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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Yousaf Butt
(ybutt2002@yahoo.com)
Harvard–Smithsonian Center for Astrophysics
Cambridge, Massachusetts

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."

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Erich Joos
(physics@erichjoos.de)
Schenefeld, Germany
H. Dieter Zeh
(zeh@uni-heidelberg.de)
University of Heidelberg
Heidelberg, Germany

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, the mean free path of an electron is about 7×10^{-5} mm. The maximum electric field without breakdown is on the order of 1 kV/mm. Thus any stray electrons would accelerate through less than 0.1 V before striking an air molecule. But air contains almost no free electrons, or it would not be the near-perfect dielectric that it is. So, go ahead, climb on that wooden stool, crank up the Van de Graaff, and watch your hair stand up as long as you like.

Jonathan Allen
(rfguy13@comcast.net)
Titusville, New Jersey

Mayer earned the lunar-table prize

Siegfried Bodenmann's article "The 18th-Century Battle over Lunar Motion" (Physics Today, January 2010, page 27) leaves the reader with the erroneous impression that Tobias Mayer simply utilized Leonhard Euler's lunar theory to produce the lunar tables that earned the £3000 reward paid to his widow by the British Parliament. The article states, "A look at [Mayer's] correspondence and works reveals that his tables are based on the lunar theory of none other than Euler."

According to Eric Forbes and Curtis Wilson, the lunar tables that Mayer submitted to the Admiralty in 1754 were a revision of his 1753 tables, which in turn were based on his own theory, not Euler's.[1] From the Forbes and Curtis article it seems clear that Mayer benefitted from Euler's advice but pursued a somewhat different strategy. One important difference between the two is that Mayer allowed his theory to be guided by observations in evaluating the coefficients rather than trying to obtain precise values analytically through lengthy calculations. His theory was therefore semi-empirical, not purely analytic. Forbes and Wilson comment that Euler, the "*supposed* author of the theory on which Mayer's tables were based" [italics mine], was "surprised" by his own £300 award. They imply that Mayer's widow might have received as much as £5000 but for a letter of Alexis Clairaut's published in an English magazine. In the letter Clairaut claimed that his and Euler's theories were more rigorous than Mayer's and that Mayer's tables were accurate mainly because of his skillful discussion of observational data. Clairaut may well have been correct on both points. However, for reasons that should be obvious, one would expect the Admiralty to have been more concerned with accuracy than mathematical rigor.

Reference

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Haywood Smith Jr
(hsmith@astro.ufl.edu)
University of Florida
Gainesville

Students need to see education's job relevance

I read with interest "What Determines How Well Kids Do in School?" by Toni Feder (Physics Today, December 2009, page 28). Mike Marder and Dhruv Bansal, whose analysis was the subject of Feder's piece, identify a sharp downturn in school performance in grades 5–8, particularly among low-income students.

I have observed the educational system firsthand over a number of years. While performing research at Xerox research labs, I developed and implemented science programs for inner-city schools in Rochester, New York. Eventually, 50 to 100 scientists from Xerox and Kodak taught science part-time in public schools. Although those programs had limited success, they did not attack the real, practical problems of life—primarily jobs and money. So I implemented money-making work activities for inner-city students on my own, because I could not get support for those practical activities.

From my observations of students in various settings, I believe that the drop in performance in grades 5–8 is related to the onset of sexual maturation, in which the surge of hormones also induces a surge of independence. It is all natural biochemical behavior, but at that age students are not prepared to be rationally independent. The problem is compounded for low-income students who have insufficient resources and insufficient parental control and influence to guide them. The students are anxious to proceed independently and successfully but lack the necessary skills and maturity. That conflict between desire and maturity level causes extensive problems from which it seems most low-income students never fully recover.

In my experience, many low-income students do not see any correlation between success in school and success in life, a trait they may have inherited from their parents and families. Judging by the programs I have initiated and implemented, low-income students relate more enthusiastically to money-making concepts than to academic subjects like spelling, history, or languages. But they are very interested in arithmetic—if money is involved.

The biggest failure of US education is its lack of direct obvious connection to fundamental realities. Therefore, I have proposed for many years that the practical relevance of education be a focus of the curriculum and that it center around a few core concepts.

In my program, a personal job/career plan would be the backbone of education for all students, starting in grade 1 and escalating through grade 12. Students would determine their personal career goals and objectives and would develop timed plans to acquire the skills necessary to achieve them. They would set primary, secondary, and tertiary goals, and plans would change to fit students' maturity, needs, and reality.

Key elements of the course would be how to choose a profession and what skills are required; how to apply for,