letters

Cosmic rays' origins unclear

In his interesting commentary "Gamma-Ray Telescopes Show Origins of Cosmic Rays" (PHYSICS TODAY, January 2010, page 13), Bert Schwarzschild argues that we have finally found strong evidence that supernova remnants (SNRs) accelerate cosmic rays (CRs) in some external galaxies. However, the facts are not so clear-cut. As Schwarzschild himself notes, "Strictly speaking, the LMC [Large Magellanic Cloud] map—and the starburst-galaxy results—tie the CRs only to star-forming regions and not specifically to SN remnants."

Many objects, not just SNRs, correlate with an increased star formation rate. For example, because gamma-ray bursts, pulsars, and superbubbles (multiple interacting SNRs) all correlate with a high star formation rate, they are possibilities for the source of the cosmic rays in the starburst galaxies NGC 253 and M82 and in the LMC. Given the spatial and temporal density of SNRs in NGC 253, M82, and the LMC, a larger percentage of SNRs would be expected to be in superbubbles rather than be isolated; in our own galaxy, about 80% of SNRs are in superbubbles.

And as I recently argued,[1] the distinction between isolated remnants and superbubbles cannot be brushed off lightly; they are physically distinct entities.

In the case of the LMC, it is more likely that superbubbles are accelerating the cosmic rays than are isolated SNRs, since there is evidence for many superbubbles within the LMC coincident with the gamma-ray emission.[2]

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References

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2. See, for example, B. C. Dunne, S. D. Points, Y.-H. Chu, *Astrophys. J., Suppl. Ser.* **136**, 119 (2001), and Y. Butt, A. Bykov, *Astrophys. J. Lett.* **677**, L21 (2008).

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Coming to terms with decoherence

In response to Charles Day's item on the solution to Hund's paradox (PHYSICS TODAY, September 2009, page 16), Robert Harris and Leo Stodolsky write that their work[1] from the early 1980s could not yet refer to decoherence because the term was created more than five years later (PHYSICS TODAY, February 2010, page 10). However, Day's formulation that their results—which we used and cited in our 1985 paper[2] when the term decoherence still did not exist—were not yet couched in "the then-nascent decoherence theory" referred not to the name but to the concept. Harris and Stodolsky's insistence that their terms "quantum damping" and "tunneling friction" are just as appropriate indicates that they adhere to a widespread misunderstanding of the concept of decoherence.

Decoherence and dissipation are described by different terms in the master equation, with decoherence usually acting on a far shorter time scale than dissipation. Although the explicit expression obtained by Harris and Stodolsky does contain decoherence terms, we do not remember that they ever mentioned the importance of those terms for the quantum-to-classical transition, superselection rules, or the measurement problem, connections one of us (Zeh) first discussed conceptually during the 1970s.[3] The term "decoherence" does not describe any fundamentally new physics; in a way the idea is already present in Nevill Mott's 1929 analysis of alpha-particle tracks.[4] The point is that this consequence of the entanglement that unavoidably arises between all systems as they interact had been overlooked since the discovery of quantum mechanics, particularly when physicists tried unsuccessfully to recover classical mechanics for isolated systems in the limit in which Planck's constant h vanishes. Hund's paradox was not concerned with the lifetimes of certain chiral states but with the absence of their superpositions. It may appear from the master equation that superpositions are destroyed by decoherence, but that is not so; they are only irreversibly "dislocalized."

References

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4. N. F. Mott, *Proc. R. Soc. London, Ser. A* **126**, 79 (1929).

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Hair-raising effects of electrostatic trick

Walter Margulis raises an interesting point (PHYSICS TODAY, March 2010, page 10) about whether any ill effects might result from applying an electrostatic charge to a human body. I agree that high-energy electron bombardment would indeed be dangerous were the demonstration performed in a vacuum with lots of free electrons floating around, but then the electrons would be the least of our brave volunteer's worries. I am assuming, however, that we do the demonstration in normal air at 1 atmosphere. Under those conditions,