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# Kinematics, Rotation, and Multiplicity of Ultracool Dwarfs with High-Resolution Near-Infrared Spectroscopy

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Ultracool dwarfs (UCDs) are the lowest-mass stars and brown dwarfs, with effective temperatures ≤ 3,000 K. Over the past two decades, thousands of UCDs have been discovered through all-sky surveys such as 2MASS and WISE, making it possible to statistically study them as a population. As part of my doctoral thesis, I have analyzed the largest sample of high-resolution near-infrared spectra of ultracool dwarfs to date with Keck/NIRSPEC (archival and observed) and SDSS/APOGEE DR17. I employed a Markov Chain Monte Carlo forward-modeling method to measure precise radial and projected rotational velocities (vsini), quantities which can be used to identify members of nearby young moving groups, confirm low-mass short-period binaries, and study population kinematics and angular momentum evolution. In this talk, I present an analysis of 172 nearby UCDs within 20 pc with 3D kinematics. I confirm that local L dwarfs are more dispersed and have an older kinematic age than late-M and T dwarfs, consistent with previous studies and contrary to theoretical predictions. However, I find that this discrepancy can be resolved by the higher fraction of thick disk members in the local L dwarf population. I further demonstrate that L dwarfs have declining velocity dispersions toward later subtypes, reflecting a higher brown dwarf-to-star ratio through the later sequence; and identify a kinematic break between L4–L6 subtypes which can be attributed to the terminus of stellar main sequence. My rotational analysis indicates that average vsini increases from late-M to T dwarfs, reflecting less angular momentum loss toward later spectral types. I also report the identification of the first two T-type spectroscopic binaries. Combining this sample with recent observations of late-M and L dwarfs with Keck/NIRSPEC, I show how comparison of the kinematic sample to population simulations constrain the local UCD star formation rate, mass function, and hint at potential modifications of evolutionary models. Finally, I summarize the future development for high-resolution spectroscopic surveys and forward-modeling for UCDs in the local sample and beyond.