moving toward the Sun. (Comet Kohoutek, 1973f, was discovered on 7 March 1973, and passed perihelion on 28 December. On 23 September its magnitude was 19.5. Early predictions of its magnitude at maximum brightness ranged from −3 to −10, but the comet failed dramatically to reach any spectacular brightness.) Recently R. Hagstrom proposed that Price's event was caused by an antinucleus.[3] Did the antinucleus come from the comet? The chances are small, but not necessarily zero.

One may expect the activity of a comet to increase gradually as the comet approaches the Sun and to decrease gradually after reaching a maximum. The activity of an "anticomet" moving along a similar path may be expected both to increase and then to decrease much more rapidly than that of a comet. Early observations of a newly discovered comet may lead to predictions of a very high maximum activity; yet the comet may fail to reach its predicted brightness. One would expect such a failure to be particularly likely in the case of an anticomet. Therefore experiments intended to detect penetrating rays (if any) emitted by a comet moving in a nearly parabolic orbit should begin as soon as possible after a suspicious comet is discovered. In chemical composition and physical structure, an anticomet may well be similar to a comet, except for the prefix *anti* here and there.

References

1. Phys. Rev. Lett. **31**, 1591 (1973). The initial paper on this general subject appeared in Astrophys. J. **91**, 257 (1940).
2. P. B. Price, E. K. Shirk, W. Z. Osborne, L. S. Pinsky, Phys. Rev. Lett. **35**, 487 (1975).
3. R. Hagstrom, Phys. Rev. Lett. **38**, 729 (1977).

V. ROJANSKY
Harvey Mudd College
Claremont, California

6/29/77

More on breeding

In recent years there has been an upwelling of enthusiasm in the physics profession for active participation in public debates on technological and sociological issues. It is often stated that training in physics provides a unique ability to grasp the fundamentals incisively. Interestingly enough the reason that individuals often come a cropper when they move outside their chosen profession is not that they are unfamiliar with the new field but that they are inadequate in their own area of supposed expertise. Thus when Derek Paul implies that it is "scandalous" that the world nuclear industry has been devoting more effort to the LWR-LMFBR uranium/plutonium-239 fuel cycle than to the thermal reactor thorium/uranium-233 cycle one must question whether he is paying sufficient attention to the physics considerations that tend to make the former cycle preferable from the engineering, economic and non-proliferation standpoints.

Four physics considerations that tend to favor the uranium-plutonium fuel cycle are:

- The intrinsic breeding ratio for Pu-239 in a fast neutron spectrum is greater than for U-233 in a thermal spectrum. This provides greater margin to cover losses due to engineering considerations.
- U-233 has a relatively short alpha-decay lifetime and therefore does not occur in nature. Hence getting started in the thorium-uranium-233 cycle requires a substantial front-end investment in highly enriched U-235 or recycled plutonium.
- The U-233 produced in reactors is contaminated with U-232 whose decay chain leads to the emission of hard gamma rays. This emission requires the use of remote fuel-fabrication techniques, which are, at least initially, not required in the uranium-plutonium cycle.
- Reactor plutonium is contaminated with Pu-240, which complicates the task of a would-be nuclear proliferator. It has been claimed that the dilution of U-233 with U-238 would provide even better protection, but this contention is open to question on grounds that have not yet been fully discussed.

Proponents of the thorium/U-233 cycle feel that the above considerations are not definitive, and the debate between the alternative fuel cycles has been carried on with vigor throughout the world for three decades. I feel that intangible considerations such as commitment to prior choices and "the grass is greener on the other side of the fence" have been roughly a wash. It is now administration policy to have another go-around on this issue. This is not objectionable provided that the intent is not simply to delay ongoing programs indefinitely and that the studies will be objective, realistic, and not dominated by preconceived conclusions on either side. Physicists who wish to participate in this debate will be well advised to not only acquaint themselves with the complex engineering and economic aspects of the situation, but also to keep clearly in mind the underlying physics.

HENRY HURWITZ, JR
General Electric Company
Schenectady, New York

6/14/77

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Derek Paul's intemperate letter shows that this gentleman should learn more about nuclear engineering before he embarrasses himself further. Although his opposition to the LWR is apparent, he is blissfully ignorant of the fact that the Shippingport experiment that he approves of is a light-water breeder, based

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While the LWR does not have optimal fuel utilization, one must remember that it was developed for submarine use and had a substantial head start. Other reactor concepts may indeed be viable, or even superior to the LWR, but they will not be developed unless the reactor vendors can see a large enough potential market.

If the government were to offer Westinghouse or General Electric or any other repository of nuclear expertise a share in the development and manufacture of a molten salt breeder, or a heavy-water thorium-cycle reactor or any other alternative type, I am willing to bet they would accept the research monies, quite readily, and produce an acceptable and marketable design rapidly.

JACK PENKROT

5/19/77 *Pittsburgh, Pa.*

Nathiagali summer college

Nathiagali—the name takes one from the scorching summer heat of the Punjab plains to the heavenly scenic hill resort (altitude 8000 feet) 50 miles northeast of Rawalpindi in northern Pakistan with snowclad views of Nanga Parbat and other Karakaram peaks. A small village, only known to those seeking escape from the heat, has become the home of the international summer college on Physics and Contemporary Needs. The first two colleges have been held in August 1976 and June 1977 and more are planned. The college is attended by participants from thirty countries and is perhaps the first of its kind to be organized in a developing country with its emphasis on physics and its applications to technologies useful for developing countries and the role it can play in solving the problems of a developing nation.

The major aim is to offer to the large number of physicists of developing countries, most of whom have had the training in fundamental research in an environment of a European–American University, a broad spectrum of topics ranging from solar energy, oceans, geophysics and lasers to elementary particles and black-hole physics. Some fundamental topics are included to share the excitement of the recent front-line discoveries in elementary particles, astrophysics and cosmology, with physicists isolated from the main stream of today's research. However, the college's main role is to encourage physicists to contribute to the development of fields relevant to the needs of developing countries. Participants have discussed examples where physicists have successfully helped in solving problems not only in technology and energy but also in transport, communications and planning. One result from these discussions has been awareness of the need to establish an international center for experimental physics along lines similar to that of the International Centre for Theoretical Physics at Trieste, primarily aimed at offering reasonable research facilities to physicists from developing countries. High costs and technological restraints make the establishment of such centers on a local basis very difficult.

Need was also felt to encourage the physicists from developing countries to devote at least some of their time doing physics that would relate to local developing technologies. Perhaps the most noticeable feature of the college was the intellectual hunger, so evident from the high-level participants who have so long been isolated from the mainstream of ideas and developments in physics, both in theory and experiment. One must record the participants' appreciation to the Chairman of the Pakistan Atomic Energy Commission, Munir Ahmed Khan, for his personal interest in the working of the seminar, to the local director of the college, Professor Riazuddin, and to their devoted staff.

In view of its success, the Pakistan Atomic Energy Commission plans to continue the college as an annual event. If these plans are realized, the Nathiagali Summer Science Centre would revive an academic tradition that existed some fifteen hundred years ago in Julian University near Taxila (forty miles away from Nathiagali) where scholars from all over the then known world gathered to contemplate problems of society, civilization and the world.

KHALID RASHID

Pakistan Institute of Nuclear Technology

8/24/77 *Rawalpindi, Pakistan*

Laser Raman spectroscopy

In his recent article on coherent Raman spectroscopy (May, page 44) Marc Levenson wrote . . . "fifteen years ago, the development of gas lasers completely revolutionized the practice of Raman spectroscopy." Later on after making remarks on tandem monochromators, cooled photomultiplier tubes and so on he continues with: "What had been a difficult and exotic technique became a routine analytical procedure for studying vibrational and other elementary excitations of materials."[1] Reference 1 lists two books that do indeed give a survey concerning the progress made. Unfortunately one does not find too much in these books about the early history of laser Raman spectroscopy—that is the period 1962–66 when lasers were used to demonstrate that Raman spectra of strongly scattering molecules could indeed be excited as well as stimulated—and other fundamental Raman processes. Already

continued on page 52