Effects of the solid tides on the P and $\dot{P}$ of pulsars and their applications

Rong Jiangxiang, Xiao Naiyuan
Astronomy Department, Nanjing University, 210093, Nanjing China

The observational effects due to the Earth's solid tides on the period P and its derivative $\dot{P}$ of pulsars are brought to light in this paper.

Let P_0 is the period of a pulsar in the rest frane, when it moves with a radial velocity V_{rad} relative to an observer, its apparent period P is fit to the expression

$$\frac{P - P_0}{P} = \frac{V_{rad}}{c} \tag{1}$$

Aftera derivation, it can be approximated by

$$\frac{1}{P}(\dot{P} - \dot{P_0}) = \frac{1}{c}\frac{dV_{rad}}{dt} \tag{2}$$

In practice, the revolution velocity of the Earth around the Sun and its rotation velocity about its spin axis and other obvious effects are removed by eq.(1).

Because of the Earth's solid tides an observer on the surface of the Earth oscilates with a nearly semi-diurnal period and gives rise to a velocity V relative to his remote pulsars. The velocity components are (in spherical coordinates):

$$V_r = \sum_{n=2}^{\infty}\frac{h_n}{g}\sum_{m=0}^{n}(\dot{A_n^m}E_n^m + \dot{A_n^{m*}}E_n^{m*}), \tag{3}$$

$$V_\Phi = \sum_{n=2}^{\infty}\frac{l_n}{g}\sum_{m=0}^{n}(\dot{A_n^m}\frac{\partial E_n^m}{\partial \Phi} + \dot{A_n^{m*}}\frac{\partial E_n^{m*}}{\partial \Phi}), \tag{4}$$

$$V_\lambda = \sum_{n=2}^{\infty}\frac{l_n}{g}\sum_{m=0}^{n}[(-im\dot{A_n^m}E_n^m - \dot{A_n^{m*}}E_n^{m*})] \tag{5}$$

where A_n^m and E_n^m are spherical harmonic functions, the formers vary with the coordinates of the Sun and The Moon, while the latters depend only on

the geocentric distance (r) and the geographic coordinates (λ, Φ) of the station where the observer finds himself, and A_n^{m*} and E_n^{m*} are their conjugate functions, respectively.

It is easy to derive $\dot{V}_r$, $\dot{V}_\Phi$, $\dot{V}_{lambda}$ from eq.(3). The order of magnitude of $|V|$ is generally equal to $1.10^{-5} m/s$ and so

$$\frac{V_{rad}}{c} \approx 10^{-14} \sim 10^{-13}, l/c\frac{dV_{rad}}{dt} \approx 10^{-18} \sim 10^{-17}$$

and they are in some case within the precision of P and $\dot{P}$, respectively.

It is proceeded to propose their application in two aspects: (1) Corrections to observational data of pulsar in order to determine their P and $\dot{P}$ more precisely. (2) Analysis of P and $\dot{P}$ of pulsars to examine the Eart-tide models and to determine their parameters.