made of Varian spectrometers. Studies on hindered internal rotations, proton exchange behaviour and determination of organic structures have been extensively carried out by employing NMR technique.

In the short span of a little over ten years time, NMR Spectroscopy has emerged out as a powerful tool for the study of the problems connected with matter in different states of aggregation. Its usefulness as a practical tool can be judged from the fact that it is already a commercial instrument and is used for routine analytical purposes. We may expect a further widening of its applications in the years to come.

A. JAYARAMAN.

1. Purcell, E. V., Torrey, H. C. and Pound, R. V., *Phys. Rev.*, 1946, **69**, 37.
2. Bloch, F., *Ibid.*, 1946, **70**, 460.
3. —, Hansen, W. W. and Packard, M., *Ibid.*, 1946, **70**, 474.
4. Andrew, E. R., "Nuclear Magnetic Resonance," *Cambridge Monographs on Physics*, 1955.

ATOMIC STANDARDS OF LENGTH AND TIME

THERE is little doubt that atomic standards will serve to define the fundamental units of length and time within the next decade. They are already in wide use and are proving themselves not only more precise but far more convenient and accessible than the standards which are the bases of the present definitions. A recommendation to establish a metre equal to 1 650 763·73 vacuum wavelengths of the orange radiation ($2p_{10}-5d_5$) of the krypton atom of mass 86, is to be submitted in 1960 for formal approval by the 11th General Conference of Weights and Measures. Recent work indicates that the wavelength of the recommended line, $6057 \cdot 8021_1 \times 10^{-10}$ m. when emitted from the hot-cathode krypton lamp at 63° K. and corrected for the small departures from the ideally specified conditions of excitation, is reproducible to about 1 part in 10^9.

There is some prospect of establishing the second of time in terms of the frequency of an atomic (or molecular) radiation, with a reproducibility of 1 part in 10^{10}, when the General Conference meets again in 1966. A line in the hyperfine structure of the caesium atom promised to be particularly suitable as a standard because its frequency near 9200 Mc./s. (wavelength 3 cm.), is very convenient for the electronic equipment. Moreover, caesium atoms are the easiest of all to detect, and they can be produced in a simple manner by heating to about 150° C. a mixture of caesium chloride and sodium. Rigorous tests carried out in the Standards Division, National Physical Laboratory, Teddington, on the caesium atomic clock since it was put into operation in 1955, have given such convincing evidence of its reliability, reproducibility and ease of application that it is already accepted to be the most accurate of all standards of measurement, including the astronomical, for the unit of time interval. As at present established the frequency of this line of caesium, $F, m\ (4, 0) \rightleftharpoons F, m\ (3, 0)$ at zero field $= 9192\ 631\ 770 \pm 20$ c/s.

Appropriate means will, however, need to be devised to correlate and harmonise, as and when found necessary, the units of time furnished by the astronomical and atomic standards. Both these must continue to be used, the former for the long term purposes of astronomy and the latter to meet the immediate needs of physics and radio-engineering. After many years have elapsed it should be possible to ascertain whether there is any difference between atomic and astronomical scales of time—a matter of some cosmological interest.

In the present state of knowledge there seems little hope of defining the fundamental unit of mass in terms of a natural standard, *e.g.*, an elementary particle, atom or molecule, with the precision of 1 part in 10^8 ascribed to the existing material standard. Attention has been drawn, however, to the possible use of the gyromagnetic ratio of the proton as the means of defining a third basic unit (probably the gauss). This with the units of length and time, also depending on atomic characteristics, might provide in the future the stable foundations of a comprehensive system of measurement for all other physical quantities.—(H. Barrell, *Science Progress*, Vol. XLVII. April 1959, No. 186).