



Supernovae, transients and high-amplitude variables in the Hubble Catalog of Variables



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Summary

We aim to construct an exceptionally deep catalog of the supernovae, transients and high-amplitude variables included in the Hubble Catalog of Variables (HCV, Bonanos et al. 2019, in prep.). The HCV contains all variable objects detected through a robust variability search in the light curves of all sources observed included in the Hubble Source catalog v3 (Whitmore et al. 2016). Taking this work one step further we queried the HCV to detect the variable sources with amplitude of variability >1 mag in more than one filter of observations. We cross-matched the sources with catalogs in CDS to check whether the high-amplitude variable sources were reported by previous studies. We proceeded to classification of the newly identified high-amplitude variables based on their magnitude, light curve shape and position on the color magnitude diagram. The high-precision astrometry extracted from the HSC for all sources in our catalog combined with the deep HST observations makes our catalog a powerful tool for further research on the environments and properties of the high-amplitude variables observed by the HST.

Method

Variability & Selection criteria: The Hubble Catalog of Variables (HCV) includes 84,428 candidate variable sources (out of 3.7 million HSC sources that were searched for variability) with $V < 27$ mag for 11,115 of them the variability is detected in more than one filter. The data points in a light curve range from 5 to over 80, the time baseline ranges from under a day to over 13 years, while 8% of variables have amplitudes in excess of 1 mag. The selection of the variable stars included in the HCV was made by using the Mean Absolute Deviation (MAD) as a variability index. All objects with a MAD value $>5\sigma$ compared to the field stars were considered as variable candidates. We queried the entire HCV and marked the amplitude of variability of each source in all available filters and distinguished the sources with amplitude >1 mag. In total we identified 5539 single-filter and 1107 multi-filter high amplitude variables. We cross-matched all multi-filter sources with amplitude of variation >1 mag with catalogs in the CDS with a search radius of $3''$. For the sources without counterparts, we checked their light curves and found 7 unidentified transient-like objects, 4 variable AGNs and 3 variable QSOs. We confirmed the accuracy of our catalog by checking the position of the known Cepheids and RR-Lyrae on the corresponding CMDs of the fields.

Results

Multi-filter high-amplitude variables
1107

In CDS: 277

Not in CDS
830

Cepheids 204
RR-Lyrae 56
Novae 10
EBs 7

Transients, QSOs and AGNs in the HCV

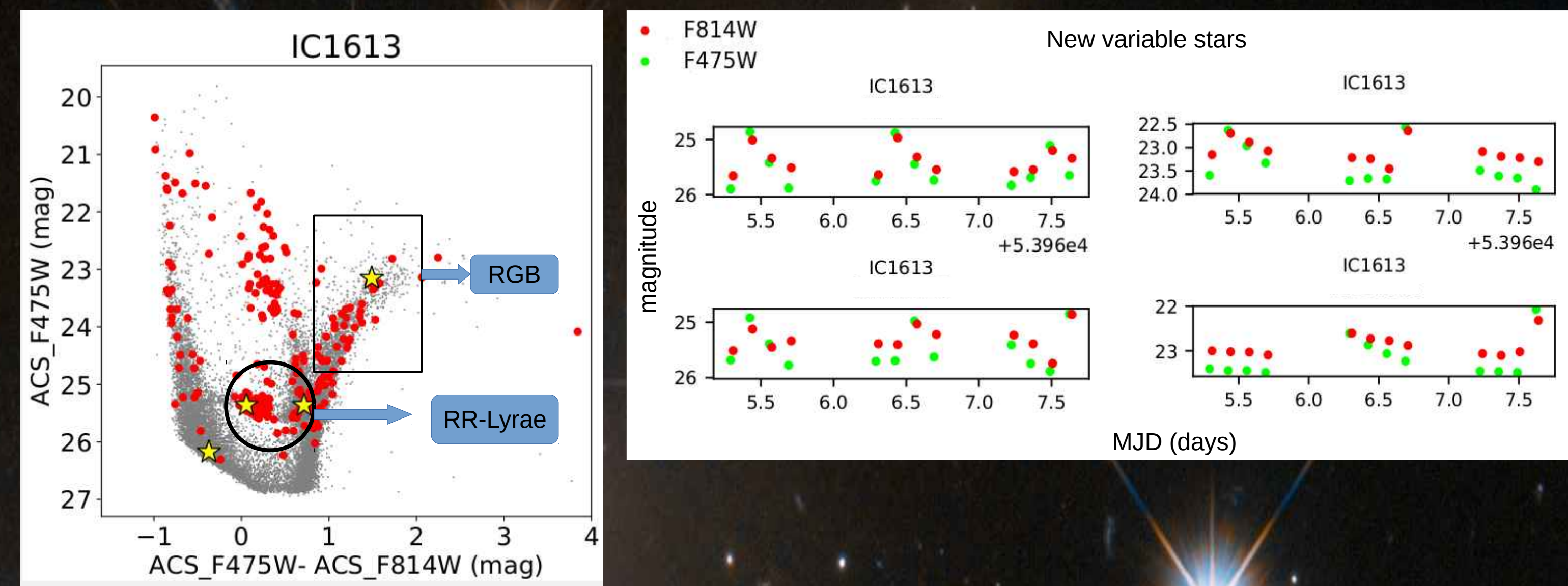


Figure 2. Light curves of new variable RR-Lyrae and RGB stars in IC1613. In the CMD the new variable stars are marked as yellow stars while the known variables are shown as red dots.

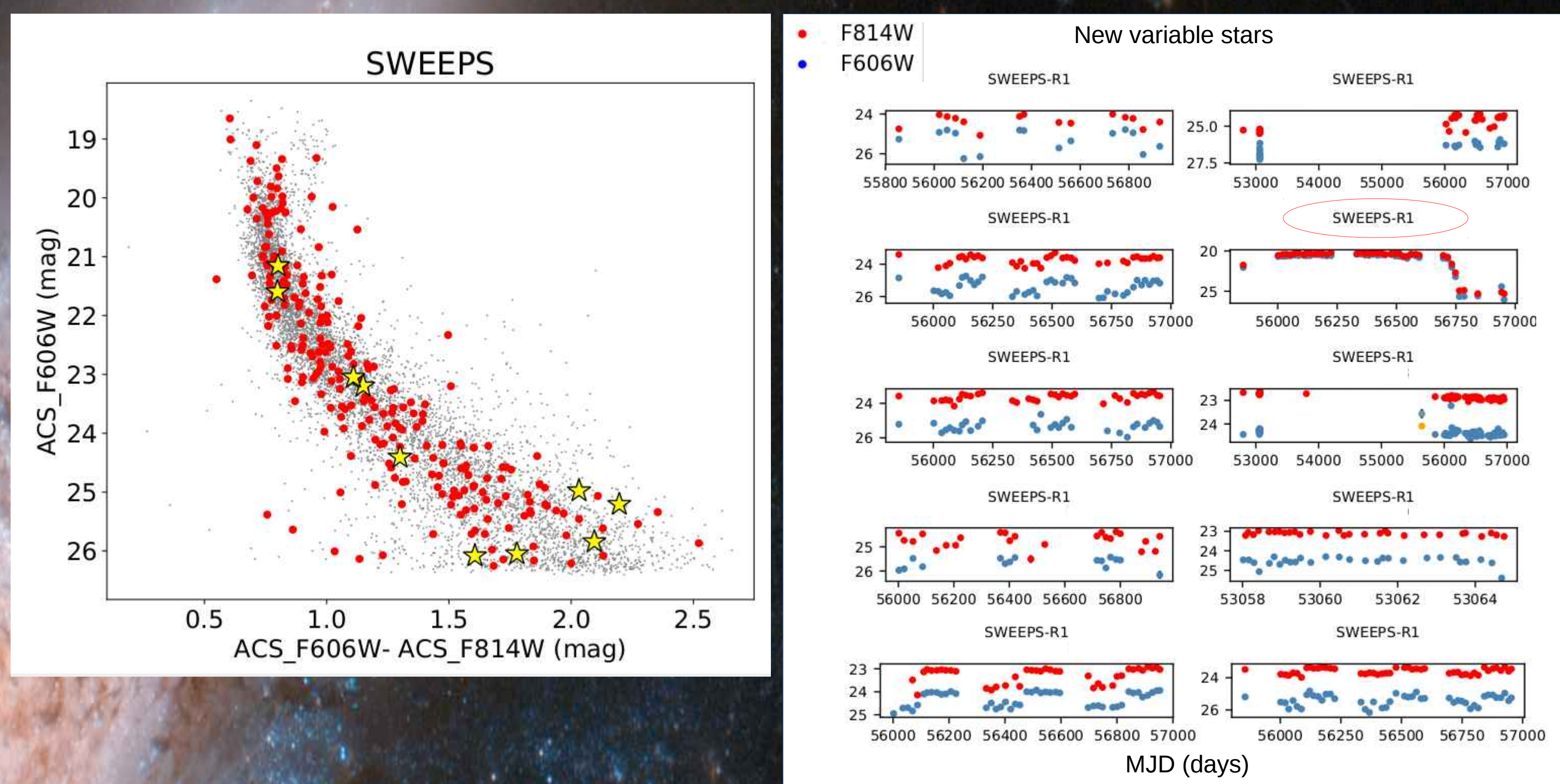


Figure 3. Light curves of new variable stars in the SWEEPS field. In the CMD the new variable stars are marked as yellow stars while the known variables are shown with red dots. We highlight the candidate R Coronae Borealis variable with a red circle.

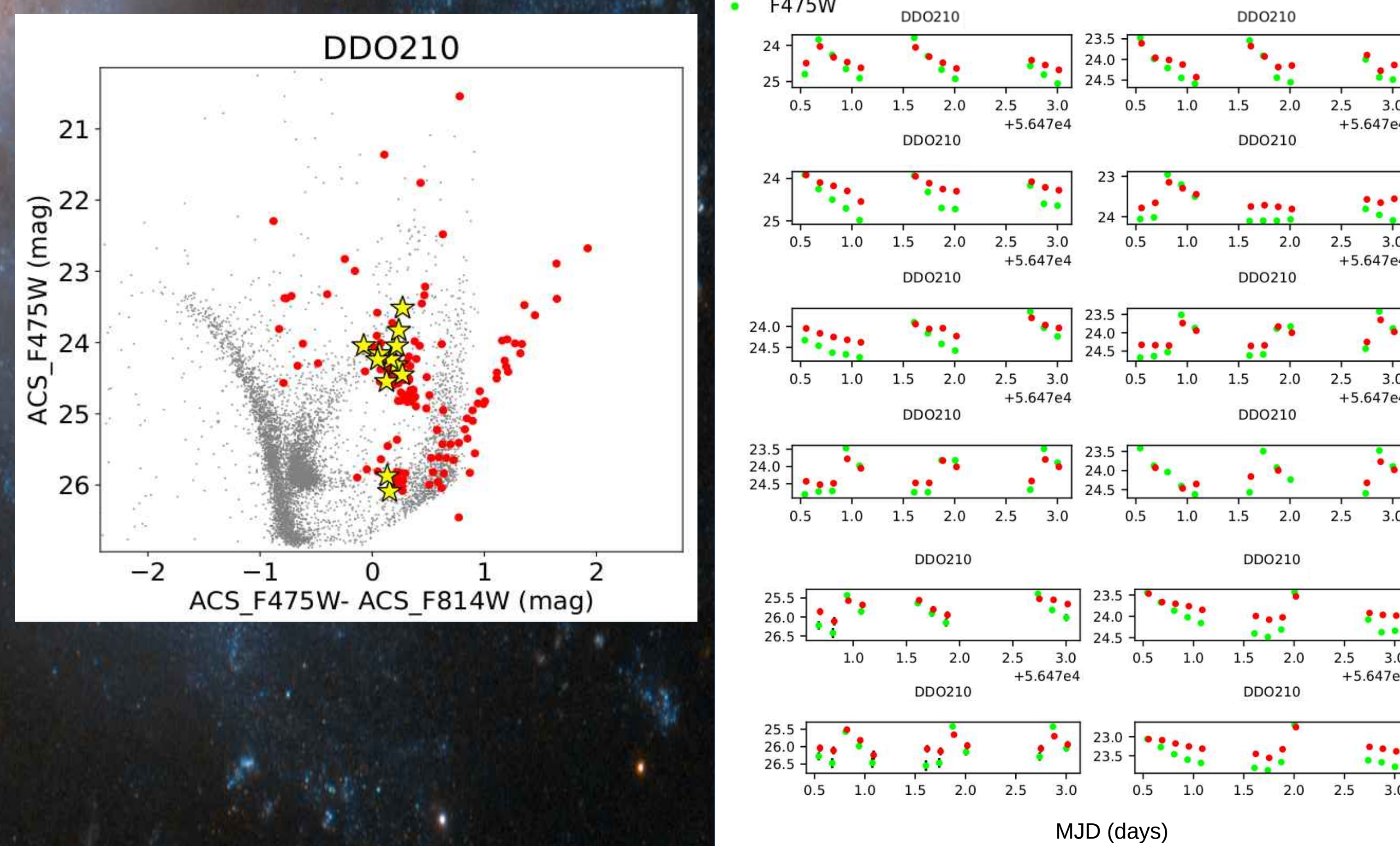


Figure 4. Light curves of new variable stars in DDO210. In the CMD the new variable stars are marked as yellow stars while the known variables are shown with red dots. The light curves presented on the right correspond to Cepheids and RR-Lyrae based on their position on the CMD.

References

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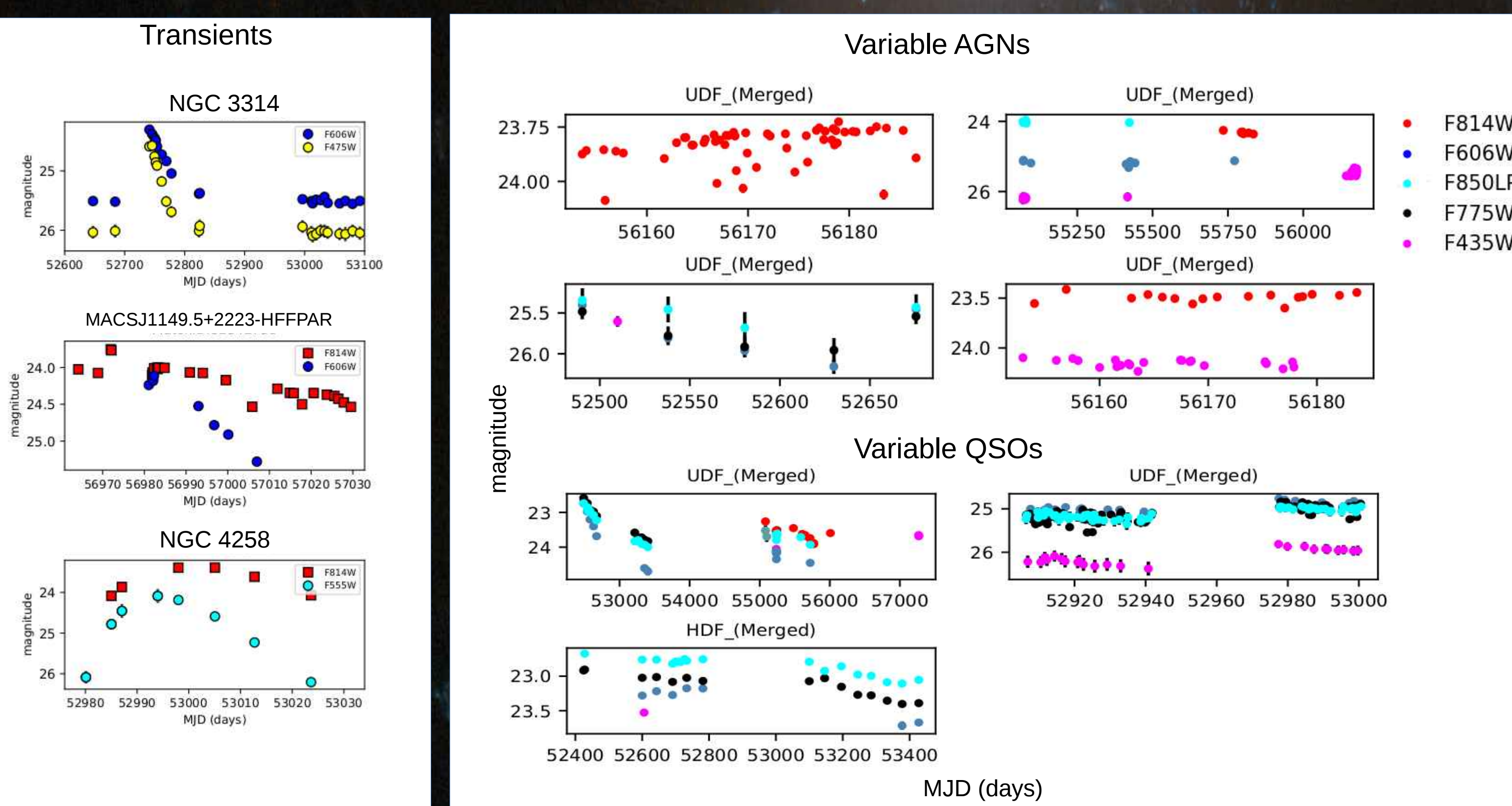


Figure 1. Left: Transient objects in the fields of NGC 3314, MACSJ1149.5+2223-HFFPAR and NGC 4258. We attempted to fit SN templates, which indicate that MACSJ1149.5+2223-HFFPAR might be a high-redshift super-luminous SN. SALT2-extended provided a good fit for a SN Type Ia at $z=0.67$ for the transient in the field of NGC 4258. Right: Light-curves of new variable AGNs and QSOs.