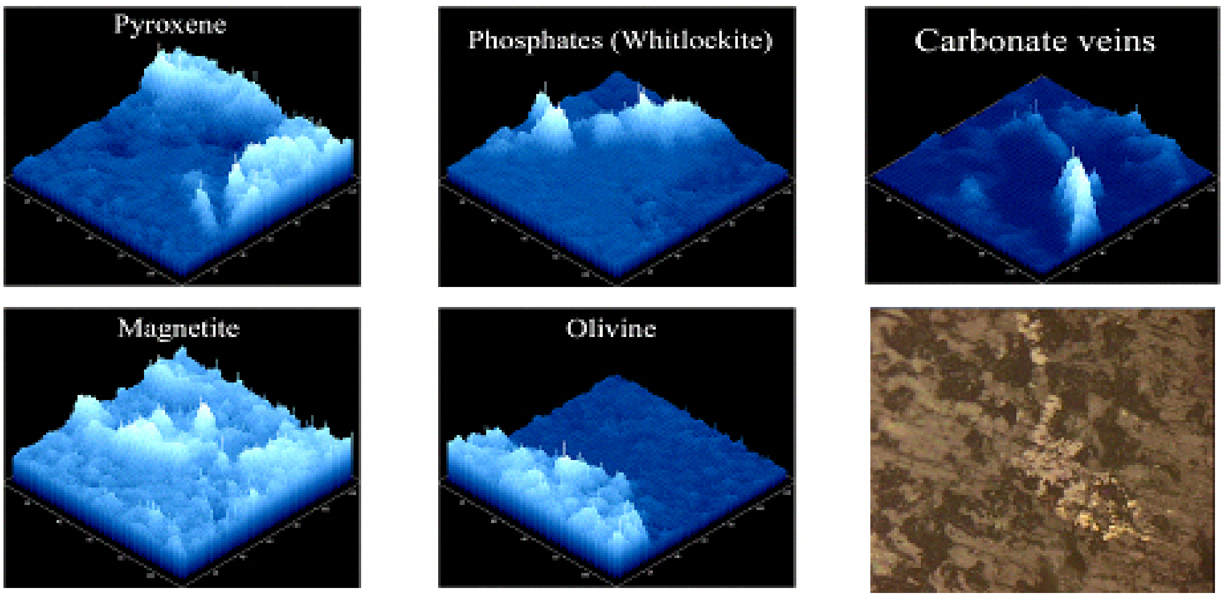

Fig 1. Spatial distribution of different minerals on the investigated surface (100 x 100 µm) of DAG 735 meteorite.

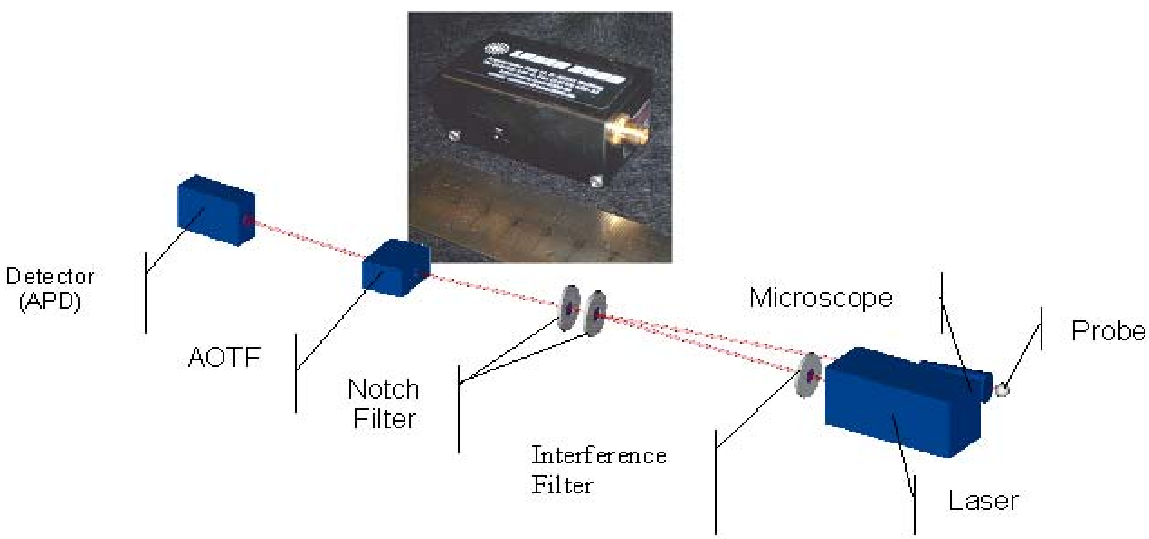

Fig 2. MIRAS: schematic of the breadboard version design based on the AOTF