

VALUES OF SOME ASTRONOMICAL CONSTANTS PROPOSED FOR NSFA

E.V. PITJEVA¹, E.M. STANDISH²
¹ Institute of Applied astronomy RAS
Kutuzov Quay 10, 191187 St.-Petersburg
e-mail: evp@ipa.nw.ru
² 519 Birchbark Court
Seneca, SC 29672, USA
e-mail: ems@jpl.nasa.gov

Improved values for the masses of Ceres, Pallas, Vesta, the Earth-Moon mass ratio, and the Astronomical Unit are hereby proposed to the NSFA WG (the IAU Working Group on Numerical Standards for Fundamental Astronomy) as current best estimates. These values are based upon the improvements of planetary ephemerides carried out by the authors at IAA RAS and at Caltech/JPL, respectively; comparisons of the values with those of other researchers ensure their reliability and provide realistic estimates of their uncertainties.

Many asteroids are massive enough so that direct dynamical determinations of their masses may come from their perturbations upon other solar system bodies. Unfortunately, the classical example, where the perturbed body is some other asteroid, often leads to inaccurate or poorly-determined estimations. However, masses of the largest asteroids, Ceres, Pallas, and Vesta, may be reliably estimated using modern planetary ephemerides to analyze the highly accurate ranging data of spacecraft orbiting Mars or landed upon its surface.

We have proposed to the NSFA the following mean representative values and realistic uncertainties for the masses of the three largest asteroids (Ceres, Pallas, Vesta), to be used as the current best estimates:

$$\begin{aligned}M_{Ceres}/M_{\odot} &= 4.72(3) \cdot 10^{-10}, \\M_{Pallas}/M_{\odot} &= 1.03(3) \cdot 10^{-10}, \\M_{Vesta}/M_{\odot} &= 1.35(3) \cdot 10^{-10}.\end{aligned}$$

Unlike the values adopted in the Astronomical Almanac of 2006, these are consistent with nearly all of the twenty or so modern accurate determinations from various authors, being based mainly on spacecraft ranging data. (See Table 1 of Pitjeva & Standish, 2009)

We also have proposed improved values for the Moon-Earth mass ratio and the astronomical unit, also obtained from the ephemeris improvement processes at JPL and at IAA RAS:

$$M_{Moon}/M_{Earth} = 0.0123000371(4) \text{ and } AU = 149597870700(3) \text{ m.}$$

This value for the AU is consistent with the value of GM_{Sun} , proposed to the NSFA WG by W. Folkner:

$$GM_{Sun} = 1.32712442099(10) \cdot 10^{20} [\text{m}^3 \text{s}^{-2}].$$

All of the main ephemerides of JPL and IAA RAS have been constructed in the TDB time scale. It is noted here that the AU , expressed in meters, has the same numerical value for ephemerides based upon the TDB or upon the TCB time scale, assuming one uses the conversion proposed by Irwin and Fukushima, Brumberg and Groten, Brumberg and Simon.

The detailed description of this paper was published (Pitjeva & Standish, 2009).

REFERENCES

Pitjeva, E.V., Standish, E.M., 2009, "Proposals for the masses of the three largest asteroids, the Moon-Earth mass ratio and the Astronomical Unit", *Celest. Mech. Dyn. Astr.* 2009, 103(4), 356-372, DOI 10.1007/s10569-009-9203-8.