Group Card Activity, Oct. 9

Until a few years ago, most exoplanet searches were directed at Sun-like stars: Main Sequence stars of 1 $M_\odot$. Recently, some astronomers have looked for planets around low-mass Main Sequence stars ("red dwarfs").

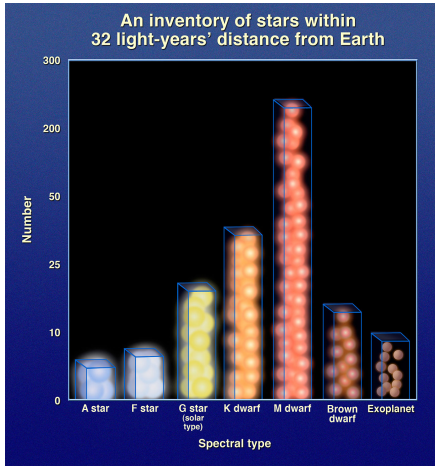
(a) What advantages do the lower-mass stars have, in terms of it being easier to detect planets around them; why should it be easier? (There are several reasons.)
(b) What disadvantages or problems do you foresee for life forms (microbes, animals, intelligent beings, etc.) potentially developing on a planet around a red dwarf? (Recall what you know about properties of red dwarfs.)

Advantages of Red Dwarfs for Planet Searches

- "Lower mass stars are less luminous .. easier to see a dim planet orbiting the star." It would seem so, but it's more complicated than this. In visible light, we see planets by *reflected* light, so if the star is dimmer, the planet will be dimmer too. (Applies to *direct detection*.)
- "The effect of the planet on the star will be more noticeable … lower mass stars would have a more noticeable gravitational wobble around the center of mass." Yes, and this is true for both a positional shift and for the Doppler effect. This is a factor for any *indirect method,* which uses effects of planets on their star to infer the presence & properties of the planets.

Advantages of Red Dwarfs for Planet Searches

- "Lower mass stars are more numerous than high mass stars." Yes, this means more candidates for searches, including more *nearby* stars. That helps with distance-dependent methods like the positional (astrometric) wobble.



Disadvantages of Red Dwarf Host Stars

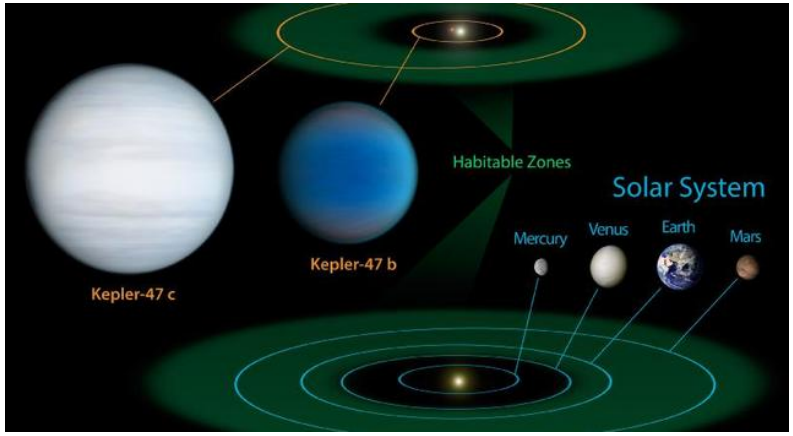
- "Red dwarfs are very active, resulting in frequent flares, mass ejections … life may not be able to exist on such planets…" Need to say *why:* for example, "the planets would be barraged with radiation."
- "Not enough energy received from their sun …being cooler and less luminous, their planets might be too cold, … less likely to have favorable conditions for life … less area that [better: "a smaller region in which"] planets could have livable conditions and foster life." A cool, low-luminosity star will still have a "habitable zone," but it will be smaller and closer to the star.

The "Habitable Zone" (HZ) of a Star

- The Habitable Zone is the region where orbiting planets have conditions favorable to life, usually defined in terms of water being in liquid form. If the planet is too close to its parent star, the water will evaporate; if too distant, the water will freeze out.
- The location & width depend on the star's luminosity: for cool, low-luminosity stars, the HB will be located close-in, while for hotter, higher-luminosity stars, it will be farther from the star (in standard units, e.g. A.U.s).

See http://planetquest.jpl.nasa.gov/video/29 - "Comparative Life Zones of Stars" (with text)

The "Habitable Zone"



Confusions and Misunderstandings (a)

- "You could see the planets easier because low mass stars rotate fast … a spread in revolution makes planets easier to see." This doesn't make any sense. In actual fact, *the opposite* is true: fast rotation broadens the star's spectral lines, making it *hard* to see small Doppler shifts, and star spots cause dips in the light curve that can be confused with planet transits.
- "The point of focus between gravitational pull would be in between both objects." True, but so what? If you meant that this leads to a larger wobble by the star, you need to say so.
- "Red dwarfs have longer life spans so [they] can be studied for longer periods." Not relevant. The lifetimes of ***all*** stars are vastly longer than a scientist's working life!
- "A red giant isn't as bright as the Sun." These are ***not*** red giants, and red giants are much more luminous than the Sun.

Confusions and Misunderstandings (b)

- "Since fusion is no longer taking place, heat would be constantly decreasing." This reveals two confusions. First, red dwarfs are indeed undergoing fusion in their cores; they are ***the longest-lived*** Main Sequence stars. Perhaps you were thinking of brown dwarfs, but these are objects which have never undergone fusion at all – it hasn't "stopped."
- "They are using degenerate energy so the planet would last a different lifetime." These are Main Sequence stars, ***not*** brown dwarfs; and degeneracy is pressure, *not* energy!
- "The planet might become too hot for any life to develop." Why? The same group had just said that the stars are less luminous than the Sun, so this is illogical and contradictory.
- "The mass is shrinking constantly so the orbit of the planets is changing … mass decreases as the star cools." What??