Some studies on 'Brown Dwarf Desert'

Dept. of Astronomy
35246121 Shodai Nezu

Brown dwarfs (BDs) are objects whose mass range is about 13-80 Jupiter masses. The temperature in their center is not enough to burn hydrogen but deuterium. In other words, brown dwarfs are the middle between gas giant planets and main-sequence stars.

The radial velocity method has discovered the companions of sun-like stars, including exoplanets and BDs orbiting around within 3 au. While these companions with long periods (100d~) are distributed in a wide range of mass, the number of brown dwarfs with short periods (~100d) and Msini ~ 30-55 Jupiter masses are poor. This area is shown in the figure below, called the 'brown dwarf desert' (Ma & Ge 2014). The authors claim that **this is not observational bias** because the radial velocity method is sensitive enough to detect objects in this area, if any. They suggest that **the difference in formation mechanisms between above and below this gap** causes brown dwarf desert.

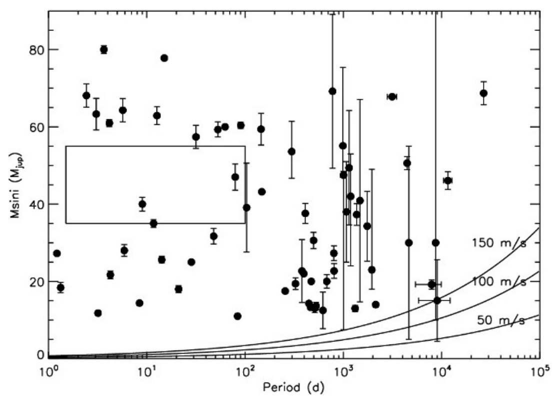

Figure 2 of Ma & Ge 2014

The authors explain the possibility of the difference in the origins of heavier and lighter BDs from two points of view. First, while the maximum eccentricity of light BDs seems to depend on their masses, that of heavy BDs is sparsely distributed (left panel of the figure below). This is consistent with the picture that light BDs are formed in a protoplanetary disk and later pumped to higher eccentricity through scattering by other objects formed in the disk. Second, the metallicity of host stars has a different distribution between BDs and giant planets (right panel of the figure below). Since metallicity plays an important role in core accretion or molecular cloud fragmentation scenarios, the difference in the metallicity of host stars implies the different formation mechanisms of their companions.

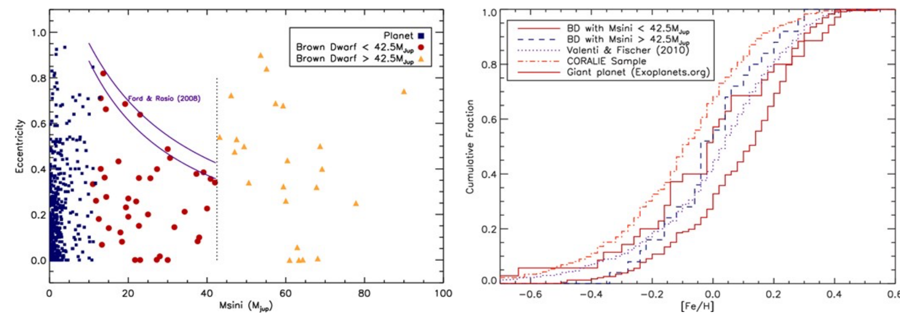

Figure 5 and 6 of Ma & Ge 2014

Although this paper was published ten years ago, some recent missions are devoted to similar studies, including Gaia and TESS (Unger et al., 2023; Henderson et al., 2024). These studies are also expected to contribute to the understanding of star and planet formation mechanisms.

References: Ma, B., & Ge, J. 2014, MNRAS, 439, 2781, Unger N., Ségransan D., Barbato D., Delisle J. B., Sahlmann J., Holl B., Udry S., 2023, A&A, 680, A16, Henderson B. A., et al., 2024, MNRAS, 533, 2823