

## RESOLUTION B2

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

*Proposed by the IAU Division I WG Numerical Standards in Fundamental Astronomy  
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<sup>i</sup> 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<sup>ii</sup>, 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  $\pm$  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,<sup>iii</sup>
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.

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<sup>i</sup> 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 19th century and officially since 1938.

<sup>ii</sup> 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.

<sup>iii</sup> 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.