RESOLUTION B2

on the re-definition of the astronomical unit of length.

Proposed by the IAU Division I Working Group Numerical Standards
and supported by Division I

The XXVIII General Assembly of International Astronomical Union,

noting

1. that the International Astronomical Union (IAU) 1976 System of Astronomical Constants specifies the units for the dynamics of the solar system, including the day (D=86400 s), the mass of the Sun, M_S, and the *astronomical unit of length* or simply *the astronomical unit* whose definition[i] is based on the value of the Gaussian gravitational constant,
2. that the intention of the above definition of the astronomical unit was to provide accurate distance ratios in the solar system when distances could not be estimated with high accuracy,
3. that, to calculate the solar mass parameter, GM_S, previously known as the heliocentric gravitation constant, in Système International (SI) units[ii],the Gaussian gravitational constant k, is used, along with an astronomical unit determined observationally,
4. that the IAU 2009 System of astronomical constants (IAU 2009 Resolution B2) retains the IAU 1976 definition of the astronomical unit, by specifying k as an "auxiliary defining constant" with the numerical value given in the IAU 1976 System of Astronomical Constants,
5. that the value of the astronomical unit compatible with Barycentric Dynamical Time (TDB) in Table 1 of the IAU 2009 System (149 597 870 700 m ± 3 m), is an average (Pitjeva and Standish 2009) of recent estimates for the astronomical unit defined by k,
6. that the TDB-compatible value for GM_S listed in Table 1 of the IAU 2009 System, derived by using the astronomical unit fit to the DE421 ephemerides (Folkner *et al.* 2008), is consistent with the value of the astronomical unit of Table 1 to within the errors of the estimate; and

considering

1. the need for a self-consistent set of units and numerical standards for use in modern dynamical astronomy in the framework of General Relativity, [iii]
2. that the accuracy of modern range measurements makes the use of distance ratios unnecessary,
3. that modern planetary ephemerides can provide GM_S directly in SI units and that this quantity may vary with time,
4. the need for a unit of length approximating the Sun-Earth distance, and
5. that various symbols are presently in use for the astronomical unit,

recommends

1. that the astronomical unit be re-defined to be a conventional unit of length equal to 149 597 870 700 m exactly, in agreement with the value adopted in IAU 2009 Resolution B2,
2. that this definition of the astronomical unit be used with all time scales such as TCB, TDB, TCG, TT, *etc.*,
3. that the Gaussian gravitational constant k be deleted from the system of astronomical constants,
4. that the value of the solar mass parameter, GM_S, be determined observationally in SI units, and
5. that the unique symbol "au" be used for the astronomical unit.

References

Capitaine, N., Guinot, B., Klioner, S., 2011, Proposal for the re-definition of the astronomical unit of length through a fixed relation to the SI metre, Proceedings of the Journées 2010 Systèmes de référence spatio-temporels, N. Capitaine (ed.), Observatoire de Paris, pp 20-23

Fienga, A., Laskar, J., Morley, T., Manche, H. et al., 2009, INPOP08: a 4D-planetary ephemeris, A&A 507, 3, 1675

Fienga, A., Laskar, J., Kuchynka, P., Manche, H., Desvignes, G., Gastineau, M., Cognard, I., Theureau, G., 2011, INPOP10a and its applications in fundamental physics, Celest. Mech. Dyn. Astr., Volume 111, on line edition (http://www.springerlink.com/content/0923-2958).

Folkner, W.M., Williams, J.G., Boggs, D.H., 2008, Memorandum IOM 343R-08-003, Jet Propulsion Laboratory

International Astronomical Union (IAU), Proceedings of the Sixteenth General Assembly," Transactions of the IAU, XVIB, p. 31, pp. 52-66, (1976)

International Astronomical Union (IAU), Proceedings of the Twenty Seventh General Assembly," Transactions of the IAU, VXVIIB, p. 57, pp. 6: 55-70 (2010)

Klioner, S., 2008, Relativistic scaling of astronomical quantities and the system of astronomical units, A&A 478, 951

Klioner, S., Capitaine, N., Folkner, W., Guinot, B., Huang, T.-Y., Kopeikin, S. M., Pitjeva, E., Seidelmann P.K., Soffel, M., 2009, Units of relativistic time scales and associated quantities, in Proceedings of the International Astronomical Union, IAU Symposium, Volume 261, p. 79-84

Luzum, B., Capitaine, N., Fienga, A., Folkner, W., Fukushima, T., Hilton. J., Hohenkerk, C., Krasinsky, G., Petit, G., Pitjeva, E., Soffel, M., Wallace, P., 2011, The IAU 2009 system of astronomical constants: the report of the IAU working group on numerical standards for Fundamental Astronomy, Celest. Mech. Dyn. Astr., doi: 10.1007/s10569-011-9352-4

Pitjeva, E.V. and 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., 103, 365, doi: 10.1007/s10569-009-9203-8

Standish, E.M., 2004, The Astronomical Unit now, in Transits of Venus, New views of the Solar System and Galaxy, Proceedings of the IAU Colloquium 196, D. W. Kurtz ed., 163

---

[i] The IAU 1976 definition is: “The astronomical unit of length is that length (*A*) for which the Gaussian gravitational constant (*k*) takes the value of 0.017 202 098 95 when the units of measurements are the astronomical unit of length, mass and time. The dimensions of k^2 are those of the constant of gravitation (*G*), i.e., $L^3M^{-1}T^{-2}$. The term "unit distance" is also for the length *A*.” Although this was the first descriptive definition of the astronomical unit, the practice of using the value of *k* as a fixed constant which served to define the astronomical unit was in use unofficially since the 19the century and officially since 1938.

[ii] Using the equation $A^3k^2/D^2=GM_S$ where *A* is the astronomical unit and *D* the time interval of one day, and *k* the Gaussian gravitational constant.

[iii] Relativistically a solar system ephemeris, for which the astronomical unit is a useful unit, is a coordinate picture of solar system dynamics. SI units are induced into such a coordinate picture by using the relativistic equations for photons and massive bodies and by relating the coordinates of certain events with observables expressed in SI units.