whenever $(t_i)_{K_i} \leq (t_{i+1})_{K_i}$ for any i (2b)

and all K_i are the same (2c)

As an illustration, consider the following. The B_0 means the appearance of monoenergetic protons at the point **x** at $(t_0)_K$, all of the protons travel in vacuum until they hit a counter at point **y** at $(t_1)_K$, at $(t_2)_K$ protons with the same energy are emitted at point **y** whenever protons hit the counter at $(t_1)_K$, but not otherwise, and, finally the protons travel in vacuum until at $(t_3)_K$ they reach point **x**. This is a perfectly consistent way of specifying boundary conditions in usual physics, provided that all $(t_i)_K \leq (t_{i+1})$. If, however, this condition is violated, for example, if $(t_2)_K > (t_3)_K$, then the above set of boundary conditions are no longer necessarily all compatible with each other. In particular, if $t_3 = t_0$, then they are certainly incompatible, because B_0 states that at **x** all protons travel towards **y**, at t_0, while B_3 states that they travel in the opposite direction at $t_3 = t_0$.

Equation 2 can immediately be generalized, remembering that whenever all signals and coordinate frames travel with velocities less than c with respect to each other, the time order of any causally connected two events is not interchanged by Lorentz transformations: if $(t_i)_K \leq (t_{i+1})_K$ then $(t_i)_{K'} \leq t_{i+1})_{K'}$ where K and K′ are any two rest frames of observers or particles. In other words, if none of the velocities is superluminal, then condition 2c can be dropped, and the frames K_i may be all different; 2b alone will insure that 2a holds.

It is important to keep in mind that 2a can not be dropped in general if some particles have superluminal velocities. This is so, because then it may happen that $(t_i)_K \leq (t_{i+1})_K$ but $(t_i)_{K'} > (t_{i+1})_{K'}$ if K and K′ are two suitably chosen frames, even if the events at t_i and t_{i+1} are causally connected. Therefore, the usual procedures of specifying boundary conditions do not guarantee that these conditions are all compatible with each other, unless condition 2c is valid. An analysis of the unusual paradoxes quoted in connection with tachyons shows that all of them arise because the boundary conditions were given in various frames in a manner that satisfies condition 2b, but in violation of 2c. That such a procedure does not lead to a self-consistent solution, that is, that condition 2a is not valid, is, in view of what was said above, not surprising. However, while these paradoxes do not at all demonstrate the logical inconsistency of a theory that permits the existence of tachyons, they do clearly illustrate that boundary conditions have to be given with care.

Independently of whether tachyons exist, the principle of retarded causality may prove to be too narrow to describe nature on the deepest level. The possibility in a more general theory (based on full causality) of defining and discussing the "velocity of time," the possibility of closing causal chains, and of changing the singularity structure of scattering amplitudes, to mention just a few, appear to indicate this. During the last century many geometers believed that Euclidean geometry was the only logically possible one. Today more general geometries are widely accepted. I believe that, quite similarly, retarded causality, which is almost universally believed today, will prove to have been merely a hangup with which many of us were inflicted, and that the time is not far away when a more general causality will be accepted as a matter of course. Then many will no longer know that the more general causality principles were not always around, and few will remember where they came from. People will probably say: "Full causality? Why not? Violation retarded causality? Who cares?"—And they will be right.

PAUL L. CSONKA
University of Oregon

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In their rebuttal (December, 1969) of several letters concerning their article on tachyons, Bilaniuk and Sudarshan represent the point of my paper (Phys. Rev. **163**, 1274, 1967) as "So what?" in reaction to the causality objections. That entirely misses its intention. Rather than trying to make the argument here in a few lines, I refer the interested reader to my forthcoming article in *Science*.

R. G. NEWTON
Indiana University

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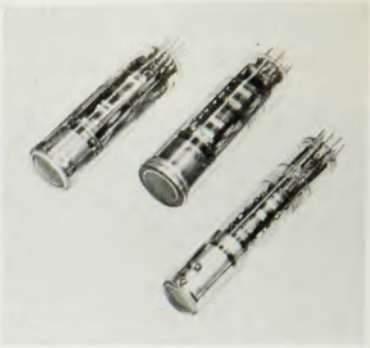

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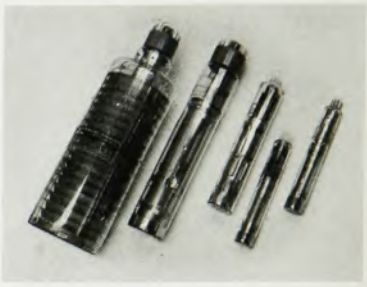

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tion by Owen Fleischman, and others (January, page 9) because it is the first good answer I have seen to the employment problem for highly trained young men. Our society suffers from a lack of research work on the basic problems in difficult scientific and social disciplines, and the consequent reinforcement of fundamental ideas plus leisure for research makes teaching the ideal first job in any field of philosophy, especially physics.

CARROLL B. MILLS
Los Alamos, New Mexico

Lunar contamination

I was interested in the letter by John O. Stoner, Jr regarding the danger of contaminating whatever lunar atmosphere there might be with exhaust gases from the landing vehicle (December, page 13). Just such questions, namely the probable nature of the lunar atmosphere and the consequences of such contamination, were discussed some years ago (see, for example, "Interaction between the solar wind and the lunar atmosphere," F. C. Michel, Planetary and Space Science **12**, 1075, 1964). There it was concluded that these exhaust gases are likely to be a sizable contaminant to any ambient atmosphere (predicted to have a mass of only about 10^2 metric tons). On the other hand, the major processes that determine the lifetime of neutral gas particles appear to be photoionization, with the resultant ion being swept away by the solar wind, and direct collisions with solar-wind particles, with the recoiling neutral having greater than escape velocities. The lifetime of contaminants can then be shown to be reduced, by either process, to the order of a year or less, rather than the thousands of years required for thermal escape.

One may hardly conclude that it is therefore satisfactory to so contaminate the moon, but at least there is the expectation that such contamination is short lived.

F. CURTIS MICHEL
Rice University

CORRECTION: December 1969, page 97—Joining the faculty of Southern Illinois University at Edwardsville as associate professor: **Ika-Ju Kang** should read **Ik-Ju Kang.** □