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The Cosmological Constant

James Glanz discusses the hypothesis, based on observations of supernovae, that our universe may be expanding at an accelerating rate ("Cosmic motion revealed," Breakthrough of the Year, 18 Dec., p. 2156). There is, however, a fundamental assumption involved that is not stated. All the measured supernovae must follow the same law of luminosity versus time.

A similar assumption applies to finding the distance of Cepheid variable stars and seems to be true. However, the distant supernovae did not start out with the same elements as those nearby: nearby supernovae initially contained the materials from earlier supernovae. If a stellar model builder could show that the requisite small amounts of heavier elements increase the luminosity of a supernova by 10 to 15%, then the need for acceleration would vanish. We could then reset the cosmological constant to zero, stop looking for grand sources of acceleration, and accept the viewpoint of Albert Einstein in his later years.

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Response

In concluding that cosmic expansion is accelerating, the supernova teams have taken up each of these interesting issues in great detail.

First, the luminosity "law" for the specific type of supernovae in question is not an assumption but an empirical fact. Extensive studies of nearby regions of the universe have shown that the rise and fall for intrinsically brighter supernovae is slower than for dimmer ones. This law allows the astronomers to calibrate the actual brightness of the supernovae quite accurately.

The law holds for nearby supernovae in a whole range of environments—from old elliptical galaxies to younger spiral galaxies. Among those environments, the range in the abundance of heavy elements is probably wider than the difference between a typical nearby galaxy and a distant one, so there is no compelling reason to think that distant supernovae behave much differently from nearby ones. Strengthening this conclusion are detailed observations of how the spectra of nearby and distant supernovae evolve during the explosion. Major differences in composition should be reflected in the spectra, but they are virtually identical.

Finally, computer models have shown that, while variations in heavy-element composition should have subtle effects on the rising part of the curve, the overall shape remains largely unaffected.

The supernova teams are expanding their work in each of these areas. So far, however, no such effect has been able to shoot down the conclusion that the expansion of the universe is accelerating. Strange as it seems, the best available evidence points to a cosmological constant that is not zero.

— James Glanz

Analyzing Solitaire

Dana McKenzie quotes Persi Draconis to the effect that "we cannot analyze the common game of solitaire," but explains

how mathematicians have cracked "a simpler version" (News Focus, 27 Nov., p. 1631). The term "solitaire," of course, comprises a menagerie of games, which share, if nothing else, the feature that they can be played alone (*1*). One is not sure, then, what exactly the probabilists' game is simpler than. From the description, it appears to be playable alone and thus is not in any sense a different species.

A distinction that can be drawn is that many solitaires involve strategy rather than rote performance and chance (*2, 3*), so the odds of winning are variable depending on skill, although perhaps subject to an upper limit that can be estimated empirically from a large sample if the opportunity is available to replay each loss and comb for missed solutions. Walter Gibson discusses strategy for 31 solitaires (*4*), including Klondike, which has been deemed the most popular (*1*, pp. 14–15; *3*, p. 94; *5*). David Bervelier devotes most of an entire book to the gold rush gambling hall variant of Klondike, which uses one-card "flops" (*6*).

The latter is a term used by Brooke Boering, creator and webmaster of the *Klondike Pro* site, through which players meet on the Internet to compete in the electronic equivalent of duplicate bridge (*7*). *Klondike Pro* uses three-card "fanned," rather than "blind," flops, so that all three cards are visible. I myself play Klondike strategically with three-card blind flops where only the top card of each trio is visible (*8*). I cannot imagine mathematicians successfully analyzing this commonest of solitaires (fanning, playing blind, or using the one-card flop), nor can I fathom that they would even try. They may want to consult the *Klondike Pro* aficionados.

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6. D. Bervelier, *Strategic Solitaire* (McFarland, Jefferson, NC, 1987).
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8. E-mail exchanges with B. Boering, 11 to 15 December 1998.

Response

I welcome Kuykendall's willingness to include the version of solitaire solved by Percy Deift as a member of the solitaire "menagerie." By the "common game of solitaire" I was, indeed, referring to Klondike solitaire. The version analyzed by Deift is simpler than Klondike in two ways. First, an optimal strategy is known. (In fact, it could probably be found by any solitaire expert, although proving it is optimal is slightly harder.) Second, the probability distribution of outcomes, assuming perfect play, is now known as well, thanks to the work of Deift *et al.*

Although, as Kuykendall suggests, the prospects for such a complete analysis of Klondike solitaire appear remote, mathematicians are trying! Persi Diaconis has conducted both human and computer experiments to determine the probability of winning at Klondike software. Interestingly, humans still win more often than Diaconis's best computer program.

—Dana Mackenzie

CORRECTIONS AND CLARIFICATIONS

Figure 1, panels F, G, and H (p. 1495) of the report "Induction and evasion of host defenses by type 1–piliated uropathogenic *Escherichia coli*" by M. A. Mulvey *et al.* (20 Nov., p. 1494) were incompletely printed. The full panels appear below.