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Imprints of Stellar Encounters in the ONC

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Abstract. External destruction of protoplanetary discs acts mainly due to two mechanisms: gravitational drag by stellar encounters and evaporation by stellar winds and radiation. It is an important question whether any of these mechanisms is important in the stellar evolution process. We focus on the effect of stellar encounters and investigate if there are any observables that could trace this mechanism in young stellar clusters. An analysis of observational data of the Orion Nebula Cluster (ONC) and accompanying n-body simulations both provide evidence for encounters of star-disc systems in the ONC, eventually leading to substantial disk disruption.

Keywords. stellar dynamics, methods: data analysis, n-body simulations, stars: kinematics, circumstellar matter

1. Introduction

In this investigation we are dealing with the question if there might be *observational* evidence for star-disc systems which have been subject to an encounter. We set up numerical simulations with an dynamical model of the Orion Nebula Cluster (ONC) to validate observational data.

2. Observational Data

We have compiled data from Jones & Walker (1988), Hillenbrand (1997), and Hillenbrand *et al.* (1998) and excluded stars lacking proper motion or infrared excess data. The resulting database contains ~ 450 stars, about two thirds of which show disc signatures.

Fig. 1 shows the observed velocity distribution for stars with ages $\leqslant 1\,\mathrm{Myr}$. The age boundary excludes possible non-members of the ONC and is roughly equal to the mean age of the cluster. The 3D velocity dispersion of the ONC is $\sigma \approx 4.3\,\mathrm{km/s}$. Potential candidates of recent encounters are stars with velocities $v \geqslant 3\sigma$. Several such stars (most of low mass, $\sim 0.2\,\mathrm{M}_\odot$) are present in the compiled data ($\sim 5\,\%$), among also apparent disc-less objects. The adopted age boundary is clarified by plotting stellar ages against velocities for the high-velocity stars only (Fig. 2, left). The diagram shows a bimodal

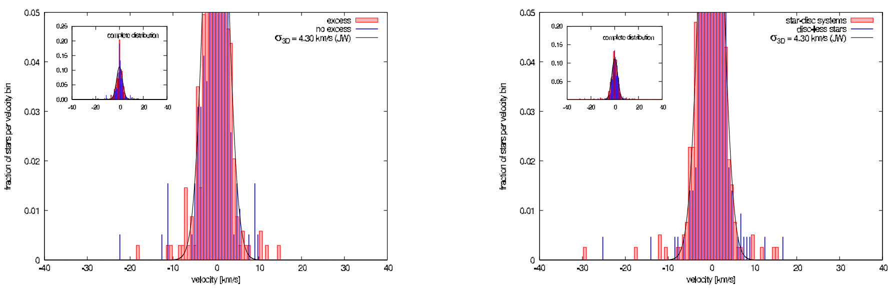

Figure 1. *Left:* Distribution of observed proper motions of stars with ages $\leqslant 1\,\mathrm{Myr}$.
Right: Velocity distribution from simulations of the ONC at 1 Myr.

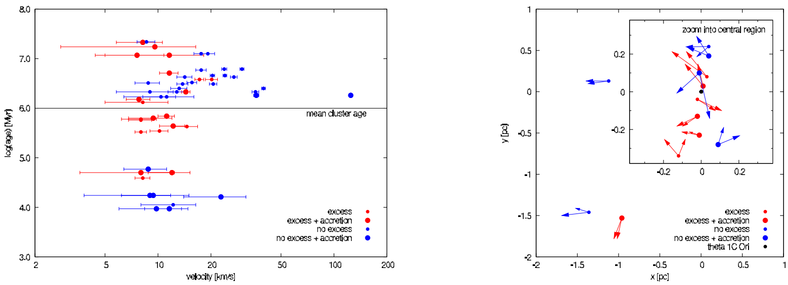

Figure 2. *Left:* Age-velocity distribution of high-velocity ($v \geqslant 3\sigma$) stars in the ONC. *Right:* Positions and velocity vectors of young ($\leqslant 1\,$Myr) high-velocity stars.

distribution: older stars have much larger proper motions and mostly lack signs of disc emission. These objects are considered to be highly probable foreground stars.

For the younger probable high-velocity members of the ONC the projected positions are plotted on the right-hand side of Fig. 2. It is apparent that most stars are located close to the cluster center ($r \lesssim 0.4\,$pc) where densities are highest and encounters most probable. The massive stars in the center act as additional gravitational foci (Pfalzner, Olczak & Eckart 2006). The high velocities of the selected stars strongly favor very recent interactions since after $\tau_{esc} \leqslant 0.4\,\mathrm{pc}/3\sigma \approx 0.05\,$Myr they should have left the inner cluster region.

3. Cluster Simulations

The basic dynamical model of the ONC is described in Olczak, Pfalzner & Spurzem (2006). Here we use the same concept but have included a background potential and primordial binaries in particular for a more realistic model of the stellar dynamics. The code used is NBODY6++.

The resulting velocity distribution is shown on the right-hand side of Fig. 1. It reproduces well the features seen in the observational data: the bulk of the stars forms an approximate Gaussian velocity distribution. Moreover, about the same fraction of stars ($\sim 4\,\%$) shows much higher velocities $v \geqslant 3\sigma$. In the simulations stellar discs are affected solely by encounters. Thus the resemblance of the two velocity distributions probably points to a dynamical origin of the observed high-velocity non-excess ONC stars.

4. Conclusions

Numerical simulations of the ONC support the scenario that the observationally established small sample of young, low-mass, high-velocity stars close to the cluster center consists of potential candidates for recent encounters. The lack of signatures of circumstellar discs in half of the stars eventually tracks destructive encounters, probably with high-mass stars.

References

Jones, B. F. & Walker, M. F. 1988, *AJ* 95, 1755.

Hillenbrand, L. A. 1997, *AJ*, 113, 1733.

Hillenbrand, L. A., Strom, S. E., Calvet, N., Merrill, K. M., Gatley, I., Makidon, R. B., Meyer, M. R., & Skrutskie, M. F. 1998, *AJ* 116, 1816.

Olczak, C., Pfalzner, S., & Spurzem, R. 2006, *ApJ* 642, 1140.

Pfalzner, S., Olczak, C., & Eckart, A. 2006, *A&A* 454, 811.

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