Hunting Down White Dwarf–Main Sequence Binaries Using Multi-Wavelength Observations

Prasanta K. Nayak[1,2 *], Anindya Ganguly[1], Sourav Chatterjee[1]

[1]Tata Institute Of Fundamental Research, Mumbai, India

[2]Institute of Astrophysics, Pontificia Universidad Católica de Chile, Santiago, Chile

*nayakphy@gmail.com

Identification of WD–MS binaries using optical & UV color-magnitude diagrams (CMDs)

- Identifying WD--MS binaries in the Solar neighborhood is important to understand binary stellar evolution and guide the theoretical predictions for a wide range of interesting transient events relevant for, e.g., LSST, ZTF, and LISA.
- Combined high-precision astrometric and photometric data in the optical from Gaia-DR3 and UV from GALEX GR6/7, and use color-magnitude diagrams (CMDs) as a tool to identify WD--MS candidates within 100 pc, as shown in Figure 1.
- Used VOSA's binary fit algorithm to the observed spectral energy distributions (SEDs) to confirm their candidature and extract the best-fit stellar parameters for both companions simultaneously.

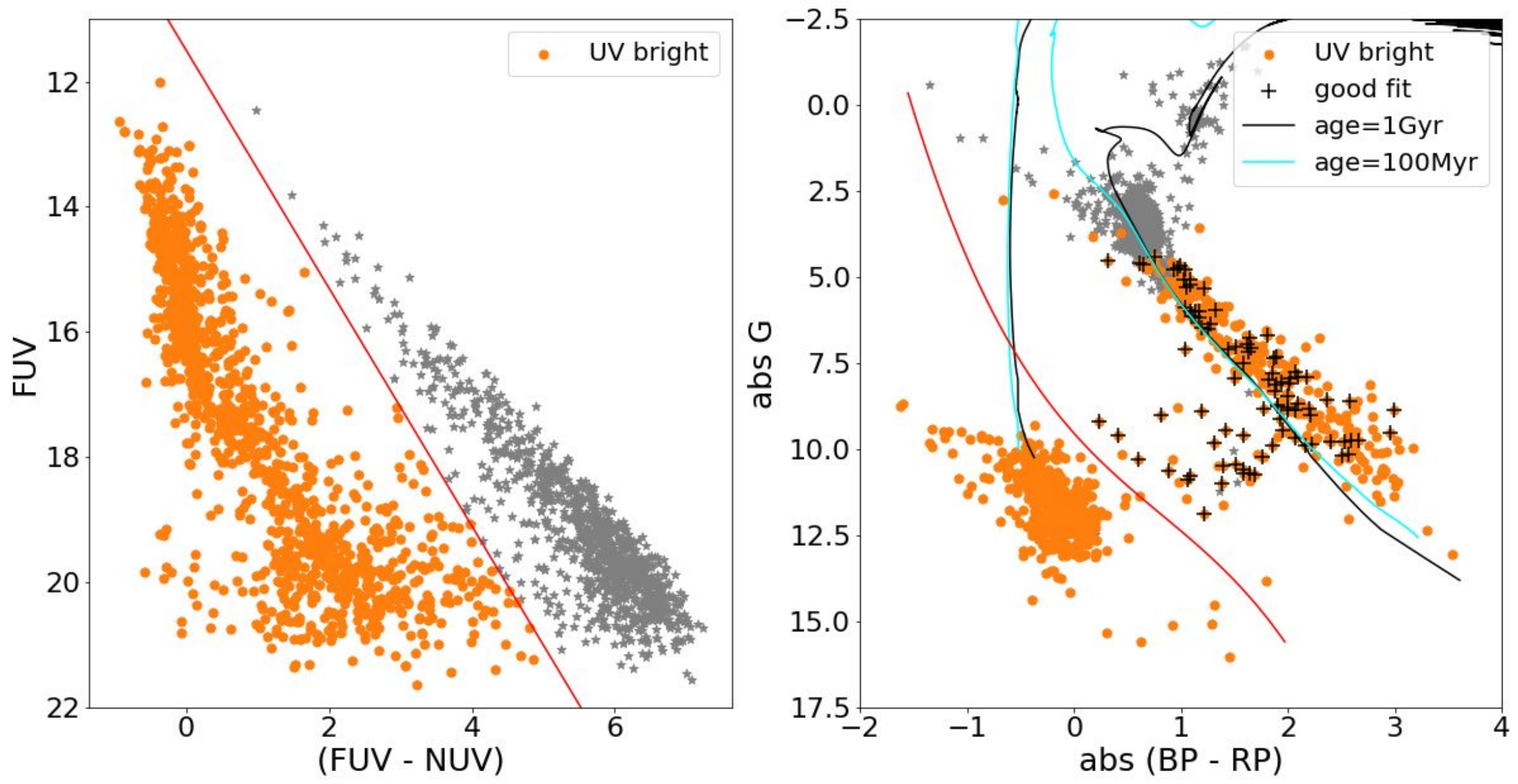
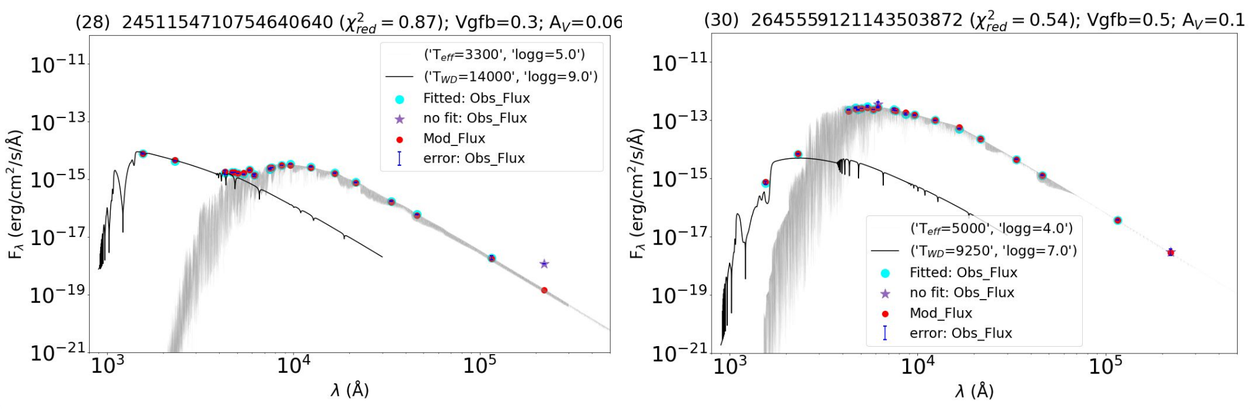


Figure 1: (*Left*): UV (FUV – NUV vs FUV) CMD for sources within 100 pc with both GALEX and Gaia-DR3 observations. The red line separates the hotter and FUV-bright sources (orange points) from the others (grey asterisks) on the UV CMD. (*Right*): Optical CMD (BP – RP vs G) in the absolute plane. The counterpart of the red line on UV CMD is also shown. The UV and optical CMDs indicate that the FUV-bright sources (orange points) are mainly WDs. However, a fraction of them migrates to the gap and MS regions on the optical CMD. These are candidate WD--MS binaries. **Black plus highlights the candidate WD--MS binaries** for which we could completely explain the SED from UV to IR using WD--MS composite model fluxes.

Examples of well-fitted SEDs



Examples of badly-fitted SEDs

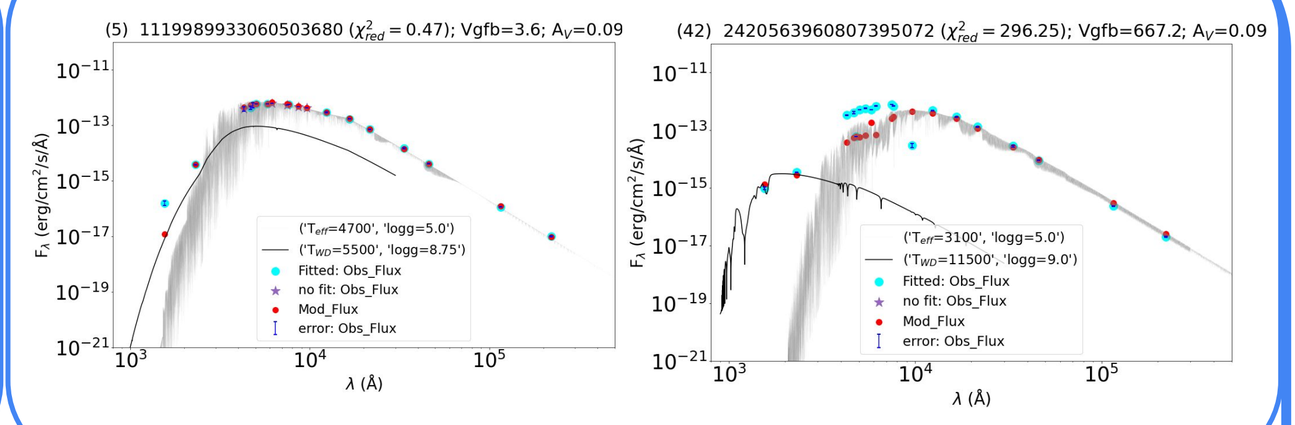


Figure 2: Index number as per the source list, Gaia-DR3 source ID, the values of A_V, χ_{red}, and Vgfb are mentioned on top of each panel. Cyan points (with blue errors) denote the observed flux from UV to IR. The observed data points with no errors or large errors (>0.2 mag) are marked as asterisks and are not included in the fit. The black (grey) line represents the best-fit synthetic spectra of WD (MS). The red points indicate the expected combined model fluxes from the best-fit synthetic spectra.

Parameters (T_{eff} & R) of WD & MS companions

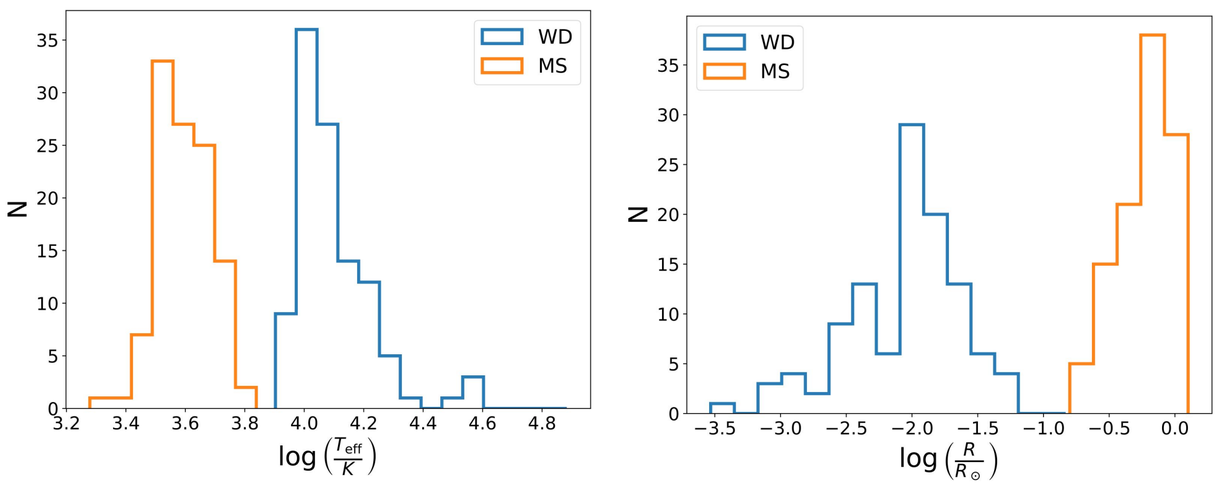


Figure 3: (Left) The median value for MS (WD) is =3800 K (11500 K). (Right) The median for the MS (WD) is log(R/$R_\odot$)= – 0.16 (-1.96).

Results

- Identified 111 WD–MS binaries within 100 pc. Of these, 92 are newly identified.
- identified hotter and smaller WD companions (majority with >10,000 K and < 0.02 $R_\odot$) relative to the WDs identified by past surveys.
- WDs are relatively more massive (>0.3 $M_\odot$).

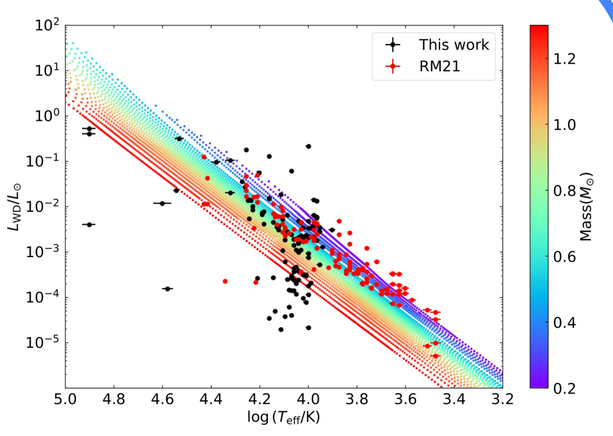


Figure 4: Model cooling sequences for CO WDs (Bedard et al. 2020). The black and red dots are the WDs identified in this work and in Rebassa-Manserga et al. (2021; RM21), respectively.

NUVA NETWORK FOR ULTRAVIOLET ASTRONOMY