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Discussion on the anisotropy of the inner core basing on the observation of the earth's free oscillations excited by Sumatra-Andaman earthquake

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Abstract:

Sumantra Andaman Earthquake (Dec. 26, 2004) was one of the largest earthquake since 1964, and it released such huge energy that not only the Indian Ocean Tsunami but also Earth's free oscillations (EFO) were excited by the earthquake. The observation of the earth's free oscillations was helpful to determine accurately the amplitude of this huge earthquake, at the same time it provided a precious chance for us to study the deep structure of the earth. The signals of earth's free oscillations were perfectly recorded by the superconducting gravimeter (SG) C0-32 at Wuhan station in China. We obtained the spectral peaks of the earth's free oscillations by applying the Fourier Transform to the observational residuals after the pre-treatment consisting of the correction of gravity tides and atmospheric pressure. More than ninety EFO modes in total were observed with the frequency -resolution-ratio of about 2.5×10^{-6}Hz. ${}_7S_{13}$ mode is very sensitive to the shear wave velocity in the top of the inner core. Comparing the observed modes with the theoretical frequencies, we found that the checked frequency of ${}_7S_{13}$ mode was three frequency-resolution-ratios lower than the theoretical frequency basing on PREM Model, which indicated that the shear wave velocity in the top of the inner core was clearly less than the theoretical parameters of present earth models, and that the top of the inner core should have the rigidity lower than the present estimation.

There is a parameter namely R value to describe the spectral splitting phenomena, which is defined as a ratio value between the observed width and the theoretical width

of spectral splitting caused by the earth's rotation and ellipticity basing on SNREI Model. When R value of a EFO mode is clearly larger than 1.0, there will be the abnormal spectral splitting of a EFO mode. We observed perfectly the abnormal spectral splitting of three modes: ${}_{10}S_2$ (R=1.98), ${}_{13}S_2$(R=3.72) and ${}_{13}S_3$(R=2.32). The spectral splitting width of ${}_{10}S_2$ mode is impressible to the anisotropy of the shear wave velocity in the inner core, and R value (1.98) of the observed ${}_{10}S_2$ mode was obviously less than the present investigation (R=3.45), so the anisotropy of the real inner core should be lower than the former estimation, which was basically according to the discussion results on the observed ${}_{7}S_{13}$ mode. The spectral splitting width of both ${}_{13}S_2$ and ${}_{13}S_3$mode are sensitive to the anisotropy of the compressive wave velocity in the inner core, and the R values (3.72, 2.32) of the observed ${}_{13}S_2$ and ${}_{13}S_3$ modes were brightly beyond the recent observation values (2.40, 1.74), which showed the anisotropy of compressive wave in the top of the inner core would be obviously higher than the present investigation.

The anisotropy of shear wave should be in accordance with that of compressive wave in the top of the inner core, so it is noticeable that there is a contradiction between the observed result of shear wave and the checked anisotropy of compressive wave in the top of the inner core. This suggested that the anisotropy of the inner core could be much more complicated than what is known to us at present, and there might be some new geophysical phenomena in the formation of the inner core.

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