Kinematics of massive stars

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Field of work: Stellar Kinematics

The Gaia space observatory of the European Space Agency provides astrometric measurements of unprecedented accuracy and precision for almost two billion sources on the sky. Main data products are parallaxes and proper motions, that are continuously improved with increasing measuring time. The current state-of-the-art is Gaia Data Release 3 (DR3), based on 34 months of observations (out of >10 years of mission duration).

In the proposed Bachelor thesis relevant data for a sample of massive early-type stars will be extracted from the Gaia DR3 database and radial velocities from other astronomical databases. The focus will then be on the determination of trajectories from the 6D data (spatial coordinates, space motion) of the stars in the Galactic gravitational potential by numerical integration of the orbits, and the visualisation of the positions and the trajectories in the Milky Way in a similar fashion like shown in the figure. While it is expected that most objects will follow the Galactic rotation, some will show peculiar trajectories (see the rightmost panel of the figure). These so-called runaway stars have witnessed a supernova explosion in a binary star system, or dynamical ejection in a star cluster. An identification of such interesting stars will be the basis for future spectroscopic observations and quantitative in-depth studies of these objects.

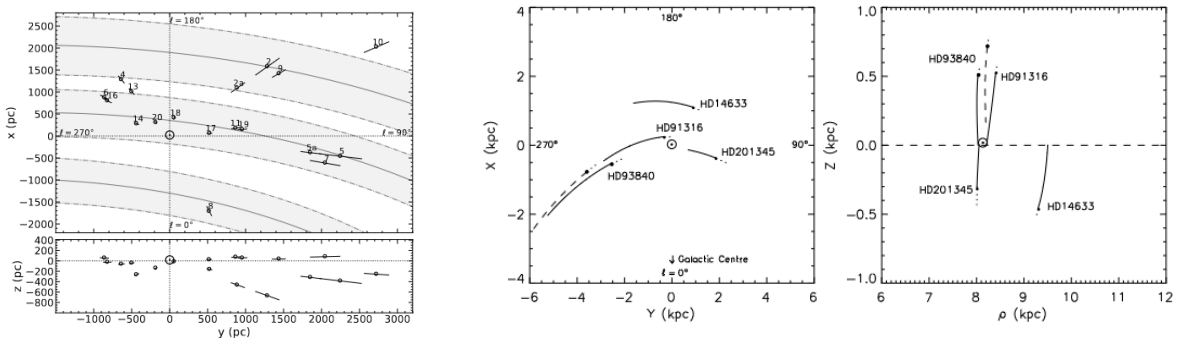

Figure: Examples of the distribution (left panel) and kinematic movement (two right panels) of massive stars in the Milky Way. Displayed are views of the Galactic plane (X-Y) and a cut through the Galactic disk (Y-Z), with the grey-shaded areas indicating thepositions of the spiral arms. The kinematics plots concentrate on massive runaway stars that were ejected perpendicular to the Galactic plane via dynamical ejection or by binary supernova disruption (Aschenbrenner et al. 2023; Weßmayer et al. 2023, 2024).

Keywords: Gaia mission – distribution and kinematics of stars – massive stars – early-type stars – astronomical databases – numerical orbit calculation

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