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Disruption of open clusters in the Galactic disk via Gaia data

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Dr. Xiaoying Pang got her Ph.D. at Heidelberg University working with Prof. Dr. Eva Grebel. She moved to Xi’an Jiaotong Liverpool University in 2019 and bold an assistant professor position there. In her Ph.D. study, she investigated the origin of mass segregation in the very young massive star cluster NGC 3603 (Pang et al. 2013) and its 2D extinction map (Pang et al. 2011) and reddening law (Pang et al. 2016). When she worked with Prof. Dr. Rainer Spurzem as a postdoc at NAOC in 2013, she began to connect N-body simulations with observations. Since Gaia data release 2, Dr. Pang started to work on the disruption of open clusters in the solar neighborhood. She and her collaborators first discovered the tidal tails in the nearby open clusters Coma Berenices (Tang, Pang, et al, 2019). Using Gaia DR2 data, She and her collaborator built an open cluster catalog in the Milky Way and discovered 76 new star clusters (Liu & Pang 2019). She has carried out a series of papers to investigate the dynamical evolution of star clusters via both Gaia DR2/EDR3, APOGEE, and NBODY simulations (Pang et al. 2018; Pang et al. 2020; Pang et al. 2021a, Pang et al. 2021b; Shu, Pang, et al. 2021; Li, Pang & Tang 2021).

Abstract

Open clusters are formed in the Galactic disk and will contribute to field stars after the disruption. They are good probes for the formation and evolution of the disk. The disruption of open clusters is a consequence of internal and external dynamical processes, which will lead to a dramatic change in the 3D morphology of open clusters. We study a dozen open clusters, plus a cluster pair (Collinder 135/UBC7) and the stellar complex Vela OB2 within 500 pc in the solar neighborhood based on the data from Gaia EDR3, we determine members of open clusters in 5D parameter space (3D spatial positions + 2D proper motions) via the self-adapted unsupervised learning algorithms based on an artificial neural network, which is advantageous at identifying low density and extended tidal structures. The hierarchical structures of the stellar complex are also disentangled via the same algorithm. Through the spatial positions of member stars, we establish the 3D morphology of open clusters, and do statistical quantification and analysis of the morphology by parametrization of an ellipsoid model. The dynamical state of open clusters is investigated with 3D velocities and velocity dispersions. Most clusters in our samples are supervirial and expanding after gas expulsion, except for one cluster NGC 2232 that is probably undergoing revirialization. The expansion rate in the youngest stellar complex Vela OB2 (10 Myr) is the most significant. N-body models of rapid gas expulsion with an SFE of $\approx$ 1/3 are consistent with clusters more massive than 250 M$\odot$, while clusters less massive than 250 M$\odot$ tend to agree with adiabatic gas expulsion models.

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