# The Creation of the Universe

REVISED EDITION

GEORGE GAMOW

PROFESSOR OF PHYSICS
UNIVERSITY OF COLORADO

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have to assume that *during the earlier stages of expansion the weight of the radiation in each volume of space exceeded that of the matter in the same volume.* During these epochs ordinary matter did not count, and the main role was played by intensely hot radiation.

One may almost quote the Biblical statement: "In the beginning there was light," and plenty of it! But, of course, this "light" was composed mostly of high-energy X rays and gamma rays. Atoms of ordinary matter were definitely in the minority and were thrown to and fro at will by powerful streams of light quanta.

The relation previously stated between the value of Hubble's constant and the mean density of the universe permits us to derive a simple expression giving us the temperature during the early stages of expansion as the function of the time counted from the moment of maximum compression. Expressing that time in seconds and the temperature in degrees (see Appendix, pages 142–43), we have:

$$\text{temperature} = \frac{1.5 \cdot 10^{10}}{[\text{time}]^{1/2}}$$

Thus when the universe was 1 second old, 1 year old, and 1 million years old, its temperatures were 15 billion, 3 million, and 3 thousand degrees absolute, respectively. Inserting the present age of the universe ($t = 10^{17}$sec) into that formula, we find

$$T_{\text{present}} = 50 \text{ degrees absolute}$$

which is in reasonable agreement with the actual temperature of interstellar space. Yes, our universe took some time to cool from the blistering heat of its early days to the freezing cold of today!

While the theory provides an exact expression for the tem-

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by the factor $a^3$. But the temperature of radiant energy in that volume will decrease by the factor $a$ (Wien law), so that its density drops by a factor $a^4$ (according to the Stephan-Boltzmann law).

perature in the expanding universe, it leads only to an expression with an unknown factor for the density of matter. In fact, one can prove (see Appendix) that

$$[\text{density of matter}] = \frac{\text{constant}}{[\text{time}]^{3/2}}$$

We see in Chapter III that the value of that constant may be obtained from the theory of the origin of atomic species.