THE USE OF SI UNITS IN ASTRONOMY

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SUMMARY

The principal features of the International System of Units (SI) are briefly described and the advantages of its wider adoption in astronomy are discussed. The need for the continued use of a system of astronomical units for some purposes is recognised.

1. THE ADOPTION AND NATURE OF SI UNITS

The International System of Units (SI) was adopted in 1960 by the General Conference on Weights and Measures to provide a practical system of units of measurement suitable for adoption in all countries for science, technology and general purposes. Details of the system are available in several official publications (see, for example, references 1 and 2), in recommendations to authors by international unions, scientific societies, and journals (eg refs 3, 4, 5) and in many textbooks. SI units are taught in schools and universities in many countries, and the system is now in widespread use.

There are three classes of SI units:- base units, derived units and supplementary units. There are seven base units: metre (m), kilogram (kg), second (s), ampere (A), kelvin (K), candela (cd), and mole (mol). The derived units are defined in terms of the base units, but may have special names and symbols (eg the unit of energy is the joule, J). The supplementary units are the radian and steradian, and these may for many purposes be treated as base units. In addition it is recognised that other units will continue to be used for some purposes; some of these are in general use (eg

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the day and the angular degree), while others are in use in specialised fields (eg electronvolt, parsec). Other units have been accepted temporarily (eg nautical mile, ångström, gal), but it is hoped that SI units will be increasingly used instead. It is considered that some units of the centimetre-gram-second system (c.g.s.) should no longer be used even though they may be directly related to SI units and have special names (eg erg, gauss).

The system includes a set of names and prefixes which may be used to form decimal multiples and sub-multiples of SI units. In general these prefixes correspond to steps of 1000, but the factors 10 and 100 are recognised; compound prefixes are to be avoided. For example, the centimetre (cm) and the cubic centimetre (cm^3) may continue to be used; the name micron is replaced by the micrometre (μm), and millimicron by nanometre (nm).

2. UNITS FOR USE IN ASTRONOMY

In 1967 the International Astronomical Union adopted a resolution recommending "the general use by astronomers . . . of units of the metric system . . .". It is understood that this was intended to be an endorsement of the use of SI units, but the resolution is ambiguous and so it has failed to give an impetus to the change to SI units, rather than c.g.s. units. An examination of current astronomical literature shows that many different sets of non-compatible units are in use, sometimes even in one paper. The wide variety of units is also noticeable at meetings; very few listeners can give their full attention to the speaker while carrying out mental conversions of quantities from one system of units to another.

It is almost certain that the coming generation of astronomers will be familiar only with SI units and will wish to express all their current results in these terms, even though they will have to learn about the other systems in order to use the older literature. The use of SI units is already much more widespread in the literature of physics and chemistry than it is in astronomy, and their use is spreading in all fields of science, technology and everyday life, even in countries where other units are still legal. It is inconceivable that this trend will be reversed, and so it is clear that it would be of general benefit if astronomers would adopt the SI system, and use non-SI units only for certain recognised purposes, as quickly as possible.

There are three situations in which the use of non-SI units is unavoidable in astronomy. Firstly, it would not be practicable to use only radians and seconds for the measures of angles and time, and so the sexagesimal units are recognised alternatives. Secondly, the "natural" units for use in studying the dynamics of

the solar system are the mean distance of the Earth from the Sun, the mass of the Sun, and the day. Even today, the mass of the Sun is known in kilograms with less precision than are the masses of the planets in units of the Sun's mass. Hence for this, and other reasons, it is useful to define a system of astronomical units of length, mass and time using a conventional value for the constant of gravitation in these units. The relationships between these units and the SI units are included in the IAU system of astronomical constants. New values of these constants were adopted at the IAU General Assembly in 1976; the day is defined in terms of the SI second. Thirdly, in stellar astronomy it is recognised that the use of parsecs and magnitudes is both convenient and justifiable.

On the other hand, in physical studies of the planets, stars and nebulae, the general adoption of SI units appears to be extremely desirable. The use of the nanometre rather than of the ångström and of the joule rather than the erg, to give two examples, involve only changes by powers of ten; it does not take long to adjust to the fact that the density of water is 1000 kg/m^3. The use of the electrical and magnetic units of the SI system does require some changes in the formulae that are used, but the advantages of the adoption of a single system for all applications would soon outweigh the disadvantages of the change.

3. CONCLUSION

I am hoping that it will be possible to include a firm recommendation for the general use of SI units in a "Guide to the presentation of astronomical data in the primary literature" to be prepared under the auspices of IAU Commission 5. I would therefore be grateful for information about any other non-SI units that are necessary to meet the specialist requirements of astronomers. It will be necessary to provide tables for the conversion between the old and new units since much valuable astronomical data is contained in books, papers and catalogues in which the old systems were used. The advantages of the use of SI units will become readily apparent when the standard reference books and the principal astronomical journals all use a common system of units.

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Note: 2a and 2b contain the same translation of reference 1.
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