

Letters

Fashion and Competition in Science

I have noticed during my professional lifetime that scientists are much influenced by fashion. There is a tendency to confuse the momentarily fashionable with the fundamental and the significant in science. In my own student days (the 1920's) my contemporaries and I were told by our teachers that only two topics were really important, namely, quantum mechanics and relativity theory. It was also explained that hydrodynamics was played out and that none but the foolish would take up the study of the motions of fluids. World War II occasioned a rude awakening. We discovered that our teachers had omitted to say that the theory of compressible, as opposed to incompressible, fluids had barely been scratched by the 19th century hydrodynamicists. The realization of this fact encouraged the development of the present day theories of gas-dynamics and of magnetohydrodynamics with their many applications to astronomy and other subjects.

I am also frequently told that this or that fashionable branch of science is "highly competitive." I am led to wonder what this means, when I reflect that the really great men in science all regarded themselves as engaged in the solution of some problem that fascinated them, with no deadlines to meet. They did not aim for a speedy solution in competition with colleagues but rather for the attainment of as complete and sound a solution as they were capable of achieving. That certain present-day scientific activities are competitive appears to mean that a sensational pronouncement must be made at the earliest possible moment, the author then being quoted in the *New York Times* or being asked to lecture on the B.B.C. The combination of fashion and competition is likely to lead to concentration on those branches

of science where quick results are expected, to the neglect of more difficult and fundamental aspects. Worse still, if results do not come quickly, there is the temptation to substitute for them plausible-sounding, but superficial, guesses.

I am inclined to agree with A. M. Weinberg's definition of a significant branch of science as one which influences and advances numerous other branches. I believe he is correct in his estimate that high-energy physics, a highly fashionable subject, fails to qualify if his definition is adopted. Like some branches of pure mathematics, high-energy physics is becoming an isolated esoteric activity with little bearing on any other aspect of physical science. It is sometimes forgotten that the phenomena noticed in the high-energy physicists' very expensive apparatus are produced in a most exceptional environment in the universe. The apparatus is built on the surface of a planet which possesses some very peculiar properties.

For example, this planet is the only object known to astronomers which carries great quantities of liquid water on its surface; its temperature is low; its surface gravity is weak; and so on. And high-energy physics has a still more exceptional characteristic: matter is forced to behave in the way it does in the devices which are employed, because of the intervention of the human mind which invented the apparatus. There is no guarantee that the behavior of matter in nature would be similar in all respects to its behavior in the apparatus. Clearly, none of the phenomena observed in a betatron on earth would be observable at all on the surface of the sun, for the apparatus itself would there be turned into gas.

These preliminaries suggest that current fashion and a competitive spirit among the practitioners of some branch

of science are unimportant matters. Significance is to be assigned to a scientific topic when it involves interplay with other such topics.

In my own specialty of cosmology, it seems to me that the concurrent development of the radio and optical astronomy of galaxies is very significant. The apparatus employed in no way affects the objects that are being studied, all events being observed and analyzed long after they have taken place. Attempts to discover why one galaxy is a strong radio source and the next is not involve many aspects of physics. The same may be said of the source of energy in quasars. The distribution in depth of radio galaxies confronts the scientist with an unsolved problem, the nature of which is still uncertain. Were radio galaxies more numerous in the past than they are now, and if so, why have they ceased to function as emitters of radio waves? Or is the problem one of the large scale motion of expansion of the universe? On the technical side, the engineering and electronic problems involved in the construction of large radio telescopes may be cited. There is also the question of determining, in the optical domain, the total flux of energy (apparent magnitude) from an extended source of radiation like a galaxy. Can this be done satisfactorily and relatively quickly from the earth's surface, or does it require an orbiting astronomical observatory?

All but a minute fraction of the matter present in the universe appears to be in the gaseous state, the liquid and solid states being almost freakish exceptions. I suggest the name cosmic dynamics of gaseous matter for the class of phenomena in which large masses of gas appear to be in rapid motion. Supernova explosions, gas motions in Seyfert galaxies, jets and other types of outflowing gases in galaxies, gravitational collapse as the source of energy in quasars, and perhaps the general expansion of the universe itself, are examples. All aspects of the theory of compressible fluid mechanics are involved. The forces are presumably gravitational and magnetic, but I would not venture to assert that these are the only forces involved. Certainly gravitation appears to be one of the most important, if not the predominant, force in the universe, at least to an astronomer's eye. It is often said by physicists, whose attention is normally concentrated only on the terrestrial

laboratory, that gravitation is to be somehow derived from nuclear or atomic physics. I would suggest that this is to put the matter the wrong way round: the dominance of gravitation in the universe might lead us to ask whether nuclear or atomic physics should not somehow be derived from gravitation.

The large optical and radio telescopes or orbiting astronomical observatory needed for the study of galaxies are expensive. If any such devices are recommended, I would urge that emphasis be placed on the need for careful planning. All aspects of the design of the instrument should be completed before construction begins, pilot projects should be undertaken, the scientists who are to use the device and who know why it is needed should be involved in the project throughout, and so on. It might be thought that these are points too obvious to mention were it not for the sad history of the 600-foot dish at Sugar Grove. Above all, I think that the competitive aspect, either between scientists in one country, or between nations, is to be avoided. The aim should be not the out-doing of the other fellow at the price of hasty and slipshod work, but the nearest approach to perfection of which we are capable.

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Lunik III Photographs Reinterpreted

In a review of recent advances in solar-system science ("Space: Highlights of recent research," 11 Sept., p. 1129), Jastrow and Cameron suggest that one of the most interesting of recent finds about the moon was the discovery of the "Soviet Mountain Range" on the rear side of the moon. They correctly suggest that this range, if similar to terrestrial examples, requires revision of our theories of lunar structure. We wish to point out that after a thorough reprocessing and study of the Lunik III photographs, Whitaker concluded that the "Soviet Mountain Range" was nothing more than a combination of bright rays from two ray centers and does not represent relief [*Commun. Univ. Ariz. Lunar Planetary Lab.* 1, 67 (1962)]. In recent correspondence Breido, Schegolev, and Lipsky, who were responsible for the

misidentification of the feature, have agreed that Whitaker's interpretation is more likely correct. Further study of possible differences between the earthward and far-side hemispheres will be greatly aided by photography, preferably under morning light, of the one-third of the far side which has still never been seen.

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Space Poll

The editorial on the AAAS "space poll" (7 Aug., p. 539) must be disappointing to many statisticians and to others trained in statistical method. We are accustomed to expect AAAS and *Science* to display much of the best in scientific thought and practice. The space poll, as presented and interpreted by the editorial, falls far short of that standard as a reflection of present-day survey methodology.

It is entirely appropriate that *Science*, by means of surveys, obtain the opinions of its membership and report them. But it is reasonable to require that the sample be representative of the membership. And many consumers of the report might ask to know how the AAAS membership compares occupationally with the scientific community generally, or to see an accompanying distribution of AAAS membership by field of primary interest.

The poll is offered as a probability or random sampling of "the best minds of this nation," and thus invites the reader to believe that the conclusions are scientifically sound, when in fact they appear to rest on a doubtful technique. Several objections might be raised, but the critical weakness is acceptance, without investigation, of the 56-percent response as being representative of the target population. Obviously, biases can arise from a high rate of nonresponse, and in my opinion—shared by many, I'm sure—an inquiry cannot be accepted as a probability survey unless nonresponse is reduced to a small proportion of the designed sample, or at the very least until the representativeness of the respondents has been explored and found to be satisfactory.

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The remarks of a former president of the American Chemical Society quoted in Abelson's editorial of 7 August ("AAAS space poll," p. 539) seem chauvinistic and inhumane. Inasmuch as "we" are only Americans we can perhaps afford to spend our surplus on technological virtuosity and shrug off the cost. But inasmuch as "we" are mankind we are poor and in need. We have to struggle against disease, malnutrition, and ignorance that this same money could ameliorate if some of it were spent not "within the country" but without regard to country. In the long run, this might be not only a "vastly better" but the only way to avoid war.

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Bigotry in Scientists: Sources

As a psychoanalyst who works in a university setting, I was most interested in Abelson's editorial "Bigotry in science" (24 April, p. 371) and I would concur with Jesseph in his letter "Bigotry in scientists" (26 June, p. 1529), in which he opines that bigotry in scientists is "another proof that they are merely human."

But to transfer the onus for bigotry from the scientist to his parents seems to me unfair. With all of a psychoanalyst's appreciation for the power of parental precept, there are additional forces, and probably more important ones, which predispose the scientist, or anyone else, toward bigotry as defined in the *Science* editorial. For example, aging and tenure seem to be important factors, or the stoking of the hot fire of ambition by success, or the wish to hold onto one's gains and status taking precedence over the wish to renew the attack on the frontiers of knowledge, or the subtle loss of appreciation in the older person for the drive of youth toward the new, a drive which sometimes "leapfrogs" the conventional and the established and takes the lead in progress.

The same alliance of conservatism with aging can be observed both in the individual and in his organizations, scientific, political, or whatever.

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