SUMMARIES OF ADDRESSES OF PRESIDENTS OF SECTIONS

STELLAR ENERGY AND STELLAR EVOLUTION

PROF. T. G. COWLING, in his presidential address to Section A (Mathematics and Physics), points out that, until a few years ago, ideas about stellar evolution had to be regarded as mainly speculative. Nearly every possible direction for stellar evolution has had its supporters. Some supposed that massive stars steadily lose mass, and evolve into less-massive forms ; others that small stars can grow into massive ones by accreting material. Some thought that giant stars were newly created, and still in the process of gravitational contraction ; others that they were stars which have been blown up from smaller radii during their evolution. All these suggestions rested to some extent on observation, and a fresh idea had to be imported before one could distinguish between them.

This idea has been provided by the recognition of the mode of generation of stellar energy. Nuclear processes provide the only source of energy adequate to keep the stars going ; moreover, one type of nuclear fusion, in which hydrogen is built up into helium, can function sufficiently fast at temperatures like those met in the central cores of stars (15–25 million deg. K., say) to be able to maintain stellar radiation. Two helium-building processes are important. The first is the carbon–nitrogen cycle, in which a carbon-12 nucleus captures protons and is converted successively into carbon-13, nitrogen-14 and nitrogen-15 ; a final capture of a proton leads to a fission yielding the original carbon-12 nucleus and a helium nucleus. The second is the proton–proton process, in which protons are built direct into helium nuclei through steps involving first the production of deuterons and helium-3 nuclei, and then the combination of two helium-3 nuclei to form a helium-4 nucleus and two protons. The first reaction is probably dominant in stars appreciably more massive than the Sun, the second in the Sun and all less massive stars. Stars which have exhausted nearly all their hydrogen can generate energy by burning helium into carbon at a temperature of about 150 million deg. K., but this provides only one-tenth as much energy as helium-building.

Helium-building cannot maintain the radiation of stars 1,000 times as bright as the Sun for more than a small fraction of the time that the solar system is known to have existed. Thus among very bright stars obvious signs of evolutionary changes should be detectable. This agrees with recent observations of globular clusters, which are aggregates born even earlier than the Sun. These possess no very bright blue stars ; those initially present have burnt themselves out long ago. The brightest stars in them are greatly distended red giants ; such giants accordingly are stars well advanced in evolution, which have burnt much of their hydrogen. This conclusion is confirmed by the theory of stellar structure, which can explain the enormous radius of a red giant only if it has a core the molecular weight of which is greater than that of the rest of the star—a core where all the hydrogen has been burnt into helium.

After the red giant stage stars probably contract again. The stellar graveyard is usually supposed to be peopled by the enormously dense but very faint white dwarf stars. Before they can reach this state, massive stars must lose a large part of their mass, either by continuous ejection or explosively. This part of the course of evolution is not yet fully understood. But we are, generally, in the exciting stage of fresh discovery ; speculation is being replaced by established fact.

CHEMICAL APPROACHES TO THE INVESTIGATION OF LUNG CANCER

IN his presidential address to Section B (Chemistry), Dr. J. W. Cook directs attention to the very large increase in lung cancer over the past few decades, and to the close statistical relationship which has been established in a number of investigations between the incidence of the disease and the smoking of tobacco—particularly in the form of cigarettes. He points out, however, that there is a legitimate difference of opinion on the interpretation of this statistical evidence. Some authorities believe that the relationship is a causal one ; others consider that a causal connexion has not been established and that other factors, such as atmospheric pollution, industrial hazards and even psychological trends among smokers, are important. A decision between the various points of view would probably be best reached by a direct experimental approach to the problem, and it is this consideration which lies behind investigations of tobacco smoke which are now being carried out.

Attempts are being made to demonstrate the carcinogenic activity of tobacco tar experimentally. With cigarette tar produced in a machine designed to simulate human smoking, Wynder and his colleagues have succeeded in obtaining malignant skin tumours in mice and also in rabbits, and Wynder and Wright later found that the active material is contained in the neutral fraction. The tar is evidently a very weak carcinogen, for the experiments had to be continued for many months before tumours arose, and if it was diluted only two or three times, no tumours were obtained.

The active components of the tar have not yet been definitely identified. The known carcinogen, 3 : 4-benzpyrene, has been detected, but the amount found (1–2 parts per million) is considered too small to account for the activity of the tar. Another carcinogenic hydrocarbon found in the neutral fraction is 3 : 4–9 : 10-dibenzpyrene. Another suspect, arsenic, has been found in varying, but always very small, quantities.

Other constituents already recognized in tobacco smoke include hydrocarbons, both aliphatic and aromatic, alcohols and phenols, aldehydes and ketones, acids, nitrogenous compounds including nicotine and its degradation products, and inorganic constituents. The paraffin, *n*-hentriacontane, has been found in smoke and in tobacco itself, and it has