



Luminosity functions of disc (dotted line) and halo (solid lines) white dwarfs as a function of luminosity. This figure assumes bursts of star formation at 10, 12, 14, 16, and 18 Gyr that lasted for 0.1 Gyr. The luminosity function of disc white dwarfs was computed assuming a disc age of 9.3 Gyr. The observational data were obtained from Liebert et al. (1988, 1989).

White dwarfs are well-studied objects and the physical processes that control their evolution are reasonably well understood. In fact, most phases of white-dwarf evolution can be successfully characterised as a cooling process. In other words, white dwarfs slowly radiate at the expense of the residual gravothermal energy. The release of this energy occurs over long time scales (of the order of the age of the galactic disc, 10 Gyr).

The mechanical structure of white dwarfs is supported by the pressure of the gas of degenerate electrons, whereas the partially degenerate outer layers control the flow of energy. Precise spectrophotometric data – like those that Gaia will provide – will introduce tight constraints on the models. Specifically, Gaia will allow the mass-radius relationship to be tested. Even today, this relationship is not particularly well constrained. By comparing theoretical models with the observed properties of white dwarfs in binary systems, Gaia will be able to constrain the relation between the mass of the star on the main sequence and the mass of the resulting white dwarf.

Gaia will also provide precise information on the physical mechanisms (crystallisation, phase separation, ...) operating during the cooling process. Given their long cooling time scales, white dwarfs have been used as a tool for extracting information about the past history of our Galaxy. The large number of white dwarfs that Gaia will observe will allow us to determine, with unprecedented accuracy, the age of the local neighbourhood and the star-formation history of the Galaxy. Furthermore, Gaia will be able to distinguish among the thin- and the thick-disc white-dwarf populations, and, in this way, it will be able to provide fundamental insight into the Galactic history. Gaia will also probe the structure and dynamics of the Galaxy and provide new clues about the halo white-dwarf population and its contribution to the mass budget of our Galaxy.

Finally, new constraints on the (hypothetical) rate of change of the gravitational constant (G) will be derived by comparing the measured average cooling rates of white dwarfs. More specifically, Gaia will largely reduce the observational errors in the determination of the disc white-dwarf luminosity function. Since the white-dwarf luminosity function measures the average rate of cooling of white dwarfs, and since this rate depends crucially on the rate of change of G , the Gaia observations will strongly constrain its rate of change.