Ex 2

30 April 2020 11:24

Exercise Sheet #2

Submit by Tuesday 12-05-2020

Exercise 1. - Galaxy Classification: Go to the STScI Digitalized Sky Survey (`https://archive.stsci.edu/cgi-bin/dss_form` and retrieve blue, red, and infrared images (10x10 arcmin^2) for the following galaxies: M 100, NGC 4486, NGC 1300, IC 5152. Insert the name of the galaxy into the form and click on 'get coordinates'. Select then POSS2/UKSTU Blue (Red or IR) and choose the size of the image as well as the file format GIF. Finally, click on 'retrieve image'.

(a) What do you reckon is the morphological type of these galaxies based on the Hubble classification scheme? (10 points)

(b) What differences can you recognize between the blue, red, and infrared images? (10 points)

(c) Briefly discuss how what you see correlates with the physical properties of the morphological type you chose. (10 points)

Exercise 2. - M 100 and composition of galaxies: Let's now consider only M 100. This galaxy lies at $\sim$ 15.9 Mpc from the Sun (Cappellari et al. 2011) and its integrated apparent magnitude is $V = 9.79$ mag (de Vaucouleurs & Longo 1988).

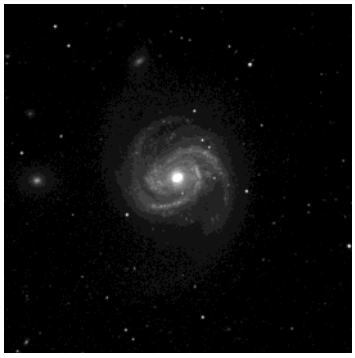
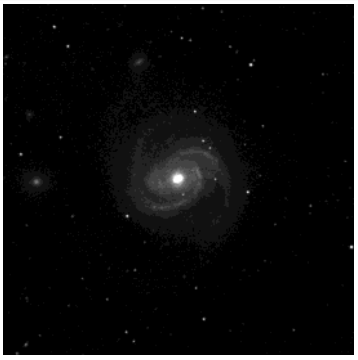
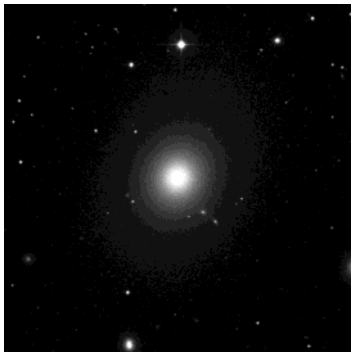
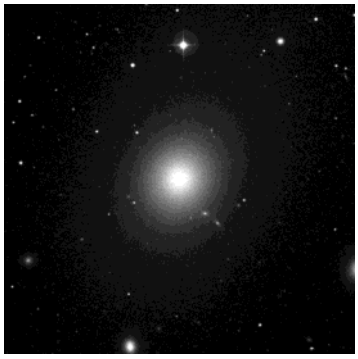
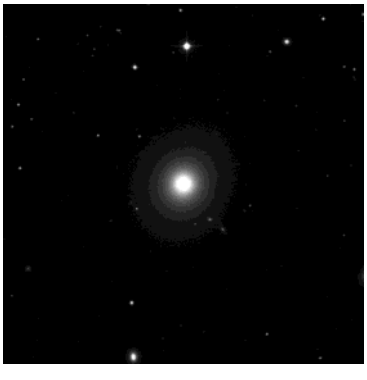
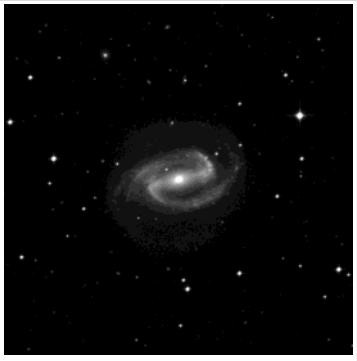
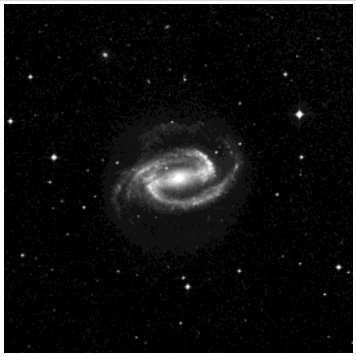
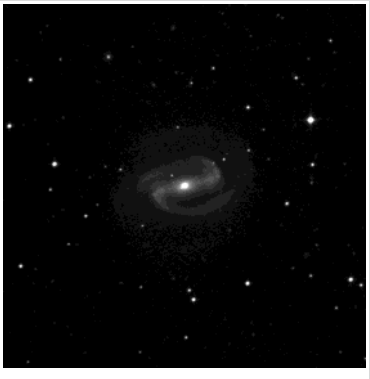
(a) What is roughly the diameter of M 100 in pc, estimated from the blue image (POSS2/UKSTU Blue)? Do you think that this is the true radius of this galaxy? Explain. (10 points)

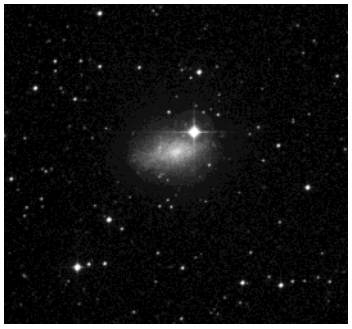
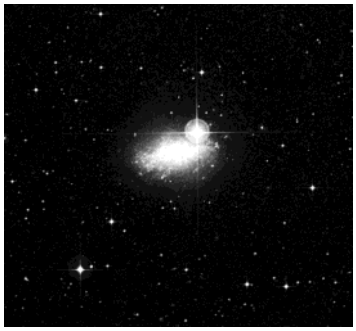
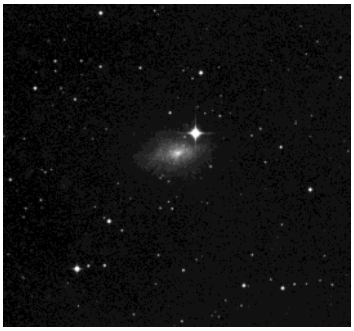
(b) Calculate the absolute integrated magnitude of M 100. (10 points)

(c) Imagine that M 100 is composed solely of Sun-like stars (absolute magnitude in the V-band $M_{V_\odot} = 4.8$ mag). Neglecting the extinction, how many stars would be present in the galaxy? How many stars would M 100 contain if it was composed only of stars similar to Barnard's star (absolute magnitude in the V-band $M_V = 13.21$ mag, spec. type M5 V)? (10 points)

Solution:

2.1 http://archive.stsci.edu/cgi-bin/dss_form

Galaxy	Red	Blue	Infrared	Morphological type
M100 (RA 12 Dec 15)				Spiral Sb
NGC 4486 (RA 12 Dec 12)				Elliptical E0
NGC 1300 (RA 03 Dec -19)				Barred SBc
IC 5152				Irregular

(RA 22 Dec -51)				

Q: What differences can be recognized between blue, red and IR images?
A: The images are most luminous in blue band where the details of spirals or the outer region of the elliptical/irregular galaxy can be clearly seen. In contrast, the infrared images lose most information of spirals and outer region of elliptical/irregular galaxy. However, the infrared image provide detailed information around the central bright galaxy core where the blue images lose information due to over-exposure. The red images present an intermediate effect among all 3.

Q: Discuss how the images correlate to physical properties of the corresponding morphological type.
A: By comparing the infrared image and blue image one could see the gas/dust fraction of the galaxy.
For spiral and barred spiral galaxies one could find out the size, shape of spirals from images.
For elliptical and irregular galaxies the red and infrared images show a condense centre core of the galaxy.

2.2. M100, distance $d{\sim}15.9\ Mpc$, integrated apparent magnitude $V = 9.97 mag$

a) Diameter of M100 in pc based on blue image.
The image is 10*10 arcmin^2. The galaxy stretches across approximately 1/3 of the image, thus its diameter is $\frac{1}{3} \cdot \frac{10 \cdot \pi}{60 \cdot 180} \cdot 15.9 Mpc \approx 1.5 \cdot 10^4 pc$ where small angle approximation is used.
It is not the true diameter of the galaxy, since the diameter of the galaxy is determined by the distance where the luminosity decreases to a certain value compared to its centre core. And galaxy observed from different band would give different luminosity information.

b) The absolute integrated magnitude of M100 is $M = m - 5 \log d[pc] + 5 = 9.97 - 5 \cdot \log\left(15.9 \cdot 10^6\right) + 5 \approx -21.0\ mag$

c) If M100 is composed solely of sun-like star (absolute magnitude $M_{V\odot} = 4.8\ mag$). Neglecting extinction, suppose M100 is composed of n stars. Then its magnitude would be $-21.0 = M = M_\odot - 2.5 \log \frac{nL_\odot}{L_\odot} \Rightarrow n \approx 2.1 \cdot 10^{10}$
If instead of sun it is compose of the Barnard's star ($M_V = 13.21\ mag$) $\Rightarrow n \approx 4.8 \cdot 10^{13}$