ABSTRACTS RECEIVED

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1. Michael Scriven: *The Age of the Universe.* The calculations that are said to give estimates of "the age of the universe" are scientifically rather suspect and logically somewhat ill-founded. Scientifically suspect because the nature of the processes being extrapolated is such that their continuation at the same rate for small values of the variables is improbable; logically ill-founded since the idea of a temporal origin (or infinite age) for the universe is apparently not susceptible to precise analysis—though it can be *given* a meaning which is in some sense related to the usual idea of beginning of null-class. The fundamental difficulties concern the definition of an existent, and the important differences between time and other physical concepts e.g. temperature.

2. J. T. Davies: *The Age of the Universe.* The observations which are compatible with temporal origins of the earth, the solar system and the universe are briefly mentioned, prior to examining the assumptions implicit in the hypothesis of temporal origin which the observations were designed to test. No decisive observation enables us to distinguish between theories of a temporal origin of the universe and the theories of infinite time (continuous creation); the aspects of the galaxies offer no test of either theory without invoking additional assumptions.

Curvature of time is rejected as being a complication at present scientifically unnecessary, as is also the hypothesis of continuous creation.

The view maintained is that the temporal theory based on linear extrapolation is acceptable until it be disproved. Various new techniques which may be useful in attempting to refute this theory are discussed.

3. E. J. Öpik: *The Age of the Universe.* The existing evidence is critically reviewed, applying the principle of minimum hypothesis. It refers to the ages of the Earth, the elements, the meteorites, and the stars; to the red-shift of nebulae and the space-reddening of galaxies. Disregarding non-Doppler interpretations of the nebular red-shift, continuous creation of matter, as well as cosmological repulsion, which all are superfluous from the standpoint of minimum hypothesis, evidence points to an expanding universe with a start about 4,500, and not more than 6,000 million years ago. The average density of the Universe would imply open space and expansion as a unique, non-recurrent process; however, within the limits of observational uncertainty, closed space and an oscillating Universe are equally probable.

4. G. J. Whitrow: *The Age of the Universe.* The root logical difficulty concerning the meaningfulness of the question of the age of the universe depends on the peculiar relation between the concepts *universe* and *time.* Kant's argument that if the world had a beginning then it must have been preceded by an empty time is rejected as is Russell's objection to Kant's counter-argument that the world must have had a finite temporal origin. Detailed discussion of recent estimates of the ages of the Earth's crust, meteorites, Main Sequence stars, close binaries, open clusters and the time-parameter in Hubble's law relating the distances and red-shifts of the galaxies reveals a remarkable convergence towards the same epoch in the past, strongly suggesting that the universe has a finite age of some four thousand million years.

5. Richard Schlegel: *The Age of the Universe.* Physical time involves both cyclic and aperiodic processes. An estimate of the age of the universe requires extrapolation of a process, as the observed expansion of the galaxies, and is subject to ambiguities arising from possible changes in physical law. Unless strongly supported, single event creation hypotheses are to be rejected. Steady-state and expansion from a condensed state theories at present indicate an infinite age for the universe. Since no progressively changing process, existing throughout the span of the universe, clearly presents itself, it may be that the universe is properly atemporal, and has no time property in its cosmological aspects. Time

is then only to be associated with the progressive changes that are observed in subdomains of the universe.

6. B. Abramenko: *The Age of the Universe.* The concept of the age of the Universe, as conventionally understood, is considered and shown to be logically inconsistent with the principles of Relativity, both Special and General.

The observational evidence pertaining to the age of various celestial bodies and formations is reviewed and it is concluded that the various values do not converge to some unique quantity, thus failing to support the notion of a common origin of the world.

Different varieties of "expanding universe" theories are examined and confronted with observational data; it turns out that none leads to completely satisfactory results from both theoretical and observational points of view.

An alternative concept of the age of the world, as a maximal age possible for any formation, is put forward; this concept being a consequence following from the hypothesis of a non-Newtonian structure of time, i.e., assumption of the existence of positive time curvature (a temporal analogue to Riemannian closed spaces).

Logical and philosophical justifications for this "finiteness" of time are adduced and astrophysical consequences thereof are derived:

1) red-shift of spectral lines from distant nebulae and apparent velocity-distance relation,
2) diversity of the values of age for various formations and existence of a definite upper limit,
3) the value of mean density of matter in the Universe.

A comparative table of the observable predictions of various theories is given and the possibility of empirical decision as to the structure of time and, consequently, the age of the Universe is pointed out.