letters

Roadblocks deter today's Einsteins

Please let me contribute a small drop to the ocean of responses that Lee Smolin's comments regarding "Why No 'New Einstein'?" (PHYSICS TODAY, November 2006, page 10; January 2006, page 13; June 2005, page 56) have apparently evoked. Rather than speaking in generalities, as in some of the published responses, I prefer to use the case-study method to make a stronger point.

The first case study is a student we'll call SJ. He and I had enrolled in a strong physics program in a large, prominent research university. SJ took the more advanced theoretical physics major and carried a heavy course load. His grades were so high that they were compiled separately from those of his classmates, in order to not unduly inflate the class averages. His professors even admitted to grading him harder than the other students. He won every available scholarship and had his choice of graduate schools. He chose a doctoral program at another prominent research university. I lost track of SJ until recently, when I found his graduate supervisor's webpage. SJ had been the first or second author of four papers during the first four years of his doctorate—and then he fell off the map. My e-mails to his graduate supervisor went unanswered. I suspect this brilliant student was told he would have to spend several years as a postdoc before even having a chance at an assistant professorship, and instead he simply gave up on pursuing that path. He probably now earns a six-figure salary as a financial analyst.

Then there was DP. Not as bright as SJ, he made up in diligence and creativity what he lacked in brilliance. He gained admittance to a master's and then a doctoral program at a less prominent, large, research-oriented university. Despite having to support himself with part-time jobs, DP excelled in his doctorate, enjoyed the graduate experience, and produced six papers, most as a first author. He then became a postdoc in a well-funded laboratory associated with a famous research site. There he turned out five more papers in just three years—again, most as a first author. DP then looked for employment in physics, and received a single tentative offer, whose financing fell through. Disgusted, he left physics never to return.

Finally, let's consider KM, who graduated with high grades from a well-regarded Ivy League college. He won a nationwide theory contest, and so caught the eye of a well-funded theorist at the same university where SJ, DP, and I had been undergraduates. KM excelled in his graduate courses and took an interest in string theory. Unfortunately, he had a personality clash with his supervisor. KM's one remaining parent died of cancer, and his siblings moved away, married, and settled down. Orphaned, out of touch with his brothers and sisters, ignored by an indifferent supervisor, and seeing no end to his doctorate, this exceptional young man threw up his hands and quit.

I end my tale with the case that I know best—my own. While still a physics undergrad I saw the writing on the wall, in the form of employment ads in PHYSICS TODAY and similar publications, calling for assistant professorship candidates to submit five letters of recommendation from world-famous experts in the field. Being less proficient than SJ or KM, I moved over to a master's in physiology, a doctorate in sensory psychology, and then several years of postdoctoral work. Thinking that I had been much more canny than the others, I sought a professorship. But the joke was on me; I now possess more than 100 glowing letters of rejection. The 13 papers that I have produced apparently count for nothing; the glut of PhDs in psychology turned out to be second only to that in physics. I still read and attend conferences in my field, but only because I have a supportive, patient, and gainfully employed wife, who is doing the equivalent of two jobs. For her I gladly cook, clean, and shop without complaint.

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If a new Einstein, with a revolutionary theory, were to suddenly appear in the 21st century as the old Einstein suddenly appeared in the early 20th, his or her paper would never see the light of day. Imagine it, a person with no PhD, no university affiliation, an unheard-of theory backed by equations constructed by that person alone, with no lab data to back it up?

Lee Smolin may be right that we are wasting our time on string theory, but in today's physics community only credentials and conformity count.

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Letters and opinions are encouraged and should be sent to Letters, PHYSICS TODAY, American Center for Physics, One Physics Ellipse, College Park, MD 20740-3842 or by e-mail to ptletters@aip.org (using your surname as "Subject"). Please include your affiliation, mailing address, and daytime phone number. We reserve the right to edit submissions.

Solar energy conversion can be small-scale and low-tech

The interesting feature article "Solar Energy Conversion" by George Crabtree and Nathan Lewis (PHYSICS TODAY, March 2007, page 37) devoted only two sentences to the simplest and cheapest form of solar conversion, the use of unconcentrated sunlight to "heat space and water in residential and commercial applications." Instead, the article focused on expensive high-tech applications not presently available, at least to the general public.

The immediate answer to the energy crisis is low-tech. Before President Harry Truman left office in 1953, he started a program to develop solar energy, but Dwight Eisenhower scuttled it. I remember attending an energy symposium in the early 1970s where the claim was made that solar energy would never be feasible because it would exhaust our water supply. President Jimmy Carter made a serious attempt to revive solar energy during the 1970s energy crisis, but he was

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ridiculed. He installed solar collectors on the White House roof, but Ronald Reagan had them ripped out.

Even some members of the technical community have tried to discredit solar energy by making claims that, among other things, solar installations are visually polluting. See, for example, the letters and comments in the October–November 2002 issue of *The Industrial Physicist* (page 12).

Six years ago, for about $1200, I built and retrofitted from secondhand components a solar space-heating system for our residence, which was built in 1916. In those days, circulating hot-water heating systems were common. They are uniquely suited to conversion to solar heat because the interior heat-transfer arrangement is already in place. All that is needed is to connect solar collectors to the existing system.

A neat feature of the conversion is that the solar heating supplements rather than supplants the gas heating system. On very cold days, we fire up the natural gas and have gas and solar systems working together, with the benefit that free solar heat tempers the cost of the metered gas heat. If the weather is really bad and the sun isn't shining, we leave the circulating pump from the collectors turned off and rely exclusively on gas heat. Our heating bill has been cut in half.

Our system is sort of a hybrid, like the hybrid autos that when outfitted with plug-in capability will go a long way toward solving that aspect of the energy problem. But that's another story.

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Physics and information

A pivotal question among today's science educators is, How can the teaching of physics be improved in this information age? The topic has recently been discussed in several publications. We propose a direct answer: Formally introduce the concept of information, in its various quantitative forms, into introductory physics coursework. That is, augment the "physicalist" viewpoint of today's physics curriculum with the knowledge-acquisition viewpoint of information theory. But is that heresy?

Physics is ultimately based on observation, and observation entails a flow of information from source to observer. Furthermore, each such flow of information can be analyzed to derive the source law of physics that gave rise to it.[1] Thus, teaching physics from both physicalist and informational viewpoints is both logical and supported by good evidence. One of us (Frieden) taught such a survey course for many years and found that the resulting unified view reaps great benefits in excitement and comprehension, for both the students and the instructor.

Thermodynamics, with its emphasis on measurable extrinsic parameters—and with the implication that our knowledge of them is incomplete[2]—is an obvious starting point for such a program. The lack of complete knowledge underlies, as well, all information theory and provides an entry point for its mathematical analysis.[1] Does that imply use of a particular information concept in the program?

There are many candidates. One, the Shannon–Jaynes information concept, is an outgrowth of the concept of Boltzmann entropy, a linchpin of thermodynamic theory. A second form of information, an outgrowth of the density matrix of quantum statistical mechanics,[1] is Fisher information, in both its classical and quantum[3] varieties. Many of the concepts of thermodynamics and statistical mechanics can be derived by either maximizing Shannon–Jaynes entropy or minimizing Fisher information.[1,2] In addition, Shannon's information theory has been extended to the quantum regime, where it opens up a fascinating world full of surprises[3] and the potential for radical new technology. These surprises center on the concept of entanglement and include quantum computation, quantum cryptography, and quantum teleportation. The basic questions concern how to effectively code,[4] store, process, and transmit information. Many physicists have realized that quantum theory is basically a theory of information, of observing and processing data. Hence, the valuable connections to information should be taught early on.

As a final example, the TCV tokamak at CERN currently uses principles of both maximum entropy and minimum Fisher information to reconstruct laser spot profiles during the implosion process.[5] The international collaboration is using the information concept to help solve one of humanity's most important problems—how to control fusion, with its promise of unlimited energy.

We urge physics educators to join us in looking toward information theory for new approaches to making physics more useful, understandable, and enjoyable.

References

1. B. R. Frieden, B. H. Soffer, *Phys. Rev. E* **52**, 2274 (1995). See also B. R. Frieden, *Science from Fisher Information: A Unification*, Cambridge U. Press, New York (2004).
2. A. Plastino, A. R. Plastino, M. Casas, in *Variational and Extremum Principles in Macroscopic Systems*, vol. 2, S. Sieniutycz, H. Farkas, eds., Elsevier, San Diego, CA (2005), p. 379.
3. M. A. Nielsen, I. L. Chuang, *Quantum Computation and Quantum Information*, Cambridge U. Press, New York (2000).
4. R. C. Venkatesan, in *Exploratory Data Analysis Using Fisher Information*, B. R. Frieden, R. A. Gatenby, eds., Springer, London (2007), p. 181.
5. M. Anton et al., *Plasma Phys. Control. Fusion* **38**, 1849 (1996).

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Justifying the funding of basic science

Despite the role it has played in the evolution of humans, science has often been considered a dangerous and profane activity or, at best, an obscure practice whose validity resides mainly in the possible usefulness of its objectives. The need to justify science through its applications dates back to the dawn of the scientific enterprise, as shown by the following dialog from Plato's *The Republic*, circa 360 BCE.

> GLAUCON: To know something about the seasons, the months, and the years is of use for military purposes, as well as for agriculture and for navigation.
>
> SOCRATES: It amuses me to see how afraid you are, lest the common herd of people should accuse you of recommending useless studies.

Things have not changed. A crucial point of any research project is the ability to demonstrate the usefulness of the proposed investigation for practical purposes.

Science does not escape cost–benefit analysis. Since its main product, knowledge, is not easy to evaluate, allocation of resources is based mainly on derived results, in the form of technology and commercial applications. When those cannot be foreseen within reasonable