Brown Dwarf vs Planet: On the Deuterium Burning Limit

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Many definitions of planet seek to clearly delineate the distinction between a Brown Dwarf and Planet. One approach to this problem invokes formation mechanisms: supposing that brown dwarfs form like stars, via gravitational fragmentation of molecular clouds, while planets form in circumstellar disks. Such an approach is disfavored by many since the formation mechanism is not directly observable, and is replaced by a definition based on the interior physics, adopting a distinction based on the fusion of deuterium. The widely accepted division between brown dwarfs and planets is at 13 Jupiter masses based on the distinction that objects above this limit will undergo fusion and objects below this limit will not. However, there is an inherent assumption in this definition that the object formed and evolved on a hot-start evolutionary track that sufficiently elevates the the core temperature to fusion temperatures. If the formation process, whether in molecular clouds or a circumstellar disk dissipates significant gravitational binding energy through an accretion disk or accretion shock before the gas becomes part of the optically thick central object, then objects above 13 Jupiter masses can form without core temperatures sufficient to achieve fusion. In principle, it is possible to form objects as massive as the Chandrasekhar limit without any fusion. A corollary is that a "Deuterium test", analagous to the Lithium test used to distinguish brown dwarfs from stars may offer some insights into the formation mechanisms of brown dwarfs and planets. Any robust definition of the definition of a planet will need to consider carefully the implications of formation on the fusion processes if fusion is to be used to distinguish brown dwarfs from planets.