Astronomy 330 / Galaxies

Problem Set 2
Due: Friday 01 October 2010

Problems 1-2. Do problems 2-8 and 2-10 in Sparke & Gallagher.

Problem 3. There is an empirically derived correlation between a star's mass and its luminosity (L goes as $M^{3.7}$). Using this relationship, derive a correlation between a star's mass and its main sequence lifetime.

Problem 4. Attached are color-magnitude diagrams for a number of stellar populations:

NGC 188 – a Galactic cluster with a distance modulus of 11.84;
NGC 147 – a dwarf elliptical companion to M31 with a distance modulus of 24.39;
SMC – a random field in the Small Magellanic Cloud with a distance modulus of 18.9;
NGC 6352 – a globular cluster with a distance modulus of 14.38;

The distance modulus is defined in equation 2.2 in your book. Label all major components of each CMD (e.g. horizontal branch, giant branch, main sequence, etc). What do you think is the age of each stellar population? Be sure to justify your answer. If you cannot estimate the age, please describe what further information you might need in order to be able to derive an age. What can you say about the star formation history of each stellar population? Again, be sure to explain your reasoning.

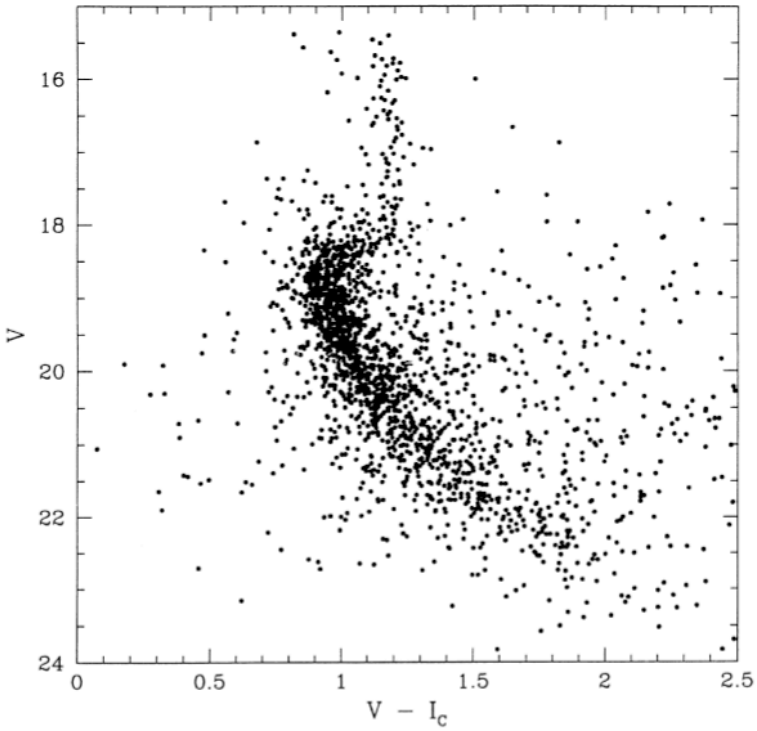
Problem 5.

(a) Show that most of the mass in stars in a galaxy like the Milky Way comes from low mass stars, while most of the light comes from high mass stars. Assuming a lower mass limit of 0.5 M_{sun} and an upper mass limit of 100 M_{sun}, what fraction of stars will turn into supernovae if all stars more massive than 8 M_{sun} turn into SNe?
(b) For a stellar population forming at time t=0 with a Salpeter IMF with an upper mass cutoff at $M = 2M_{sun}$, estimate the time after which most light comes from post main sequence stars.

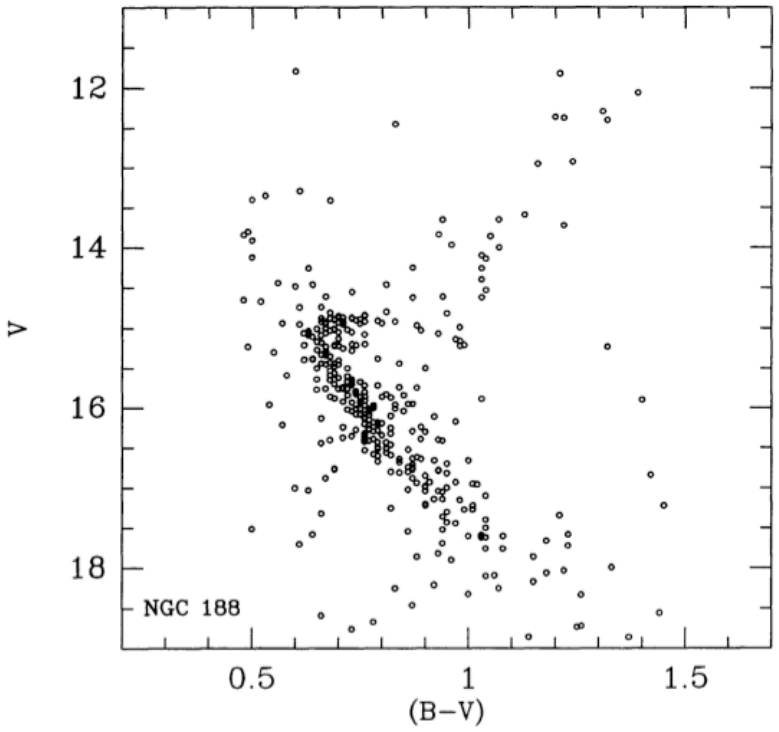
Problem 6. A galaxy has a star-formation rate (SFR) of 10 M_{sun} yr^{-1}. What is its Hα luminosity in erg s^{-1}? Assume a Salpeter IMF and that every UV photon capable of ionizing hydrogen does so. Also assume that every ionized electron recombines. Here's a table that gives you the log of the flux of ionizing photons (photons sec^{-1}) as a function of spectral type. Stars less massive than about a B2 don't contribute very much to the Hα luminosity.

O4	49.9	O6	49.2
O8	48.6	B0	47.6
B2	44.9		

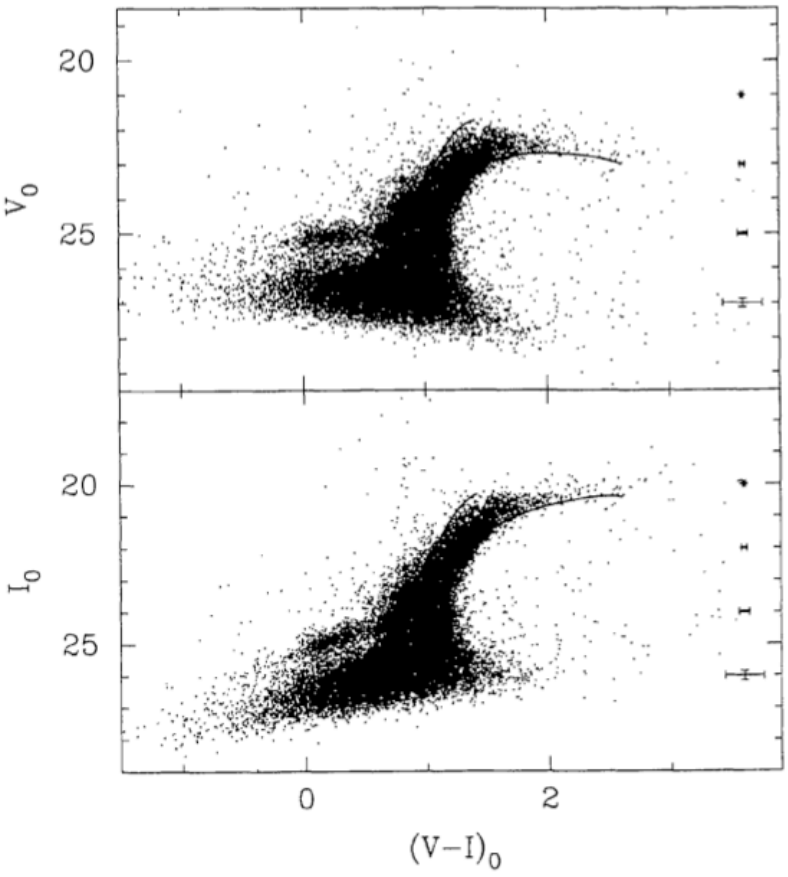
NGC 6352:



NGC 188:



NGC 147:



SMC: