Dying Stars

White Dwarfs.
G. WEGNER, Ed.
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From a colloquium, Hanover, NH, Aug. 1988.

White dwarfs mark the final stage in the lives of relatively low-mass stars, including, eventually, our own sun and most or all other stars with masses less than about six times that of the sun. These dying stars have used up their nuclear and gravitational energy sources and contracted to densities a million times those of familiar substances. They radiate the residual heat of their constituent atomic nuclei in a miserly fashion that keeps them dimly shining for 5 to 10 billion years. A few dozen astronomers, world-wide, devote most of their research to white dwarfs, and another couple of hundred are interested enough to come to an occasional meeting like the International Astronomical Union Colloquium whose 27 OCTOBER i989 proceedings are contained in the present volume.

Half a dozen or so questions would occur to a white dwarf lover who had been deprived for a couple of years of journals, conferences, and preprints. Good, clear, up-to-date answers (epoch August 1988) to essentially all of those questions are to be found somewhere in this book. Unfortunately, they are not easy to find. The volume has no index; the papers are printed, apparently, in the order they were presented and are not fully grouped by topic; and the abstracts of the longer review papers have been omitted to save space.

To save your having to hunt, here are a few of the critical questions and the answers presented at IAU Colloquium 114. The oldest white dwarfs set a limit to the age of the Milky Way galaxy, an important parameter in calculations of galactic and cosmological evolution. The oldest will also be the faintest, and thus difficult to look for. Despite the difficulty, it can now be said with some confidence that the number of white dwarfs per unit brightness interval drops sharply below 104 solar luminosities (papers by C. C. Dahn et al., M. T. Ruiz et al., and F. D'Antona). This may indeed mean that the galactic disk is not much more than 7 billion years old (the sun is 4.5 Gyr). But it may alternatively reflect physics missing from the cooling calculations whose effect is to prolong stellar life near 10-4 Lo and then hasten the subsequent fading.

Another topic of recent acrimonious debate is the number of pairs of close binary white dwarfs with total mass exceeding a critical limit near 1.4 solar masses and periods short enough for the stars to merge in a few billion years. Such pairs are the current "best buy" for progenitors of the kind of supernova that occurs among old stars. Unfortunately, the short-period systems all seem to have low masses, and the massive systems all seem to have excessively long periods for the purpose. A new round of careful searches for white dwarfs with variable radial velocity has uncovered a handful of new candidates. D. Foss reported three, A. Bragaglia et al. two, and R. A. Saffer and J. Liebert one more (which unfortunately is already known to have too small a mass for the stars to explode when they merge). On the theoretical front, new models of merging white dwarfs were presented by three groups. M. Kato et al. are rather pessimistic about the requisite sort of explosions occurring, even if the white dwarfs are massive enough; W. Benz et al. are quite optimistic; and R. Mochkovitch and M. Livio decline to state.

Binary white dwarfs are also investigated for their own sake. Current questions concern whether the binary ones differ systematically from the single ones in either mass or magnetic field properties. The observed binary white dwarf masses are, indeed, higher than average for single stars, but M. Politano et al. conclude that this is an effect of observational selection and that the real distributions are the same. The fields, on the other hand, are genuinely different. Only 2 to 3% of single white dwarfs have measurable magnetic fields (ranging from 2 to 500 megagauss). Among the binaries, according to G. D. Schmidt and J. P. Lasota et al., strong fields are much commoner (found for more than 20% of the stars) and confined to a narrower range of 10 to 50 MG. Curiously, no white dwarf fields between 105 and 106 gauss are known, though they would be conspicuous in detailed spectral analyses.

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