Zurich in a dilapidated VW in the middle of the night, lost and broke, and Werner Kanzig met us and took us under his wing. And so it was to be for my stay in Zurich. I found the Swiss to be very helpful in all matters, we made many friends, and never once was I ever treated with disrespect or condescension. In fact, my stipend from ETH quickly proved inadequate, due entirely to my misjudgment of living costs in Zurich, and Walter Granicher and Kanzig quickly (and mysteriously) found an additional stipend for me. In short, I have only fond memories of my stay in Zurich, and we were very sad to leave Switzerland. I have visited ETH every two or three years since my postdoc there, and I have never detected the ostracism Spicer and Barrow complain of.

I found Switzerland to be a country of impeccable standards of honesty, integrity and hospitality—would that I could reverse the unfortunate experiences of Spicer and Barrow.

W. N. Lawless
CeramPhysics, Inc.
Westerville, Ohio

2/84

Mathematics as an obstacle

In connection with the discussion on educating the younger generation in the physical sciences (September, page 25), I would like to mention a general difficulty.

The laws of physics are formulated as differential equations: for example, Newton's laws of motion for a particle, a rigid body and a gyroscope. Maxwell's laws of electromagnetic field are partial differential equations, and so are the laws of gas dynamics.

The teenagers are able to understand all this stuff.

A more exact statement is that they are *unable* to understand deeply and to love physics if the needed mathematical vocabulary is lacking. Here is my point: In most cases, the calculus begins late and involves difficult and tedious elements of set theory and the theory of limits.

The so-called "rigorous" proofs and existence theorems are much more difficult than the intuitive approach to derivatives and integrals.

The result is that the mathematical ideas needed to understand physics come to teenagers too late. It's like serving the salt and pepper needed for lunch somewhat later—during five-o'clock tea.

I tried to remedy the situation by writing in 1960 *Higher Mathematics for Beginners*; more than half a million copies were printed. The last edition with I. Yaglom was printed in 1982 and translated into many languages. But I do not know of any attempt to use it as an official school (college) textbook.

An anonymous group of talented mathematicans invented Bourbaki, called him an army general and wrote under this pseudonym a comprehensive course of modern mathematics, beginning in the first 7 or 10 volumes with set theory and abstract algebra, and ending with calculus.

Perhaps the high military rank ascribed to Bourbaki made his position strong in education. In many countries the difficult ideas of set theory and formal limit theory are exposed to twelve-year old boys and girls. Obviously this is a very difficult barrier to understanding things that are much simpler—the intuitive understanding of the derivative as velocity or of the integral as area. The use of minicalculators could be very useful in understanding calculus. But most important is the interaction of math and basic physics.

A mixed course of physics and calculus (including vector fields) would be a blessing for both physics and mathematics.

The division of mathematics and physics and the Bourbaki approach in teaching math to beginners are disastrous.

Ya. B. Zeldovich
Academy of Sciences of the USSR
Moscow

2/84

Polymeric fluids

In their excellent article "Fascinating Polymeric Liquids" in January (page 36), Byron Bird and Charles Curtiss mention several phenomena in which polymer melts and solutions behave in unexpected ways. In particular, the behaviors shown in figures 1**a**, 1**b**, 1**c**, and 1**e** (rod-climbing, die-swell, and so on) are ascribed to the fact that these fluids have a non-zero first normal stress coefficient. They state that the first normal stress coefficient is positive in polymeric fluids. While this is undoubtedly true in the vast majority of cases, I would like to point out that several cases are known in which this quantity is negative. Roger Porter and I have observed lyotropic solutions of helical polypeptides give rise to large, time-independent negative normal stresses. It was further observed that the sign of the first normal stress difference depended on shear rate, changing from positive to negative and then back to positive with increasing shear rate.[1,2] These changes in sign corresponded to observable texture changes in these liquid crystalline solutions when viewed under crossed polars.[3] A mathematical model that de-

continued on page 121

continued from page 15

scribes some of these peculiar phenomena has been proposed by C. E. Chaffey and Porter.[4] Other examples of systems exhibiting negative first normal stress difference are given by K. F. Wissburn in a review article on rod-like polymers in the liquid crystalline state.[5] An example of a system that exhibits similar effects and does not contain rod-like polymers is described by K. W. Lem and C. D. Han.[6] They observed negative first normal stress differences (and also sign changes) in concentrated suspension of polyethylene in unsaturated polyester resins. I am not aware of any cases in which fluids exhibiting negative first normal stress difference have been tested in non-rheometric experiments such as the ones described by Bird and Curtiss.

References

1. G. Kiss and R. S. Porter, J. Poly. Sci. Polym. Symp. **65**, 193 (1978).
2. G. Kiss and R. S. Porter, J. Poly. Sci. Phys., **18**, 361 (1980).
3. G. Kiss and R. S. Porter, Mol. Crys. Liq. Crys. **60**, 267 (1980).
4. C. E. Chaffey and R. S. Porter, to be published.
5. K. F. Wissburn, J. Rheology, **25**, 619 (1981).
6. K. W. Lem and C. D. Han, J. Rheology, **27**, 263 (1983).

GABOR KISS
Celanese Specialty Operations
2/84 *Summit, New Jersey*

More on radon hazard

Whenever possible, disagreements about facts should be resolved by appeal to data.

In November (page 13), Leonard Katzin and Robert Pohl disagree about the importance of radon release from mining tailings. Pohl refers to an EPA report, which is published—though not in a refereed journal—and which has been widely criticized. That report depends primarily upon calculation, and, as is appropriate for an agency set up to defend the environment, the calculation is designed to be—and to err—on the safe side. Those measurements referred to in the report to justify the calculations are over 10 years old and fall below the calculation.

In the last 10 years, the track-etch technique has become available to all. According to an advertisement in front of me, a measurement of the average level of radon and daughter products can be made for $50. Radon levels have now been measured in 50 000 houses throughout the world. Some of these have levels much higher than have been suggested near mining tailings.

This experience suggests to me that all concerned with mining tailings, EPA, American Mining Congress, Pohl and Katzin leave their offices and return to the laboratory; when the data are in, we can regulate first those places with the highest combination of human occupancy and radon level.

RICHARD WILSON
Harvard University
2/84 *Cambridge, Massachusetts*

Physics in decline

Recently, there have been many discussions on the educational crisis and decline in physics (September's special issue; February, page 57). Although we would like to be optimistic, our current situation should not be compared with physics before Sputnik. In 1957, the terrors of Joseph Stalin and Adolf Hitler were fresh memories. Russian tanks had just invaded Hungary. Out of despair, perhaps, many of us felt the necessity of nuclear weapons. The transistor had also been recently invented. Space physics (due directly to Sputnik) was merely the icing on the cake of nuclear and solid-state physics. Furthermore, there were no worries about huge Federal deficits, high inflation, high interest rates, foreign trade deficits, depletions of oil reserves and the decline of such basic industries as steel.

On the other hand, the current situation may be somewhat similar to physics at the turn of the century. Before Albert Einstein, H. A. Lorentz and Henri Poincaré had too many hypotheses. Today, we have too many quarks (and colors, and so on). The vacuum was filled with ether then, and it is filled with virtual photons now. Despite great efforts, experimental confirmations of key theoretical predictions have often been inconclusive (magnetic monopoles, fractional charged quarks, proton decays, electric dipole moment of neutrons, and so on). Obviously, we could use another Einstein. But Einstein might have troubles surviving today. Any research program involving relativity, photoelectric effect and Brownian motion simultaneously would be judged as incoherent. It is very difficult to write up $E = mc^2$ as a grant proposal. Lacking technical qualifications, he might not even get his patent-office job. (The director appreciated his deep knowledge of electrodynamics only after a long and grueling interview.) Such studies also require great concentration. Willard Gibbs was able to live for 15 years on the investments from a modest inheritance (the equivalent of a quarter of million dollars today, shared between brothers and sisters) without receiving