Mem. S.A.It. Vol. 74, 454

Memorie della

The Galactic white dwarf populations

M. Cignoni[1], S. Degl'Innocenti[1,2], V. Castellani[3], P. G. Prada Moroni[1,2], and S. Petroni[1]

[1] Dipartimento di Fisica, Università di Pisa, Pisa, Italy
[2] INFN, Sezione di Pisa, Pisa, Italy
[3] INAF, Osservatorio Astronomico di Roma, Monte Porzio Catone, Italy

Abstract. We present the results of a Galactic model able to describe the observational behavior of the various stellar components in terms of suitable assumptions on their evolutionary status. The theoretical framework allow us to predict the expected distribution of the Galactic White Dwarfs (WDs) population. Results appear in rather good agreement with recent estimates of the local WD luminosity function.

Key words. galaxy: stellar content – stars: white dwarfs

1. Theoretical framework

We develop a three components Galactic model which closely follows the 'classical' Galactic models by Bahcall & Soneira (1984) (see also e.g. Gould et al. 1993, and references therein) and Gilmore & Reid (1983) concerning the spatial density distribution of stars. However, our model relies on suitable assumptions on the evolutionary status and the initial mass function (IMF) of the various Galactic populations to reproduce the observed disc and halo luminosity functions. In this way, we are able to predict star counts and synthetic color-magnitude diagrams of field stars from the main sequence to the white dwarf (WD) evolutionary phase for various photometric bands and Galactic coordinates. The main goal of our work is the introduction of disc, thick disc, and spheroid WD population in an evolutionary consistent way. We assume that stars with $M > 8$ $M_{\odot}$ evolved up to supernova explosion, while stars more massive than the evolving AGB ones are WDs, whose mass is obtained from suitable initial-final mass relations for the different WD populations.

As widely discussed in Castellani et al. (2002), the WD population is barely sensitive to a change of theoretical WD models or to a variation of the adopted relation between the WD mass and the progenitor mass, while, as expected, the results are significantly affected by the variation of the initial mass function for masses which could evolve into WDs in a time shorter than the estimated age of the Universe.

Send offprint requests to: M. Cignoni
Correspondence to: Dipartimento di Fisica, Università di Pisa, Via Buonarroti 2, I-56127 Pisa, Italy

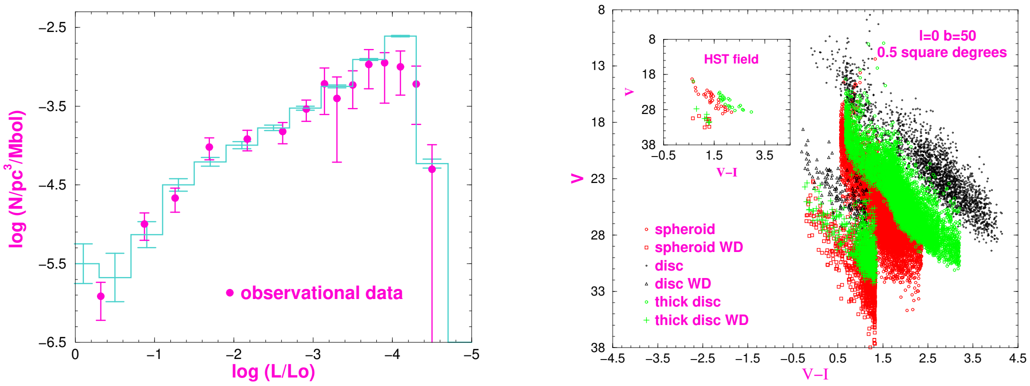

Fig. 1. Comparison between the predicted local WD luminosity function and recent observations by Liebert et al. (1988) and Leggett et al. (1998) (left panel). Statistical (Poissonian) errors in the theoretical histogram are also shown. Theoretical $(V, V-I)$ CMDs for field stars in the Galactic direction: $l = 0°$, $b = 50°$; the area is 0.5 square degrees (right panel). Different symbols refer to stars of the various Galactic populations, as labeled; white dwarfs are separately shown. Note that in our model we do not introduce artificial colour dispersion simulating observational spread in colours.

2. Results

Fig. 1 (left panel) shows the rather good agreement between the predicted local WD luminosity function and the observations by Liebert et al. (1988) and Leggett et al. (1998). We remind that the only normalization adopted in our model is the one of the hydrogen-burning stars in the solar neighborhood. Thus, the density distribution of WDs naturally arises from the model and the plotted WD luminosity function is just the output of our code without any additional normalization.

Fig. 1 (right panel) shows the $(V-I, V)$ color-magnitude diagram for the field stars in an area of extension 0.5 square degrees, at the Galactic coordinates $l = 0°$, $b = 50°$ The diagram is extended down to magnitude $V = 38$ to display the strong presence of spheroid WDs at extremely low luminosities. The small panels show the CMDs obtained for a field of about 6.6 arcmin^2 of extension, that is the area generally covered by *Hubble Space Telescope* observations. A relevant finding of our prediction is that observations down to $V = 28$ include almost the whole disc population and disc WDs.

We note that the whole WD population takes place at colors bluer then $V-I \sim 1.5$. Inspection of this figure reveals that there are regions of the CMDs in which the contribution of WDs to star counts seems to be distinguishable from other Galaxy stars. In particular, at sufficiently blue colors, i.e. $V - I \lesssim 0.5$, and not too high luminosity ($V \gtrsim 16$), the sample should be constituted exclusively by WDs.

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