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Toward long-term all-sky time domain surveys- SINDICS: a prospective concept for a Seismic INDICes Survey of half a million red giants

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Abstract. CoRoT and *Kepler* have brought a new and deep experience in long-term photometric surveys and how to use them. This is true for exoplanets characterizing, stellar seismology and beyond for studying several other phenomena, like granulation or activity. Based on this experience, it has been possible to propose new generation projects, like TESS and PLATO, with more specific scientific objectives and more ambitious observational programs in terms of sky coverage and/or duration of the observations. In this context and as a prospective exercise, we explore here the possibility to set up an all-sky survey optimized for seismic indices measurement, providing masses, radii and evolution stages for half a million solar-type pulsators (subgiants and red giants), in our galactic neighborhood and allowing unprecedented stellar population studies.

1 Seismic indices, a direct legacy from CoRoT and Kepler to be developed:

CoRoT and *Kepler* have revealed the possibility to characterize thousands of red giant stars in terms of mass, radius and evolution stage with a few seismic indices, namely:

- $\Delta\nu$: the so-called large separation, characterizing the first order regularity in frequency of (p-dominated) oscillation modes.
- ν_{max}: the frequency of maximum pulsation amplitude.
- ΔP : first order regularity in period for g-dominated oscillation dipole modes.

The interest of these data for studying stellar populations in our galaxy has been stressed already by several prospective works. It is our expectation that these results will in the future naturally call for an all-sky seismic survey and thus call for a concept optimizing long duration and wide field, while keeping the sampling time adapted.

2 Mission concept - the platform and instrument:

A platform is carrying four identical elementary cameras, each covering a 11.25x11.25 deg^2 field of view (FOV). Cameras are grouped by two, so that at any time they are staring at two fields opposite on the sky, 22.5x11.25 deg^2 each.

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The platform is spinning around the same rotational axis during Dc (here we take Dc=103 days) and the detectors ”sweep” regularly a 22.5x360 deg^2 corona on the sky. The rotation period Prot (here Prot=16 minutes) ensures that each star of this corona is observed regularly with a sampling time Ts=Prot/2 (here Ts=8 minutes).

The image of each star is crossing the focal plane in 30 s and thus one CCD in 15 s. The CCDs are read in TDI mode (as for GAIA), the charges being drifted at the same speed as the star images.

A first optical sketch considered, for each camera, a dioptric (6-lenses) system with a 30 cm objective (equivalent to CoRoT), illuminating a focal plane with four CCDs (4.5kx4.5k pixels, 18μm/px, similar to PLATO CCDs) and a point spread function within 4 pixels anywhere on the square FOV 11.25x11.25 deg^2.

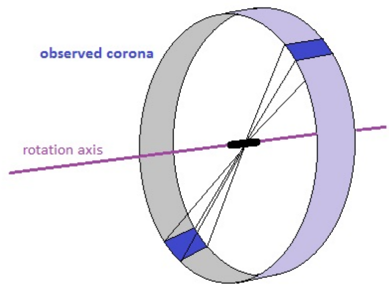

Fig. 1. The 22.5x360 deg^2 sky corona swept by the instrument every Ts=8minutes.

3 Mission concept-orbit and observationnal strategy:

We considered a platform located at Sun-Earth L2, observing the same corona on the sky during Dc=103 days. With a rotation axis chosen to point toward the Sun at Dc/2, the Sun is kept away from the FOV by a guard angle (here 28 deg).

Phase 1 (27months): by shifting every Dc (103 days) the rotation axis by 101 deg, it is possible to cover the whole sky with 8 successive corona within 27 months. For comparison, covering the whole sky by shifting every 3 months a pointed instrument with a FOV of 1000 deg^2 requires more than 10 years.

We notice that beside this, the two regions of the sky where the 8 coronas overlap will be observed a longer time (up to the total length of the mission for two symmetric disks of diameter 22.5 deg).

Phase 2 (+27months → 4.5 years, nominal duration of the mission): with 16 runs of duration Dc, the whole sky will be observed twice and each target observed two times Dc, separated by 8 Dc (here 2x103 days separated by 2 years and 3 months).

Phase 3 (possible extension: +27 months → 6 years and 9 months): with 24 runs of duration Dc, the whole sky will be observed 3 times Dc, separated by 8 Dc (here 3x103 days).

4 Performances on seismic indices measurements:

These estimates result from tests and scalings based on CoRoT and Kepler data. These tests suggest that seismic indices of red giants could be measured on continuous periods or on discontinuous periods 2xDC or 3xDC separated by 2 years without noticeable loss of precision.

In phase 2 (4.5 years, nominal mission): we measure seismic indices $\Delta\nu$ and ν_{max} for all red giants up to HGB included and up to 1.2 kpc ($m_V \leq 10.5$) and for the subgiants up to 150pc ($m_V \leq 9.5$), i.e. approximately 500000 stars spread over the whole sky. We also measure indices ΔP for part (~50%) of the red giants around the HGB, where this index is of crucial interest to disentangle stars on the RGB from stars on the HGB.

In phase 3 (7 years, extended mission): ΔP are measured for all red giants around the HGB with $8. \leq m_V \leq 10.5$.