Editorial note

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Below we are publishing some materials furnished by the International Union of Pure and Applied Physics, since we share the Union's belief that some standardization in terminology, notation, and physical quantities will contribute to information exchange in physics. Standardization in the physical sciences deals primarily with the system of physical units, but some flexibility must be preserved with regard to physics. The recent attempt to introduce the SI system of units as a common system for use throughout the sciences runs into difficulties because the SI system is poorly suited for describing many physical phenomena. We certainly acknowledge that this system of units is the most convenient for engineering purposes, but we believe that better choices in various branches of the physical sciences would be the cgs system or special physical unit systems (atomic units, the unit system of field theory, and so forth). Let us examine some of the arguments for this position.

The SI system is much poorer than the cgs system in describing electromagnetic phenomena. The cgs system deals with electrical phenomena on the basis of Coulomb's law, while magnetic phenomena are described by introducing a new dimensional quantity—the speed of light—in the system of equations. The cgs system generalized in this manner retains its physical clarity. In contrast, the SI system introduces two dimensional constants for a description of electrical and magnetic phenomena. These are the permittivity and permeability of free space–quantities without physical meaning. As a result, even in vacuum the electric field **E** and the magnetic field **H** differ from the electric displacement **D** and the magnetic induction **B**. This separation of the electric field in vacuum into **E** and **D** and of the magnetic field into **H** and **B** is an artificial complication. It arose in the 19th century in the elastic theory of the ether, when it was assumed that there was no fundamental distinction between vacuum (the ether) and material media. This approach became completely meaningless, however, when it was established that there was no mechanical ether at all. For this reason, the use of the SI system in lectures and textbooks on electrodynamics, Maxwell's equations, and optics makes it more difficult for the student to reach a correct understanding of the nature of the electromagnetic field. This system of units is also inconvenient for use in the corresponding scholarly literature.

This example shows that there is no such thing as a universal system of units which is equally convenient for all branches of science. It is precisely for this reason that the IUPAP materials published below contain some special unit systems and the relations between them. These special systems are convenient for studying certain classes of phenomena; they leave quantities in their natural scale; and they permit a clear understanding of the various quantities. For example, when we measure interatomic distances in a molecule in units of the first Bohr radius, we are comparing this distance with the size of the hydrogen atom, while in measuring nuclear masses in terms of atomic mass units we are comparing the nuclear mass with the mass of the nucleon. With regard to the range of application of the special unit systems we cannot offer any universal recommendations, but we can say that such systems should exist. This is particularly true of the various branches of theoretical physics, where the traditional use of special units (for example, $m_e = \hbar = c = 1$) simplifies the calculations considerably and reveals the physical meaning of the phenomena. The choice of a unit system which will be convenient for a particular range of problems must be based on reasonable physical considerations.

Translated by Dave Parsons

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