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ORIGINAL ARTICLE

From magnitudes and redshifts of supernovae, their light-curves, and angular sizes of galaxies to a tenable cosmology

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Abstract Early physical cosmologies were based on interpretations of the cosmic redshift for which there was insufficient evidence and on theories of gravitation that appear to be falsified by galactic dynamics. Eventually, the big bang paradigm came to be guarded against refutation by ad hoc hypotheses (dark matter, cosmic inflation, dark energy) and free parameters. Presently available data allow a more satisfactory phenomenological approach. Using data on magnitude and redshift from 892 type Ia supernovae, it is first shown that these suggest that the redshift factor $(1+z)$ is simply an exponential function of distance and that, for "standard candles", magnitude $m = 5\log[(1+z)\ln(1+z)] + \text{const}$. While these functions are incompatible with a big bang, they characterize certain tired light models as well as exponential expansion models. However, the former are falsified by the stretched light curves of distant supernovae and the latter by the absence of a predicted $1+z$ increase in the angular sizes of galaxies. Instead, the observations suggest that physical processes *speed up* and objects *contract* uniformly as an exponential function of time, standards of measurement not excluded, and only free waves being excepted. Distant events proceed, then, more slowly, while angular sizes remain unaffected, approximately as observed. Since all objects contract in proportion, the Universe retains a static appearance. A corresponding physical theory, which should also explain galactic dynamics, remains yet to be derived from first principles. A way to do this, satisfying also Mach's principle, is vaguely suggested.

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1 Introduction

The first physical model of an expanding universe was presented by Lemaître (1927), who already knew that the redshift $z = (\lambda - \lambda_{em})/\lambda_{em}$ in the light from galaxies increases with their luminosity distance (Livio 2011). This relationship was described as a linear one by Hubble (1929) and, more reliably, by Hubble and Humason (1931). We shall refer to this redshift phenomenon as the "cosmic redshift". If it is interpreted as a Doppler shift, it is clear that the galaxies are rushing away from each other. This interpretation was adopted by Lemaître, but his model (of 1927) was not yet a big bang (BB) model. It assumed eternal expansion from an initial state, at $t = -\infty$, such as described by Einstein's (1917) model of an eternal but spatially closed universe.

Until then, most natural philosophers considered the Universe as eternal, while there had long been a split opinion concerning its spatial extension. According to one, the world is spatially confined, and it was popularly thought of as surrounded by a solid firmament with stars fixed on it. The competing conception of an infinite universe, which perpetually regenerates itself and which contains infinitely many similar worlds, is also ancient. It was argued for by Epicurus, as communicated by Lucretius in *De rerum natura*.

In the BB paradigm, the Universe is assumed to be finite in age and to have come into being in an explosion either out of nothing or, in any case, out of a state to which physics does not apply. It represents one of the alternatives offered by Friedmann (1922, 1924), whose analysis suggested that

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