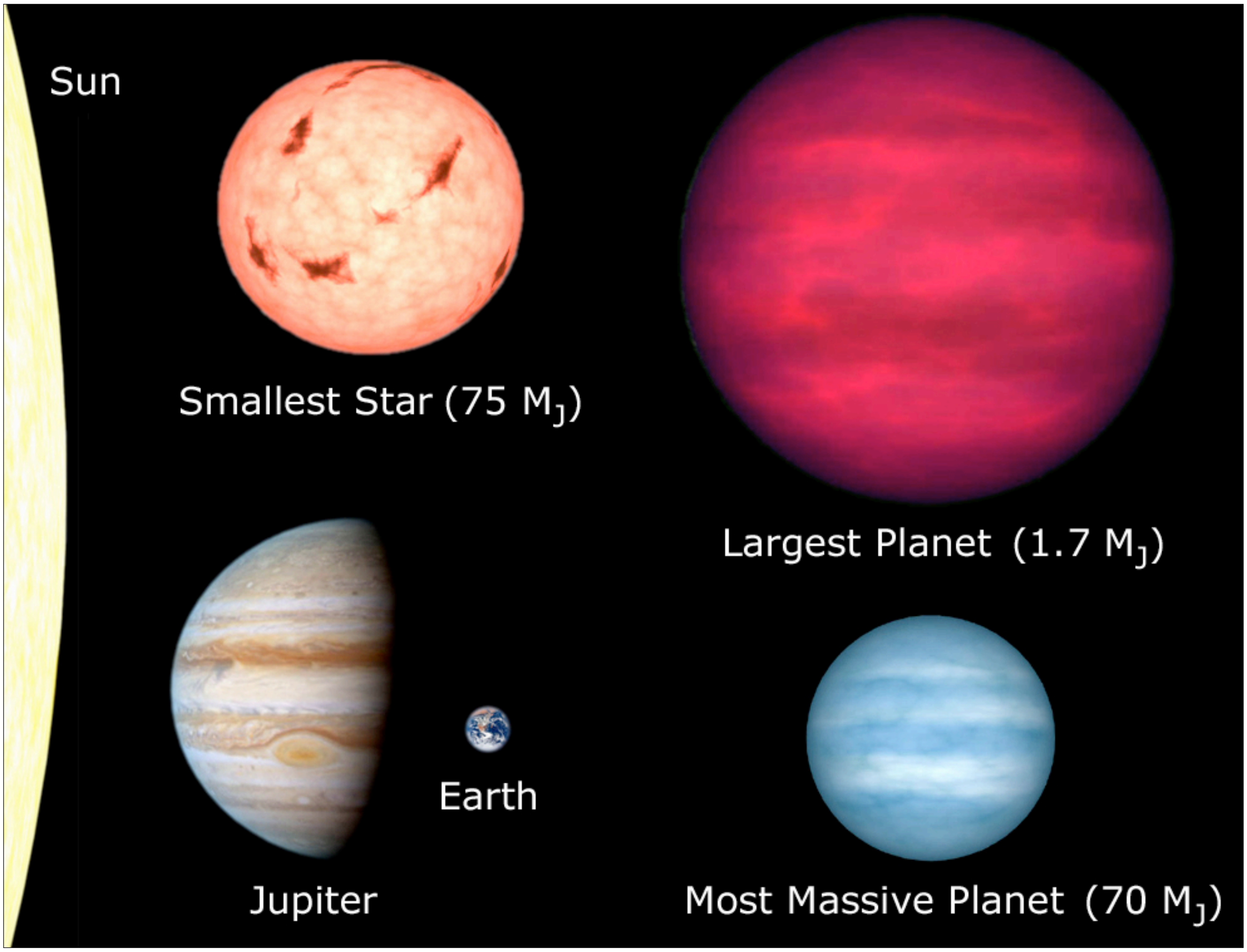
Plate 2: Shrinking Planets



This figure compares the radii and masses of large objects. (M_J = one Jupiter mass = 318 Earth masses.) The radius of a planet increases with increasing mass only up to a point, then it begins to shrink as gravitational compression takes over and begins to steadily crush the planet downward. Looking first at Jupiter, we see that it is actually larger in radius than a small star, but has barely 1.5% of the mass. In other words, the small star is far more compressed.

If Jupiter were made about 70% more massive, then you would have the large red planet at upper right. This planet is about as large as *any* object can be (in radius) if it is NOT burning nuclear fuel.

Adding mass beyond 1.7 M_J very gradually crushes a planet into one like the bluish globe at lower right. This immensely heavy object[1] is 42 times as massive as the red one, yet has only 60% of the red one's

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[1] I call it an "object" because technically, only objects with masses below about 13 M_J are called "planets" by astronomers. Objects with masses between 13 M_J and 75 M_J are called *brown dwarfs*. The details behind the name change are interesting in their own right, but a bit off the subject. With respect to how they behave under high compression, both planets and brown dwarfs behave the same, so I have elected to lump super-massive planets and brown dwarfs together in this article.

radius. More tellingly, since volume equals length x height x width, the volume[2] of the bluish planet is just 0.6 x 0.6 x 0.6 = 22% that of the red one. The corresponding increase in density (mass divided by volume) for the bluish planet then works out to be 42/0.22 = 190 times that of the red one! Its mass of 70 x 318 = 22,260 Earths gives the blue planet a density 20 times that of lead!

By comparison, the Sun (whose size is hinted at on the left) is much more massive than any of the other objects in the figure, but it is also far less dense as the fierce nuclear burning in its interior has caused it to expand into a relatively "soft" ball of gas.

[2] As unlikely as it looks, a hollow globe the size of the red planet could hold nearly five times as much water as a globe the size of the bluish planet. Volume is three dimensional, and while your eye is very good at sizing up distances in one dimension, it is very poor at sizing up volumes in three dimensions.