



## What Is a Planet?

**COOL OBJECTS FOUND IN YOUNG STAR** clusters in Orion and Perseus, such as those reported by M. R. Zapatero Osorio and colleagues in their research article (6 Oct., p. 103), have been described variously as “planetary mass objects,” “isolated giant planets,” “free-floating planets,” and “superplanets” (1). The word “planet” has been invoked because the masses of these objects are apparently only about 5 to 10 times that of Jupiter. However, even if those masses are confirmed, we maintain that such bodies are better thought of as low-mass brown dwarfs, as they are not in orbit around stars.

Brown dwarfs are “failed stars” with masses below 7.2% of the sun’s mass ( $0.072M_{\odot}$ ). Unable to develop the central pressure and temperature required to sustain hydrogen fusion, they decline in luminosity precipitously in less than 100 million years (2), whereas stars maintain a near-constant luminosity for billions of years. At even lower masses, below  $0.013M_{\odot}$  (about 13 Jupiter masses), even deuterium fails to fuse, and thus, by analogy,  $0.013M_{\odot}$  has been proposed as the boundary between brown dwarfs and planets (3). However, deuterium burning is a relatively minor phenomenon, producing at most a few-million-year slowdown in the cooling of low-mass sources just after birth, and it seems disproportionate to draw such a major demarcation solely on this basis.

Yet, if one must discriminate, use of the term “planets” for the bodies below  $0.013M_{\odot}$  is an inappropriate (albeit notably media-friendly) choice. Science does not take place in a cultural vacuum, and the word “planet” has a 3000-year history. Common usage today implies a low-mass object that is born and orbits around a more massive stellar object, whereas the Orion and Perseus objects are isolated and likely to have formed by direct collapse and fragmentation of a molecular cloud core, just like stars and brown dwarfs. Calling them “planets” implies swarms of Jupiters stripped from their parent stars, a

scenario currently unsupported by any evidence, and one that has created confusion in the press (4).

Our preference is to call these bodies low-mass brown dwarfs, but if a new name is deemed necessary based on characteristic mass alone, then we suggest “grey dwarf.” This term preserves the neutral terminology introduced by Tarter with

Three planetary mass objects (or free-floating planets, or low-mass brown dwarfs, or grey dwarfs, or...) discovered in the  $\sigma$  Orionis star cluster.



This discussion of What Is a Planet? is continued in dEBates, with invited comments from experts from several fields. Join the dEBate at [www.sciencemag.org/cgi/eletters/291/5508/1487](http://www.sciencemag.org/cgi/eletters/291/5508/1487)

“brown dwarf” (5) and provides a link to higher mass free-floating objects without suggesting implausible relationships to our familiar solar system gas giants.

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### References and Notes

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2. J. Liebert, *Astron. Soc. Pacific Conf. Ser.* **212**, 7 (2000); C. G. Tinney, *Nature* **397**, 37 (1999).
3. A. Burrows et al., *Astrophys. J.* **491**, 856 (1997).
4. See, for example, the articles at <http://www.cnn.com/2000/TECH/space/10/06/space.planets.reut/index.html>; [http://news6.thdo.bbc.co.uk/h/english/sci/tech/newsid\\_957000/957518.stm](http://news6.thdo.bbc.co.uk/h/english/sci/tech/newsid_957000/957518.stm); <http://spaceflightnow.com/news/n0010/08planets/>
5. J. C. Tarter, *Astrophysics of Brown Dwarfs* (Cambridge Univ. Press, Cambridge, 1986), p. 121.

### Response

**NO MATTER WHICH NAME IS GIVEN TO THOSE** astronomical bodies found with masses below 13 Jupiter masses and free-floating in Orion and Perseus, they are of major scientific interest indeed. The entire astronomical community agrees that the finding of this kind of objects contributes significantly to our knowledge of substellar formation mechanisms and might improve our understanding of the structure of the galaxy. Recent results suggest that these bodies together with brown dwarfs could constitute a rather numerous population in young regions of the Milky Way, possibly outnumbering stars. Many intriguing scientific questions related to origin, evolution, and properties still remain open, which will be addressed by astronomers and physicists in the following decades.

Albeit several proposals for naming these objects have been made, there is no final nor formal consensus on the designation that best fits their properties and characteristics. Criteria based solely on genesis or on “circumstance” (isolation or bound to a more massive object) appear to be rather ambiguous because how objects form and how they interact dynamically with each other are open issues in astrophysics. On the other hand, a definition making use of physical properties (light-element burning, degeneracy of the interiors, metallicity) could be more appropriate.

Since the discoveries of the first massive brown dwarfs (direct imaging) and extrasolar planets (radial velocity technique) in 1995, hundreds of these objects have been identified. The “mass gap” between Jupiter and the smallest stars is being filled with hydrogen nonburning bodies, which are found either floating freely or orbiting more massive objects. Those isolated astronomical bodies less



massive than 13 Jupiter masses discovered in Orion and Perseus will look like the giant planets of our solar system when they become as old as Jupiter is. The definition of the word "planet" has been modified several times in the last three millennia on the basis of an increasing scientific insight. Our knowledge of the solar system, other extrasolar systems, and the substellar population of the galaxy continues to expand, and thus we can expect such knowledge to be used to refine definitions of terms such as "planet" and to reveal the need for new terms.

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## ADHD: Disorder or Discipline Problem?

**TREATING CHILDREN FOR ATTENTION DEFICIT hyperactivity disorder (ADHD) with stimulant medications predisposes them to substance abuse, according to Peter Breggin in his letter to *Science* ("Questioning the treatment for ADHD," 26 Jan., p. 595). In support, he cites one article, but does not mention that**

it was criticized for faulty methodology (1). And there are two studies that contradict Breggin's statement: one by Hechtman (2), who found no evidence that stimulant exposure predicted substance abuse, and another by Biederman et al. (3), in which we found that pharmacotherapy predicted an 84% reduction in risk for substance abuse. Breggin also cites two animal studies (4) as showing that stimulants permanently change the brain. However, these studies used dosing schedules that are not comparable with therapeutic practice. And the authors of these studies concluded that the brain changes observed were reversible, not permanent. Breggin's letter misses the point. It is the disorder, not its treatment, which is the public health problem.

Breggin also says that ADHD symptoms "can be caused by anything from normal childhood energy to boring classrooms or overstressed parents and teachers." Blaming parents and teachers is stigmatizing and counterproductive. It also ignores data

showing that genes play a major role in the etiology of ADHD (5). Indeed, its heritability, about 70%, is similar to that seen for other complex genetic conditions (5).

In another letter in the same issue, Fred Baughman argues that ADHD, rather than being a disorder, is simply the extreme of normal behavioral variation. There are many examples of extreme variation being medically urgent. Hypertension and hypercholesterolemia are two such examples. Medicine treats extremes of variation if they are associated with distress or disability. ADHD can lead to antisocial behavior, substance abuse, poor school functioning, traffic accidents, poor vocational functioning, and difficult marriages. It easily meets the distress and disability criteria defined in psychiatry's diagnostic manual.

Stimulant medication, used for decades to treat ADHD symptoms, is safe and efficacious when prescribed appropriately. The idea that parent and teacher training can duplicate this efficacy is wrong. That was

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