Contribution ID: **89** Contribution code: **P4** Type: **Poster**

Limitations of aperture photometry for star cluster studies

Monday, 19 August 2024 16:36 (2 minutes)

Recent studies have shown, that inconsistencies in the integrated colour indices (CIs) between real star clusters and theoretical models arise due to projection of bright stars inside the apertures. Thus, in this study we determined achievable accuracy and applicability limits of the aperture photometry approach for star cluster studies. We modelled a large grid of artificial 3D star clusters covering the parameter space of the M 31 clusters. Images were simulated by projecting each model onto 2D plane from 100 directions. Cluster images were generated in six passbands, matching Panchromatic Hubble Andromeda Treasury (PHAT) survey. To investigate the accuracy limits of aperture photometry, we measured artificial cluster images and performed parameter determination tests. We have shown that star clusters with and without post-main sequence stars exhibit considerable differences. We have demonstrated that CIs measured using an aperture with radius smaller than cluster's half-light radius lead to unreliable determination of cluster parameters. Additionally, we recommend to use colour-magnitude diagram fitting methods to derive parameters of young (<30 Myr) clusters, as aperture photometry-based parameter determination of such objects is troublesome regardless of the aperture size. Furthermore, we have shown that the randomness of cluster projection angle introduces uncertainty of CIs reaching up to 0.1 mag, depending on cluster parameters and aperture size. Also, we have demonstrated that due to stochastic effects structural parameters of low mass (<1000 $\mathrm{M}_{\odot}$) and younger than ~100 Myr star clusters are rather unconstrained and show large uncertainties. We anticipate that the results of this study will be helpful in data analysis and interpretation of present/future star cluster surveys in the Local Universe (<10 Mpc).

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Session Classification: Flash Poster Presentations (in-person)