
UV study of BSS Populations Present in M67

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UVIT Open Cluster Study. II. Detection of Extremely Low Mass White Dwarfs and Post-Mass Transfer Binaries in M67

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Abstract

A detailed study of the UV-bright stars in the old open star cluster M67 is presented based on the far-UV observations using the Ultra Violet Imaging Telescope (UVIT) on *ASTROSAT*. The UV and UV-optical color-magnitude diagrams (CMDs), along with overlaid isochrones, are presented for the member stars, which include blue straggler stars (BSSs), triple systems, white dwarfs (WDs), and spectroscopic binaries. The CMDs suggest the presence of excess UV flux in many members, which could be extrinsic or intrinsic to them. We construct multiwavelength spectral energy distributions (SEDs) using photometric data from the UVIT, *Gaia* DR2, Two Micron All Sky Survey, and *Wide-Field Infrared Survey Explorer* surveys, along with optical photometry. We fitted model SEDs to seven WDs and find that four of them have mass $>0.5 M_{\odot}$ and cooling age of less than 200 Myr, thus demanding BSS progenitors. SED fits to 23 stars detect extremely low mass (ELM) WD companions to WOCS2007, WOCS6006, and WOCS2002 and a low-mass WD to WOCS3001, which suggest these to be post-mass transfer (MT) systems. Twelve sources with possible WD companions need further confirmation. Nine sources have X-ray and excess UV flux, possibly arising out of stellar activity. This study demonstrates that UV observations are key to detecting and characterizing the ELM WDs in nondegenerate systems, which are ideal test beds to explore the formation pathways of these peculiar WDs. The increasing detection of post-MT systems among BSSs and main-sequence stars suggests a strong MT pathway and stellar interactions in M67.

Unified Astronomy Thesaurus concepts: Ultraviolet astronomy (1736); White dwarf stars (1799); Blue straggler stars (168); Open star clusters (1160); Hertzsprung Russell diagram (725)

What are BSS and Why they are peculiar?

- BSSs are peculiar stars that appear younger than other stellar populations of the clusters.
- Their formation contradicts standard stellar evolution theories.
- BSSs appear brighter and bluer than the MSTO in HR diagram, where most coeval stars have evolved from the MS ([Sandage 1953](#)).
- BSSs are the most massive stars in a cluster, formed via stellar interactions, gaining mass to extend their MS lifetime ([Ahumada & Lapasset 2007](#)).

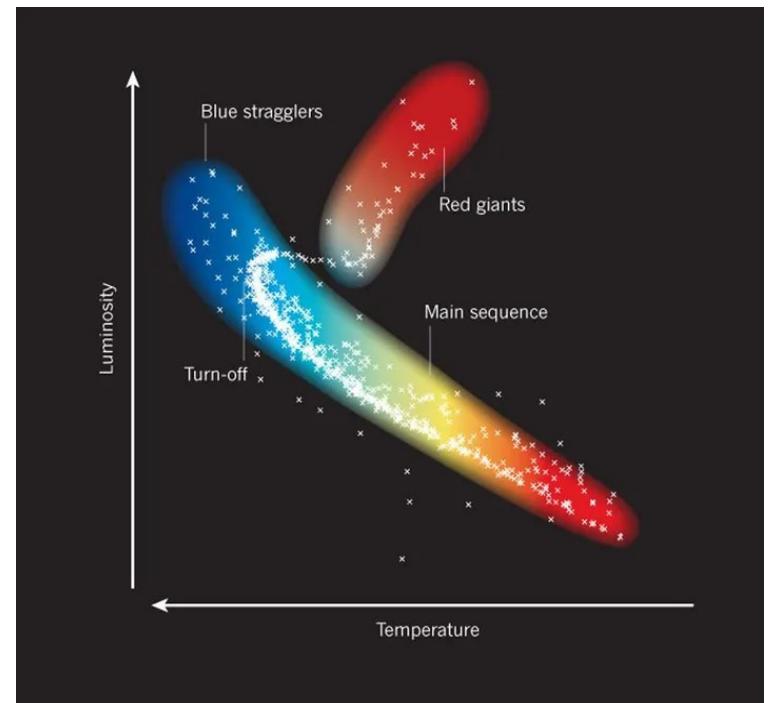


Figure 1: The CMD showing the location of BSSs.
Credit- Tout C. (2011).

- Using ensemble based unsupervised machine learning technique, we identified 1386 cluster members in M67 from *Gaia* DR3.
- From CMD, we identified 14 BSSs, out of them 10 having UVIT (F154W) counterparts.

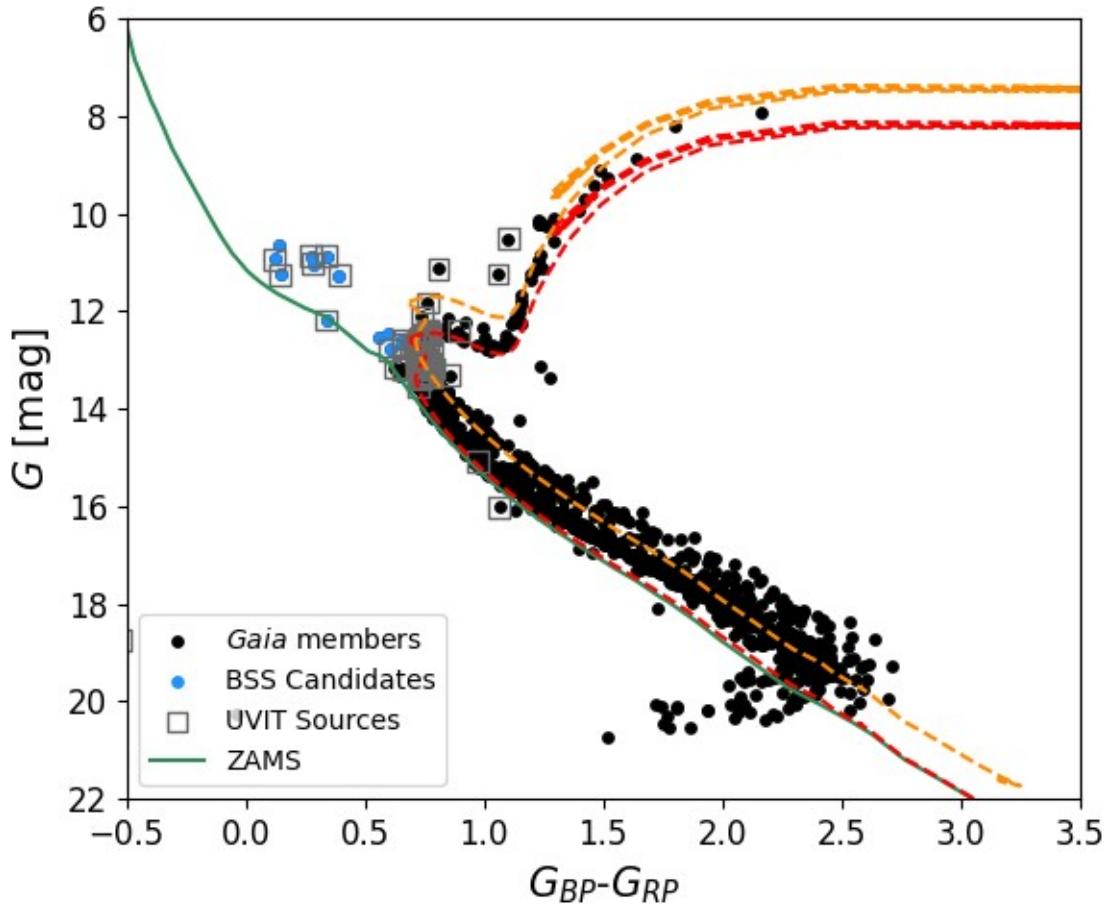


Figure 2: The CMD of M67 for the identified cluster members showing the location of BSSs.

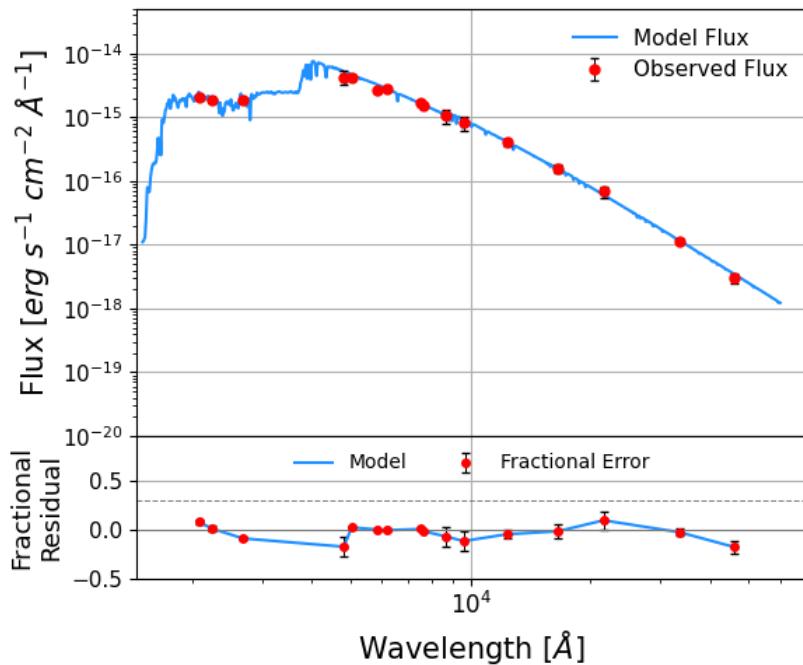


Figure 3: The single-component SED of BSS.

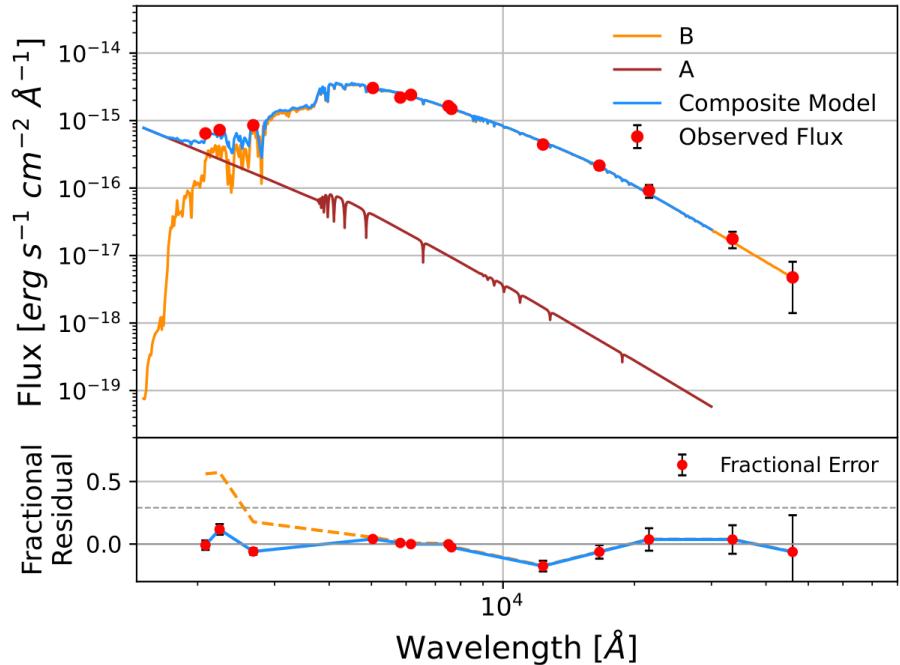


Figure 4: The binary-component SED of BSS.

- A single-component SED is fitted successfully for 6 BSSs. But 4 BSSs shows significant UV excess in UVIT and UVOT filters. We successfully fitted binary-component SED for these 4 BSSs
- From binary-component SED, we found that these 4 BSSs have hot companions having temperature ranges from 10000K to 13000K, which suggest that these are post-mass transfer systems.

Thank You!