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Open cluster study in LAMOST DR3

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Abstract. In studying Galactic open clusters based on LAMOST DR3, we deliberately selected several nearby cluster, which have relatively large projection area and reliable proper motion measurements. For each cluster, we firstly determine the typical proper motion distribution profiles in the cluster-core and the outskirt region, respectively, and perform field-star decontamination on the cluster area. We then calculate kinematic membership probability for each star in the cluster area and cross-match the highly probable members with LAMOST DR3 spectral catalog. Based on enhanced signal of cluster-member radial velocity distribution emerging from the whole field, we have also obtained reliable radial velocity membership probability for each star. Finally, we perform isochrones fitting with MCMC technique to study basic properties of these cluster, including age, metallicity, and distance modulus.

Keywords. methods: data analysis — open clusters and associations: general — catalogs — surveys

1. Overview of cluster observation in the LAMOST survey

Open clusters are ideal tracers to study the stellar population, the formation and evolution of Galactic disk. Comparing with observation of single stars, open cluster, as a group of stars with same origin, distance and similar composition, can provide more accurate fundamental properties, like age, distance, metallicity, extinction and so on. Further more, it is important to study the stellar evolution, luminosity function and initial mass function, based on basic parameters of various open clusters.

However, not only the reliable measurement of fundamental parameters of open clusters but also the statistical study of Galactic structure with open clusters, are still on the initial stage. And due to the lack of sufficient spectroscopic observation, only small portion of the confirmed open clusters have been well studied.

The study of star clusters by using the LAMOST spectroscopic data was firstly performed by Zhang *et al.* (2015). In their work, they presented 2189 candidate members from 24 star clusters in LAMOST DR2 and demonstrate the great potential of LAMOST spectra to identify cluster members and study the cluster properties, by using the radial velocity determination.

Although LAMOST spectroscopic survey covered large number of cluster fields on the Galactic disk (about 716 observed star clusters in LAMOST DR3), the fiber arrangement of LAMOST is too uniform to target sufficient members with only single observation. The insufficient sampling rate of member stars bring about that it is hard to identify the cluster members directly based on the radial velocity clumping from the LAMOST spectra.

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Table 1. Fundamental properties of three reduced clusters

Designation	Ra deg	Dec deg	$\mu_\alpha \cos(\delta)$ mas yr^{-1}	μ_δ mas yr^{-1}	RV km s^{-1}	FeH dex	Logt yr	Modulus mag	E(B-V) mag
NGC2281	102.0749	41.080	-3.92 ± 1.22	-8.21 ± 0.93	16.0	-0.11	8.83	8.15	0.051
NGC2168	92.3025	24.360	0.74 ± 1.55	-4.12 ± 1.23	-10.3	-0.16	8.40	9.23	0.053
NGC2632	130.0950	19.690	-1.54 ± 1.43	-2.19 ± 1.47	28.6	0.16	8.54	6.21	0.049

Notes: Designation and celestial coordinates are from the MWSC catalog (Kharchenko *et al.* 2013); $\mu_\alpha \cos(\delta)$ and μ_δ are average proper motion distribution of the cluster members; RV is average radial velocity of high membership probability stars in LAMOST; FeH is average metallicity of high membership probability stars in LAMOST; Logt and Modulus and E(B-V) are derived by the isochrone fitting.

2. Membership classification method

To avoid the shortcoming of LAMOST observation in the open cluster, we specially selected several nearby clusters for studying, which have relatively large projection area and reliable proper motion measurement. For these cluster fields, with the multiple observations, the LAMOST sampling rate is sufficient to perform the membership determination and the fundamental properties study.

To identify the members of star clusters with the LAMOST data, we adopt the equations described in Balaguer-Núnez *et al.* (1998) to estimate the proper motion (PM) membership probability of each star in the cluster field firstly. After estimating the PM membership probability for each star, we exclude field stars to enhance the signal of cluster members in the radial velocity (RV) histogram distribution, and then perform the RV membership probability calculation. In order to reduce the field stars contamination as much as possible, we only retain the member candidates with PM probability greater than 80 %. The calculation method of RV membership probability is similar to the membership determination method described in Balaguer-Núnez *et al.* (1998), and the radial velocity distribution and spatial distribution for cluster and field stars are considered respectively.

3. Preliminary results

In this preliminary study, we adopted the membership classification method to reduce three standard clusters: NGC2281, NGC2168 and NGC2632, and then perform the isochrone fitting of cluster members in the color-magnitude diagram by an adaptive algorithm of Markov Chain Monte Carlo (MCMC) by Haario *et al.* (2001) to estimate fundamental properties of these three clusters.

The results are listed in Table 1, including cluster common designation, celestial coordinates at the 2000.0 epoch, average proper motions along the R.A. and decl., average radial velocity and metallicity with high probability of membership stars, age and distance and extinction estimated by the isochrone fitting in the color-magnitude diagram. The agreement of previous study indicate the great potential of uncover fundamental properties by the LAMOST spectroscopic survey.

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