'Hot' hydrogen initiates amino acid production

from D. O. Hall

IT is just 21 years since Miller reported his now classic experiments in a paper entitled "A Production of Amino Acids under Possible Primitive Earth Conditions". This non-biological synthesis of amino acids by sparking for a week a gaseous mixture of methane, ammonia, hydrogen and water vapour initiated a new phase of research on the origin of life. Since then an impressive list of many different amino acids, sugars, aromatic hydrocarbons and nucleotides and nucleosides have been synthesised using various energy sources such as sparking, heat, ultraviolet (UV) light, α, β and γ rays, and shock waves. These experiments are well described in Miller and Orgel's recent book *The Origins of Life on the Earth* (Prentice-Hall, New Jersey; 1974).

The sulphur-containing amino acids which are so essential components of proteins have been conspicuous by their absence among the products of all these types of experiments. In 1971, however, Sagan and Khare (*Science*, **173**; 417) solved this problem by including H_2S in a UV-irradiated gas mixture which included methane, ammonia, ethane and water; cysteine was produced as one of the six amino acids detected. The H_2S provided the source of sulphur and importantly also provided the means by which UV light at wavelengths below 266 nm could be absorbed as an energy source to catalyse the prebiotic synthesis of organic compounds. These authors calculated that about 200 kg of amino acids could have been produced by UV light absorbed by H_2S per square centimetre on the primitive Earth in 10^9 years. This large amount of amino acids must have allowed a high concentration to accumulate even allowing for considerable destruction by other processes.

Hong, Hong and Becker (*Science*, **184**, 984; 1974) have now confirmed and extended this earlier work by showing that H_2S or CH_3SH (methyl mercaptan) can act as UV photon absorbers and can initiate by releasing 'hot' hydrogen atoms the production of up to nine amino acids, including the important cysteine. Whereas Sagan and Khare reported that a two-carbon substrate such as ethane is required to produce amino acids, Hong *et al.*'s experiments worked well with just the one-carbon methane. A simple mixture of H_2S, NH_3, CH_4 and H_2O will produce nine amino acids but interestingly cysteine may require a two-carbon substrate in order to be synthesised. These authors state that the amino acids produced were in the free form and were not breakdown products of polymers which would have formed as polypeptides—as was suggested by Sagan and Khare. These differences in experimental procedure and products may be important in future 'prebiotic experiments' where the aim is to synthesise polypeptides.

The 'hot' hydrogen atoms produced by the action of ultraviolet light on H_2S or CH_3SH have kinetic energies of about 17 to 32 kcal mol^{-1}, which is sufficient to provide the activation energy for the synthesis of organic compounds in interstellar space or on the primitive Earth. That these types of syntheses may occur in interstellar space has become a real possibility with the recent discoveries using radio astronomy, of compounds such as ammonia, hydrogen, hydrogen cyanide, acetaldehyde, methyl alcohol and hydrogen sulphide in interstellar clouds. In 1971 Buhl reviewed this rapidly developing field (*Nature*, **234**, 332; 1971) and concluded with this fine paragraph: "The important parallels appear to be between the formation of interstellar molecules and the synthesis of amino acids in prebiological chemistry experiments. It is here that the key to the evolution of interstellar molecular clouds lies".

Limited progress at GR7

from P. C. W. Davies

ALTHOUGH the location of the Seventh International Conference on Gravitation and General Relativity at Tel Aviv University from June 24–28, was somewhat controversial—few Eastern European countries were represented and some eminent Western relativists were also absent—nevertheless, there was a generous sprinkling of familiar names among the participants and the usual atmosphere of conviviality seemed unimpaired.

On the theoretical side, only modest progress seems to have been made since the sixth conference in Copenhagen. Both S. Deser (Brandeis University) and J. Goldberg (Syracuse University) made discouraging remarks about quantum gravity, reinforcing the prevailing opinion that traditional covariant quantisation techniques are going round in circles, while only hinting at the possible direction of more radical approaches. At a less sophisticated level, the recent claim by Hawking that quantum field theory in a classical gravitational field predicts the disintegration of microscopic black holes seemed to have been readily accepted in spite of the rather unusual nature of the result. (Hawking himself was not present.) The effect was discussed at some length by W. Press (California Institute of Technology) in a summary of astrophysical processes occurring near black holes. Helpful review talks on cosmology and exact solutions were delivered by R. Matzner (University of Texas) and W. Kinnersley (University of Montana) respectively, and a sparkling account of exotic mathematical developments connected with the BMS group was given with much humour by E. Newman (University of Pittsburgh).

The experimental results were rather more dramatic. M. Rees (University of Cambridge) gave a spirited and carefully balanced review of the theoretical and observational aspects of the detection of black holes, concentrating particularly on the situation regarding the X-ray source Cygnus X-1. Having presented some evidence to suggest that this source has a mass of at least $6M_\odot$, he commented that explanations of this object involving models of differentially rotating white dwarfs or three-body systems seemed "contrived and *ad hoc*", and that in his opinion Cygnus X-1 was instead a "strong candidate" for a black hole. Characteristically, his optimism was tempered by the remark that this was "not a firm conclusion", but that the balance of evidence did seem to favour the black hole explanation. If this was so, then there was a new opportunity to test general relativity by examining the behaviour of the accretion disk which would surround such an object and produce the X rays, possibly by relating this behaviour to curious fluctuations in intensity which have been observed from this source.

By far the most controversial issue of the conference was left to the last day, with a panel discussion on gravitational wave detection. During the past few months the interpretation of J. Weber's epic experimental data in terms of gravitational pulses from the galactic centre has been increasingly open to doubt. The subject reached a new peak of controversy with the presentation of results from other similar experiments being carried out in Munich/Frascati, Glasgow and the Bell Telephone Laboratories/University of Rochester. First, Weber (University of Maryland) reasserted his existing position in confident and ebullient style, claiming a further high event rate for the period May 21–June 15, 1974 using improved equipment. He did admit, however, that the use of a new algorithm favoured by other groups led to a greatly diminished event rate, but asserted that his original algorithm had a very much better detection efficiency.

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