COLD DENSE MATTER

FOR his presidential address to the Section of Physics at the thirty-first Indian Science Congress, held at Delhi in January, Dr. D. S. Kothari took as his subject "Cold Dense Matter". Here the word 'cold' is used in a technical sense as meaning that any free electrons present constitute a degenerate gas—the actual temperatures can range from planetary temperatures to those of the interiors of white dwarf stars. Dr. Kothari's address has now been published, and it gives us a welcome summary of the main features of temperature- and pressure-ionization of matter at high and low temperatures and at high and low densities.

The thermodynamic theory of ionization in gases, though first used in particular applications by Lindemann (now Lord Cherwell), was given its dominating importance in astrophysics by the work of Saha. Saha showed that the dissociation of atoms into ions and electrons is encouraged by reduction of pressure or increase of temperature. But, as Kothari points out, pressure variations are comparatively unimportant in influencing the degree of ionization unless the temperature is of a certain order of magnitude given by the relevant ionization potential; for temperatures much lower or much higher, ionization will be either negligible or complete, whatever the pressure, and we therefore rightly describe Saha's ionization theory as the theory of temperature or *thermal* ionization. In his address, Kothari proceeds to discuss in some detail another kind of ionization, which he calls *pressure* ionization. This occurs in the case of relatively cold matter at high densities, when the atoms are pressed so tightly together that there is room neither for the outer electrons to be in bound orbits nor for them to be associated with particular ions. Kothari sums up the differences between thermal and pressure ionization in three compact propositions:

(i) Thermal ionization occurs in hot or non-degenerate matter; pressure ionization in cold or degenerate matter.

(ii) If, keeping temperature constant, the density be reduced, then the degree of ionization is increased for thermal ionization, and decreased for pressure ionization.

(iii) If, keeping density constant, the temperature be increased, the degree of ionization is increased in thermal ionization but remains practically unaffected in pressure ionization—unless the increase in temperature is so large that degeneracy is removed and pressure ionization passes into thermal ionization.

The discovery by Fermi and Dirac in 1926 of the correct form of quantum statistics to apply to gases had its repercussions on ionization theory: the early simple formulæ require modifications at large densities and low temperatures, where there sets in a 'degeneracy' which we have already mentioned. In addition, at very high temperatures further modifications are required, due to the need to use Einstein's modifications of Newtonian dynamics when the kinetic energy of thermal motion becomes comparable with the rest energy due to mass. The early part of Kothari's address contains a useful complete summary of the various discriminants which determine the different cases that arise at high or low densities or temperatures.

The later portions of his address are chiefly concerned with the applications of these general principles to the particular circumstances of the white dwarf

stars and the planets. White dwarf stars were first recognized as configurations with degenerate cores by Sir Ralph Fowler. This theory has been considerably developed by Stoner and Chandrasekhar, and in his address Kothari rounds off these investigations, showing *inter alia* what had previously been assumed outright, namely, that for white dwarfs of mass exceeding a certain small critical mass, the stellar material is completely ionized. The application of the theory to bodies of planetary mass is a piece of original work of great beauty, due to Kothari himself. He shows that if we consider a series of 'cold' bodies of increasing mass, the radius increases to a maximum for a mass about one thousandth of that of the sun, and thereafter decreases; the physical reason is that ultimately increase of mass so increases the central pressure that the atoms suffer such a degree of pressure ionization that they finally occupy a smaller total volume in spite of the increased mass. The value of the radius at the maximum is shown by Kothari to depend to some extent on the chemical composition of the material, and he infers that the observed mass/radius values for Jupiter and Saturn are consistent with their being formed largely of (dense) hydrogen, whereas the terrestrial planets (Mercury to Mars) lie nearer the iron curve. The address concludes with a closely reasoned account of the probable evolutionary history of a body of planetary mass, together with Kothari's own difficulties with his theory.

E. A. MILNE.

MEDICAL EDUCATION IN INDIA

FOR his presidential address to the Section of Medical and Veterinary Sciences at the thirty-first Indian Science Congress held at Delhi in January, Dr. K. V. Krishnan chose "Medical Education" as his subject. Progressive medical educationists in India are not, he said, satisfied with the existing medical educational institutions, and wish to reorganize them in the light of recent trends of Western medical thought. It is now more than a hundred years since the first medical college was established in India and it is time for a stock-taking. India and the U.S.S.R. are the only two countries in the world which still have a dual standard of medical education, and both have decided to abolish it. The U.S.S.R. has already done much to abolish the lower standard. Madras and the United Provinces have already abolished it. Elsewhere in India there are still the medical schools which turn out licentiates with a lower standard of education and the colleges which produce university graduates. In the very near future, Dr. Krishnan hopes, there will be only the medical colleges.

Most of these colleges are not, however, planned according to the principles laid down by Flexner in his "The Idea of a Modern University". India is still producing the "tradesman doctor"; and should go on, as Britain, the United States and the U.S.S.R. have done, to the production of medical men whose ideals are the service of the public, the prevention of disease and the maintenance of health, rather than the cure of illness after it has been allowed to develop.

In the course of his address, Dr. Krishnan makes valuable suggestions for improvements along these lines. The libraries of the medical colleges should be extended and provided with foreign periodicals, textbooks should be produced which deal with Indian

problems of health, men with the scientific bent of mind should be attracted to medicine and should be given better facilities for research. Clinical teaching should be improved by the provision of more beds per student and of teachers who emphasize the art of medicine and correct the tendency of students to depend too much on laboratory aids to diagnosis. More Indians should be given opportunities to become deans of medical colleges, and all teaching staff should be debarred from private practice. The teaching staff should, indeed, be specially chosen for the work and should find in it all the elements of an attractive profession. Improvement in the hygiene departments is also needed, and every medical college in a country where two-thirds of the deaths are due to bacteria should have a separate department of microbiology. Qualified men should all spend postgraduate time in hospital work and should also have the opportunity of doing postgraduate laboratory work. There should be adequate schemes for the training of specialists, refresher courses for general practitioners and others and courses in tropical medicine.

Discussing the supply of medical students, Dr. Krishnan finds that very few of them at present choose medicine as a profession for humanitarian reasons. India has not nearly enough medical practitioners. On the basis of 1 for every 1,000 people, which is the standard aimed at in Western countries, India should have at least 400,000, which is ten times the number that she actually has at the moment. It will be a long time before the number of colleges can be increased sufficiently to correct this deficit. Dr. Krishnan advocates instead a system of training medical students in batches or shifts—a system by means of which the U.S.S.R. is increasing the number of medical men without, he says, reducing the standard of education. The Leningrad medical school, he states, is said to train four batches of medical students at one time by a system of shifts “as in a factory”, and he would like to see a serious trial of this mass-production of medical men in India. It is not easy to understand how such a system is compatible with Dr. Krishnan's other and excellent ideal of emphasizing the art of medicine.

Two outstanding needs of India are dealt with in some detail, the need for more women practitioners and the need for medical men in the rural areas. India has an even greater need for women than the U.S.S.R., where almost 50 per cent of the practitioners are women. But it is the need for rural medical men that Dr. Krishnan emphasizes. There are 388 million people in India and 95 per cent of them live in rural areas. “Intellectually, financially, physically and physiologically the villager may be said to be ‘down and out’.” In all rural areas are found the witch doctor, the quack, the *ayurvedic* and *unani* doctors and the allopaths. Everyone agrees that the witch doctor and the quack should be stamped out. Some think that the *ayurvedic* and *unani* systems should be retained, but Dr. Krishnan is among those who would abolish these also. India must make up her mind whether to abolish the allopaths as well. Most of her 42,000 existing qualified medical men are in the towns, which have enough doctors. For the rural areas the urgent need is a band of workers qualified in both medicine and public health, who have had also a training in rural problems and psychology. These men should be specially chosen for their desire to tackle the special job of attending to rural needs, to endure its almost con-

tinuous hardships and to go to the country people as friends and not as exploiters of their lot. They should be paid a fixed salary by the Government, with free quarters, and should agree to serve for ten years. Dr. Krishnan does not think there would be any difficulty in finding enough men of the right kind for this beneficent work.

Throughout his address, Dr. Krishnan refers to the interdependence of health control and social and economic problems, and thus alligns himself with progressive medical opinion everywhere. It is evident that, if he were an Indian medical student to-day, he would be found among the 5 per cent whom he mentions who chose the medical profession, not because it pays well, but because it offers a chance of serving their fellow men. His ideals are clearly those of the progressive social medicine advocated by Prof. J. Ryle (*Brit. Med. J.*, Nov. 20, 1943, p. 633) and other recent contributors to the *Lancet* and the *British Medical Journal*. These can perhaps be summed up in Ryle's statement that social medicine is “a logical development from and a direct expansion of clinical medicine, of medicine construed in its best Hippocratic sense and activated by the highest Hippocratic ideal; for ‘where there is the love of man there also is the love of the Art’”.

Let us hope that the Government of India will, like the Government of Great Britain, take heed of the sufferings of the humble as well as of the great, and see that India gets the medical men and women whom she needs. If the princes and rajahs and merchants contribute to its finance, as Dr. Krishnan invites them to do, they will live in the future with Rockefeller, Nuffield and all the others whose gifts have led so swiftly and directly to incalculable relief of human suffering. G. LAPAGE.

THE BLACK REDSTART: A NEW BRITISH BREEDING BIRD

By R. S. R. FITTER

British Trust for Ornithology

EXTRAORDINARILY little is known of the process of extension and contraction of range which many animal species periodically undergo. Among British birds, the only two the extension of range of which during the past hundred years has been at all adequately described are the little owl (*Athene noctua vidalii*)¹, an introduced species, and the fulmar petrel (*Fulmarus g. glacialis*)².

An opportunity now presents itself to make a year-by-year study of a bird species, the black redstart (*Phoenicurus ochrurus gibraltariensis*), which is evidently at the beginning of the process of colonizing the British Isles, or at any rate their south-eastern corner. The black redstart was not known to breed anywhere in the British Isles before 1923, and has only quite recently begun to spread away from the southern coastline, where it secured its first foothold. In the summer of 1943, black redstarts were present in eleven English counties, five of which held at least ten breeding pairs³. It seems probable that but for the restrictions placed on observation by the War, many more breeding pairs would have been discovered.

The first breeding record for the black redstart in the British Isles was in Sussex, where a pair nested in maritime cliffs in 1923 and 1924, and probably