Stellar Tracer

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Tidal tails form in open clusters due to two-body relaxation and gas expulsion (Kroupa et al., ApJ, 2024). Mapping tidal tail star trajectories provides key insights into understanding open clusters' formation, dynamic evolution, and dark matter halo concentrations. In numerous studies on tidal tail evolution (e.g. Kos et al., Astronomy and Astrophysics, 2024; Noormohammadi et al., MNRAS, 2023), astronomers spend considerable time and computational resources in clustering stars and detecting tidal tails before being able to analyze their properties. Built to run on laptops, Stellar Tracer is a unique, customizable software tool that automates this process for facilitating tidal tail research. Stellar Tracer incorporates a hybrid DBSCAN-GMM ML model for cluster membership to maximize tidal member count while reducing field star contamination. High accuracy was achieved with mean silhouette scores > 0.8 and Davies-Bouldin indices < 2.5 for all 15 tested clusters. PARSEC isochrones are fitted to compute cluster mass and Jacobi radii for separating tidal tails from core stars. The integrated MWPotential2014 model then computes trace star trajectories. For up to 1000 integration steps, orbits were generated within 1 minute, using less than 4 MB of peak memory usage. Limitations that affected accuracy during Stellar Tracer's development involved a lack of precise spectral data for tidal stars and limited GPU access. Therefore, next steps involve gathering additional spectral data from telescopes such as SDSS and HIPPARCOS, an ANN to filter field stars by age, and a distributed cloud-based platform with GPU cores for faster processing and increased accessibility.

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