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area. The faculty participants in the program have resisted the temptation to develop separate applied-physics courses, requiring the students to take existing graduate courses in engineering and physics as well as preliminary examinations split between the two schools. In addition, there has been created a graduate co-op program at the Master's level, which further increases the employability of the Masters of Engineering students.

ROBERT E. JOHNSON
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11/27/78 *Charlottesville, Virginia*

Stock-market fluctuations

Rolf Landauer's comments (November, page 23) on the influence of noise on "open systems" are well illustrated by recent fluctuations of historic proportions in the stock market. The market may be considered an open system in which an adequate flow of money will effect a transition from disorder (random walk) to order (cooperative or crowd behavior). Near the critical threshold it is highly susceptible to noise (random economic or political news).

In mid-October of this year the Federal Reserve Board announced that the discount rate of interest charged to member banks would be raised to an unprecedented 8.5%. This bad news came at a time when the market was near the transition threshold (undamped). It resulted in the largest single-week decline in history (59.08 points on the Dow Jones Industrial Average) and a staggering two-week loss in the market value of all stocks on the order of 100 billion (10^{11}) dollars!

The concept of the second-order phase transition in equity markets is new. It implies that the market is not always efficient, that is, the impact of random economic and political news is not always discounted (damped) quickly. In particular, a virtual lack of damping near transition implies a highly inefficient market, characterized by large, long-lasting fluctuations.

Noise (chance developments) always has a strong influence on the stock market, and it represents an ever-present element of risk to investors. By understanding that the market is of necessity more susceptible to noise during the undamped transitional period, investors can be aware that even small changes in economic or political fundamentals at these times can have a big impact on the market.

TONIS VAGA
11/15/78 *Cream Ridge, New Jersey*

THE AUTHOR COMMENTS: Tonis Vaga points out that the coupling of the opinions of people leads to situations that share some of the characteristics found when many physical degrees of freedom are coupled to each other. This point has been brought out on a number of occasions.[1]

I would like to supplement Vaga's example with one that may be equally important for the readers of PHYSICS TODAY.

The evaluation of scientific work has become much like the stock market; the influence of the opinions of others provides a coupling leading to positive feedback, and to a strong dominance by fads and fashions. Just as the investor can no longer ask: "Which company will do well?" but must ask, "Which company will *others* think will do well?" the scientist who asks, "What are the important problems?" instead of, "What will *others* think are the important problems?" takes a serious risk with contract-granting agencies and with his chances for invited papers. You need competitors to be grouped into a reasonable APS meeting session.

Some clustering into communities of interest is, of course, essential to the healthy development of science. I believe, however, that we have let the coupling, leading to positive feedback, get out of hand.

Reference

1. W. V. Smith, Science **167**, 957 (1970); E. Callen, D. Shapero, PHYSICS TODAY, July 1974, page 23. For other citations see refs. 1 and 21 of my PHYSICS TODAY paper.

ROLF LANDAUER
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11/29/78 *Yorktown Heights, N.Y.*

Too many physicists

I feel that the letters of Robert Yaes (February, page 83), G. Adomian (June, page 48) and others (November, page 15) have put too much emphasis on tenure and missed the important point.

The careers of physicists are far longer than the careers of professional football players. For example, out of the 45 players on the 1972 Washington Redskins team, only seven are still present in 1978. On the other hand, many physics departments hire as many postdoctorals every year as the draft choices of Los Angeles Rams or New York Giants. With or without tenure, there will be few positions for young physicists. Take another example; there is no tenure system in the national laboratories or industrial laboratories, but the turnover rate is not much higher than the universities with the tenure system.

We must recognize that the physics community is now approaching the steady state rather than the expanding state. The number of physicists has grown fifteenfold since 1926, when the dawn of

quantum mechanics promised solutions to virtually all mysteries of atomic physics or molecular physics or nuclear physics or solid-state physics. It may be possible to say that physics of 1978 is as promising as physics of 1926, but certainly not fifteen times more promising. There has been a fourfold increase in the number of physicists since 1948, when the growth potentials in nuclear energy and semiconductors appeared to be unlimited.

Again, it may be possible that the horizon of physics in 1978 is as "unlimited" as 1948, but certainly not four times more "unlimited."

May I make an alternative proposal. Any professor with two or more unemployed (or vastly underemployed) disciples should refrain from accepting any more graduate students. Nobel laureates may work in any field of physics, but there is simply very little room for the less talented foreign student recruited from the underdeveloped countries to work on gauge field theories.

T. TSANG
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11/28/78 *Washington, D.C.*

OBAFGKMRNS

Concerning the letter by Owen Gingerich on page 15 in September; there is a time-tried mnemonic for the spectral star classes, which has been around a long time; I heard it first at Princeton around 1930. It goes:

Oh be a fine girl, kiss me right now—smack!

The fact that I have remembered this so long indicates that it is more memorable than the example given in the letter.

EDWIN M. MCMILLAN
Lawrence Berkeley Laboratory
9/25/78 *Berkeley, California*

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Re Owen Gingerich's OBAFGKMRNS mnemonics, I have composed a few new ones:

1. For the Freshman: Observing Bright and Faint Galaxies Kills Many Rambunctious New Students
2. For the Senior: Only By Accident, Faded Giants Keep Mimicking Reddened Neutron Stars
3. For the Teacher: Observatories Boast A Few Graduate Knaves; Most Rascals Never Study
4. For the Administrator: Occasionally, Because A Fabulous Grant Keeps Multiplying, Research Never Stops
5. For the Physicist: One Befuddled Astronomer Finds Goofy K-Mesons Revealing Nuclear Structure
6. For the Radioastronomer: Oversize Broadband Antennas For Gigahertz Klystrons Modulate Radio Noise Sinusoidally
7. For the Musician: Old Bruckner, Austria's Foremost Gentle Kapellmeister, Manufactured Rather Noisy Symphonies
8. For the Businessman: Often, By A Financial Gimmick, Knotty Manipulations Revive Nosedived Stocks
9. For NASA: Overriding Bureaucratic Arguments, For Greater Knowledge Mankind Receives NASA Satellites
10. For NSF: Our Biggest Accelerators Fission Gravitational Kilobucks, Making Relativity Nasty Science
11. And finally, for the Astronomer (who views the Universe through an inverting telescope): Super Nova Remnants May Keep Going For Ages Beyond Ours

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The views expressed here are personal and do not necessarily reflect those of the US Government.

WALTER A. FEIBELMAN
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THE AUTHOR REPLIES: My rather casual mention of the annual mnemonic contest in my Harvard Natural Sciences course evoked an unexpectedly wide response; I have now received prize-winning entries from astronomy classes across the country. It went without saying that our contest seeks replacements for the well-known and time-worn entry that is sometimes attributed to Henry Norris Russell, a memorable mnemonic that is nowadays often considered objectionally sexist.

I admire Feibelman's ingenious vocabulary, but memorable mnemonics also require a felicitous rhythm such as that found in "Oh bring another fully grown kangaroo, my recipe needs some." Among the winners in our contest have been: (1972) "On bad afternoons fermented grapes keep Mrs. Richard Nixon smiling," and (1973) "Out beyond Andromeda fiery gases kindle many red new stars."

OWEN GINGERICH
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More on diode lasers

"Laser heterodyne spectroscopy measures planetary winds" in Search and Discovery (May, page 17), is an interesting introduction to an exciting new field. However, it contains statements about tunable diode lasers that may be subject to misinterpretation, and may lead to an undeservedly negative view of these important new devices. Michael Mumma's statement "... appropriate diode lasers have not been available commercially ..." refers to a narrowly limited application in extra-terrestrial studies requiring a combination of exceptionally high single-mode power (about 1 milliwatt), long lifetime (about 1 year), and long wavelength operation, which is admittedly beyond the capabilities of present standard-model tunable diode lasers. PbSe lasers ($\lambda < 8.5$ microns) with operating characteristics superior in some respects to those used in Mumma's earlier work are available. Mumma is also quoted as saying that presently available tunable diode lasers can be tuned over a range of $\pm$ 0.5 microns; our standard Model SDL-3 lasers tune over a range of $\pm$1.25 microns around 10 microns and over wider ranges at longer wavelengths.

While the emphasis of the article was on extraterrestrial planetary atmospheres, the topics discussed include a range of other laser heterodyne activities. We were therefore surprised to note that two significant recent papers[1,2] involving tunable diode laser heterodyne measurements were not cited. Margaret Frerking's study of stratospheric ozone with a ground-based heterodyne system[1] is generally recognized as an important advance in the field.

References

1. M. A. Frerking, D. J. Muehlner, Applied Optics **16**, 526 (1977).
2. R. T. Ku, D. L. Spears, Optics Letters **1**, 84 (1977).

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