Quiz 4 Feedback

1. Collapsing clouds of 0.1 $M_\odot$ and 0.05 $M_\odot$. What stops their collapse, what does each become and how does it evolve?

The 0.1 $M_\odot$ cloud exceeds the minimum mass needed for it to become a Main Sequence star, 0.08 $M_\odot$. It will stop collapsing when the core becomes hot and dense enough for H fusion reactions to begin. After that, the energy generated by fusion keeps the core hot and maintains the thermal pressure that balances gravity. It will maintain the same radius, temperature, and luminosity for its (very long!) Main Sequence lifetime.

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The less massive cloud "misses the cut" and will become a brown dwarf. Its collapse will be stopped by electron degeneracy pressure, also called quantum pressure, before the central temperature rises high enough for nuclear fusion to begin. At this point it has no means for producing more energy – it doesn't have fusion and cannot contract further – so it just radiates away its heat, getting dimmer (in luminosity) and cooler (in surface temperature) with time.

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2. Why did astronomers create new spectral types L, T, and Y? How do these fit into the spectral sequence? Note the hint.

The new spectral types were created because of the discovery of cooler objects than those of class M. The new spectral types apply to ***brown dwarfs*** of progressively cooler temperatures, in the following order: M, L, T, then Y. While it is true that cooler stars have spectra that peak in the infrared, spectral classes are ***defined*** by the pattern of absorption lines seen in the spectrum. These spectral classes have different molecules, in particular larger molecules (more than 2 atoms), such as CH_4 and H_2O, than hotter stars.

Common Misunderstandings

- On question 1, some students misread the numbers as 0.1 and 0.5 $M_\odot$ and concluded that both clouds became Main Sequence stars because they had more than 0.08 $M_\odot$.
- Others were confused about which forces are involved in hydrostatic equilibrium. Gravity always acts radially inward, and is countered (balanced) by an outward pressure. For Main Sequence stars, this is thermal gas pressure. For special types of stars, namely brown dwarfs and white dwarfs, electron degeneracy pressure provides the outward force.
- On question 2, most people knew that these new spectral types are cooler than the previous ones, but some lost partial credit if they did not explain how the ***spectra*** of these objects differ. Spectral types are based on the appearance of spectra, specifically the *absorption* lines.