Exploration of UV-bright sources in Globular cluster NGC 3201 using UVIT observations

Authors: Manasi Kulkarni, Sonika Piridi, Ranjan Kumar, Ananta C. Pradhan

Presented by Elias Works

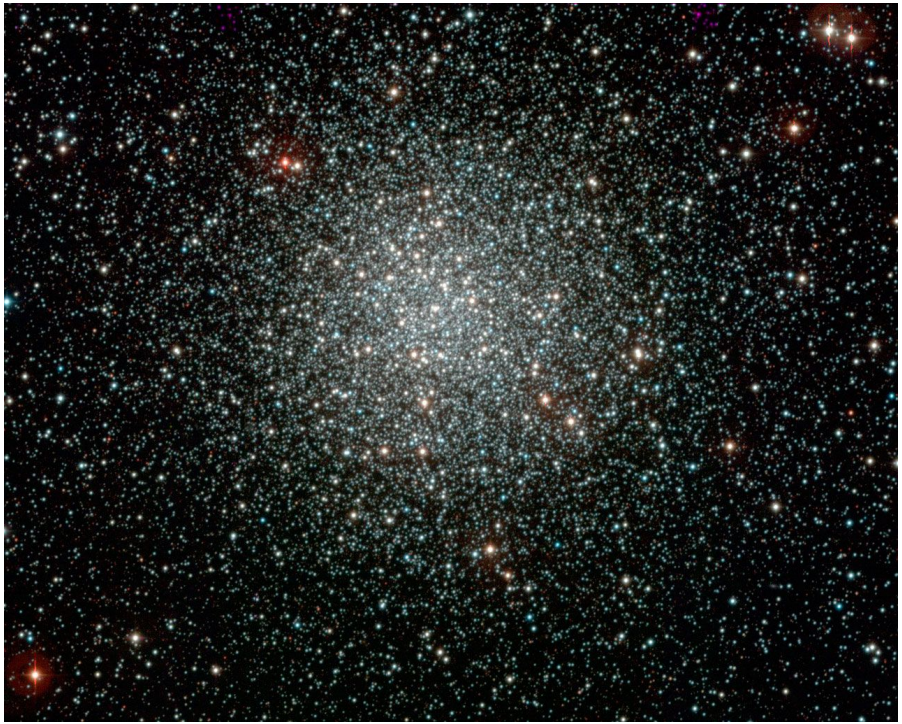
Outline

- Background
- Motivation
- Methods
- Results
- Conclusion

What Are We Looking At?

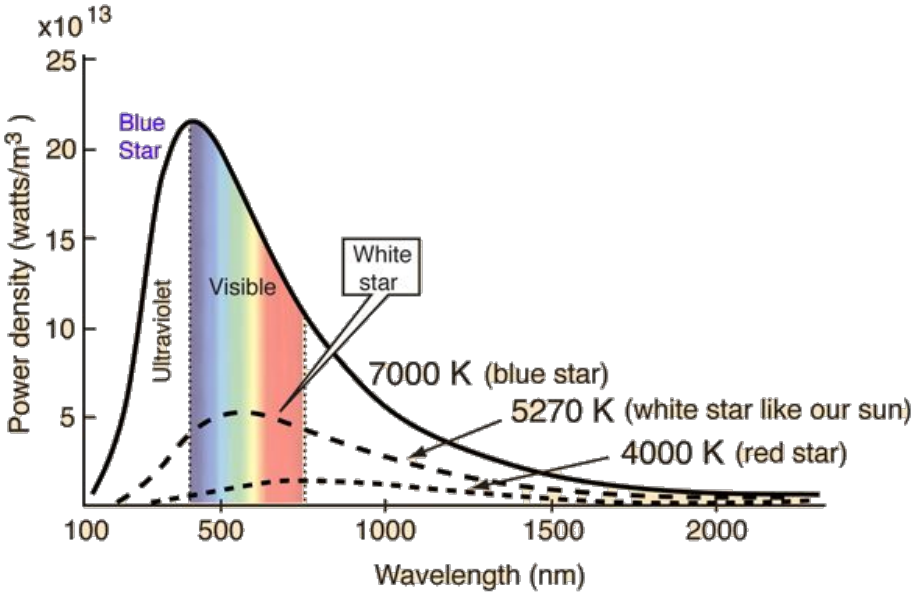
Globular cluster NGC 3201

- Old old old
- Dense collection of stars in our galaxy.
- Stars of different evolutionary stages and types.



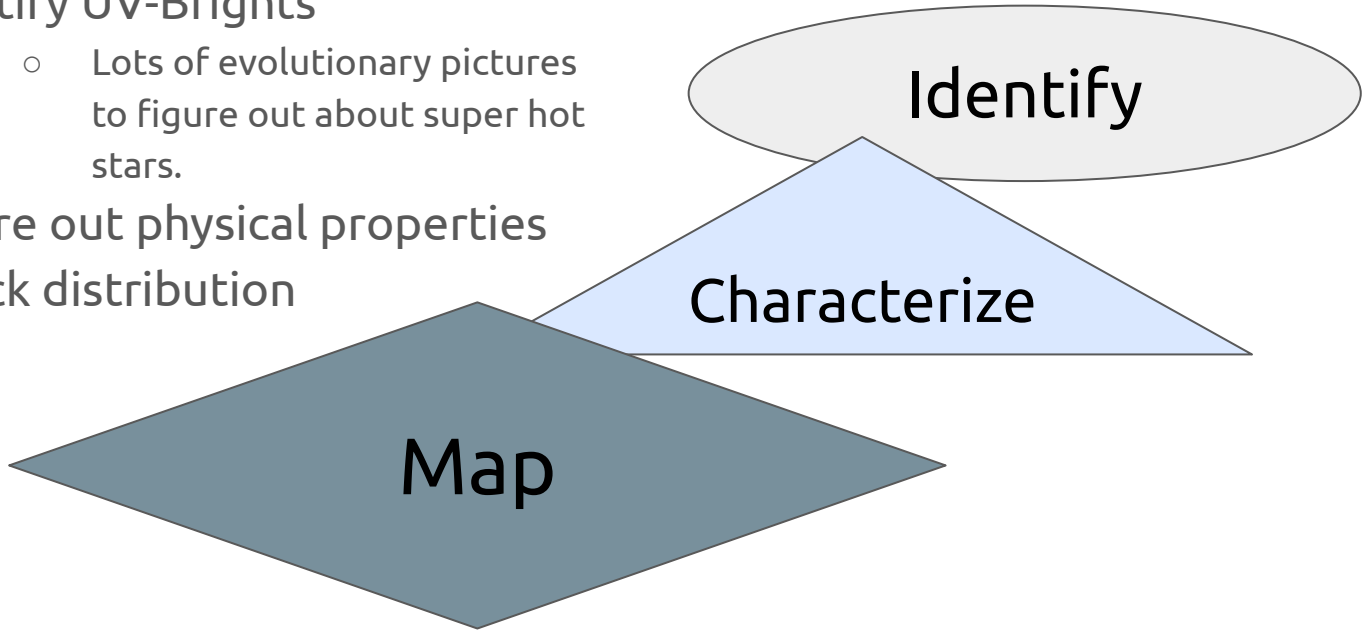
Why Focus on UV-Bright Stars?

- Wien's Law: Smaller λ = Bigger T
- MS stars mostly peak in visible
- O and B class stars are shorter wavelengths.
- UV observations allow us to observe and study these hotter stars better.
- Hot stars are cool.
    - Weird evolutions
    - Exotic observations



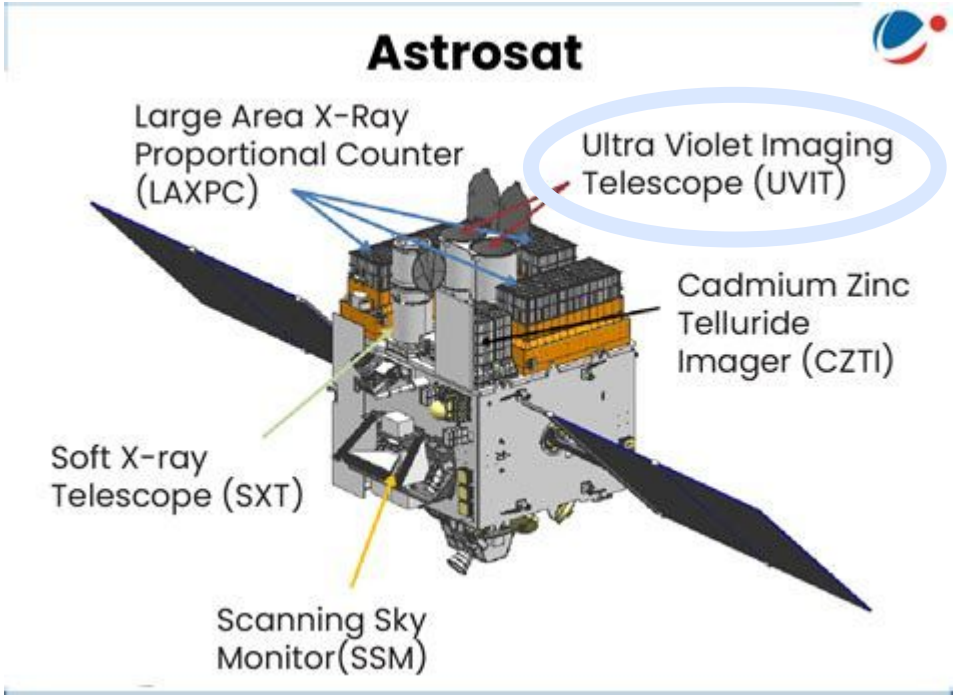
What was the motivation?

- Identify UV-Brights
    - Lots of evolutionary pictures to figure out about super hot stars.
- Figure out physical properties
- Check distribution



Observations

- UV imaging from UVIT on AstroSAT
- Indian Space Research Organisation (ISRO) AstroSAT
- Used two far-UV filters F148W and F169M (1.48/1.69 microns)
- Combined with optical data from Gaia and Hubble for more astrometry and precision in the high density sections.



Identification

- Match their found UV sources to the stars in other catalogs.
- Plotted on Color-Magnitude diagrams.
- Fit isochrone for cluster age (11.8 Gyr).
- Compared tracks on the CMD with evolutionary models.
- Fit this light across wavelengths (SED fitting) to estimate properties.

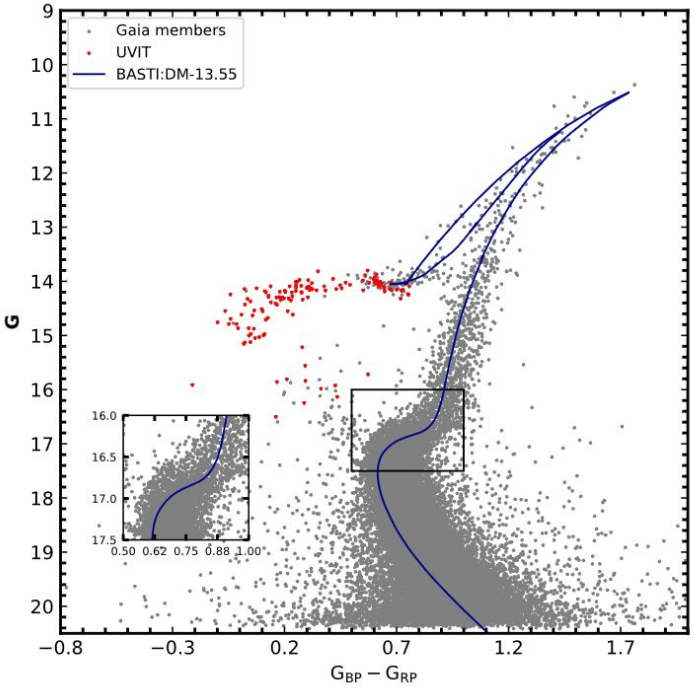
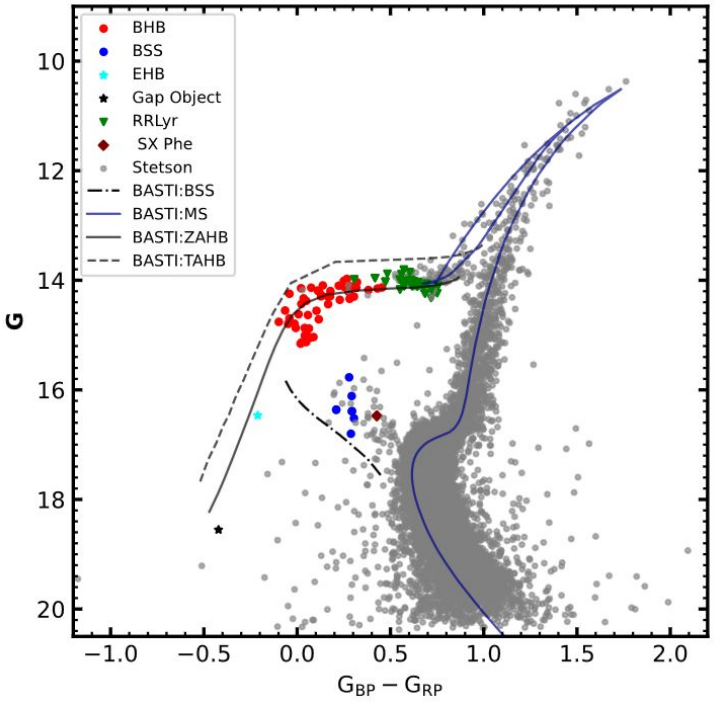


Figure 1: CMD of the GC in the Gaia photometric systems, showing G_{BP} - G_{RP} versus G. The UVIT detections are plotted as red triangles. Overplotted are BaSTI-IAC isochrones corresponding to age = 11.80 Gyr, [Fe/H] = −1.40 dex and DM = 13.55.

Populations

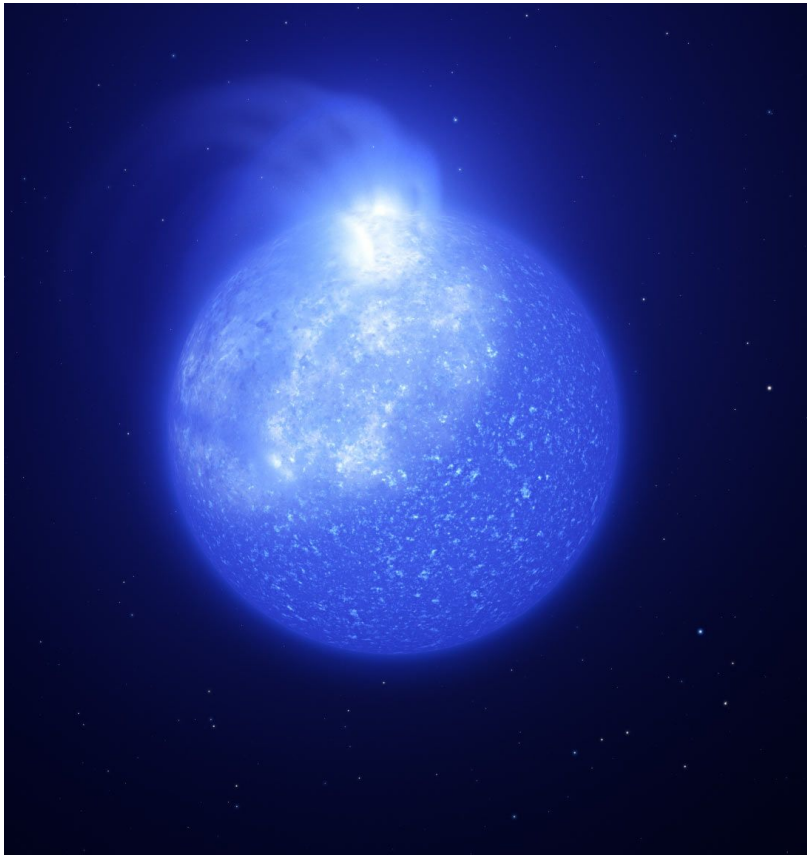
UVIT Observations:

- 71 Blue Horizontal-Branch (BHB)
- 15 Blue straggler stars (BSS)
- 51 RR Lyrae
- Two extreme horizontal-branch stars (exotic)
- Two unusual “gap” objects (mystery)



Blue Horizontal-Branch (BHB)

- 71
- Hot, evolved stars past Red Giant Branch (RGB)
- Estimated EFFECTIVE temperatures of 7,250K - 11,250K (SED fitting)
- Distribution gives population to compare to cluster stars.
    - 40 inside half-light radius, 31 outside.



Weird, especially hot stars

- 2 extreme horizontal-branch (EHB) stars, about 17,000K and 25,000K. Much hotter.
  - The 17,000K star is outside the cluster's core; the 25,000K star is inside it
- 2 other objects in CMD which lie between the post-HB stars and white-dwarf cooling tracks.
  - Temperatures at about 20,000K and 32,000K
  - "Blue-hook" objects possibly, but spectroscopy is needed in depth to mitigate uncertainties.
  - Rare picture of transitions between evolutionary stages.

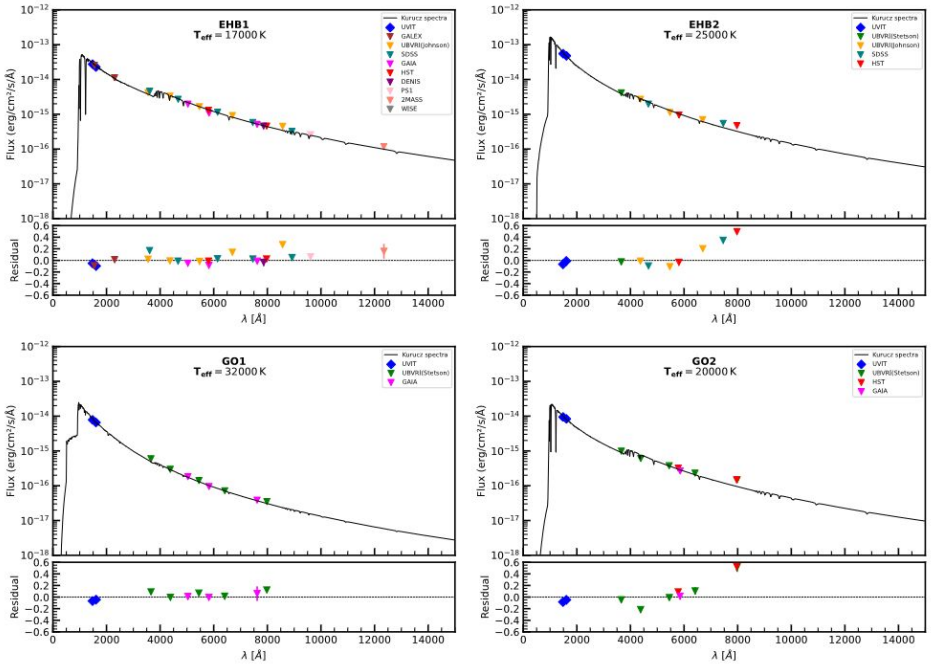


Figure 3: Spectral energy distribution of EHBs and GO objects. In legend, blue diamonds are UVIT fluxes, and color triangles for other bands. The Kurucz model with best-fit parameters is overplotted on the residuals of the respective SEDs in the lower panel.

Blue Stragglers

- 15
- Younger UV stars in the old population cluster.
  - Above and bluer than main-sequence turnoff, stars in an old cluster might have moved on to later stages.
- 7 were variable, 8 had temps of 7,500-8,500K, 3.9-17.8 $L_\odot$, 0.86-1.94 $R_\odot$
- Isochrone give *apparent* ages of 2.7-5.62 billion years, much younger than cluster, unusual, most stars are about same age in globular clusters.
- Apparent ages are deceptive, possible mass gain from companion or merger.

Radial Concentration

- Plotting the distribution vs radius from core:
  - Blue Stragglers are strongly concentrated closer to the center.
  - Most other star types also have greater concentration, and more “linear-ish” dependance.
- Authors interpret the lack of bimodal distribution to insinuate the cluster is dynamically evolved and still not fully relaxed (not fully linear).

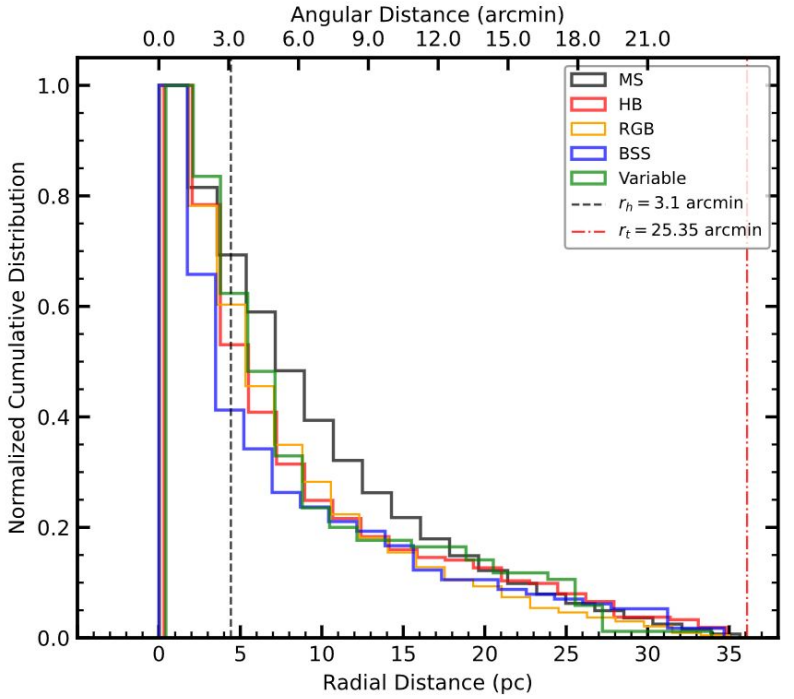
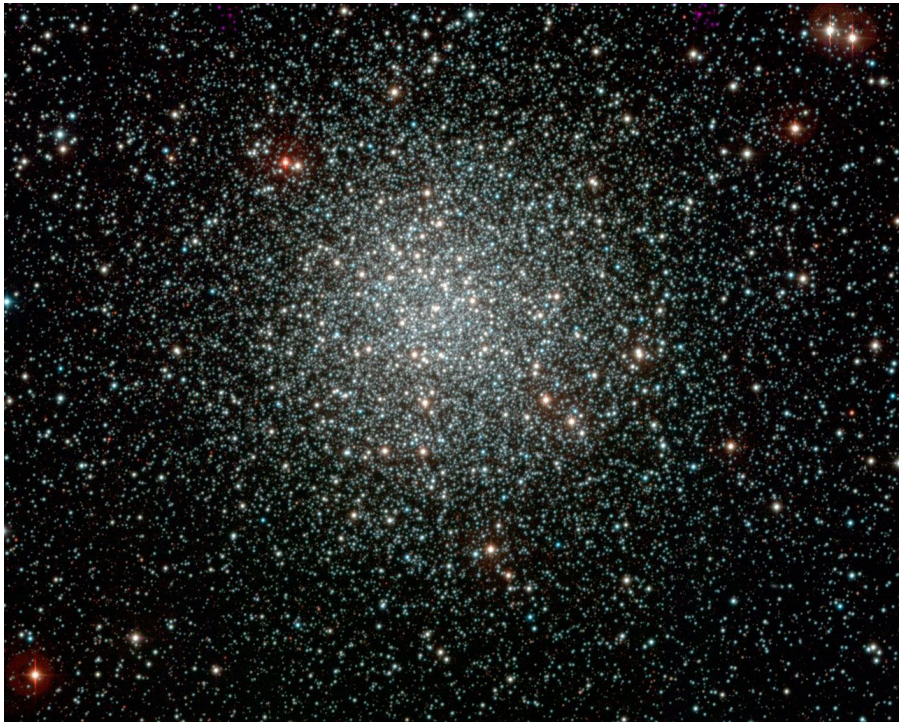


Figure 6: Normalized cumulative distribution for MS, HB, RGB, BSS and Variable stars. The half-light radius and tidal radius are plotted as dashed lines.

Conclusion

- UV observations help us identify hot stars which can be easily missed in optical data.
- The study identifies several stellar populations and estimates their properties.
- The “Blue hook” transition stars are good follow up targets, due to their exotic nature.



Thanks :)

