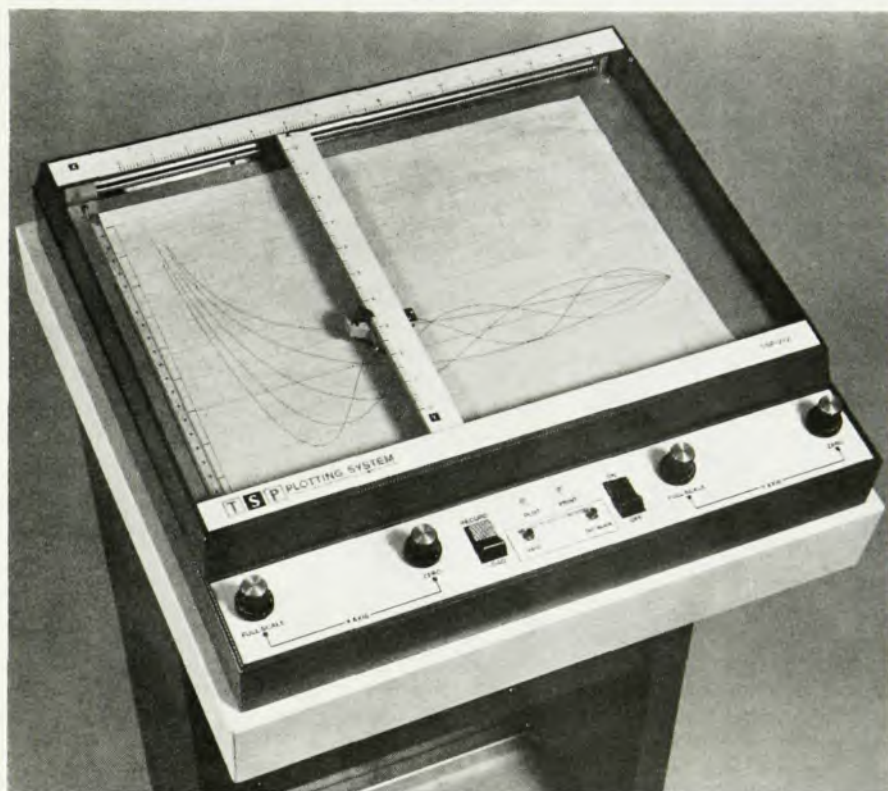


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letters

come about.

For many years scientists have been saying "While we as scientists find the study of these fields fascinating, you as nonscience students are not able to appreciate or understand them. You as laymen are only interested in the practical applications that can be derived from what we are doing." Are scientists really the only ones interested in understanding nature, or in resolving discrepant events? Are scientists the only ones curious about science? Certainly not! Yet this somewhat snobbish attitude of scientists annoys the layman and serves to broaden the gap between the scientists and the nonscientists.

What we need, I believe, are courses for nonscience students that provide a carefully planned, intellectually honest treatment of a few of the current research areas in science emphasizing not only possible applications, but the methods and aims of science, and the possible relationship that new knowledge may have on man's view of nature and of his place in space and time. These courses should deal with what is happening now in science and what we think might be happening in the next 20 to 30 years—the years in which these students will be living and working. To develop such courses requires innovation, creative people with an understanding of the nature of science, the current research efforts in science, and the nonscience student's interests and abilities.

RICHARD REIS
Stanford University

Time-sharing addendum

Congratulations to PHYSICS TODAY on the July special issue featuring computers. Now that about 90% of your readers use computers in their work, the informative surveys are well timed to help physicists get a wider view of computer capabilities and trends.

If we had not missed the deadline for responding to the time-sharing questionnaire, the table in Hussein Elkholy's survey would have carried the following added information: Telcomp Corporation of America, a subsidiary of Bolt Beranek and Newman Inc. of Cambridge, Mass., offers services in regions 1, 2, and 3 on two kinds of systems. The first uses PDP-10 central processors; fast memory space of 32 K 36-bit words; cycle time of 1 microsec; user languages TELCOMP III, BASIC, FORTRAN IV; simultaneous users, 64 per system; no minimum charge; terminal connect \$10/hr; CPU charge, \$0.05/sec per 4000 words of core memory; storage charge, \$0.40/month/640-char-

acter block. The second system uses PDP-7/8 central processors; cycle time of 1.75 microsec; user language TEL-COMP II; simultaneous users, 32 per system; no minimum charge; terminal connect, \$15/hr; no charge for CPU or storage.

We've been time-sharing since 1962 and offering services commercially since 1965, with special interest in research and educational applications. Harvard University has just signed a 3-year, \$900 000 contract to use our Telcomp services starting September 1, 1970. These services will be used by faculty and students in several schools including Harvard College and the Graduate Schools of Business Administration and of Arts and Sciences. The students, in physics as well as other fields, will use the time-sharing as part of their general education to learn programming and to gain experience in applying computer capabilities.

RICHARD H. BOLT
Bolt Beranek and Newman Inc.
Cambridge, Mass.

Relativists criticized

I have read Alfred Landé's letter on subjective relativity (November 1969, page 11) and Mendel Sachs's reply to it.

I consider, like Landé, that the theory of relativity is very far from the objectivity that is necessary to the very nature of science; this theory is indeed founded on various abstract postulates, represented by equations or statements that can not be verified directly by measurements of the quantities that appear in them.

Nevertheless one of these postulates is related to a physically measurable magnitude; it is that of the invariance of the velocity of light. The relativist is so lacking in objectivity that the velocity of light from a distant star has never been compared with the velocity of light from a local source. Certainly there is no reason why the velocity of light that left a star a million years ago, in a gravitational field different from that on earth and from a star moving relative to the earth, should equal the velocity of light from a local source.

Relativity explains Michelson's experiment, but it only shows that, within experimental error, the space enclosed by the interferometer is isotropic, as is well known.

This failure of objectivity has had, as a consequence, that many experiments have been done to show that the velocity of light originating from a source having radial velocity V_r with respect to the frame of the measuring apparatus is not such that $c'/c = 1 - V_r/c$ where c is the velocity of light issuing from a local source. This

formula is contrary to rational mechanics as confirmed by experiment.

To be objective we should find the function f in the equation $c'/c = f(v/c)$ which has not been done. One must, however, note that an experiment by D. Sadeh [*Phys. Rev. Lett.* 10, 271 (1963)] showed $c'/c = f[(v/c)^2]$ within experimental error, which was not given in Sadeh's note.

Another consequence of the lack of objectivity: Pound and Reka's experiment, made to confirm the theory of relativity by showing that the frequency of a Fe^{57} source depends on its height ("Einstein's effect") begs the question because the velocity of light was not measured at the time of the experiment. This experiment, if we ignore the postulates, shows that the velocity of light depends on the height of the source.

For the case of the sun, the same Einstein effect has another interpretation if the postulates are ignored; the velocity of light in the gravitational field of the sun is $c' = c + 0.636 \text{ km/sec}$ in rational mechanics [*Appl. Optics* 7, 1391 (1968)].

JEAN LOISEAU
Paris

THE AUTHOR COMMENTS: I believe that in Loiseau's interesting comments there are perhaps some misconceptions about the meaning of the term "objectivity" in science and about the role that is played by the speed of light in relativity theory.

Loiseau assumes that a theory which is based on abstract postulates, rather than assertions that are directly related to observations, can not be an objective theory. Thus he assumes that the philosophical stand of realism can not lead to an objective theory of natural phenomena and that the only philosophical stand which can do so is the one of positivism. I think that this is a false interpretation of the word "objectivity." The latter term, when applied to science, requires that the natural laws be independent of the particular characteristics of any observer or measuring device (for example microscopic or macroscopic, at rest or in motion, and so on) that deduces these laws. Thus, if any sort of observation or interaction should be described with a theory based on abstract postulates, and its formal structure is covariant with respect to the transformations from one observer to any other, then this would be an objective as well as an abstract theory (that is, a theory that is based on assertions, some of which are not directly observable with the human senses or his instruments). The theory of relativity is of this sort. Thus, in contrast with Loiseau's comment, this theory does indeed entail an objective description of nature.

Regarding his comment about the

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