Formation and early evolution of star clusters in the era of large surveys

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Stars do not form in isolation, but in clusters with 10 to 10^6 siblings during the collapse and fragmentation of molecular clouds (e.g., Lada & Lada 2003; Mckee & Ostriker 2007). The majority of clusters disintegrate in ~10 to 100 Myr. The study of the processes driving the formation and early evolution of star clusters is fundamental to understand the properties of the Galactic field stars and their planetary systems. There are still open questions in these research field, e.g. whether the stars form in bound clusters or in unbound associations, what are the processes that lead the dissolution of the majority of clusters and those that lead to the formation of rare long-lived bound ones, what is the timescale of star and planet formation and where the Galactic population comes from. The next years will be fundamental in this respect, thanks to both the European space mission Gaia (Perryman et al. 2001; de Bruijne 2012) and its associated ground-based spectroscopic survey Gaia-ESO (Gilmore, Randich et al. 2012; Randich & Gilmore 2013). The former has been successfully launched in 2013, with the aim to perform an all-sky survey to derive the astrometric and photometric data of ~10^9 stars. It will provide parallaxes and tangential motions, along with precise photometry. The Gaia-ESO Survey is instead a large public spectroscopic survey carried out with FLAMES on ESO/VLT and it is conceived to complement Gaia data, acquiring ~10^5 spectra of Milky Way stars. It will derive radial velocities, stellar parameters and elemental abundances of the stars selected in the Galactic field and in a large set of open clusters. The astrophysical observatory of Arcetri is the home institution of the co-PI of the Gaia-ESO survey and thus it has a leading role in this project.

The aim of my PhD project is to address the open issues mentioned above by combining the potential of the observations of Gaia-ESO survey with the ones of European space mission Gaia.

In the first year, my project research will focus on the analysis of the Gaia-ESO data. In particular, I will study the structural and the dynamical properties of the young and middle age clusters observed in the survey using stellar parameters, such as radial velocities, temperatures, gravities and abundances. During the second year, the Gaia-ESO data will be then combined with the astrometric and photometric data from Gaia satellite. Parallaxes and proper motions will be used to analyze the structural and dynamical properties of clusters in the 6-dimensional phase space and investigate departures from spherical symmetry, which characterize many young clusters and are fundamental to understand their dynamical evolution (e.g. Proszkow et al. 2009). During the last year I will compare the results with the models describing cluster formation in molecular clouds (e.g. Bonnell et al. 2003; Tan et al. 2006; Bate 2012), their evolution to form the Galactic field and open clusters (e.g. Longmore et al. 2014, and references therein) and the internal evolution of pre-main sequence stars (e.g. Tognelli et al. 2012).

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