Astr 323: Extragalactic Astronomy and Cosmology

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Homework Problem Set 1

(each problem is worth 3.333 points for a total of 10)

1) For a Sersic surface brightness profile

$$I(R) = I_o \exp(-(R/R_e)^{1/n}) \tag{1}$$

with $R_e = 1$ arcsec

a) plot the surface brightness (μ = -2.5 $\log[I(R)/I_o]$) as a function of radius in the range $0 < R < 30$ arcsec (and μ varying from 5 to 0) and for n=1, 2, 3 and 4

b) what radius encloses half the total light from a galaxy with $n = 1$? (hint: here you need to integrate $I(R)$)

c) what is the average intensity (in units of I_o) within R_e? (hint: here too you need to integrate $I(R)$)

2) An amazing HST image of a spiral galaxy M51 is linked to our class website.

a) how would you classify it using the Hubble-Sandage scheme and why?

b) print that image (or you can do it interactively on computer if you know how) and measure the position (distance from the center of the galaxy) of the two arms as a function of the polar angle (for example, you can overlay an (R, ϕ) grid on top of image). Your results will depend a bit on where you think the center of an arm is, so try to estimate your error bars, too.

c) Once you have your measurements, plot $R(\phi)$ for each arm. Are they same (to within error bars)?

d) Can you find an analytic function that provides a good fit to your data?

3) Our class website contains a link to a catalog of $\sim$2,000 galaxy measurements obtained by the SDSS. The third column lists redshift, and the 8th and 10th columns list the magnitudes in the SDSS u and r bands (UV and red light). Using these data,

a) Plot and describe their $u - r$ color histogram. What fraction of galaxies have $u - r < 2.2$? Is their average r band magnitude brighter or fainter than for galaxies with $u - r > 2.2$?

b) Is the $u - r$ color correlated with the redshift? Try to explain why.

c) Go to http://cas.sdss.org/dr5/en/proj/advanced/galaxies/spectra.asp

and do Exercise 7 (including answers to questions 7-10)