

Variable stars around selected open clusters in the VVV area: Young Stellar Objects

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Abstract. Time-varying phenomena are one of the most substantial sources of astrophysical information, and led to many fundamental discoveries in modern astronomy. We have developed an automated tool to search and analyze variable sources in the near infrared Ks band, using the data from the Vista Variables in the Vía Láctea (VVV) ESO Public Survey ([5, 8]). One of our main goals is to investigate the Young Stellar Objects (YSOs) in the Galactic star forming regions, looking for:

- Variability.
- New pre-main sequence star clusters.

Here we present the newly discovered YSOs within some selected stellar clusters in our Galaxy.

1 Methods

- We compute a set of variability indexes: the Stetson J and K indices ([9]), the η index ([10]), the chi square statistic χ^2 ([6]), the small kurtosis κ ([7]), and the ratio between the average Ks magnitude from the light curve over the standard deviation of the data.
- We use an unsupervised algorithm, which identifies patterns among the values of these indices, grouping populations of objects with similar features.
- The periods are determined with Generalized Lomb-Scargle periodograms ([11]), and the Information Potential Metric ([4]).
- The variability class was assigned via comparison with VVV Templates ([2]), the period of the variability and the position on the color-magnitude diagram (CMD).

2 Results

The VVV tiles d001 and d002 are centered on RA = 175.8521, DEC = -63.5298 and RA = 179.0511, DEC = -63.8750. Following our algorithm 134 variable sources were discovered, 89 of them projected

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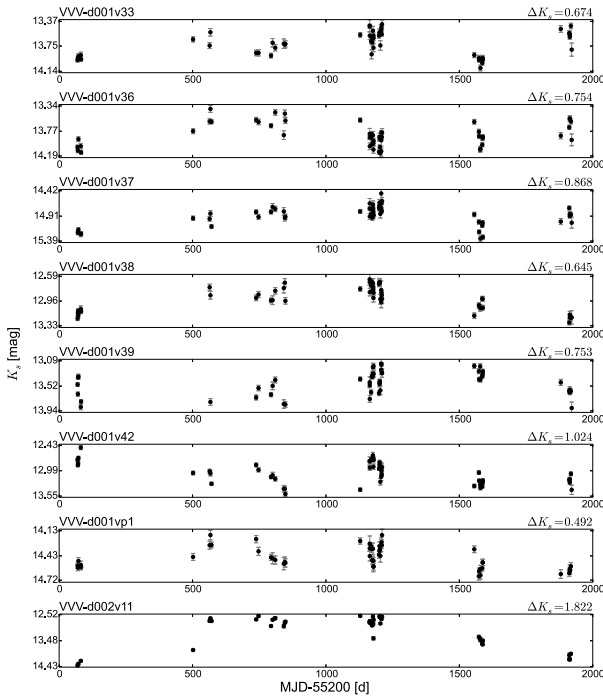


Figure 1. Light curves of the variable YSOs in the vicinities of clusters VVV CL 005, VVV CL 007, LS001, and LS002.

in the d001 area, while 45 belong to d002. Nine Young Star Clusters (YSC) are projected in the field of view of d001 and d002, namely VVV CL 005, 007, 008 and 009 ([5]) and La Serena 001, 002, 003, 009 and 015 ([3]). Eight variable stars were discovered in the vicinity of four of the clusters. Based on the shape of the light curves (Fig. 1) and the position on the CMD they are classified as YSO candidates.

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References

- [1] Angeloni, R., Contreras Ramos, R., Catelan, M., et al., *A&A* **567**, 100 (2014)
- [2] Barbá, R. H., Roman-Lopes, A., Nilo Castellón, J. L., et al., *A&A*, **581**, 120 (2015)
- [3] Borissova, J., Bonatto, C., Kurtev, R., et al., *A&A*, **532**, A131 (2011)
- [4] Huijse, P., Estevez, P., Zegers, P., et al., *IEEE Signal Processing Letters*, **18**, 371 (2011)
- [5] Minniti, D., Lucas, P. W., Emerson, J. P., et al., *New Astronomy*, **15**, 433 (2010)
- [6] Rebull, L. M., Stauffer, J. R., Cody, A. M., et al., *AJ*, **150**, 175 (2015)
- [7] Richards, J. W., Starr, D. L., Brink, H., et al., *ApJ*, **744**, 192 (2011)
- [8] Saito, R. K., Hempel, M., Minniti, D., et al., *A&A*, **537**, 107 (2012)
- [9] Stetson, P. B., *PASP*, **108**, 851 (1996)
- [10] von Newmann, J., *The Annals of Mathematical Statistics*, **12**, 367 (1941)
- [11] Zechmeister, M., & Kürster, M., *A&A*, **496**, 577 (2009)