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The super rotation of the inner core

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In 1980 Lembeck pointed out that the inner core might rotate faster than the mantle, which is called in the literature as super rotation or differential rotation. Later, in 1995, based on the magnetic coupling in three-dimensional numerical simulations, Glatzmaier and Roberts suggested that the quantity of super rotation is about three degrees per year[1]. At the beginning of 1996, based on the Newtonian mechanics, Gai derived out a dynamic result that the inner core rotates faster than the mantle, without quantity declaration[2]. Rapid progresses were achieved since late of 1996. Based on seismic observations covered a period about 30 years, Song and Richards first concluded that the super rotation rate is about one degree per year[3], and after Song and Richards, with dependent approach, Wu, Dziewonski, and Jeanloz concluded that the super rotation rate is about three degrees per year[4], in agreement with the prediction of Glatzmaier and Roberts[1]. Since then, a lot of geoscientists made contributions in determining the quantity of the super rotation, most of whom concluded that the super rotation rate is not so large as originally declared. Now, it is generally agreed that the super rotation rate, if it exists, most likely could not exceed 0.2 degree per year[5]. The conclusions were made mostly based on the seismic observations.

Is it possible to detect the super rotation by using gravity data? This problem will be investigated in this paper. It has been found that the ellipticity of an equipotential surface at the inner core boundary is around 9.2×10^{-5}[6,7]. In another aspect, the symmetric axis of the inner core is tilted with the Earth's rotation axis about 10 degrees[4]. Since the gravitational field generated by the inner core is symmetric about the inner core's rotation axis, if there exists a super rotation, the gravity field generated by the whole Earth will variate in a definite way with the development of time. Now, the key problem is to estimate the quantity of the gravity variation. To realize this, the super gravity observation data covered 5- to 10-year's period will be used. In this case, if the super rotation rate is about 0.2 degree per year, with a period of 5 to 10 years, the inner core's rotation axis will process 1 to 2 degrees around the Earth's rotation axis, and accordingly, the gravitational field generated by the inner core will rotate 1 to 2 degrees. Such an effect is expected to be detected.

Key words: inner core; super rotation; gravity field variation; super rotation detection

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