From
C. H. SCHAUER

Posted 29/10/65
Answered 4/11/65

Grote:

This leads me toward anti-contemplation of an anti-cosmos of anti-metagalaxies.

Anticlimactically —

Hap

NEWS FROM THE AMERICAN INSTITUTE OF PHYSICS
335 EAST 45 STREET, NEW YORK 17 MURRAY HILL 5-1940

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FOR RELEASE MORNING OF THURSDAY, NOVEMBER 4, 1965

COSMOLOGIST SAYS ANTIMATTER MATTERS

New York, November 3 --: If your theory of the universe makes no provision for antimatter, you may be ignoring half the objects in the sky.

A recently completed review of the theoretical implications of the symmetry of matter and antimatter makes this a distinct hazard for professional, as well as amateur, cosmologists.

Writing in Reviews of Modern Physics, a publication of The American Physical Society, Professor Hannes Alfvén of the Royal Institute of Technology, Stockholm, Sweden, emphasizes that elementary-particle physics has demonstrated the complete symmetry between the two kinds of matter. Therefore, "it seems logically unsatisfactory that cosmological theories should be based on the assumption that the universe contains only matter and no antimatter."

By this criterion, the two most popular theories of our universe's origin and development, the "steady state" and "expanding universe" models, are incomplete.

Professor Alfvén also suggests that a number of astronomical spectacles may be attributable to large masses of antimatter "annihilating" with ordinary matter. Among these are the various emissions of radio stars, supernovae, and quasi-stellar sources (quasars).

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To verify or disprove any hypothesis about the antimatter content of the universe, one of only two experimental methods are available. The first depends on the fact that subatomic particles of antimatter bend in just the opposite sense of ordinary matter when moving through a magnetic field. However, for tests on an astronomical scale, the second method, annihilation, provides an almost practical test. It is "almost practical" because our ability to throw matter at suspicious celestial objects is severely limited.

We can, for example, be sure that the moon is not made of antimatter since terrestrial rockets have crashed there without generating the kind of explosion that would be expected of an annihilation. But, as Professor Alfvén points out, "by direct observation it is at present impossible to decide whether a distant celestial object consists of matter or antimatter, and we cannot exclude that, for example, half of the celestial objects in the universe consist of antimatter."

Another fascinating question raised by the possibility of regions containing large amounts of antimatter is, "How can antimatter and matter exist in space without rapidly annihilating each other?" The answer may be that there is an insulating layer between regions of matter and antimatter similar to the insulating layer is set up in the "Leidenfrost phenomenon."

This is an effect that occurs when a liquid is dropped on a hot surface. If the surface of a stove, for example, is hot enough, drops of water falling on it form globules which, rather than evaporating immediately, may last for several minutes. The globules are insulated from the direct heat of the stove by a layer of superheated vapor. Calculations by Professor Alfvén on a similar mechanism for matter and antimatter show that a thin, very hot layer of ambiplasma (a "gas" of subatomic particles and antiparticles) may provide an adequate insulating boundary.

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One theory of the universe that does consider the existence of both kinds of matter is Professor Oskar Klein's theory of the metagalaxy. (Professor Klein is well-known to all students of physics from the Klein-Nishima formula of the absorption of gamma radiation.) In his view, the initial condition of the world was an extremely dispersed gas of subatomic particles and antiparticles. Under gravitational attraction, this "ambiplasma" contracted until annihilation occured producing a radiation pressure that reversed the gravitational contraction. All the galaxies were then formed, and are considered to constitute the "metagalaxy" (a term sometimes used synonymously with "universe").

In broad outline, the theory resembles the expanding universe model. It differs critically, however, in two aspects of the "beginning." First, instead of attributing the current expansion of the universe to an initial explosion of ordinary matter (only) from a highly compacted state formed by gravitation, it is assumed that annihilation of matter and antimatter reversed the inward gravitational collapse. Second, this "turning point" required an average density of matter of only one particle per every 100 cm^3, which is a few thousand times higher than the present average density in the metagalaxy. The expanding universe picture, on the other hand, requires an initial density equal to that of nuclear matter itself.

Calculations based on Professor Klein's model of the metagalaxy give values for the present average density of the universe and its rate of expansion in satisfactory agreement with observations. The theory also allows for the existence of other metagalaxies outside the limits of our own.

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H. Alfvén, "Antimatter and The Development of The Metagalaxy," REVIEWS OF MODERN PHYSICS, Vol. 37, No. 4 (October, 1965), p. 652.