MOMENTS OF INERTIA AND PERIOD OF THE CHANDLER WOBBLE FOR TWO AND THREE LAYER MODELS OF GALILEAN SATELLITE IO. V. N. Zharkov and A. L. Sobisevich. *Institute of Physics of the Earth, RAS, 123995, Moscow, Russia* zharkov@ifz.ru

Introduction. All Galilean satellites are in synchronous rotation; their orbits are nearly circular and lie in the equatorial plane of Jupiter. Io is the large satellite closest to Jupiter. Therefore, the influence of the Jupiter's tidal potential on the equilibrium figure and gravitational field of Io is appreciably stronger than it is on the remaining large satellites. For the theory of Io's figure to be consistent with currently available observational data, it must include effects of the second order of the small parameter [1].

$$\alpha = \frac{3\pi}{G\rho_0\tau^2} = \frac{\omega^2 s_1^3}{Gm_0} = \left(\frac{M}{m_0}\right)\left(\frac{s_1}{R}\right)^3 = 171.37\times10^{-5}, \qquad (1)$$

where ρ_0, τ, m_0, and s_1 are the mean density, rotation period, mass, and mean radius of Io, respectively, G is the gravitational constant, M is the mass of Jupiter, R is the radius of the satellite orbit. The numerical value in (1) was obtained using data from Table 1.

Table 1. Observational data and the model parameters for Io

Parameters	Io
Orbital radius R, 10^3 km	421.6
Period τ, days	1.769
s_1, km	1821.6 ± 0.5
m_0, 10^{23} g	893.2
ρ_0, g cm^{-3}	3.5278 ± 0.0029
g_0, cm s^{-2}	179
$\alpha = \frac{3\pi}{G\rho_0\tau^2}$, 10^{-5}	171.37
$\frac{C}{m_0 s_1^2}$	0.37685 ± 0.00035
J_2, 10^{-6}	1845.9 ± 4.2
C_{22}, 10^{-6}	553.7 ± 1.2
Jupiter's mass M, 10^{30} g	1.897

Principal formulas. A remarkable achievement of the successful Galileo mission was the determination of the first coefficients in the expansion of the gravitational field in terms of spherical functions for the Galilean satellites and the proof that their figures are actually in hydrostatic equilibrium [2]. The Love number k_2 in [2] was found by using the observed value of gravitational moment $C_{22} = (553.7 \pm 1.2)\times10^{-6}$:

$$k_2 = 4(C_2/\alpha) = 1.2924 \pm 0.0027 \qquad (2)$$

To determine the dimensionless moment of inertia Anderson et al., [2] used a formula valid in the Radau approximation for a satellite in hydrostatic equilibrium from the book by Jeffreys [3]

$$\frac{C}{m_0 s_1^2} = \frac{2}{3}\left(1 - \frac{2}{5}\sqrt{\frac{4-k_2}{1+k_2}}\right) = 0.37685 \pm 0.00035. \qquad (3)$$

Let us now explain the meaning of formula (3), which was used by Anderson et al., (2001) to constrain the moment of inertia of Io. Recall how this formula was derived. For the equilibrium figure of a rotating planet or satellite in the Rado approximation, the Radau-Darwin formula is valid (see, e.g., Zharkov and Trubitsyn 1980; formula (32.20))

$$\frac{C}{Ma_1^2} = \frac{2}{3}\left[1 - \frac{2}{5}\sqrt{\frac{5\alpha}{3J_2+\alpha} - 1}\right], \qquad (4)$$

where C is the polar moment of inertia, M is the mass, a_1 is the equatorial radius, J_2 is the quadrupole moment, and α (1) is the small parameter of the rotating equilibrium planet. Zharkov et al. (1985) showed that for a synchronously rotating equilibrium satellite in the field of the tidal potential in the furst approximation, the equilibrium quadrupole moment J_2 of the body under consideration is the sum of the part attributable to the tidal potential $J_{2t} = 0.5\alpha k_2$ and the part attributable to centrifugal potential $J_{2r} = 1/3\alpha k_2$:

$$J_2 = J_{2t} + J_{2r} = \frac{5}{6}\alpha k_2. \qquad (5)$$

Formula (3) is obtained if we substitute not J_2 (5) but only the part of J_2, more specifically, J_{2r} into (3). Thus, it refers to an equilibrium rotating planet or satellite, i.e., to a similar but not the same problem studied here. Therefore, it would be natural to use the

Love number k_2 or $h_2 = 1 + k_2$ as a constrain when modeling any Galilean satellite.

Conclusions. In the report there are considered two (Fe-FeS core + silicate mantle) and three (Fe-FeS core + silicate mantle + crust) layers models of Galilean satellite Io. Two parameters ρ_0 – average density and the Love number k_2 for equilibrium figure of satellite are known. With help of theory of figure formulas there were obtained the principle moments of inertia A, B, C and the mean moment of inertia I for two and three layers models of Io using only ρ_0 and k_2 as boundary conditions. We conclude that when modeling the internal structure of Io, it is better to use the observed value k_2 rather than the moment of inertia derived from k_2 with help of the Radau-Darwin formula.

We calculated the periods of the Chandler wobble for considered models. This period is equal approximately to 460 days for three layers model.

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