INTRODUCTION

This Colloquium on White Dwarfs and Variable Degenerate Stars and the associated Fourth Annual Workshop on Novae, Dwarf Novae, and Other Cataclysmic Variables comes at a time of increased interest in the late stages of stellar evolution. New instrumental opportunities open the spectral range from 3000Å to approximately 50Å for (at least) limited study, while the more usual spectral bands can be pressed to either fainter stars or higher resolution. The color and proper motion searches of H.L. Giclas and W.J. Luyten provided rich lists of white dwarf candidates in which the bulk of the objects discussed in these meetings were first noted. A new survey by R.F. Green of blue objects has already provided us with an unusual object of a new class, PG1159-035, an unusually hot DB, two-mode oscillator.

The theoretical structure erected to understand this wealth of new material, the physics of dense matter, has been much extended but has not reached definitive formulation. The thermodynamics of the cores of these stars includes electron degeneracy, a highly imperfect ion equation of state with strong Coulomb terms leading to crystallization, but these latter effects have evaded both experimental verification and quantitative observational tests. In the atmospheres of these stars we find a split into H, He and C stars (if not others) which may reflect the combined effects of diffusion and/or selective light pressure. Here calculations remain controversial as there are many conceptual difficulties in dealing with these phenomena in an atmosphere which may be simultaneously partially degenerate, partially ionized, and strongly imperfect. This same part of the pressure-temperature plane is traversed in the laser-induced fusion experiments. It brings astrophysical techniques into that field, and experimental results into ours, a welcome collaboration.

Clearly, our discussions elaborate the present state of our knowledge of degenerate stars. We do not burden the reader with the history of our subject from Bessel's discovery of Sirius' duplicity to the present, nor do we didactically expound the contributions of Fowler, Chandrasekhar, Marshak and Mestel to the understanding of the degenerate equation of state and of the subtleties of these fading stars. But today, amidst the discussion of oscillations and eruptions, let us try to sort out some themes for the next decade.

First, XUV whole-sky surveys will spot the hottest white dwarfs in numbers which will allow discussion of the neutrino loss rates. One expects that the maximum effective temperature for these stars should be related to the maximum mass of actual white dwarfs.

Secondly, observer-interpreters of white dwarfs find a remarkably narrow range in masses for single white dwarfs, a range which seems inconsistent with the components of binaries. Do we deal with two classes of objects? Will the difference persist as we acquire a larger sample? If these stars are indeed the remnant cores of massive stars (say $M = 2\text{-}6M_\odot$), why are the end-products of nearly the same mass? Is there a significant mass difference associated with different atmospheric composition? Remember, theorists can accomodate masses ranging from Jupiter up to the modified Chandrasekhar limit. Where are they?

Thirdly, faint white dwarfs, admittedly red, should show the rapid drop in internal energy below the Debye temperature by more rapid evolution. Is the absence of these stars measuring the Debye temperature or does it reflect the absence of stars of sufficient age in the accessible volume of space?

Fourthly, the large magnetic fields carry us beyond the familiar Zeeman patterns into a little-explored part of atomic physics, into a parameter range in which the magnetic and electrostatic coupling constants are comparable. We lack adequate theoretical models for both line formation and the polarization of the continuum at these field strengths.

Fifthly, while the crystallization of simple media is reasonably treated, mixtures present new phenomena including possible separation of elements by differential solubilities in the crystallizing liquid. This may provide a significant energy source, in spite of the small density changes, because of the strong gravitational field. This may affect white dwarf temperature and luminosity functions.

Sixthly, the present low limits upon the rate of white dwarf rotation is as puzzling as the physical and numerical instabilities which place evolutionary calculations of rotating white dwarfs beyond our reach.

Lastly, the excitation of white dwarf pulsations and the rapid recovery of dwarf novae still elude us.

In conclusion, white dwarfs and evolved stars hold our interest through the variety of observed physical effects and by the novel and challenging physical phenomena that must be explored in response to the observational challenge. This mature field lacks the glamour of the neutron star, the quasar, or the burster; yet we have a precious commodity to offer those who accept the challenge, redundancy. In an observational science, only that knowledge is secure which can be established upon several independent arguments. Half a century ago Adams and Moore separately, but not independently, measured the velocity of Sirius B and confirmed the Einstein red shift. We know today that the red shifts which were reported imply an impossibly large hydrogen abundance. This demonstrates how easy it is to be seduced by a seemingly agreeable measurement, how difficult

https://doi.org/10.1017/S025292110007562X Published online by Cambridge University Press

to maintain critical judgement when one has the result one seeks. Today, we expect that the mass and radius of a binary star should not only fit the Einstein relation, and the modified Chandrasekhar mass-radius relation, but also that they should lead to an evolutionary age compatible with its companion and with the likely earlier history of the system. Our study of the spectra far exceeds the minimum number of colors needed to establish a temperature, and we expect consistency with the intricate details of the observed spectra over the wide wavelength band that is now available. It is the hope of exploring this intricate complex which has inspired this colloquium.

The program of these meetings was set in collaboration with the Scientific Organizing Committee, especially with my colleague Hugh Van Horn, who has also served as chairman of the Local Organizing Committee and co-editor of this volume. In truth, we shared responsibilities for this meeting; our titles served only as a convenience for those outside our community who needed a unique address.

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