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PROBLEM 4

Briefly define and discuss the relevance of the following terms to modern astronomy. 1 point per question

1. Cepheid variable star
2. Initial mass function
3. tunneling in the context of the PPI chain reaction
4. age-metallicity relation
5. damped Lyα system (DLA)
6. s-process
7. G dwarf problem
8. Tully-Fisher relation
9. Galactic thin disk
10. isophotal radius

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Astro #4

a) A Cepheid Variable star is a type of pulsating star that follows the period-luminosity relation, which states that the longer the star's period of pulsation, the more luminous the Cepheid is. By calibrating this relationship using parallax techniques to determine the distances to nearby Cepheids, the period-luminosity relation allows us to determine the distance to these special class of stars simply by knowing how bright they are. Cepheids make up one rung of the astronomical distance ladder.

b) The initial mass function (IMF) of a galaxy is an attempt to estimate the amount of stars that will form in a galaxy of a certain mass, within a certain volume

c) In the context of the PPI chain, tunnelling is the ability of charged particles to overcome the coulomb barrier b/w them and begin the fusion process. Without the ability of the particles to tunnel, the hydrogen atoms would not be able to this barrier (at any velocity) and fusion would not occur. This quantum mechanical property of these H atoms is what allows stars to exist, as w/o fusion, the stars would only illuminate themselves by conversion of gravitational potential energy + would be unable to sustain themselves for long periods of time.

d) The age-metallicity relation is the correlation b/w the ages of stars in a galaxy and their chemical compositions. As early, massive stars die, they chemically enrich the surrounding medium. Therefore, as newer stars form from these gas clouds they contain a higher percentage of fusion byproducts like carbon and iron (metals) than stars that formed earlier. Therefore, when we look at stars of similar types, stars with higher metallicities must be younger than stars w/ lower metallicities. This provides us w/ a rough estimate of stellar ages w/in a galaxy.

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#4 (cont.)

e) Damped Lyman-α systems are concentrations of neutral hydrogen gas associated w/ quasars at high-z. It is believed that these systems contain most of the neutral hydrogen in the universe, and that they are correlated w/ the early stages of galaxy formation. Therefore study of the dynamics of these systems may allow us to better understand galaxy formation mechanisms.

f) The s-process is a nuclear fusion process by which elements heavier than Fe can be formed. In regions w/ a low neutron flux, like stars undergoing neutron cooling or SN remnants, the atom will fuse with the neutron and create an unstable particle, where the neutron will eventually β-decay, increasing the # of protons in the nucleus of the atom. Non-radioactive heavy elements can be formed by this process.

g) The G-dwarf problem arises from a discrepancy b/w theory + observation of stars in the solar neighborhood. Current models of chemical enrichment in the galaxy suggest that we should see many more G/F class stars w/ metallicities close to 0 than we do. This suggests that there was another method of chemical enrichment that occured earlier in the galaxy formation process

h) The Tully-Fisher Relation is a relationship that exists b/w the luminosity and maximal rotation velocity of a spiral galaxy. Because of this relationship, it can be used as a rung on the distance ladder for nearby galaxy's.

i) The galactic thin disk is the region w/in the disk of a spiral galaxy close to the mid-plane of the disk where most star formation occurs. Stars w/in the thin disk are younger and will over time drift away as their specific velocities carry them away from the mid-plane. Stars w/in the thin disk typically have higher metallicities according to the age metallicity relation.

j) The isophotal radius is a measurement of the approximate size of a galaxy. Near the edges of a galaxy, its luminosity becomes low, making an exact measurement of its size hard. Typically, the isophotal radius are measured by a % of the night sky background brightness