THE DEVELOPMENT AND THE FUTURE OF PHYSICS

THE exciting prospects of physics was the theme of the first Presidential Address to the recently amalgamated Institute of Physics and Physical Society given by the President Sir John Cockcroft in London on 2 May.

In it he made a rapid survey of recent and likely developmets in solid state physics, mentioning among other things transistors, tunnel diodes, semiconductors, optical masers, modern electronic valves and artificial diamonds. "These, perhaps" he remarked "are a sufficient number of examples to show the creative power of physics in one single field".

Atomic energy development, he reminded his audience, has provided another major demand for physicists, and their work ranged from determining nuclear data to the prediction of kinetic behaviour of reactors and the study of radiation damage. Then there was the important group of physicists engaged in plasma physics research. Sir John's view was that dontrolled fusion research is likely to remain in the basic research stage for some considerable time yet.

Studies of nuclear structure, the President thought, were likely to have at least ten to twenty further years of interesting life. Space research he thought seemed likely to outstrip nuclear physics research both in glamour and expense in the U.S. and U.S.S.R. He thought it very remarkable how the advent of rockets, with their prestige and military implications, had brought the once greatly neglected field of astronomy into the full limelight. The military and disarmament interest in the detection of underground explosions has had a similar effect on the earth sciences and seismology in particular. Molecular biology and biophysics, though employing few physicists at present, were already becoming of major importance ; it is a field in which physicists can have a powerful influence.

Sir John stressed the importance of international co-operative efforts in providing the expensive equipment now needed for fundamental research in physics such as bubble chambers, particle accelerators, large computers and equipment for space research.

RAMAN SPECTRUM OF DEUTERATED METHANE (CD_4)

IN the latest communication in the series of contributions from the McLennan Laboratory, University of Toronto, on high-resolution studies of Raman Spectra, Olafson, Thomas and Welsh have presented recent results on the spectrum of methane-d_4 (CD_4). (*Canadian Jour. Phy.*, 1961, **39**, 419.)

Heavy methane, like ordinary methane (CH_4), is a spherical top molecule (point-group T_d), and has four normal modes of vibration, one totally symmetric $\nu_1(a_1)$, one doubly degenerate $\nu_2(e)$, and two triply degenerate $\nu_3(f_2)$ and $\nu_4(f_2)$, all of which are active in the Raman effect. In the present investigation Raman spectrum photographs taken with a newly developed grating spectrograph of high light-power, and having a reciprocal linear dispersion of 6 cm.$^{-1}$ per mm. at 4358 A, and a practical resolving power of $\sim 0{\cdot}4$ cm.$^{-1}$, have enabled precision analysis of the rotational structure of the ν_2 and ν_3 bands to be effected leading to a more accurate evaluation of the constants involved.

The Raman tube, 1·1 metre long with a volume of 1·7 litre, was equipped with a multiple reflection mirror system, and was irradiated by four hairpin-shaped mercury arcs with water-cooled electrodes operated at 17 amp. The Raman tube was filled with high purity CD_4 gas to a pressure of 1 atm.

The exposure time for photographing the weak ν_2 band excited by 4358, varied from 90 to 115 hours. 84 lines were measured in the shift range 950-1330 cm.$^{-1}$ The permissible rotational transitions followed the selection rules $\Delta J = 0, \pm 1, \pm 2$. Accordingly there should be five branches O, P, Q, R and S. However, analysis showed that the rotational levels of the upper vibrational state were each split into two, an upper and a lower level. Thus out of the ten possible branches, seven were observed in the ν_2 band.

Photographs of the ν_3 band were obtained both with the line 4047 and the line 4358, the exposure time varying from 12 to 64 hours. In this band the rotational levels of the upper vibrational state are split by the coriolis interaction of the rotational and vibrational motions into three sublevels. Transitions are allowed to all three sublevels in Raman scattering ; the selection rule $\Delta J = 0, \pm 1, \pm 2$, thus gives 15 bands in the rotational structure. 202 lines were measured in the shift region 1950-2500 cm.$^{-1}$ 60 of these lines in the region 1950-2115 cm.$^{-1}$ belonged to the ν_1, $2\nu_4$, and $\nu_2 + \nu_4$ bands. The remaining 142 lines

in the region 2110-2500 cm.$^{-1}$ could be analysed into 13 of the possible 15 branches of the ν_3 band.

From these analyses the length of the C-D bond could be calculated. The effective bond length, r_0 (C-D), was found to be 1·09181 ± 0·00029 A. The corresponding value for methane, r_0 (C-H), is 1·09403 ± 0·00016.

EVOLUTION AS A TEST FOR ETHICS*

TWENTY years ago, Professor Waddington wrote a book on "Science and Ethics" to which his present book *The Ethical Animal* is a sequel. He does not try, as some critics have stated, to derive ethics from a study of evolution. He believes, however, that evolution helps us to judge between different ethical systems. Here are his exact words (p. 30) "We have first to try to ascertain the general character of human evolution or indeed, of animal evolution as a whole. We have then to enquire, of any particular ethical belief which comes to our attention, how effective it is in mediating this empirically ascertained course of evolutionary change."

The same ideal was expressed over three centuries ago, by Chapman in Clermont's speech in "The Revenge of Bussy d' Ambois", who held

> "That in this one thing all the discipline
> Of manners and of manhood is contained;
> A man to join himself to the universe
> In its main sway, and make, in all things fit
> One with that All, and go on, round as it."

I think that this is a noble fallacy, but yet a fallacy.

I do not think we know enough about the universe, or even about evolution on our planet, to use our knowledge as a test of ethical systems. It is possible that on the basis of messages received from the artificial satellite circling round our planet, the inhabitants of one of the planets of Tau Ceti or Delta Pavoins are at present saying something like this about our species. "The inhabitants of G_1 17898 III have now reached the stage of technical knowledge when they will be able to exterminate one another completely. Judging from their past behaviour it is certain that they will do this. On all the 7319 planets known to us where living beings descended from carnivorous ancestors learned to promote nuclear fission they killed one another. The best hope for the survival of such a species is the appearance of a series of tyrants who massacre in the name of some religious belief. This checks the growth of physical knowledge. Unfortunately for the species now dominating the planet in question it did not produce enough men of the type of Charlemagne and Mahmoud of Ghazni, and is in consequence now doomed. From a broader point of view this is a welcome prospect, as some herbivorous species devoid of fighting instincts may possibly evolve a high brain organization on this planet in the next hundred million years".

I do not happen to believe this, but I think it entirely possible that it may be true. Waddington's mind seems to move in the rather narrow set of intellectual grooves fashionable in modern Britain. Thus on page 35 he writes of philosophy as "understood by the most influential modern school, the followers of the later Wittgenstein". This school is not very influential compared with many older (and in the reviewer's opinion more intellectually coherent) philosophies such as Thomism and Vedantism. And its influence is negligible compared with that of Marxism as developed by Lenin, which is a modern school. Waddington may believe that Marxism is false, but if he thinks it is less influential than the school of Wittgenstein, he is blind to historical fact.

I do not even believe in Waddington's account of how man became an ethical animal. I think our ancestors underwent a rather sudden change of habitat, perhaps a "fall" from trees, which rendered their ancestral instincts incompatible with survival. They lost most of them, which enabled them to start technology; but to perform the functions of instincts they had to produce ethics. The human needs for ethics may be a temporary and unhappy phase in evolution.

In spite of all these criticisms the book contains some interesting bits of thought, and I hope that it will stimulate others to more constructive criticism than my own. I hope it will be widely read in India. But if so I trust that nobody will say "The teaching of modern evolutionary biology, as Waddington has shown, is....". When we have studied evolution for two thousand years we may be able to use it as an ethical criterion. Or we may not.

J. B. S. HALDANE.

* *The Ethical Animal*. By C. H. Waddington. (George Allen and Unwin, Ruskin House, 40, Museum Street, London, W.C. 1), 1960. Pp. 230. Price 25 *sh.*