

gress, the accuracy in the determination of $\frac{1}{G} \frac{dG}{dt}$ will improve with time. Shapiro *et al.* calculate that a further five years would bring the accuracy of the experiment to the order of magnitude suggested by Dicke. Similar observations made elsewhere could, of course, reduce this delay. Shapiro *et al.* suggest, however, that the determination of $\frac{1}{G} \frac{dG}{dt}$ from the lunar laser ranging experiment set up by the crew of Apollo 11 seems to be affected at present by complications caused by the Earth/Moon tidal interaction.

Some of the aspects associated with having a slowly varying gravitational constant have been considered by Dicke and Peebles (*Space Sci. Rev.*, 4, 419; 1965). Among the effects enumerated by these workers, the following two quantitative values, based on Dicke's estimate of the possible rate of change of G , are of considerable interest. First, a steadily decreasing gravitational constant would make computed stellar ages too large by a factor of two or three; second, because the Sun's luminosity is proportional to the power of G^7 or G^8 , it would have been considerably more luminous in the past. Thus, if primitive life arose on Earth 3×10^9 years ago, the average Earth temperature at that time would have approached the boiling point of water. These and other uncertainties will be clarified if a value for the time variation of the gravitational constant is ultimately found.

SOLID STATE PHYSICS

Condensed Matter

from a Correspondent

AT the eighth annual solid state physics conference held at the University of Manchester from January 5-7, the topics covered could be more properly described as "condensed matter" rather than "solid state" because a symposium on liquids was one of three that were organized there.

Some particularly interesting work on techniques reported involved, on the one hand, methods of electron spectroscopy and, on the other, high voltage electron microscopy with particular reference to studies of radiation damage. Much of the pioneering work in the first of these fields has been carried out by Professor K. Siegbahn and his colleagues at the Institute of Physics at Uppsala and Dr C. Nordling from this group gave a fascinating account of this work, ranging from a study of water vapour to a discussion of electron transfer in transition metal carbides. Related theory of X-ray and ultraviolet spectroscopy was discussed in general terms by Professor I. Hedin (Chalmers University of Technology), and it seems fair to say that all the principal

elements in the theory are now known and that the data can now provide precise information on the dominant, underlying one-electron effects. This does not mean that the many body effects or the role of the core in the soft X-ray emission experiments are not of interest, but that densities of electronic energy states from this type of measurement are still needed. This lack of data is particularly evident in disordered systems, where the classic crystalline state experiments are not applicable. There was substantial interest at the meeting in this area of research.

In the liquids symposium, one of the highlights was undoubtedly the contribution by Dr M. Ross (Lawrence Radiation Laboratory, Livermore), who discussed the exciting new information that can be obtained from shock wave studies on liquids. Here, the high pressures and the tremendously high temperatures are opening up a whole new field of research. Related work on the critical region in liquid metals was dealt with by Dr R. G. Ross (University of East Anglia) who stressed the relation between the critical point and the metal insulator transition. The metal insulator transition continues

to be an area of considerable interest—a plethora of transitions is now described, for example, Witner, Mott, Anderson and Hubbard—but it is difficult to obtain decisive experimental evidence for such transitions.

Professor C. Domb (King's College, London), focusing on other aspects of critical phenomena, gave a lucid review of an area in which critical behaviour can now be understood, and a tremendous pattern is being revealed. Although so far the pattern is clear the underlying justification for scaling theories is still not sufficiently basic. But such deeper understanding is hardly likely to alter the established relationships between the critical indices.

It is worth emphasizing that three areas that were particularly prominent at the meeting—electron transport in semiconductors, amorphous materials and magnetism—were no doubt stimulated by technological interest. The resurgence of interest in magnetism, both because of its technological importance and because its fundamental phenomena involve the correlations between electrons so basically, was evident.

Cyclic Delocalization of Electrons

ONE of the successes in the field of theoretical chemistry has been the understanding of the structure and properties of aromatic compounds. The term aromaticity was originally confined to a class of molecules, the prototype of which was benzene. It was shown by Hückel many years ago that most of their properties could be interpreted in terms of the delocalization of π electrons and that aromatic compounds obeyed the rule which states that $(4n+2)$ numbered rings have stable electron configurations. The success of Hückel's molecular orbital theory chiefly arose from the emphasis it placed on orbital symmetry; several later studies emphasized and extended various symmetry aspects of the theory.

In next week's issue of *Nature Physical Science* E. A. Magnusson examines in detail the topological characteristics of electron delocalization in linear and ring systems. He suggests that with the aid of so-called π graphs (delocalization pathways) it is possible to group unsaturated molecules in a systematic manner. Compounds are first classified as "homomorphic" or "heteromorphic"; these terms were first introduced by Craig in the study of phosphonitrilic halides to distinguish systems containing π orbitals all belonging to the same local symmetry species from those which include different species. A further subgrouping is possible depending whether or not all the π -orbitals can be chosen in phase. They are

termed "matched" and "mismatched" systems, and benzene, for example, belongs to the matched class, whereas the hypothetical Möbius benzene belongs to the mismatched class. This classification is important because the two subgroups show different ordering and pattern of orbitals, and thus display Hückel and anti-Hückel behaviour. These differences, in turn, are related to properties such as ring currents, stability, and reactivity. Some unsaturated compounds do not fit into the classification scheme because there are several topologically non-equivalent delocalization pathways. Sandwich compounds such as ferrocene belong to this category and exhibit what is called complex delocalization. A large number of compounds have been classified and discussed in this way.

Magnusson's discussion of the topology of π electron paths is timely and important especially because of the recent emphasis on orbital symmetry in reaction mechanisms as embodied in the Woodward-Hoffmann rules. It now seems that the analysis could be made much simpler by examining the topology of the π electron pathways in transition states. Matched and mismatched transition states, called aromatic and anti-aromatic respectively, exhibit different reactivities and Magnusson's topological classification of π electron systems should be of considerable use to chemists in this context.