Division I of the International Astronomical Union (IAU) proposes that the astronomical unit (au) be defined as a fixed number of meters. Traditionally the astronomical unit (au) has been considered to be a measure of the mean distance of the Earth from the Sun. Originally it was regarded as the length of the semi-major axis of the Earth's orbit. Officially since 1938 and unofficially since the 19th century the astronomical unit has been unit of length such that the Newtonian gravitational constant G is equal to the square of the Gaussian constant k and $G = k^2 = 0.000\ 295\ 912\ 208\ 285\ 591\ 102\ 5$, provided that the mass of the Sun and the day are taken as the units of mass and time. The value of $k = 0.017\ 202\ 098\ 95$ was first proposed by Carl Friedrich Gauss in his 1809 work *Theoria motus corporum coelestium in sectionibus conicis solem ambientium* ("Theory of Motion of the Celestial Bodies Moving in Conic Sections around the Sun"), and was retained in the IAU 2009 system of constants. This definition also made the au equivalent to the radius of an unperturbed circular Newtonian orbit about the Sun of a particle having infinitesimal mass, moving with an angular frequency of 0.017 202 098 95 radians per day, or that length for which the heliocentric gravitational constant (the product GM_S) is equal to $(0.017\ 202\ 098\ 95)^2$ au^3/d^2. The value of GM_S in Système International (SI) units (*i.e.* meters) would then be determined from the expression, $GM_S = au^3k^2/D^2$

The concept is similar to other cases when a unit is defined indirectly by fixed values of some natural constants (e.g. $G = c = \hbar = 1$ for the geometrized units). This style of definition was useful for many years because the lack of precise distance measurements in the solar system created the need for a specific scale unit in planetary orbit analyses. However, the accuracy of modern ranging observations is now such that this is no longer a consideration. Current ephemerides are capable of providing direct estimates of GM_{planet} and GM_S in SI units, and we expect to be able to detect observationally the variation with time of the solar mass parameter GM_S in the near future caused by the mass loss of the Sun. An additional concern is the need to consider the effects of general relativity in defining the au. In its original definition no thought was given to this aspect. Now its interpretation through the motion of the Earth around the Sun is not only problematic, but it is also necessary to account for the time scale being used.

Therefore, a new definition of the astronomical unit of length (au) is proposed in 2012. Specifically the recommendations call for the astronomical unit to be defined to be a conventional unit of length equal to 149 597 870 700 m exactly and that this definition be used with all time scales such as Barycentric Coordinate Time, Barycentric Dynamical Time, Geocentric Coordinate Time, Terrestrial Time, *etc*.. This eliminates possible conflicts with SI units, dependence on theories of motion, and requirements for additional conventions within the relativistic framework. It also makes it possible to determine directly the variation with time of the solar mass parameter GM_S. The issue mainly concerns those in the field of high-accuracy solar system dynamics. The astronomical unit does define the parsec and thus the whole astronomical distance ladder, but the relative difference between the old and the new definitions will not exceed 10^{-10}, so there is no significant effect considering the relative errors of cosmic distances outside the solar system. The exact wording of the proposed recommendation follows, and more detailed information can be found in the references that follow.

IAU 2012 Resolution proposal

Proposed by the IAU Division I WG Numerical Standards in Fundamental Astronomy
Supported by Division I

Re-definition of the astronomical unit of length

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 IAU 1976 definition of the astronomical unit was to provide accurate relative distances in the solar system when absolute distances could not be estimated with high accuracy.
3. that, to calculate the heliocentric gravitation constant, GM_S, 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 relative distances 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, as 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 heliocentric gravitation constant, 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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[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.”

[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 au 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 observable SI units.