a full-page advertisement in *Science* (10 April 1959, p. 931) by the Rand Corporation, and it might well serve as a text for the theoretician in the computer lab.

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Luyten's contributions to our understanding of white dwarf stars are so basic to all work in the field that his comments deserve serious attention.

Luyten's inference that I am dissatisfied with the contributions of observational astronomy to our knowledge of the deaths of stars is a misunderstanding resulting from my poor choice of phraseology. In actuality, I find it inspiring that, despite the great technical difficulties involved, observers can discover as much as they have about the final stages of stellar evolution.

Of the four subtopics in "Gravitational collapse and the death of a star" —white dwarf stars, dynamics of supernovae, neutron stars, and collapse to zero volume—only white dwarfs are amenable to extensive observational study. Luyten wishes that I had devoted a larger portion of my article to observational results on white dwarfs. However, great progress has been made recently in our theoretical understanding of supernovae, of neutron stars, and of gravitational collapse, whereas by comparison white-dwarf observations and theory have changed little in the last 5 years. To do justice to exciting recent developments, it was necessary to be brief in describing the beautiful but well-known observational and theoretical results on white dwarfs.

Luyten fears that the present trend of science is to pursue mathematical computations in an experimental vacuum. On the contrary, it seems to me that recent developments furnish beautiful examples of the manner in which observation and theory are jointly, and inseparably, responsible for the progress of science. For example, the computations reviewed in my article provide a link between experimental nuclear physics and experimental elementary particle physics on the one hand, and observational astrophysics on the other: From experimental laboratory studies one obtains a fairly reliable understanding of the properties of matter at and below nuclear density ($\lesssim 10^{15}$g/cm^3). One then uses this laboratory-based knowledge, together with arbitrary assumptions about the equation of state of matter at supranuclear densities, and together with the theories of relativity and of hydrodynamics, to compute the properties of superdense stars, the dynamics of supernovae, and the dynamics of collapse to zero volume. Happily, one finds that, although the results of the computations are highly sensitive to the known properties of matter at subnuclear densities, they are insensitive to the unknown equation of state at supranuclear densities (*1*). From these experimentally based computations one concludes that supernovae, collapsing stars, and young superdense stars should all be copious sources of x-rays, of neutrinos, and of gravitational radiation. This conclusion provides an important impetus to the development of the very young, and as yet necessarily primitive, fields of neutrino astronomy and x-ray astronomy, and to the search for gravitational radiation.

The scope of observation, far from being decreased, is undergoing in the newer developments of astrophysics the greatest enlargment of this century. Everyone will agree with Luyten when he stresses that observation is the foundation of all knowledge; and everyone is excited by the new realms of observation which modern astrophysics is opening up.

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References

1. See, for example, C. W. Misner and H. S. Zapolsky, *Phys. Rev. Letters* **12**, 635 (1964); R. Penrose, *ibid.* **14**, 57 (1965); M. M. May and R. H. White, *Phys. Rev.* **141**, 1232 (1966); B. K. Harrison, K. S. Thorne, M. Wakano, J. A. Wheeler, *Gravitation Theory and Gravitational Collapse* (Univ. of Chicago Press, Chicago, 1965), chapters 5 and 11.

Quarks Defined

May I add a linguistic remark to Edwin M. McMillan's lecture on particle physics (27 May, p. 1210). McMillan states that Murray Gell-Mann suggested the name "quarks" for a possible set of particles, using a "made-up word originally used by James Joyce in an entirely different connection." In German the word quark is not a made-up word, but is the term for a somewhat gluey cottage cheese. Maybe the "hadrons" should be called quarks.

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