NUCLEAR REACTIONS IN STELLAR EVOLUTION*

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(1). THE question of the sources of energy of stars, and the closely connected question of stellar evolution, have presented for a long time the most important unsolved problem of theoretical astrophysics. The first step towards the understanding of the physical processes leading to the tremendous energy liberation which is responsible for the observed radiation of stars was made about ten years ago. It was shown[1], on the basis of the quantum theory of nuclear transformations, that, at the very high temperatures existing in the interior of stars, the ordinary thermal collisions between the particles possess sufficient energy to produce artificial nuclear transformations. It was also shown that the energy liberation in such *thermo-nuclear reactions* is sufficiently high to explain the radiation of stars only in the case of collisions between the protons and the nuclei of light elements (up to about atomic number 10). It took, however, ten more years before our knowledge concerning nuclear reactions developed to such an extent that it became possible to choose particular nuclear reactions as responsible for the energy-production in different cases and to give on this basis a clear and consistent picture of stellar evolution. The exact formula for the energy production of a thermo-nuclear reaction (per gram per second) can be written in the form[2]:

$$\varepsilon = \frac{4}{3^{5/2}} \rho X_1 X_2 \frac{\hbar \Gamma r_0^2 Q}{m_1 m_2 m e^2 Z_1 Z_2} \exp.^4 \left(\frac{2 v_0 m e^2 Z_1 Z_2}{\hbar^2} \right)^{1/2} . \tau^2 e^{-\tau} \quad (1)$$

Here ρ is the density of the gas, X_1 and X_2 the concentrations (by weight) of the two reacting types of nuclei, m_1 and m_2 their masses