Universal Cosmic Rays and the Matter-Antimatter Universe

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The conflict between the universal theory of cosmic rays and the matter-antimatter theory of the universe, discussed by Noerdlinger, can be resolved by looking for antiparticles in the high-energy end of the cosmic-ray spectrum.

THE discussion by Noerdlinger is of considerable interest and the following merely adds to his remarks.[1]

There are various views[2,3] concerning the distribution of cosmic rays; at one extreme it is believed that all cosmic rays are confined to the galaxy (the galactic theory), and at the other extreme it is argued[4,5] that cosmic rays extend uniformly throughout space (the universal theory). The generally accepted view is a compromise that tends more towards the galactic theory. According to this view, most cosmic rays in our galaxy are generated in and confined to the Galaxy, with some leakage into and out of intergalactic space. Thus, most theories would admit that in the Galaxy there is possibly an admixture of cosmic rays which originate in extragalactic sources. If the leakage consists mainly of very high-energy particles, as is often thought, then the abundance of cosmic rays in the Galaxy from other galaxies is extremely small. For example, the fraction of cosmic rays with energies above 10^{12} eV/nucleon is 10^{-5}; the fraction with energies above 10^{16} eV/nucleon, for which the Galaxy is "transparent," is only 10^{-12}. Extragalactic cosmic rays, which must contain antiparticles according to the matter-antimatter theory of the universe, may therefore be extremely rare. Above energies of the order 10^{13} eV/nucleon, we must also allow for secondary particles produced by collisions which give an antiproton-proton ratio[6] of approximately 10^{-4}.

Attempts to detect antiparticles have yielded upper limits for energies of less than 10^{10} eV/nucleon,[7–10] and therefore, they apply to cosmic rays which quite probably originate in our own galaxy. The fact that in these experiments less than the order of 0.1% of the events are for antiparticles indicates that the Galaxy consists predominantly of matter, but still leaves open the question of a matter-antimatter theory of the universe in which some galaxies consist of matter and others of antimatter. The difference between the universal theory of cosmic rays and the matter-antimatter theory of the universe can presumably be resolved by looking for antiparticles in the high-energy end of the cosmic-ray spectrum.

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[2] See Ref. 4 cited in Ref. 1.
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