UE7b: Evolution of Galaxies
Homework 2; return before 25 jan 2013
(Please don't wait until last moment)

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3 Quickie: Solar abundances

The space probe SOHO was designed to monitor the activity of the Sun and follow coronal mass ejections. But it also discovered that there are many "kamikaze" comets that plunge into the Sun. Is it possible that the metallicity of the Sun had been influenced by accretion of matter from bodies of the Solar System during all its previous life? Perhaps there existed bodies that crashed into the Sun and therefore were not able to become planets ... Let us make a rough estimate of these effects: let us assume that all the mass in all the planets of the Solar System is in the form of 'metals'. Compare that amount of material with the mass of metals which is present in the Sun. If all the planets would be merged with the Sun, and the material thoroughly mixed, by how much would the solar metallicity change? Would that be detectable? Perhaps this misxing is not complete, and the planetary material is mixed only to the photospheric layers (for a rough estimate, let us assume that a thickness of the photosphere of 400 km, and that the density is constant within the Sun)? If one took a proper model for the photosphere, how does this compare (qualitatively) to our rough estimate?

4 The IMF rules the yield

Interpretation of the metallicity distribution functions of disk G dwarfs, bulge K giants, and halo globular clusters in terms of closed box models leads to the determination of the metal yields of 1.8 $Z_\odot$, 0.4 $Z_\odot$, and 0.025 $Z_\odot$for the Bulge, Disk, and Halo of our Galaxy. One explanation could be that the IMF in these three stellar populations differ from each other.
Let us suppose that the IMF is a power-law function $dn/dm = \Phi(m) \propto m^{-x}$ between mass limits 0.1 and 100 $M_\odot$(Salpeter is $x = -2.35$; please note the normalization of the IMF $\int m\Phi dm = 1$ to unity total mass). Let us also assume that all stars above 10 $M_\odot$produce 20 percent of their initial mass ($p(m) = 0.2$) in the form of metals, and that all stars

more massive than 5 $M_\odot$leave a remnant of 1.4 $M_\odot$and eject $E(m)$ $M_\odot$of gas. Compute the yield of such a stellar population as a function of the IMF exponent x. What is the yield for a Salpeter IMF, and what exponents are needed to match the derived yields of Bulge, Disk, and Halo? Furthermore, if you stick to the Salpeter exponent, which values of the upper and lower limit for the stellar masses could also explain the three values? Your opinion?

For your own checking: for Salpeter IMF the locked-up mass fraction $\alpha \approx 0.8$.

5 Quickie: Metallicity of the Sun

The metallicity (abundances of oxygen and iron) of the Sun is somewhat higher than in the nearby gas (e.g. H II regions). Someone proposed the idea that it could be because the Sun shows the products of its own fusion processes. From your knowledge of stellar structure and evolution you can give at least two reasons why this idea cannot be true! Also, discuss the consequences for other objects, if this idea were true, and suggest one or more observational tests with which we could confirm or refute this idea!