Fiber-Optic Gyroscope For 6-component Planetary Seismology

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Planetary seismology is a key technique for imaging the internal structure of planetary objects. It targets some of the fundamental science objectives from the formation of planetary systems to the characterization of habitable worlds. But standard methods suffer from various limitations inherent to planetary missions.

An important limitation is that it is difficult to deploy several instrument at the surface of other planets. We therefore plan to develop a single instrument able to monitor both translations and rotations of planetary surfaces : it would allow to perform both seismology and global rotational monitoring of the planetary object.
An important aspect of the innovation using fiber-optic gyroscope in planetary seismology mission is to take benefit of the very latest improvements in seismology through so called “rotational seismology”. Indeed, the measurement of 6 Degrees of Freedom (DoF) demonstrates the significant scientific return of a single sensor recording the 3 DoF rotations in addition to the usual 3 components of translation (Igel et al., 2005, Sollberger et al., 2017, Schmelzbach et al, 2018).

Moreover, from a practical point of view the deployment of fiber-optic gyroscope brings unrivalled advantages to ensure optimum scientific return, even in worst case deployment scenarios: no moving and/or fragile parts as it is a true strap down technology and no need for levelling as it can work in any position and orientation.

Hence, to enter a new realm of planetary exploration with an innovative ground motion instrumentation concept relying on high precision sensors based on optical interferometry, an innovative ground motion instrumentation concept will be described.

Applications for this kind of 6C sensors are:

- first generation instruments will open the way to a new kind of geodetic sensors for small fast rotators (asteroids) to contribute to defense and asteroid resources applications

- second generation will support fundamental science objectives, from the formation of planetary systems to the characterization of habitable worlds

The Cost optimization, ITAR-free strategy and adaptation to CubeSat standards will drive technological developments opening new markets for high precision scientific instrumentation with large scientific return at affordable price.