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Line Broadening in White Dwarf Photospheres

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White dwarfs are the simplest stars with the simplest surface chemical compositions known. Spectroscopically we detect only hydrogen in surfaces of the vast majority of these stars. The remainders are of various types, including stars with surfaces of nearly pure helium and some apparently massive stars with carbon and oxygen at the photosphere. We will examine the potential offered by the white dwarf stars in the context of both astrophysics and physics. This potential includes studying cosmochronology–establishing the age and evolutionary history of our galaxy and an independent lower limit on the age of the universe, constraining the properties of axions and WIMPS in the context of dark matter models, constraining dark energy by establishing the properties of the massive progenitors of type Ia supernovae, studying nucleosynthesis from their internal composition structure, and crystallization in dense Coulomb plasmas, among many others. Realizing this tremendous scientific potential depends on the determination of two boundary conditions for each star: the surface gravity and effective temperature. To do this, we must establish the photospheric plasma conditions, density and temperature, using observations of the stellar absorption spectra. Our understanding of line broadening appears to be an obstacle, at present. We will discuss the evidence for past theoretical inadequacies in line broadening theory and the hope for recent and future calculations. We will discuss how the experiments underway on the Z-facility at Sandia National Laboratories –where we can create macroscopic uniform plasmas under white dwarf photospheric conditions–will provide the benchmarks for improving our understanding of line broadening under white dwarf photospheric plasma conditions. These experiments will guide future theory and improve our understanding of the white dwarf stars and, through them, the contents and evolution of the cosmos.