Variable Stars in M31 Stellar Clusters from the Panchromatic Hubble Andromeda Treasury (PHAT) survey

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Richard Smith*, Avi Patel, Monika D. Soraisam, Puragra Guhathakurta, Pranav Tadepalli, Sally Zhu, Joseph Liu, Léo Girardi, L. Clifton Johnson, Sagnick Mukherjee, Knut A. G. Olsen, Benjamin F. Williams

***richard.smith@noirlab.edu**

Goals

→ **Identify variable stars in M31 stellar clusters using PHAT** (Dalcanton+ 2012) **light curves and difference imaging.**

→ **Obtain evolutionary phase of cluster variable stars from host cluster isochrones**, using PHAT photometry and available stellar cluster age & metallicity data**.**

→ **Identify most likely variable star type of each cluster variable star** using evolutionary phase, initial mass & variability characteristics.

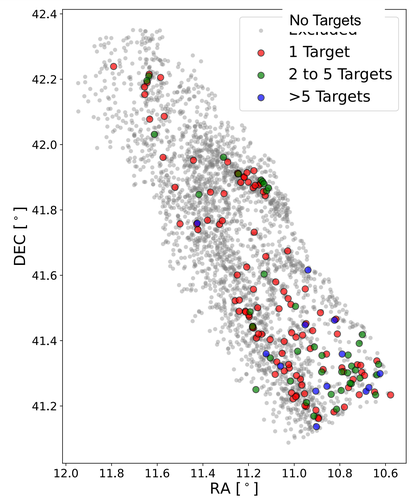
Data

- PHAT survey: ACS/WFC3 data (Dalcanton+ 2012).
- Mapped ~1/3 of M31 disk & bulge.

We use:

- **photometry of >117 million PHAT stars in Williams+ 2014 catalog**.
- **2753 PHAT stellar clusters identified by Johnson+ 2015**.

→Initial sample of 375 luminous (F814W < 19 mag) cluster stars.



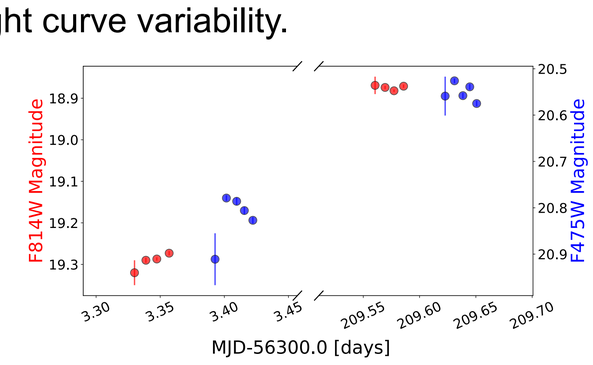
2753 Johnson+ 2015 PHAT stellar clusters; colors denote number of luminous (F814W < 19 mag) stars in the cluster.

How?

1) Light curve analysis

- Compare F814W light curve with mean F814W mag for each luminous star using reduced χ^2.

→239 luminous candidate variable stars with light curve variability.

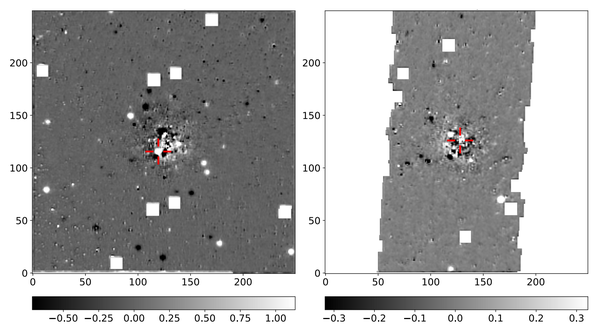


F475W and F814W light curves for a candidate cluster variable using Williams+ 2014 PHAT photometry

2) Difference Image (DI) analysis

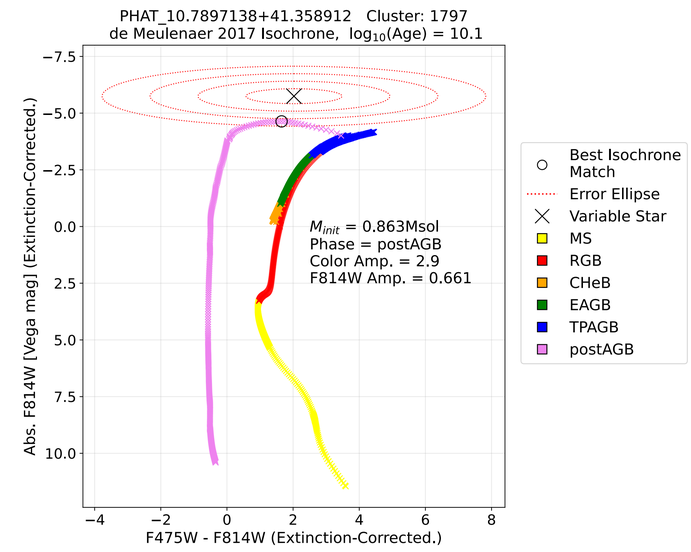
- Difference image combined drizzled exposures of candidate-hosting clusters.

→**89 cluster variables with light curve variability & counterpart detections.**



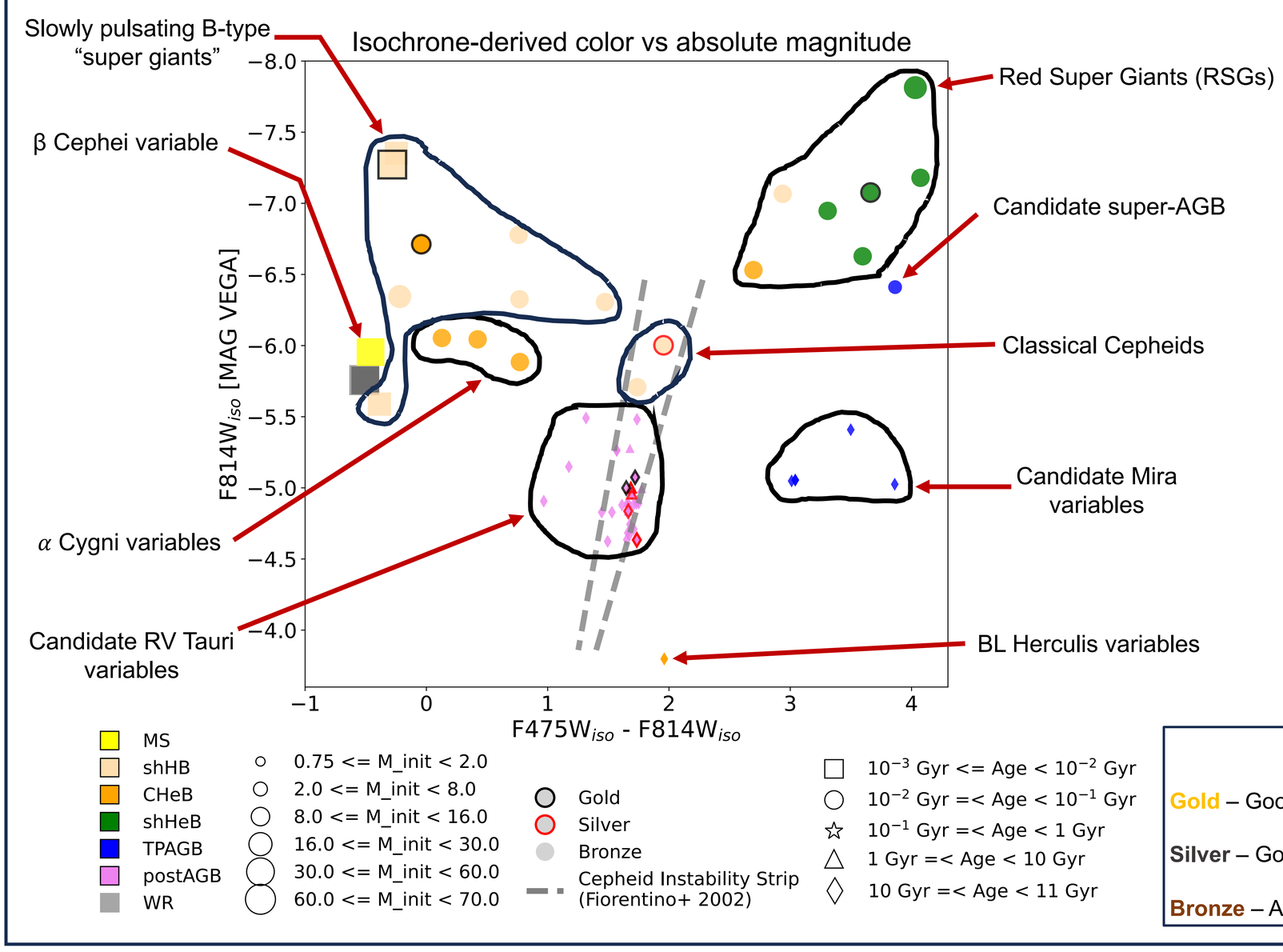
Example difference images for verifying the light curve variability of variable stars located at each crosshair.

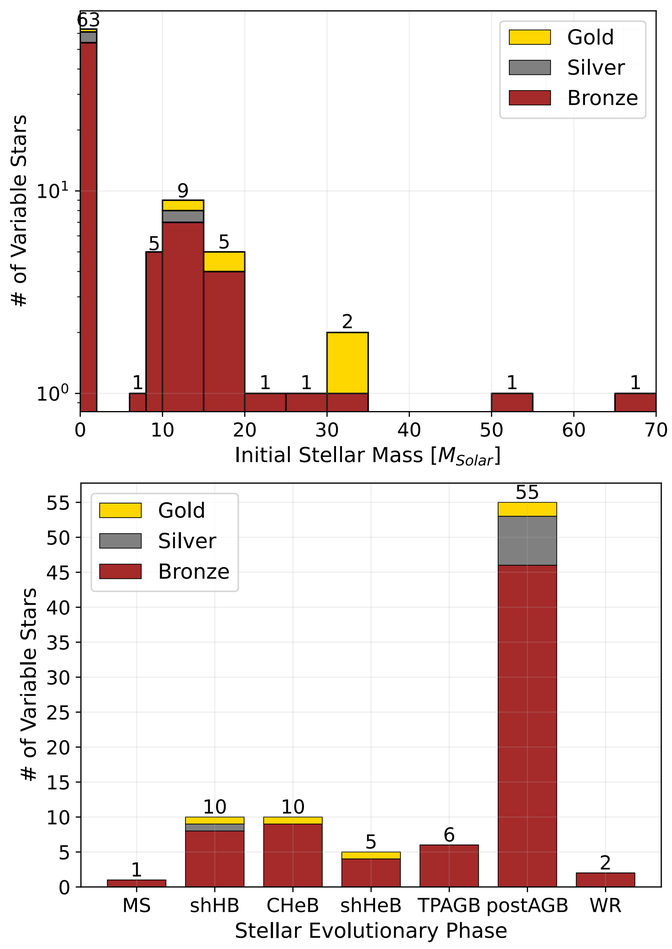
3) Isochrone analysis



Example cluster variable star CMD, including its host cluster isochrone and error ellipse scaling used to calculate the most probable isochrone datum.

Results





Confidence Levels:

Gold – Good DI detection & photometry least likely blended.

Silver – Good DI detection & photometry likely blended.

Bronze – Ambiguous DI detection & photometry highly likely blended.

References: **Dalcanton+ 2012**, "The Panchromatic Hubble Andromeda Treasury", ApJ Supp., Vol 200, Iss 2 --- **Williams+ 2014**, "The Panchromatic Hubble Andromeda Treasury. X. Ultraviolet to Infrared Photometry of 117 Million Equidistant Stars", ApJ Supp., Vol 215, Iss 1 --- **Johnson+ 2015**, "PHAT Stellar Cluster Survey. II. Andromeda Project Cluster Catalog", ApJ, Vol 802, Iss 2 --- **de Meulenaer+ 2017**, "Deriving physical parameters of unresolved star clusters. V. M 31 PHAT star clusters", A&A, Vol 602, id.A112