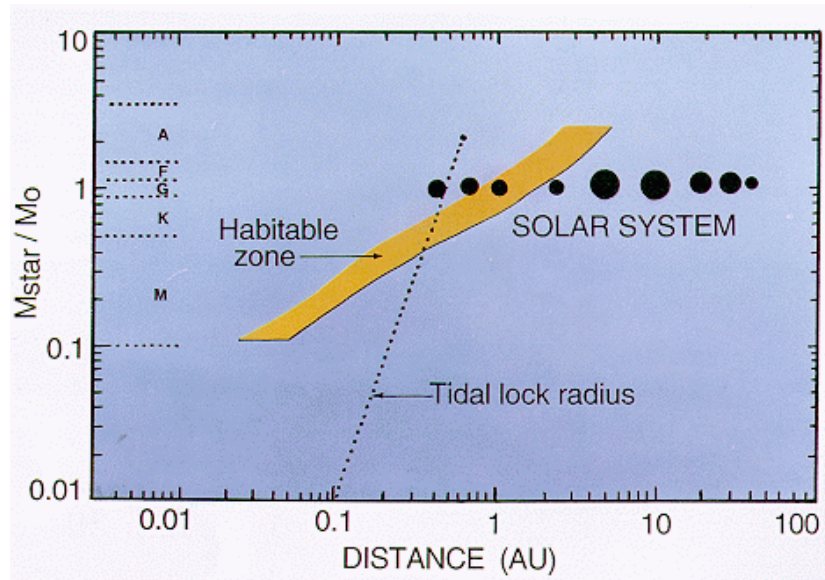


### Conditions for Life

For life to form and evolve to its present form on Earth, some things had to change over time and some had to remain constant. Here are some of those things.

- A. Long term climate
- B. Orbit around the sun
- C. Output of the sun
- D. Composition of Earth's atmosphere
- E. Rate at which Earth was bombarded by meteors
- F. Plate motions
- G. Positions of the continents



1. Identify the ones that had to remain constant

A      B      C      \_\_\_\_\_

2. Identify the ones that had to change

E      F      G      D      \_\_\_\_\_

3. What would happen to life on Earth if the sun were very gently (so it wouldn't disturb the orbits of the planets) deflected so it left the Milky Way, with the entire planetary system going along?

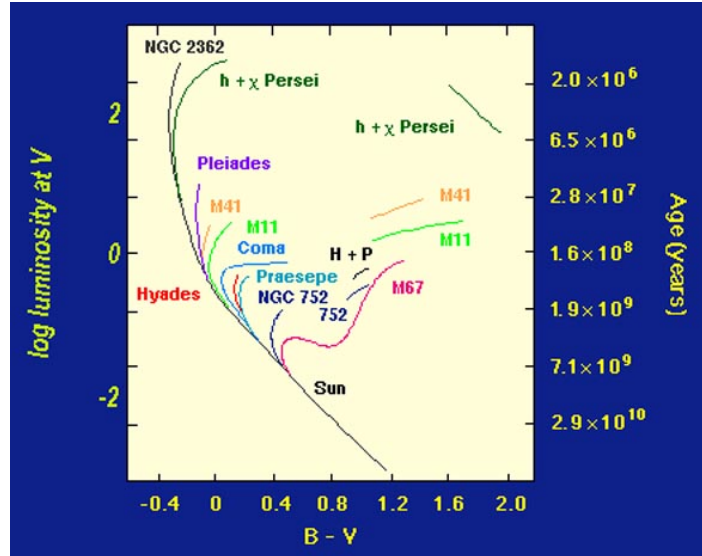
**Assuming the shove was very gentle so the planets stayed in their orbits, life on Earth now would be unaffected by such a change. Long-term comets would no longer be deflected into the inner Solar System so if this change had happened early in the history of the Solar System, life on Earth would have been affected. Much less cometary material would have fallen on the early Earth so there would have been less water. Fewer mass extinctions would have occurred.**

4. If the Earth were in the same orbit as now, but only half its present diameter, similar to the diameter of Mars, what do you think the consequences for the formation and evolution of life might have been?

**-- atmosphere would be less dense and so the surface temperature would be colder  
-- core of the Earth would have cooled off more so continent building might have stopped which would lead to more of the surface covered by water.  
These might lead to sea life only and less modification of the atmosphere by plants**

5. If a planet just like the earth orbited a B star that is 5 times as massive as the sun, but the orbit put the planet far enough out that the energy received was the same as for the earth in its position relative to the sun (that is, the climate on this planet would be just like that on Earth), are there any problems you can think of with regard to complex forms of life evolving on this planet? Hint: look at this HR diagram where the relevant stellar ages are indicated.

-- output of star is shifted to the ultraviolet so life forms would have to be more robust to "sunburn"  
 -- star's main sequence lifetime would be much shorter so life must develop much more quickly than it did on Earth



6. Most stars are double. What would the consequences be for the formation of life in a double star system

a. If the second star were far away (say 1000 AU) from the central star with planets

A second star at this distance would have few consequences. The main consequence would be a change in the nature of the Oort cloud and how long term comets would get close to the planets. Such comets might be much more common due to the interactions between the distant star or it they could be much less common if the distant star tend to deflect the comets out of the system altogether. Life might form and evolve about the same as it has on Earth it the distant star did a good job of comet deflecting or it could be slowed if the rate of accumulation of water from comets proved to be a lot slower or if too many comets hit the Earth and caused mass extinctions.

b. If the second star were very close to the central star (say 0.3 AU away)

A close pair of stars could lead to severe difficulties for life developing because the amount of light received could vary by a factor of two depending on whether one or both stars were visible. It is also possible that life could still develop in the oceans because the big swings in amount of light received during day time would be smoothed over by the ocean.