substantially ergodic. This has been shown by machine computation of the orbits. At the other extreme Dr S. Fujita (Buffalo) announced a new formulation of the many-body problem in which the infinite hierarchy of coupled equations is replaced by a single closed equation for the one-particle distribution function. As he remarked: "There are many, many methods, and you can use any one of them to derive desirable results."

There were some sad absentees: nobody said anything substantial about biological thermodynamics, nor about critical phenomena, which received a brief but illuminating mention in a survey by Dr L. Tisza (Cambridge, Massachusetts). But the full proceedings, which are expected to be published in July, should include an important paper on the analytical description of critical points by Dr M. H. Coopersmith (Virginia), who was not able to read his paper at Cardiff.

JOSEPHSON EFFECT

Making Way for a New Volt

by our Solid State Physics Correspondent

THE Weston cell may be on its last legs as an international standard of voltage because of the rapid progress in developing high precision measurements of the a.c. Josephson effect. T. F. Finnegan, A. Denenstein and D. N. Langenberg (*Phys. Rev. Lett.*, **24**, 738; 1970) have wrought several changes in the apparatus which provided W. H. Parker *et al.* (*Phys. Rev.*, **177**, 639; 1969) with a value for the ratio e/h to a precision of 2·5 parts in a million, and have improved on the accuracy by a factor of five. This puts the measurements within touching distance of the accuracy claimed for voltage determinations from Weston cells and makes it virtually certain that the cell will soon be ousted as a voltage standard in favour of the far more elegant solid state device.

The real attraction of the a.c. Josephson effect, in which the voltage across a junction varies with the frequency of the supercurrent, is its independence of the shape of the junction. Different sets of apparatus will give the same characteristics, as Parker *et al.* found in their determinations of the ratio e/h, which relates the frequency to the voltage. Frequencies, moreover, are very easy to measure accurately, being independent of temperature and extraneous effects. What Finnegan *et al.* have achieved is to increase the precision of the experiment to the point at which the ratio can be redefined as an auxiliary constant, allowing a voltage standard to be established in terms of frequency.

Comparison of the junction voltage with a reference cell provides the limiting accuracy in e/h. In previous determinations a conventional potentiometer was used with adjustable resistances, but Finnegan *et al.* have capitalized on the potential of a Josephson junction as a variable voltage source by allowing microwave radiation of a chosen frequency to interact with the supercurrent to give the desired voltage. A fixed ratio resistance network can then be used. They have also managed to raise the Josephson voltage by a factor of ten, to 10 mV, which reduces noise factors and lead resistance corrections and improves the voltage ratio with the standard cell. With further modifications, they are confident that e/h will soon be known to less than 0·1 p.p.m. and see attention shifting to the problem of how to disseminate the standard volt, once established in a Josephson device, to different parts of the globe.

The results of Finnegan *et al.* are likely to be discussed at the forthcoming conference at Gaithersburg, near Washington. Similar experiments at the National Physical Laboratory are expected to be ready in time for the conference on atomic masses and related constants at the NPL in September 1971, but it seems that the fate of the volt will have to await the next international meeting on standards due to be held at Sèvres, near Paris, some time within the next five years. Certainly the present system in which the ampere, measured by the force between two wires, is taken as the primary electrical unit will come under fire. The ampere can only be reproduced to an accuracy of about 4 parts in a million.

The fine structure constant α is related to e/h by the gyromagnetic ratio of the proton. Finnegan *et al.* point out that if α could be measured to better than one part in a million, their new value for e/h would provide a superior determination of the gyromagnetic ratio than that available from direct experiments.

PHOTOGRAPHY

Shock Tactics

from a Correspondent

A COMMON interest in shock wave phenomena brought together the Association for High Speed Photography and the Shock Tube Liaison Group at Liverpool between April 6 and 8. Early in the meeting a cautionary note was struck by Professor P. L. Clemens (von Karman Institute for Fluid Dynamics, Brussels) when he discussed the analysis of schlieren photographs. The marked lack of correlation in data obtained from these photographs of the flow about very high speed bodies, particularly in the wake region, indicated a requirement for a general sensitivity definition, he said. Clemens formulated such a definition, taking account of the human element in the form of the sensory nature of vision, and including the behaviour of the photographic materials and the optical arrangement of the schlieren system.

Holography attracted considerable interest, and applications to the study of shock phenomena and to the investigation of small particles moving at very high speed were described. Dr J. C. W. Gates (National Physical Laboratory) discussed the use of pulsed lasers and holographic recording in shock tubes and wind tunnels. The potential advantages included the study of variations in three dimensions from a single record, and also making several more or less independent measurements from one record by multiple reconstruction. From the economic point of view it may not be necessary to buy expensive optical equipment for this type of work because some techniques are not very sensitive to the quality of the optical components.

Another form of diagnostic technique used in shock tubes is to photograph the movement of very small particles which are convected in the flow. In the method developed by Professor J. M. Dewey (University of Victoria, British Columbia, Canada), cigarette smoke is induced to form thin trails across a shock tube, and the variation of all the physical parameters behind