Characterisation of Galactic blue stragglers with Gaia data

Vikrant Jadhav
PhD candidate

Collaborators: Annapurni Subramaniam, Sindhu Pandey, Ram Sagar

Indian Institute of Astrophysics,

Indian Institute of Science

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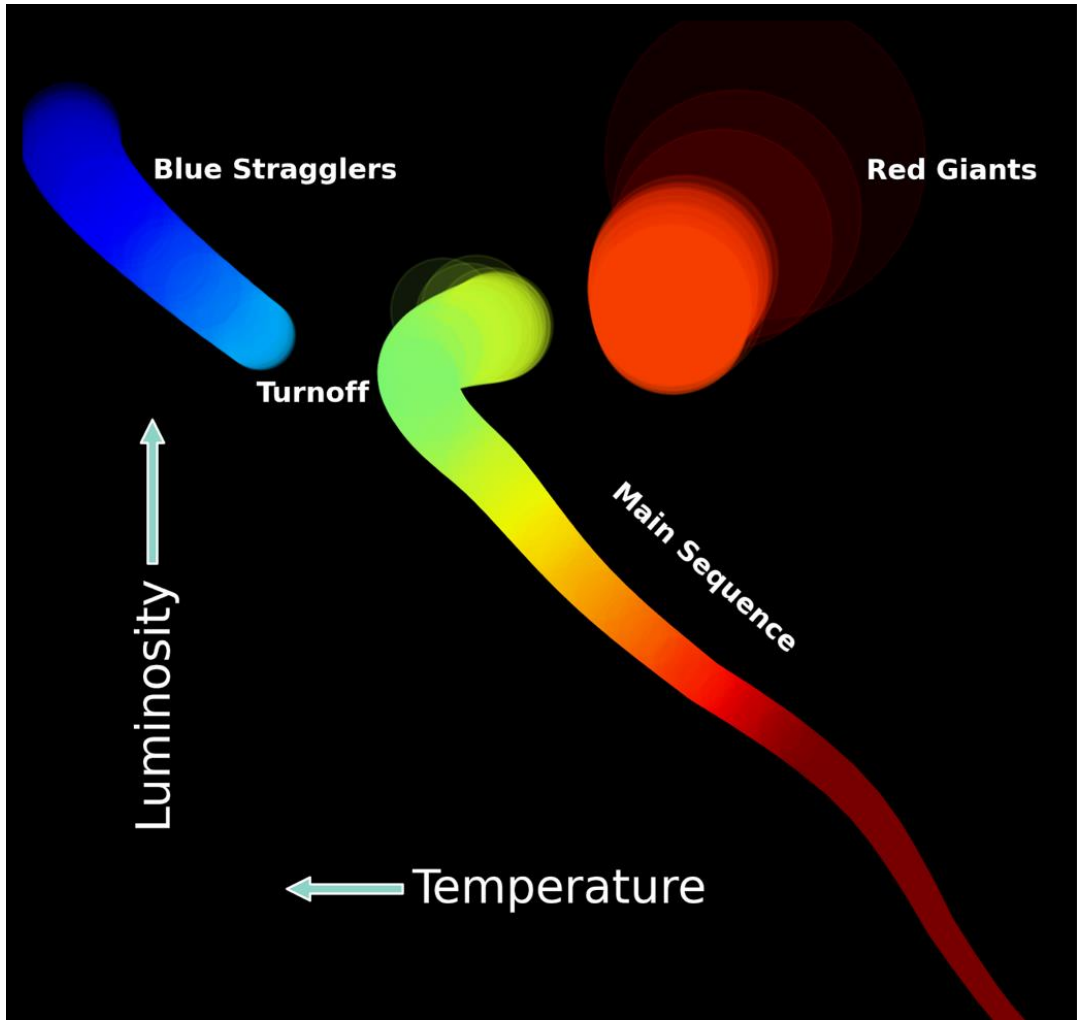
Blue Stragglers:

Massive and bluer stars than MS turnoff

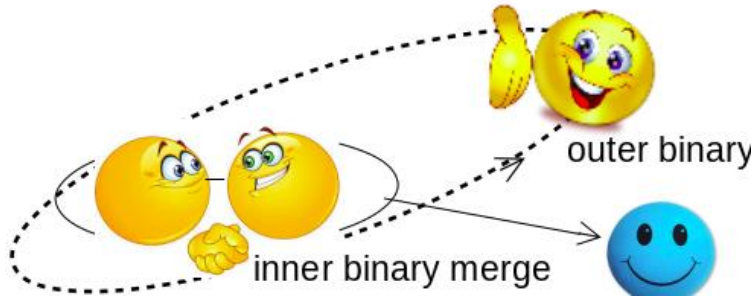


Formation Mechanisms

Binary mass transfer

Collision/merger

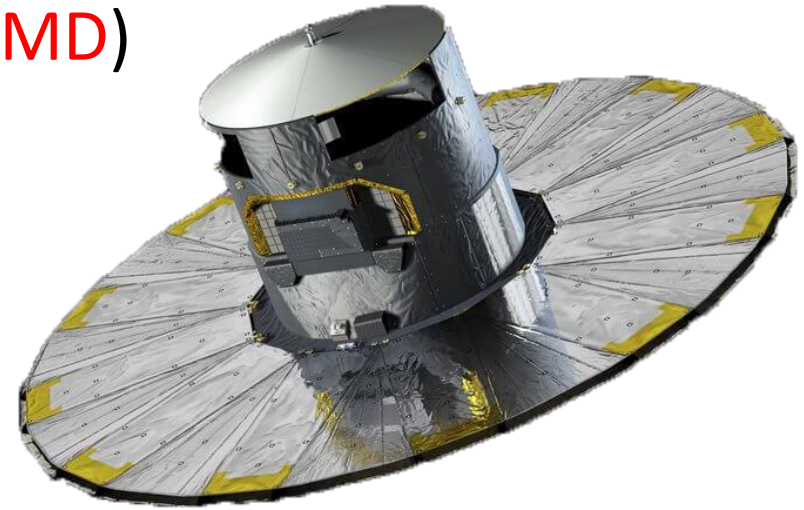
Hierarchical triple systems



Credits: Subramaniam+2020

Identification of BSSs

- Confidence in cluster membership
  - Parallax, proper motion
- Selection of BSSs in color magnitude diagram (CMD)
  - Photometric data



- Gaia
  - All sky coverage
  - Accurate proper motion and photometric data
  - Open cluster membership catalogues of Cantat-Gaudin+2018;2020

Selection criteria

- 670 clusters > 300 Myr

- Reidentification of MS turnoff
- Selection of members within 1 x 5 mag box starting from the MS turnoff
  - Within 0.1 color distance considered as probable BSS (pBS)

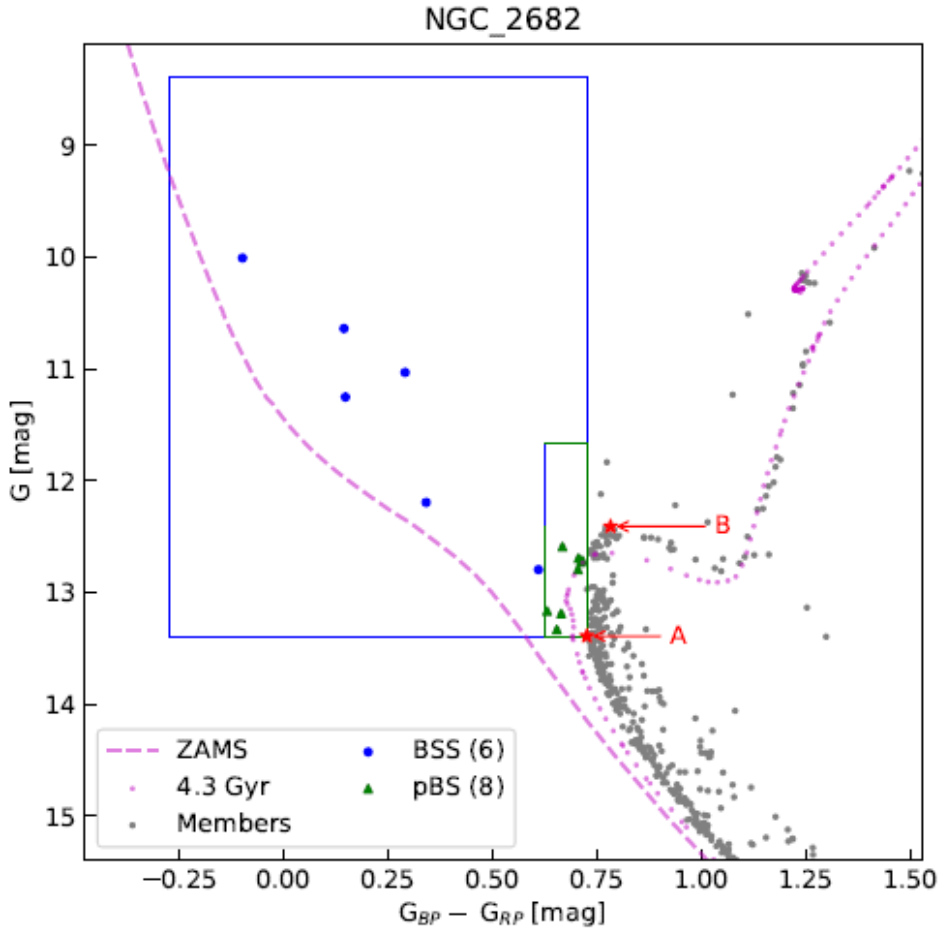
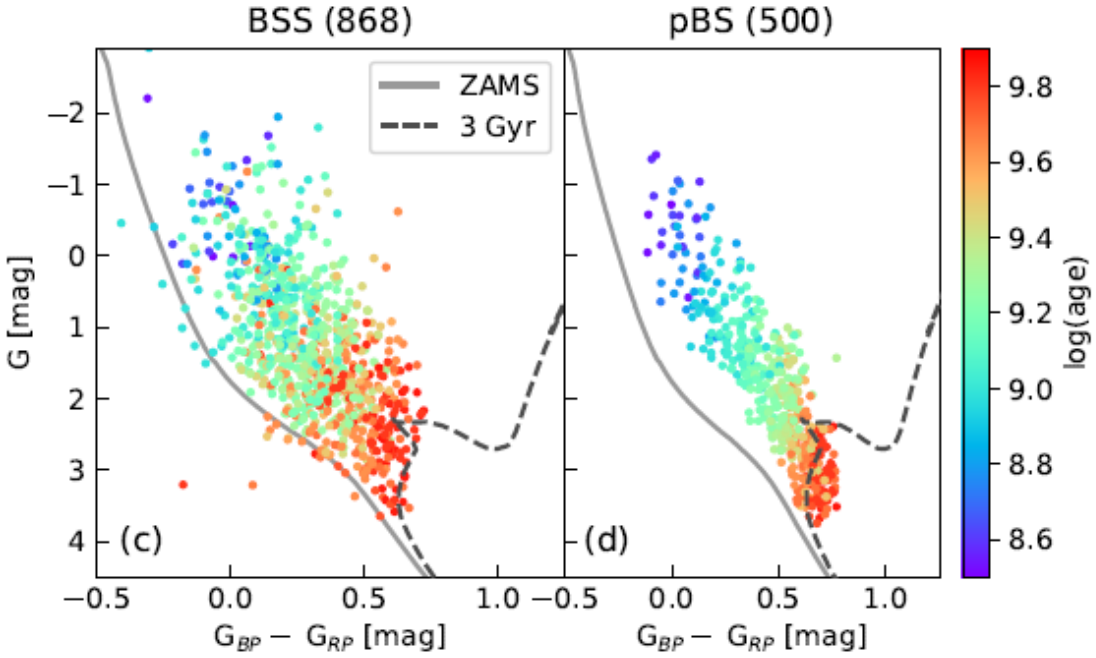
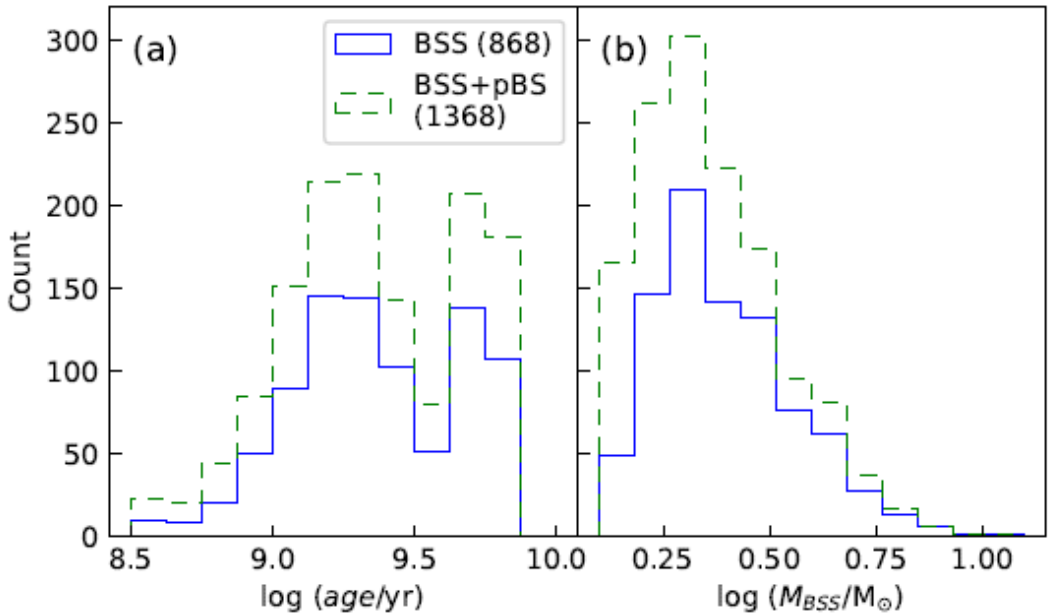


Figure 1. Schematic of classifying BSSs and pBSs in the colour-magnitude plane. Stars in blue and green boxes are classified as BSS and pBS respectively. The isochrone and ZAMS are shows for comparison. The manually identified A and B points are shown as red stars.





868 bona fide BSSs

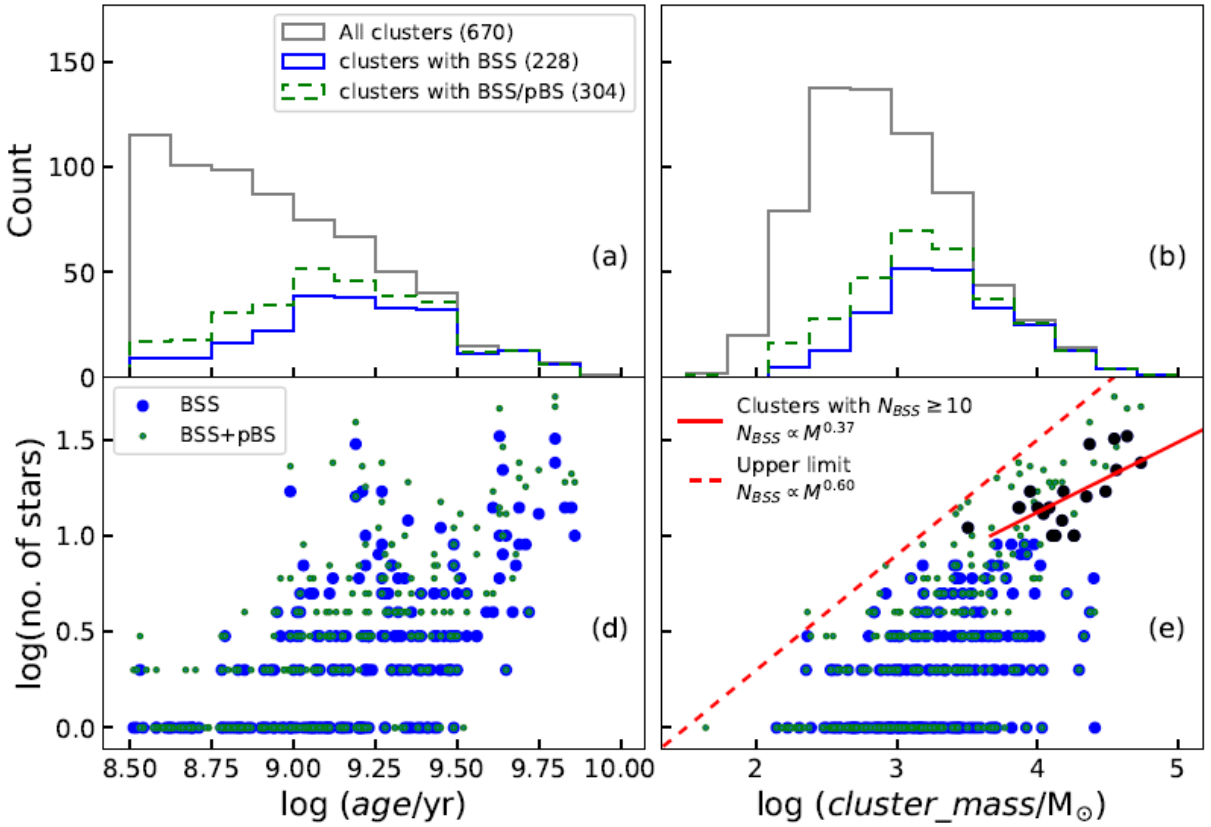
500 probable BSSs

Most BSSs are older than 1 Gyr

Mass range is 1 to 10 Msun

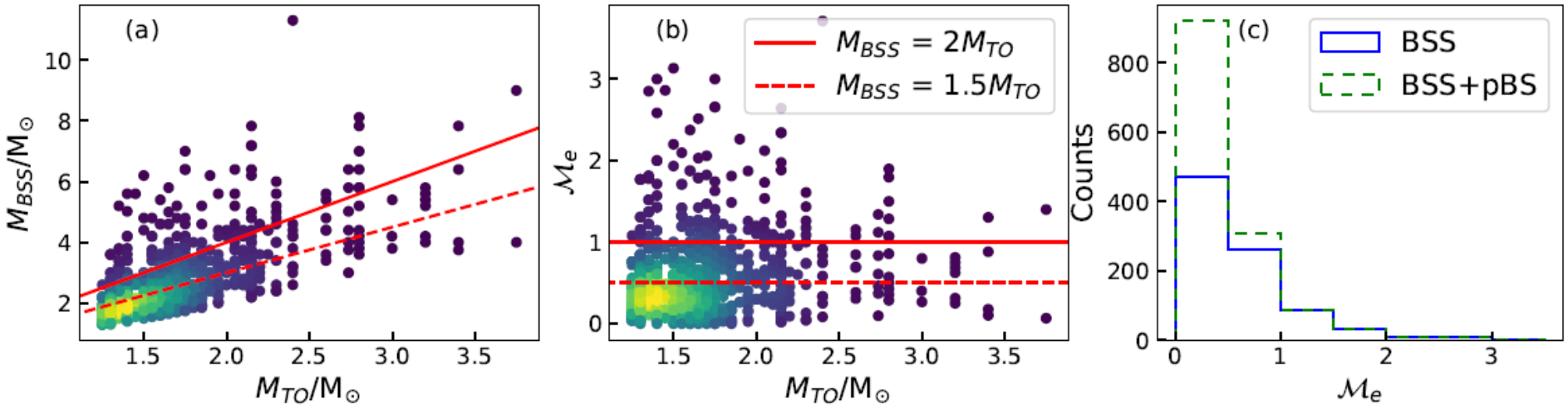
Which clusters have BSSs and how many

- Among 670 clusters >300 Myr
  - 228 clusters have 868 BSS
  - 208 clusters have 500 pBS
  - 366 clusters have no BSS/pBS candidate
- Old and massive clusters have BSS
  - $N_{BSS,max} \propto M_{cluster}^{0.6}$
    - Upper limit on BSS population
  - $N_{BSS} \propto M_{cluster}^{0.37}$
    - Similar to globular clusters



Fractional mass excess

- $M_e = \frac{M_{BSS} - M_{MSTO}}{M_{MSTO}} \sim$ Equivalent to mass transfer efficiency

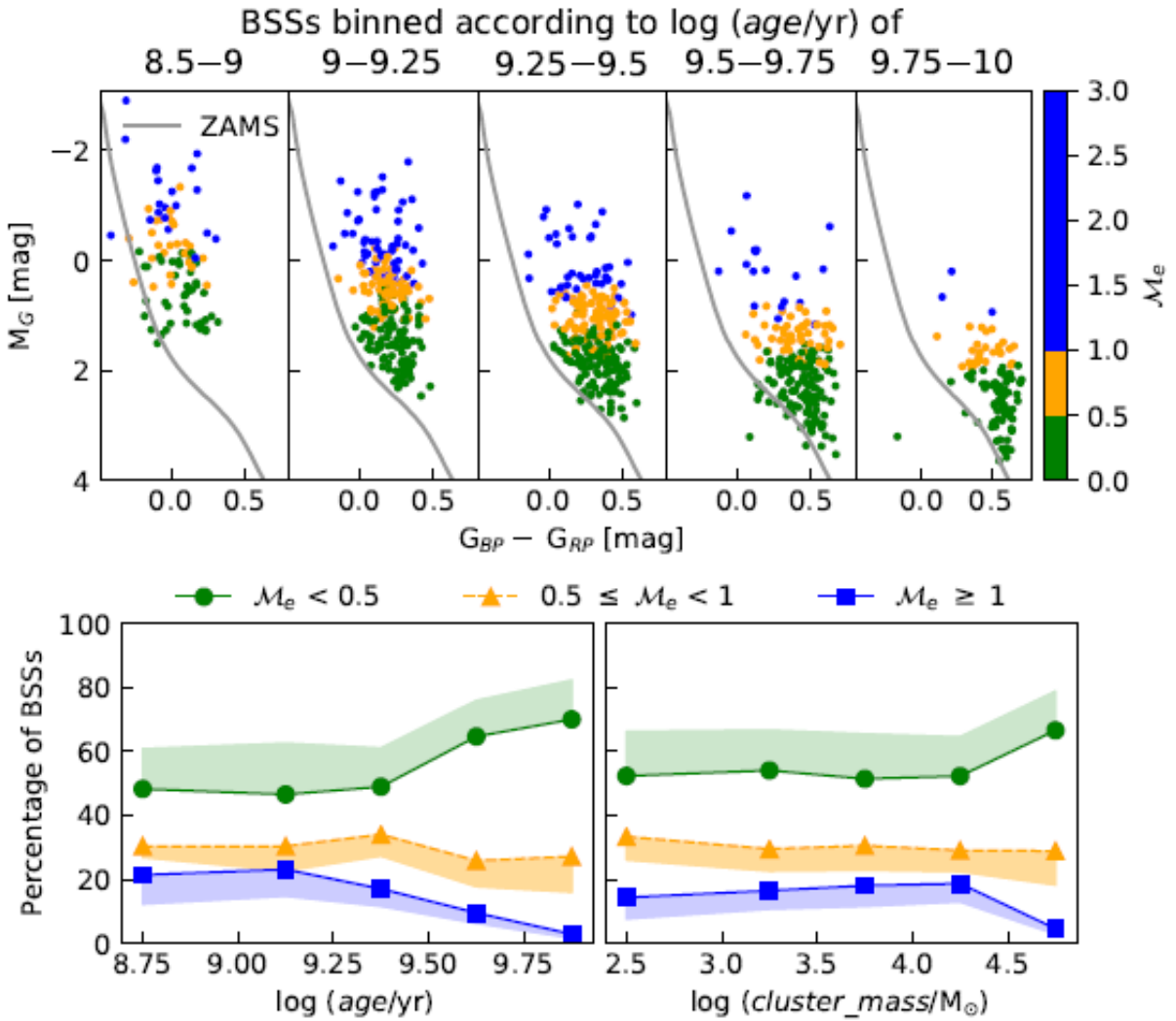


- Me < 0.5 : possible through MT
- 0.5 < Me < 1 : Likely mergers
- Me > 1 : More than 2 MSTO stars

Variation of Me with cluster age/mass

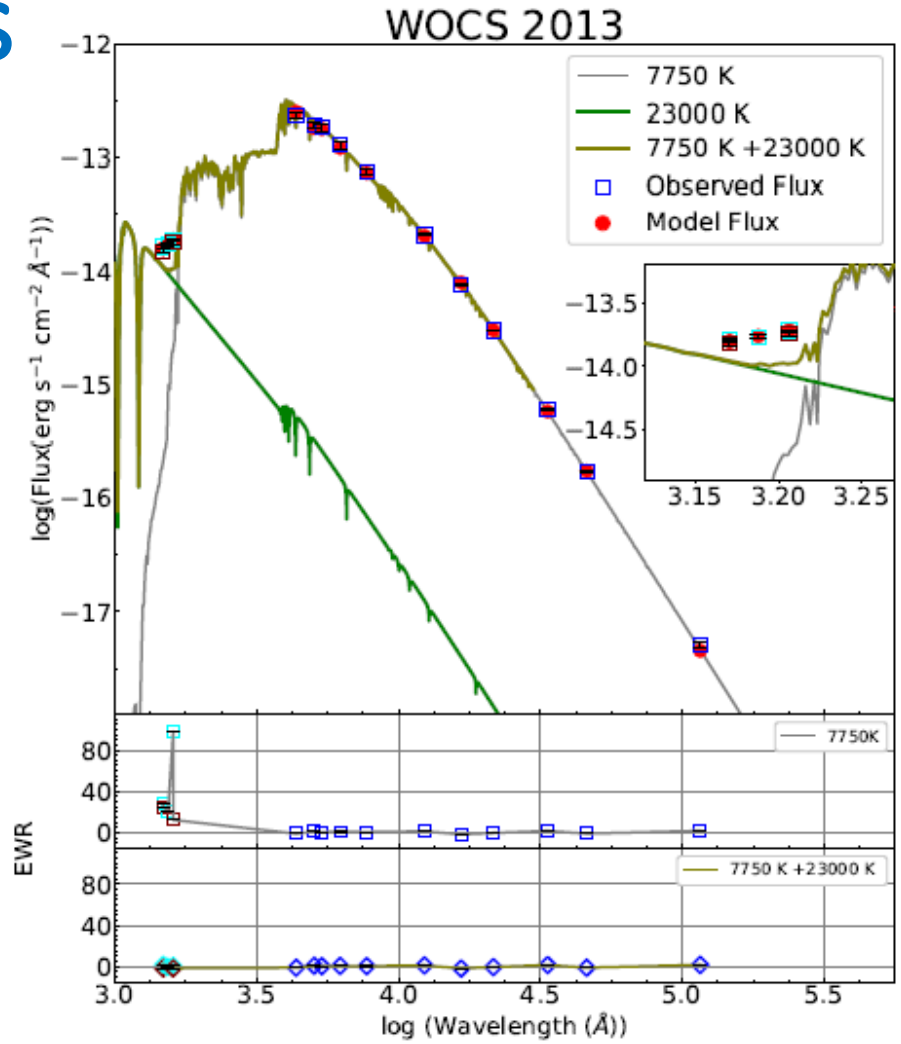
- Fraction of low Me BSS increases with cluster age
- Fraction of Me>1 decreases with age
- No dependence on cluster mass

- Jadhav & Subramaniam (2021), MNRAS, 507, 1699



UVIT Open Cluster Study: Characterizing Individual BSSs

- Multiband UV imaging of OCs: targeting clusters with BSSs
  - **NGC 188** (Subramaniam+2016)
  - **M67** (Jadhav+2019, Pandey+2019,2021)
  - **King 2** (Jadhav+2021)
  - **NGC 7789** (Vaidya+ in prep)
- Spectral Energy Distributions
  - UV dominated by a WD/hotter companion
  - Optical/IR dominated by BSS
  - Binary SED deconvolution

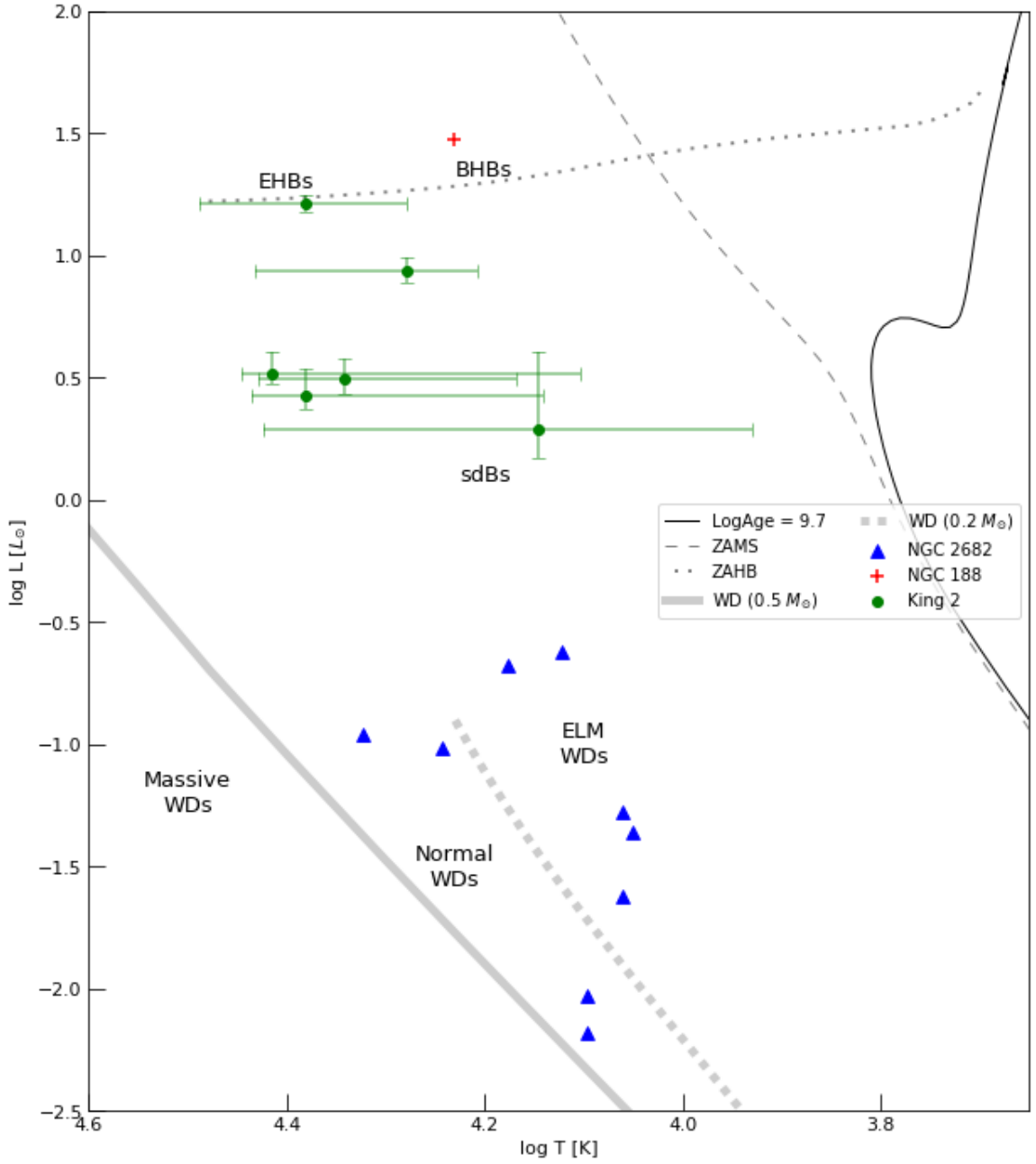


Diverse hot companions in OCs

- WDs, ELM WDs, sdBs ,EHB, Post-AGB/HB

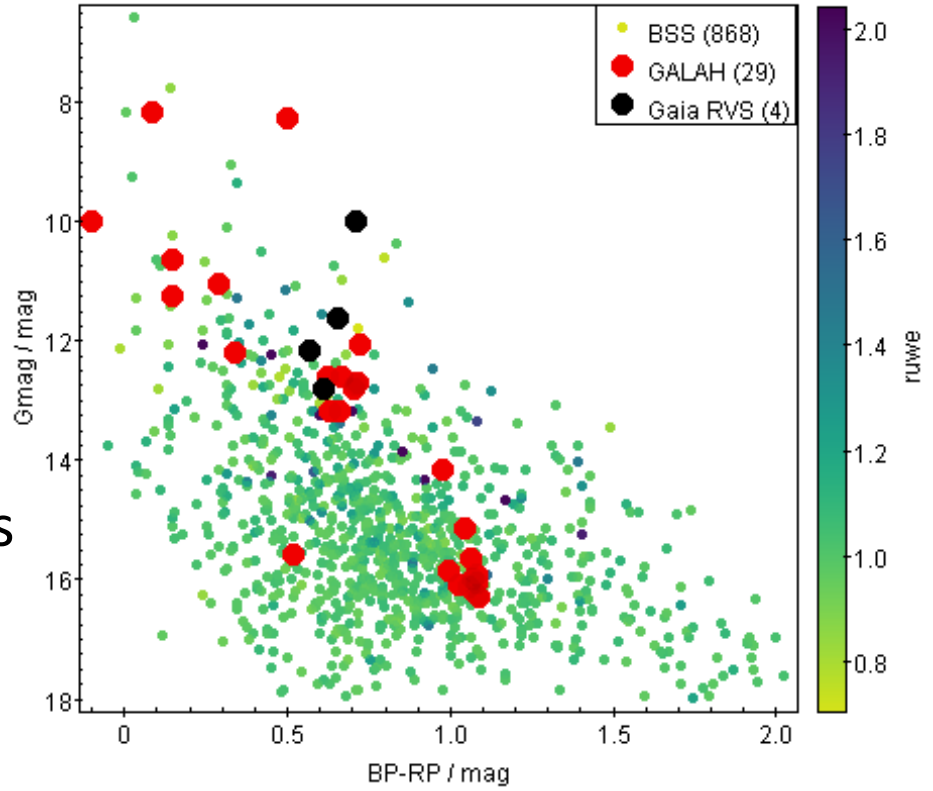
- Companions requires mass loss
- BSS requires mass gain

→ Binary MT pathway



Outlook

- Photometric identification, confirmation and characterization
  - Membership with Gaia DR3 – without selection biases
  - Multiwavelength single and binary SEDs
- Spectroscopic follow-ups of BSSs
  - Formation mechanism → abundance differences with Me?
  - Radial velocity variability → orbital parameters



Thanks

vikrant.jadhav@iiap.res.in