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Searching for Dark Matter Subhalos in Astronomical Data using Deep Learning

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Due to poor observational constraints on the low-mass end of the subhalo mass function, the detection of dark matter (DM) subhalos lacking a visible counterpart on sub-galactic scales would provide valuable information about the nature of DM. Novel indirect probes for DM substructure within the Milky Way (MW) are stellar wakes, which are perturbations of the stellar medium induced by DM subhalos and which encode information about the mass properties of the perturber. The dramatic increase in high-precision observations from current and future stellar surveys of our Galaxy (e.g. Gaia satellite) encourages the gravitational detection of these low-mass subhalos using deep learning techniques. As these methods have already been effective in unravelling the stellar substructure of the MW, we now employ them on MW-like galaxy simulations to explore the Galactic dark substructure. Motivated by the above, our work estimates the feasibility of using supervised and unsupervised deep learning methods on simulations and synthetic Gaia observations to detect disturbances in the stellar phase-space induced by orbiting DM subhalos. Furthermore, we expand on the above with findings from an ongoing study of stellar wakes in windtunnel-like N-body simulations, where we investigate the detectability of the wakes as a function of Galactocentric radius and subhalo mass.

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