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Application of a Non-Linear Harmonic Analysis to the search for the surface gravity effect of the translational motion of the inner core

S. Rosat, T. Sato, T. Fukushima and Y. Tamura

National Astronomical Observatory of Japan, Japan

(rosat@miz.nao.ac.jp / Fax: (+81)-197-22-2715 / Phone: (+81)-197-22-7194)

Our knowledge of the Earth's deep interior can be improved by the observation of the surface gravity effect of the translational motion of the inner core, the so-called Slichter triplet (Slichter, 1961). This sub-seismic mode has been the subject of various controversial debates concerning its theory (e.g. Rieutord, 2002), and the non-convincing observation by Smylie (1992) and then by Courtier et al. (2000) has not been confirmed (Rosat et al., 2003; 2004). The weak amplitude of this signal and the lack of knowledge about its parameters (frequency, damping and source of excitation) require the use of more sophisticated tools than the usual Fourier transform. We propose an application of a Non-Linear Harmonic Analysis (NLHA), developed by Harada (2003), which successfully enabled a new determination of planetary precession and a harmonic decomposition of time ephemeris (Harada and Fukushima, 2003; 2004), to the time-varying gravity recorded by the Superconducting Gravimeter installed at Canberra (Australia). The algorithm decomposes the given time series into the sum of a quadratic polynomial, an arbitrary number of Fourier terms and an arbitrary number of mixed secular terms. The differences from other methods of Fourier analysis are that (1) the frequencies and the number of waves are not fixed but determined optimally through the analysis, and (2) the mixed secular terms are taken into account. The application of this method to synthetics data and to the gravity variations associated with the seismic normal modes after the recent 2004 M_w = 9 Sumatra earthquake highlights the efficiency of the method to recover any small harmonic components buried in much larger amplitude signals and to estimate the frequencies and amplitudes with accuracy. The algorithm is then performed in the search for the

Slichter modes. The detection of this mode is fundamental as its period is directly linked to the value of the density jump at the Inner Core Boundary.

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