SYSTEM OF ASTRONOMICAL CONSTANTS IN THE RELATIVISTIC FRAMEWORK*

T. Fukushima[1], M.K. Fujimoto[2,3], H. Kinoshita[3], S. Aoki[3]

[1]Hydrographic Department, Tsukiji, Tokyo 104, Japan
[2]Geodätisches Institut der Uni., 7000 Stuttgart, F.R.G.
[3]Tokyo Astronomical Observatory, Mitaka, Tokyo 181, Japan

ABSTRACT. The relation between the units and the readings of time and space coordinates of the terrestrial and the barycentric frames is discussed from the viewpoint of general relativity. Attention is paid to the unit of space coordinates since the International Astronomical Union (IAU) regulates only the unit of time coordinate in the above two frames. Two definitions on unit of length are examined and their effects on the numerical expression of coordinate transformation, equations of planetary motions, and those for light propagation time are discussed. A clear conflict is found between the IAU(1976) recommendation on the definition of the time-scales in different frames and the statement that all constants in the IAU(1976) new system of astronomical constants are defined in terms of the international system of units (SI units). In order to dissolve this conflict, one of the two examined definitions on unit of length is proposed to be adopted, which requests the least alteration on the current procedures to analyze the astrometric observations such as radar/laser rangings, range and range-rate measurements, and very long baseline interferometric observations. An interpretation of numerical values in the IAU(1976) system of astronomical constants is also presented. It is stressed that the definition proposed in this paper requires that a slightly different formula from the current one be used in the numerical transformation of coordinates between the terrestrial and the barycentric frames.

---

* This paper has been accepted to be published in Celestial Mechanics.

See next page a proposal submitted by the authors.

J. Kovalevsky and V. A. Brumberg (eds.), Relativity in Celestial Mechanics and Astrometry, 187–188.

PROPOSAL

The "SI second" and the "SI meter" in the IAU(1976) recommendation should be read as the barycentric second and the barycentric meter respectively, which are related to the SI(local) units by

$$[s_B] = \frac{1}{\eta}[s_L],\quad [m_B] = \frac{1}{\eta}[m_L],\quad \tilde{c}_B = \tilde{c}_L,$$

where

$$\eta = \left\langle \frac{dt_L}{dt_B} \right\rangle = 1 - 1.55051 \times 10^{-8}.$$

The astronomical unit of time is defined as

$$1\ [d] = 86400\ [s_B]\ .$$

Some astronomical constants in the IAU(1976) recommendation 1 are read as follows:

1. Defining Constants

$$k = 0.01720209895\ [AU]^{3/2}/[d]$$
$$c = 299792458\ [m_L]/[s_L] = 299792458\ [m_B]/[s_B]$$

2. Primary Constants

$$\tau = 499.004782\ [s_B]$$
$$a_e = 6378140\ [m_L] = 6378140\,\eta\ [m_B]$$
$$GM_\oplus = 3.986005 \times 10^{14}\ [m_L]^3/[s_L]^2$$
$$= 3.986005 \times 10^{14}\,\eta\ [m_B]^3/[s_L]^2$$

3. Derived Constants

$$GM_\odot = 1.3271243857693865\cdots \times 10^{20}\ [m_B]^3/[s_B]^2$$
$$1\ [AU] = 1.4959787014953416\cdots \times 10^{11}\ [m_B]\ .$$

https://doi.org/10.1017/S0074180900148156 Published online by Cambridge University Press