letters

Amateur scientists

In his recent guest comment (December, page 9), Lawrence Cranberg has emphasized that amateur scientists can be more impressive and more productive than professional scientists. May I point out that this phenomenon may be far more common than generally thought. The airplane was invented by two bicycle mechanics, not by Professor Samuel Langley. Xerography was discovered by a New York City lawyer in his Brooklyn apartment, not at any well financed and well-organized industrial research laboratory.[1] Thomas Edison never went to college. Gregor Mendel was a monk. Wilhelm Roentgen made the discovery of x rays in a momentary lapse from a lifelong study of crystals.[2] The important geological concept of continental drift was introduced by Alfred Wegener, a meteorologist who received his doctorate in astronomy.[3] Among the truly great mathematicians, Fermat was a government official, Galois and Ramanujan were college dropouts. In recent years we have seen Nobel prizes coming from the glorified tinker toys of James Watson and Francis Crick, the beer bottles of Donald Glaser and the phonograph turntables of Rudolph Mossbauer.

It is not my intention to be anti-intellectual. However, I do wish to emphasize that the first-generation founding fathers are often amateurs. In fact, Hallam[3] has pointed out that professionalism can be a hindrance in some cases; for example, concepts such as continental drift or virial origin of cancer were not accepted for fifty years as a consequence of professional inertia. As the field matures and progresses, these amateurs were then followed by the more academically oriented professionals. It was the natural cycle of evolution that Thomas Edison was succeeded by the Irving Langmuirs, the Wright brothers by the Donald Douglases, the Willie Messerschmitts and the slide-rule engineers (and now, of course, the computer engineers). Similarly, the more sophisticated Maxwell's equations would come many years after the kite of Benjamin Franklin. In 1945, there were no molecular biologists around to be the founders of molecular biology, so it was up to the physicists (such as Max Delbruck) to do so.

Under present conditions of more bureaucracy combined with rising oil prices and hence less venture capital, it is much safer to solve the same problem on a slightly bigger computer for a slightly more accurate answer, since few can afford to risk their careers (May 1978, page 15). With high unemployment in physics, young physicists are often forced to work along the lines of their thesis research. With very scientific matchings between jobs and applicants by computers, Willard Gibbs would have had to work on "the form of the teeth of wheels in spur gearing" forever under our present conditions. I wonder if the amateur spirit is gradually leaving us. Indeed, this "departure" may contribute to the well-publicized breakdown of US innovation.

References

1. L. Lessig, *Fortune*, April 1972, page 69.
2. J. R. Platt, *The Excitement of Science* (Houghton Mifflin, Boston, 1962), page 17.
3. A. Hallam, *Scientific American*, February 1975, page 88.

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12/28/79

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"Einstein: Amateur Scientist" by Lawrence Cranberg was a beautifully lucid, if provocative, exposition.

Allow me to quote from two relevant letters from Einstein (to this writer) that may shed more light on the issues: "... Spinoza was moved by similar thoughts as you expressed ..." (27 Feb. 1938), and: "... I appreciate your brave and intelligent remarks concerning witch hunts." (4 July 1953).

Note that although the witch hunt included Einstein, his note is directed toward an appreciation of a defense of freedom *per se*. It may be difficult for many of us to grasp, but objectivity of this concerned order follows from Spinoza's "psychology of the emotions."

Also note that Einstein had the remarkable ability and endearing quality to judge a case on its own merits; the protagonist might indeed be a "professional" plumber or an "amateur" academic!

Although Einstein thus advocated civil disobedience against witch hunts *per* Thoreau and Gandhi, he did not suggest

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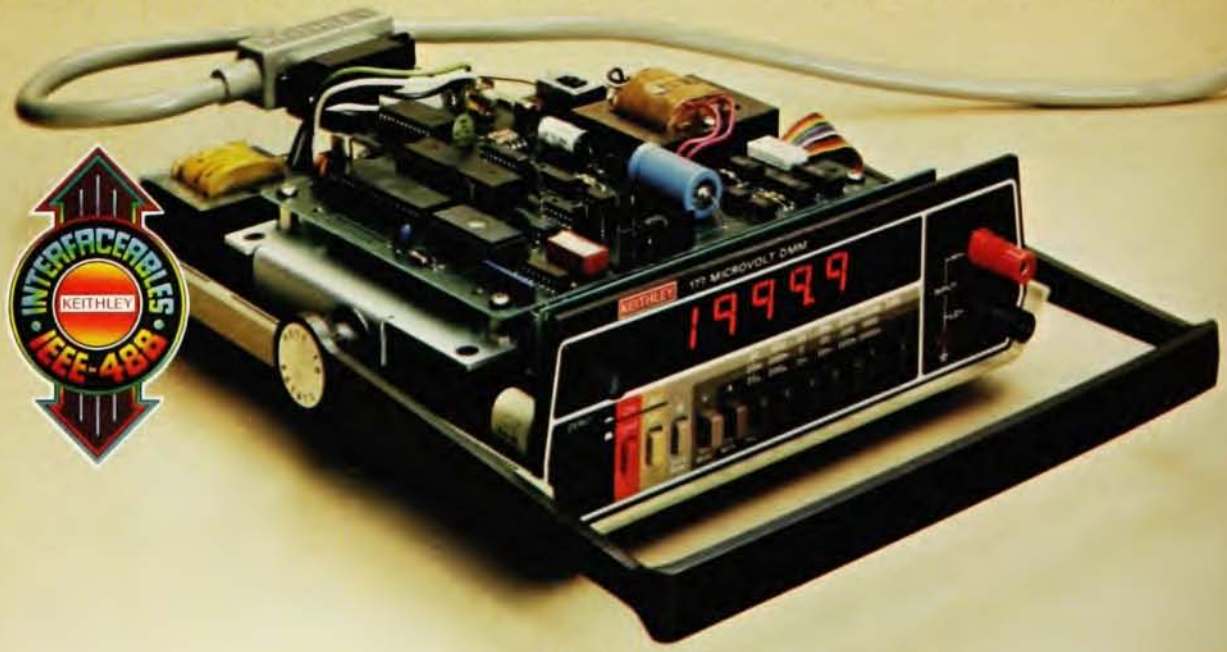

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acquiescence to unjust economic deprivation. Plumberdom might serve as a last resort to the national scandal of limited academic posts, but there are other alternatives in various collective actions more suited to our democracy.

CARL COLODNE

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Lawrence Cranberg's guest comment reminded me of a letter I published in PHYSICS TODAY about a year ago (February 1979, page 15). Apparently the primary difference between his letter and mine is not what we say, but in our vantage points: my view, unlike Cranberg's, is that of an "amateur scientist." Rather than adding more strokes to the romantic picture Cranberg painted, I would like to describe some of the realities of the avocational study of nature I've encountered while performing some recent work (Phys. Rev. **D 20,** December 1979).

Unless you're independently wealthy, the best research topics will of economic necessity be theoretical. Furthermore, you will probably want to limit your study to a topic which requires calculations that can be completed with a pocket calculator (or a small computer for you computer buffs). This restriction is not as great as it might at first appear. (I have compiled a list of topics that should require only time to complete. If you would like to see the list, let me know and I'll send you a copy.)

Once you've chosen a topic, you might need to review the literature. With the relatively widespread availability of interlibrary loans, most books should be accessible. Copies of journal articles may be more difficult to obtain, but authors are usually good at responding to requests, even if the request is not from an institution.

Having accumulated your background information (as much as you need to get started anyway; your comprehensive literature search will probably not be complete), you are ready to attack your problem. The biggest task you have now is allotting time for reasearch. One word of caution: do *not* let yourself feel guilty if you do no work at all over an extended period of time. Unlike "professionals," you are not paid to produce quantity. Your biggest satisfaction will come from producing a quality paper. As an "amateur" you do not have to function in a publish-or-perish environment.

You have now completed the study of your research topic and have prepared a manuscript (in accordance with the guidelines of the target journal) describing your contribution. If you can let a colleague preview the manuscript, fine. If not, and this could well be the norm for isolated physicists, set the manuscript aside for a week or two and then review it yourself. This step is important because it may save you some embarrassment when you submit the manuscript. It will also help minimize premature submissions, which only irritate referees and make them more hostile than they may already be (remember: your byline does not include the name of a prestigious institution; although this should not matter, there is a chance it will).

Finally, your manuscript is accepted and you are asked to pay page charges. Chances are you cannot afford to pay $70–$80/page. Say so! The result will be publication delay of three months in some cases. This depends on the journal.

The above briefly describes some realities of "amateur science" and brings me to the heart of what I have to say. Those of us who study nature as an avocation have a difficult—but not impossible—path to follow. Our task could be made easier by the physics establishment if it chose to do so. Cranberg's comments indicated that it might. If his words are more than just rhetoric, then perhaps he and other members of the physics establishment will use their influence to diminish the obstacles facing the growing number of physicists who must accept vocations out of their chosen field yet seek to contribute to humanity's store of knowledge. But what can the establishment do? Two immediate obstacles that can be eased are the following:

First, referees should not judge a paper by its byline. We all know they do not intend to, but we also know that referees are human and Harvard University looks more credible on a paper than Broken Arrow, Oklahoma.

Second, eliminate the three-month delay in publication because page charges are not honored. This delay is contrary to the stated object of the APS to advance and diffuse the knowledge of physics. The delay hurts unfunded research, which is often just research that is not part of the mainstream. In the case of "amateur science," virtually all research will be unfunded since most grants may go only to institutions, not individuals. Remuneration of any lost funds could be sought from the Federal government which has a vested interest in fostering "amateur science." After all, contributions from "amateur scientists" are basically windfall gains to the nation's knowledge base.

The removal of these obstacles could greatly aid the revival of "amateurism" in the study of nature.

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THE AUTHOR COMMENTS: I welcome the opportunity to compare notes with a fellow amateur scientist on the problems of the amateur's role in present circumstances.

There is no question that the difficulties can be substantially alleviated by appropriate official actions. In addition to those recommended by John Fanchi, I recommend reconsideration by the Na-

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tional Science Foundation of its policies in implementing Section 3.(c) of the National Science Foundation Act, which stipulates:

". . . it shall be one of the objectives of the Foundation to strengthen research and education in the sciences, including independent research by individuals."

So far as I have been able to determine, this provision of the Act has been ignored or flouted almost without exception for the entire 30-year history of the Foundation. If Einstein or the Wright Brothers were to apply for an NSF grant, they would be risking disclosure of their ideas to others and they might invest substantial time and trouble with almost no prospect of a good-faith review of their proposals.

Either the Act should be modified to eliminate provision of support for individuals, or the Act should be implemented in good faith.

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Lawrence Cranberg states that: "His skill as an instrument maker . . . brought Spinoza a living that was ample for his modest needs. Equally important, it brought him the friendship and patronage of the leading intellectuals and scientists of his day, including Huygens and Leibnitz, whose scientific correspondence with Spinoza is still extant . . . "

Scholars of Dutch history do not paint such an idyllic picture of the life of Spinoza, the underemployed intellectual. For example, according to Leo Balet[1]: "When we hear that the philosopher Arnold Geulinex, as a professor at the University of Leyden, enjoyed a salary of 300 guilders a year, and that everybody in those days held the man for *gruwelijk arm* (terribly poor), we can imagine the poverty of the lens-grinder Spinoza with his yearly earning of one hundred guilders." It was malnutrition, and unheated room, and the fine dust he ground that exacerbated Spinoza's tuberculosis and led to his early death.

Balet goes on to state that: "Huygens could not abide him [and] did not even call him by his name [but] used to speak of Spinoza as the "Jew of Voorburg" or the "Israelite." Huygens found that Spinoza was a lens-grinder, but a poor philosopher . . . Leibnitz did not like Spinoza either . . . Leibnitz, who owed much to him, concealed his debt, and carefully abstained from saying a word in his praise . . . The last important influence on Leibnitz's philosophy was that of Spinoza, whom he visited in 1676. Leibnitz spent a month in frequent discussions with Spinoza, and secured part of the *Ethics* in manuscript. In later years he joined in decrying Spinoza, and minimized his contacts with him, saying he had met him once, and "Spinoza had told some good anecdotes about politics . . ."

The tragic life of Spinoza may provide a "moral for our days," but not the one that Cranberg cites. Rather, the moral is that underemployment makes intellectuals vulnerable to exploitation, attack and annihiliation.

Reference

1. L. Balet, *Rembrandt and Spinoza*, Philosophical Library, New York, 1962 pages 103 and 107. This book also contains an excellent and extensive bibliography on Spinoza.

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THE AUTHOR COMMENTS: Neither of Spinoza's contemporary biographers[1] confirm the "tragic" interpretation of Spinoza's life advocated by Gerald Rosen, nor does his own source, read in context. Spinoza's refusals of a Heidelberg professorship and of designation as sole heir of an affluent admirer speak to his employment opportunities and to his economic options. A man who outlived his mother by 39 years and his father by 23 years has not obviously been cheated on life span.

Rosen's "tragic" view derives from secondary sources that may reflect sectarian hostility lingering from Spinoza's excommunication and are not supported by evidence.

Spinoza's life was not idyllic but an inspiring example of strength in adversity. He survived condemnation in his youth without bitterness or self-pity and went on to create a legacy of enduring intellectual achievement, adorned by universal testimony of his gracious personality and impeccable character.

He amply earned the role of hero and life-style model not only for Einstein but for generations of intellectuals.[2] His position remains unassailable today, and stands as a monument to the opportunities and rewards of free thought and personal resourcefullness in an open society.

References

1. *The Oldest Biography of Spinoza*, A. Wolf, ed., Dial, New York, 1927.
2. For an admirable recent interpretation of Spinoza, see *Spinoza and the Rise of Liberalism*, by Lewis S. Feuer, Beacon, Boston, 1958.

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Laser for Fusion

I read with great interest your news story "Shiva Moves Closer To Laser Fusion" in November (pages 20–22). I should like to

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