De Revolutionibus in Orbe Coeleste

Trying to explain how quasars do what they do is leading some astrophysicists to propose a revolution in physics

BY DIETRICK E. THOMSEN

When a new scientific phenomenon is discovered, scientists proceed to make a model, to think up a mechanism or structure that can account for the observations. As observations continue, refinements are added to or forced on the model, which can gradually grow into quite a rickety structure, carpentered up piece by piece. In a recent article in NEW SCIENTIST, Victor Clube of the Royal Observatory at Edinburgh compares this process to a mathematical series. The first gross model is like a simple equation, to which higher and higher order terms are successively added. Occasionally this leads to a revolution: Someone notices that what is developing is an infinite series, and suggests going over to the logarithmic or exponential equation that is the equivalent.

The mathematical analogy is apt for physics or astronomy, which Clube happens to be talking about, because physical models are usually mathematical, but the revolution here is more than notational legerdemain or mathematical transcendence for doing away with infinities; it is a radical change in the physical point of view that rearranges everything and puts a stop to the carpentry of the model makers. The ultraclassical example is the continual addition of new epicycles to the Ptolemaic planetary system until it got unbelievably complicated. Then a few people noticed that the whole thing could be simplified by a radical change in point of view: Put the sun in the center. The contemporary example that Clube is pushing is the theory of quasars.

Quasars have been a severe theoretical problem for almost 20 years. When astronomers first deduced the rates of quasar energy production, they looked for the densest and most violent things in the physics they knew to make a model. Black holes have become one of the favorites. But Clube remarks, "The range of energies we observe far outstrips that which led to our existing paradigm." And he quotes the late Fritz Zwicky and V. I. Ambartsumian, director of the Crimean Astrophysical Observatory, on the dangers of making models too early. Zwicky's advice was to be sure there was enough of a pattern visible in the observations that one could be certain one's zero-order model was in the right ballpark.

It is quite clear by now that Clube is unhappy with conventional quasar models. Indeed, he says that a lot of astrophysicists are waiting for a revolution to happen, and that is what is making astronomy so exciting these days. There is an excitement and there are prominent astronomers who are unhappy with quasar modeling, including those Clube cites as belonging to the loyal opposition: H. C. Arp of the Hale Observatories, G. R. Burbidge, now director of Kitt Peak National Observatory, and Fred Hoyle.

But there is an establishment, too. In a previous article in NEW SCIENTIST, Martin Rees, who is Plumian Professor of Astronomy and Experimental Philosophy at the University of Cambridge, argues explicitly against any unconventional solutions for the quasar problem. But he does so as a *"reluctant* conservative [his italics]." And he continues, "Philosophers of science of the Kuhn school [which Clube invokes in his arguments about model building and revolution] would be surprised at the many astronomers who are eager rather than reluctant to jump on a revolutionary bandwagon."

Surprised perhaps because physical scientists are a notably conservative lot. *Stare decisis* is a principle that is not for high court judges only. Conventional physics, the physics of now, has shaped people's thinking, and it has a weight that is hard to chip away at. One can imagine a cardinal saying to Galileo: "Of course you can calculate orbits better, but think of the philosophical implications of this idea." Einstein said no less in slightly different words about quantum mechanics. Here in the quasar question the revolutionaries are tampering with the basic laws about matter and energy, and the surprise is widespread enthusiasm for the revolution. In the past, revolution in physics required dragging physicists by the feet. Of course that is not to say there is no opposition this time, nor a good deal of philosophical apprehension nor even some real anger.

The revolution proposes to lay violent hands on two aspects of the quasar problem where the dangers to conventional ideas are fundamental: The redshifts of light and the production of energy in general. One of the fascinating things about quasars from the beginning has been that the light emitted by most of them is strongly shifted to the red end of the spectrum. In conventional physics there are two mechanisms to produce such a redshift: a high velocity of the source away from the observer or a strong gravitational field in the source. The velocity explanation is the usual one in astronomy, and, if adopted, places most quasars at enormous distances from us in space and time.

The great distances in space and consequent earliness in time raise other physical problems, and there have always been astrophysicists who refused to take quasar redshifts as a measure of distance. One of them is Arp, who goes around showing pictures of quasars that appear physically linked to galaxies, usually galaxies with much different redshifts, in order to show that redshift and distance don't go together for quasars. He is sometimes treated like a public inconvenience, but he persists. Since the other conventional explanation for quasar redshifts, gravity, has been put out of court, largely through the work of Maarten Schmidt, director of the Hale Observatories, and Jesse Greenstein of Hale, a new mechanism is necessary if Arp is right.

The even larger question is the central energy mechanism of the quasars. Conventionally many astrophysicists would like to use a black hole somehow as the prime mover. The other suggestion is spinars, extremely massive stars or clusters of stars. But spinars already raise a problem for conventional physics, because, according to the usual general relativity, spinars should not stay spinars but should collapse into black holes.

That is a problem for their proponents to solve, which some of the proponents readily admitted at last summer's Workshop on QSO's and Active Galactic Nuclei sponsored by the Lick Observatory (SN: 10/21/78, p. 282). They got a respectful hearing at that meeting, but they did not really specify the spinars' energy source. Clube is willing to do it in two sentences: "In developing theories of the masses of fundamental particles, however, modern physicists are quite accustomed to invoking the existence of a superfluid, superconducting vacuum state which is the source of all mass-energy. Thus, however radical the hypothesis may seem at first sight, there can be no objection in principle to our drawing on this virtually infinite source under particular intermittent physical circumstances to build supermassive [galatic] nuclei." Periodically or rather quasiperiodically, for several million years every 100 million years or so, the nuclei of galaxies and quasars draw mass from this vacuum and go supermassive. (Then they give the extra mass back to the vacuum.)

These supermassive stages can supply the energy for the quasar phenomena. They can also explain the redshifts, which become gravitational again, since the arguments against gravitational redshifts are based on the nonexistence of supermassive galactic nuclei.

This intermittent supermass creation may not be the only radical suggestion to be floated in the future, but it is certainly an interesting one. It may not be in the ballpark, but it's surely from left field. Will astrophysicists take it? Will they even pay attention? Stay tuned. □