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Spin rotation, Chandler wobble and free core nutation of isolated multi-layer pulsars

Alexander Gusev and Irina Kitiashvili

Kazan Federal University, Russia
email: `Alexander.Gusev@mail.ru`

Abstract. At present time there are investigations of precession and nutation for very different celestial multi-layer bodies: the Earth (Getino 1995), Moon (Gusev 2010), planets of Solar system (Gusev 2010) and pulsars (Link *et al.* 2007). The long-periodic precession phenomenon was detected for few pulsars: PSR B1828-11, PSR B1557-50, PSR 2217+47, PSR 0531+21, PSR B0833-45, and PSR B1642-03. Stairs, Lyne & Shemar (2000) have found that the arrival-time residuals from PSR B1828-11 vary periodically with a different periods. According to our model, the neutron star has the rigid crust (RC), the fluid outer core (FOC) and the solid inner core (SIC). The model explains generation of four modes in the rotation of the pulsar: two modes of Chandler wobble (CW, ICW) and two modes connecting with free core nutation (FCN, FICN) (Gusev & Kitiashvili 2008). We are propose the explanation for all harmonics of Time of Arrival (TOA) pulses variations as precession of a neutron star owing to differential rotation of RC, FOC and crystal SIC of the pulsar PSR B1828-11: 250, 500, 1000 days. We used canonical method for interpretation TOA variations by Chandler Wobble (CW) and Free Core Nutation (FCN) of pulsar.

The two - layer model can explain occurrence twin additional fashions in rotation pole motion of a NS: CW and FCN. In the frame of the three-layer model we investigate the free rotation of dynamically-symmetrical PSR by Hamilton methods. Correctly extending theory of SIC-FOC-RC differential rotation for neutron star, we investigated dependence CW, ICW, FCN and FICN periods from flatness of different layers of pulsar.

Our investigation showed that interaction between rigid crust, RIC and LOC can be characterized by four modes of periodic variations of rotation pole: CW, retrograde Free Core Nutation (FCN), prograde Free Inner Core Nutation (FICN) and Inner Core Wobble (ICW). In the frame of the three-layer model we proposed the explanation for all pulse fluctuations by differential rotation crust, outer core and inner core of the neutron star and received estimations of dynamical flattening of the pulsar inner and outer cores, including the heat dissipation. We have offered the realistic model of the dynamical pulsar structure and two explanations of the feature of flattened of the crust, the outer core and the inner core of the pulsar.