

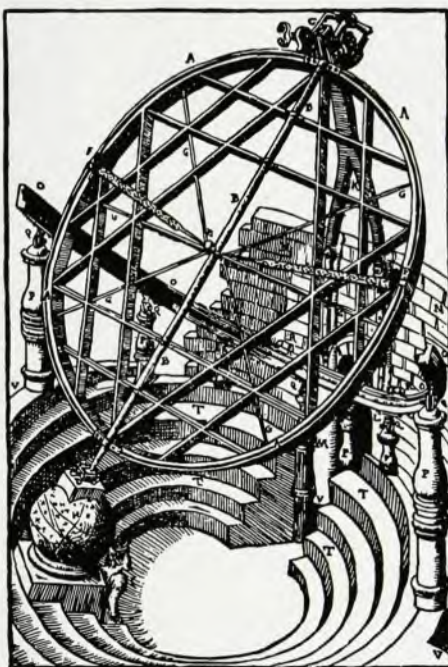
The astronomical establishment in 1570

There is a fascinating admonitory excursion into folklore by Robert J. Yaes in your December issue (page 11), in which he imagines a mammoth astrolabe built during the 1570's by the astronomical establishment to measure planetary positions to the thousandth of a second of arc. (This is an order of magnitude better than the resolving power of Michelson's stellar interferometer, but no matter.) Through this mischanneling of funds, young astronomers were deprived of needed support even down to 1667 when young Isaac Newton, despairing of a future in science, turned down a Fellowship at Trinity to migrate to the Inner Temple and study law.

Extrapolation is an interesting process, especially when one projects into a region in which the data are known. It is just possible that Yaes's appeal to the past may be an argument in favor of scientific gigantism and the generous support of fat cats. The data seem to show that Newton himself depended upon in-house funding, but that the theoretical structure on which his advances were based had grown from the concentration of lavish resources into the hands of a single prestigious operator.

In 1576, Tycho Brahe received an enormous government grant for the construction and operation of an astronomical observatory. He did not equip it with an astrolabe, to be sure, but with a wide variety of triquetra, armillas and divided circles in the form of quadrants and sextants. Some of these instruments were relatively small and portable, some were large and fixed, a few were gigantic. All were built to a standard of workmanship beyond the means of other astronomers, and they were housed in special buildings, specifically designed for their use.

To carry out his observations, Tycho employed a crew of research assistants, who were probably paid the customary pittance. As not infrequently happens, they turned out better work under his direction than they managed for themselves in later life. While they did not achieve that thousandth of a second of arc, they did push the precision of their measurements to one or two minutes.



Tycho Brahe's great equatorial armilla

This is hardly so glamorous, but it was enough to make Kepler's eight-minute discrepancy intolerable.

If we are to draw salutary lessons from history, we should no doubt applaud Tycho's grant and probably also the change of administration, which later cut back his funds and induced him to switch institutions. We might applaud in addition those ideological pressures that presently enabled him to pick up an inexpensive theoretician, a refugee scholar named Johannes Kepler. (It is an interesting sidelight that in the seventeenth century the unorthodox were forced to leave the country, whereas in the twentieth they are usually prevented from doing so.) We should certainly notice how the precision of the observations from Tycho's data factory forced Kepler to abandon both the Ptolemaic and the Copernican formalisms for representing the heavenly motions. Perhaps we need not dwell on the unattractive scheme involving an Apollonian conic with which we replaced them.

A good novelist, no doubt, could produce half a dozen scenarios that would be morally more acceptable. The facts

are that Newton *did* use Kepler's laws, that Kepler *did* use Tycho's observations, and that Tycho's observations were produced by the extraordinarily generous funding of a single, extravagant, overbearing, conceited aristocrat.

The comforting thing about history is that it either may or may not be applicable to the present.

ALFRED ROMER
St. Lawrence University
Canton, N. Y.

The letter by Robert J. Yaes (December, page 11) is well taken for the most part. My only quibble would be at his suggestion that Newton would study law.

I suggest that he would be much more likely to study theology, since he actually wrote a respected commentary on the Book of Daniel. The Church of England was quite literally "the establishment" of his day, and thus a safer refuge for a prospectively unemployed scientist than his other possibilities in mathematics and chemistry or alchemy. He did, of course, get a good "civil service" job, anyway, as Master of the Mint.

WILLIAM F. WHITMORE
Los Altos Hills, Calif.

Physics & society conflict

While it is refreshing to see George Brown's "Physics and Social Change" (October 1971, page 23) as a lead article, and while I welcome his general purpose, I fear that much in the article is based on misconception of the way in which physics has evolved and of the way by which societies, especially in their economic and political aspects, are changing. This can only lead to illusion and false hope concerning the way in which future change (both in physics and in society) will take place.

The very examples that Brown cited near the end of his article—the replacement of the Ptolemaic cosmology by the Copernican, the classical mechanistic physics of Newton by the relativistic physics of Einstein and also by quantum mechanics—have to be viewed in

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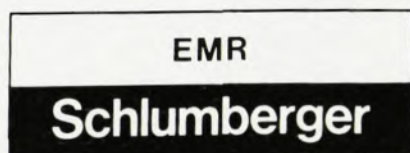
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letters

their true historical development. In each case (and for many other models and constructs), the newer view was not at all so readily accepted, frequently strongly resisted by the adherents of the older, former view.

While it may be true that at this stage of the scientific game physicists should recognize, as Brown states, that change is to be expected (and, by implication, accepted), Brown himself has not focused on the intellectual (and other kinds of) conflict that has ensued when new and old concepts in physics clashed. While there is obvious historical process involved here, Brown has not described the nature of the process at all. The nub of the process is conflict. In physics it is conflict that arises out of the constant seeking out and the discovery of new knowledge that develops in contradiction to the old, incomplete knowledge. In brief, this is the dialectical process that Brown merely skirts.

When Brown writes, "The creation of abstract mental structures that best represent the reality of his world and time, that gives significance to Man's existence, are his universal characteristics. From these abstract structures are crystallized human institutions to nourish and guard the symbols," he again leaves out the element of conflict inherent in the advocacy by human beings of different institutions within the same society.

My contention is that the nature of the process of change in physics and that of change in society, though both are marked by dialectical conflict, are only superficially similar. In science, except where scientists are "locked-in" by nonscientific aspects of their personalities (such as strong adherence to current religious, economic or political institutions, or by vanity or fear) that may be in conflict with new scientific ideas, they are more apt to be open to new ideas and concepts. But in the area of social, political and economic institutions men most frequently set up constructs of these institutions in terms of the position that men occupy in society. Hence, some men fear change in these institutions and in their concepts of these institutions, whereas others welcome it, depending on how the proposed change will affect them. Men's consciousness of the institutions governing their lives is mostly determined by their "total" position within the society in which they find themselves. Largely, but not solely, this is "economically" determined. Different classes in society see the same institution with different eyes and mind.

Hence, it is not true that Man has sated his appetite for material things; only some men, in some countries and societies, have done so. Also, it must

be quite clear that those men, classes and countries that are a long way from having even begun to satisfy their "security-survival" needs will continue to press for their share of what is available. Physicists might well ponder what is the process that has driven some classes and countries to the counter-productive limits of "controlling" and "consuming" that are threatening not only themselves but others.

HYMAN R. COHEN
Brooklyn, N. Y.

The author comments: I cannot disagree too much with Hyman Cohen's comments regarding my article. I was seeking to present the science of physics as a good example of Man's adaptation to the process of change—the continuing revolution.

I am well aware of the problems of power and conflict involved in social and political change. This has been my vocation for many years. Only recently have scientists in the social field focused in their analyses on the importance of developing social and political institutions which can, non-destructively, generate and absorb continuing transformation. (For example, see Piaget's *Structuralism*, Halpern's *The Revolution of Modernization* and similar works.) There is much more to be said on both the parallels and the differences between the so-called "hard" and "soft" sciences. To my mind, the imperative need is for more trained minds looking at human problems in total perspective (Taoistically) rather than atomistically. I hope Cohen would agree.

GEORGE E. BROWN, JR.
Los Angeles, California

Consumer complaint

Among the public (and some companies) these days there is a great deal of interest and concern about consumer protections. I wonder if it would be in order for AIP to establish an office or committee to review complaints from individuals who have had some difficulty with the suppliers of scientific equipment, especially those that supply apparatus for labs.

As it is with human nature, one does not become concerned until the problem becomes a personal one. In particular, I ordered a small amount (dollar-wise) of equipment on 5 August of last year and have not, as of this writing, (October) received even acknowledgment of my order. This is the second time I have had this large delay in receiving an order from this particular company. I know of at least two other people from schools with small budgets that have experienced the same problem. In relation to another problem

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