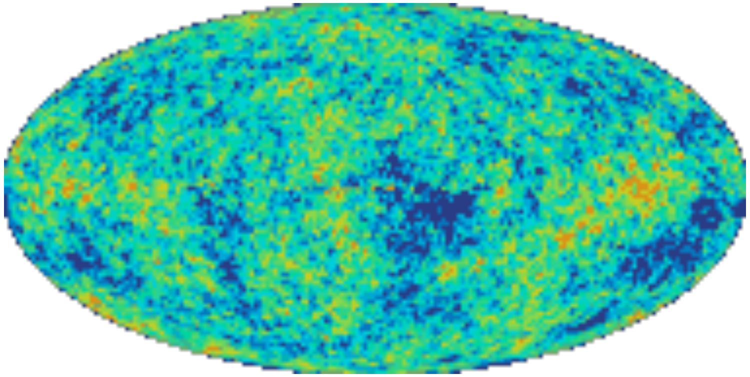
UCL PHAS3136 2010

Cosmology and extragalactic astronomy



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http://zuserver2.star.ucl.ac.uk/~hiranya/PHAS3136

Course structure

- Topics:
  - 1. Normal galaxies (~3.5 weeks)
  - 2. Active galaxies (~1 week)
  - 3. Cosmology (~4.5 weeks)

- Format:
  - Lectures
  - Interactive problem solving classes
  - Materials specified for self-study

Course textbooks

- Jones & Lambourne, An Introduction to Galaxies and Cosmology (hereafter JL)
  - 22 copies in UCL science library
  - On amazon.co.uk 30 pounds

- Liddle, An introduction to modern cosmology
  - In UCL science library

Also, for further information:

- Peterson, Active galactic nuclei
- Binney & Merrifield, Galactic Astronomy

Normal galaxies: interface with JL

All of JL chapters 1 and 2 are examinable, except:

- 1.2.1 - 1.2.3 is (hopefully) a revision of earlier courses
- 1.4.1 paragraphs on open clusters and OB associations
- 1.4.2 paragraph on interstellar dust
- 1.5 is more detail on our galaxy, not in our course
  - (generally, features of our galaxy not readily observable in other galaxies are not in this course)
- 2.5.4 on galaxy mergers - non examinable

The following are examinable but not in JL:

- details of chemical evolution, including G-dwarf problem
- the luminosity function
- galaxy light profiles: exponential and de Vaucouleurs
- rotation curves for non spherically symmetric mass distributions
- more details on fundamental plane, Tully-Fisher, Faber-Jackson relations
- calculation of expected luminosity evolution of galaxies

1.1 Our Galaxy: basics

List of topics:

- Disk, bulge, halo
- Stellar populations: Baade's observations
- Stellar populations: Current thinking
- Metal enrichment
- Age-metallicity relation
- Galactic fountain

See JL 1.2.1 to 1.2.4

Spiral arms

Gemini Observatory - GMOS Team http://www.gemini.edu/gallery/science/g0139.htm

http://sci2.esa.int/interactive/media/print/sec12p2.htm

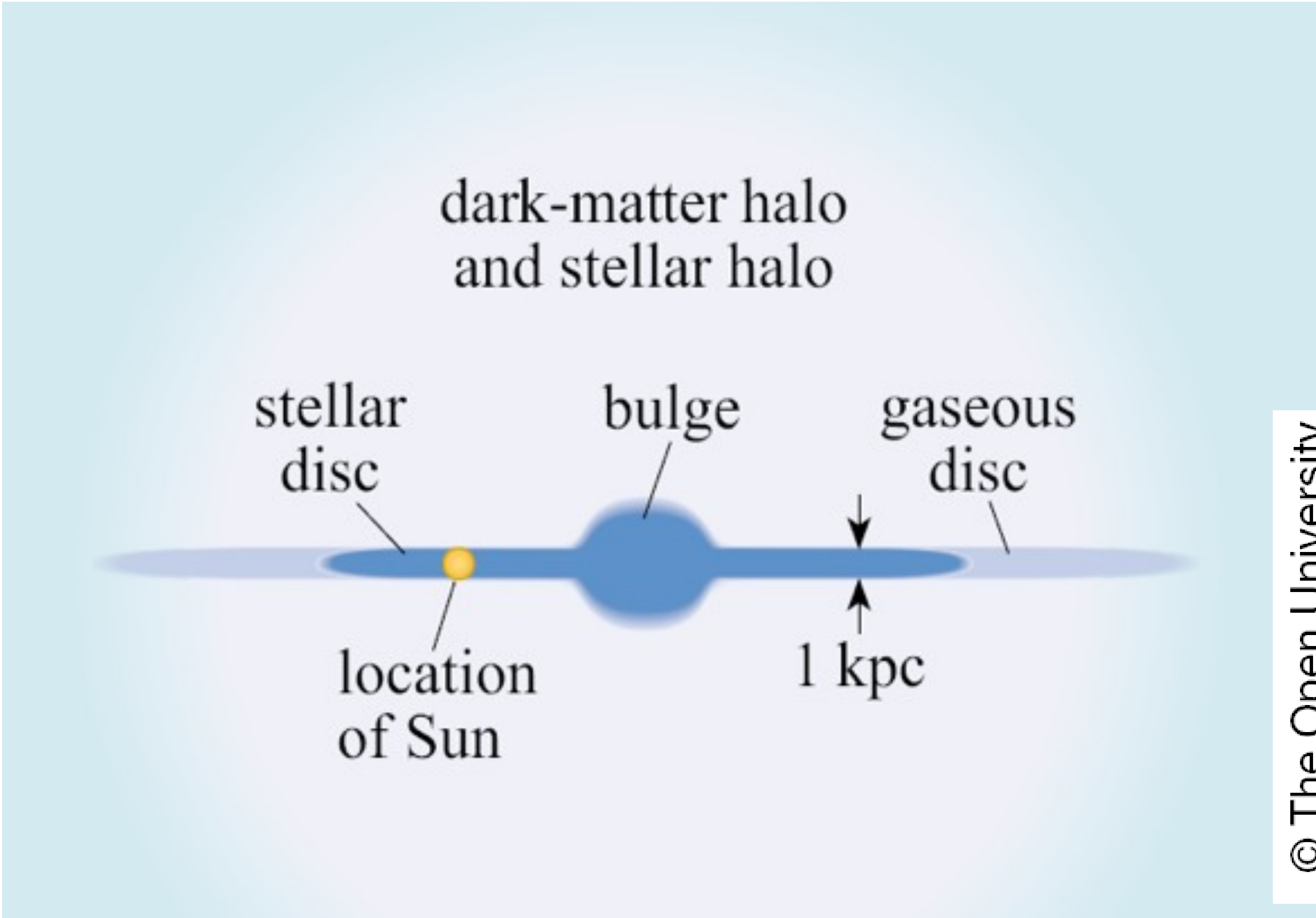
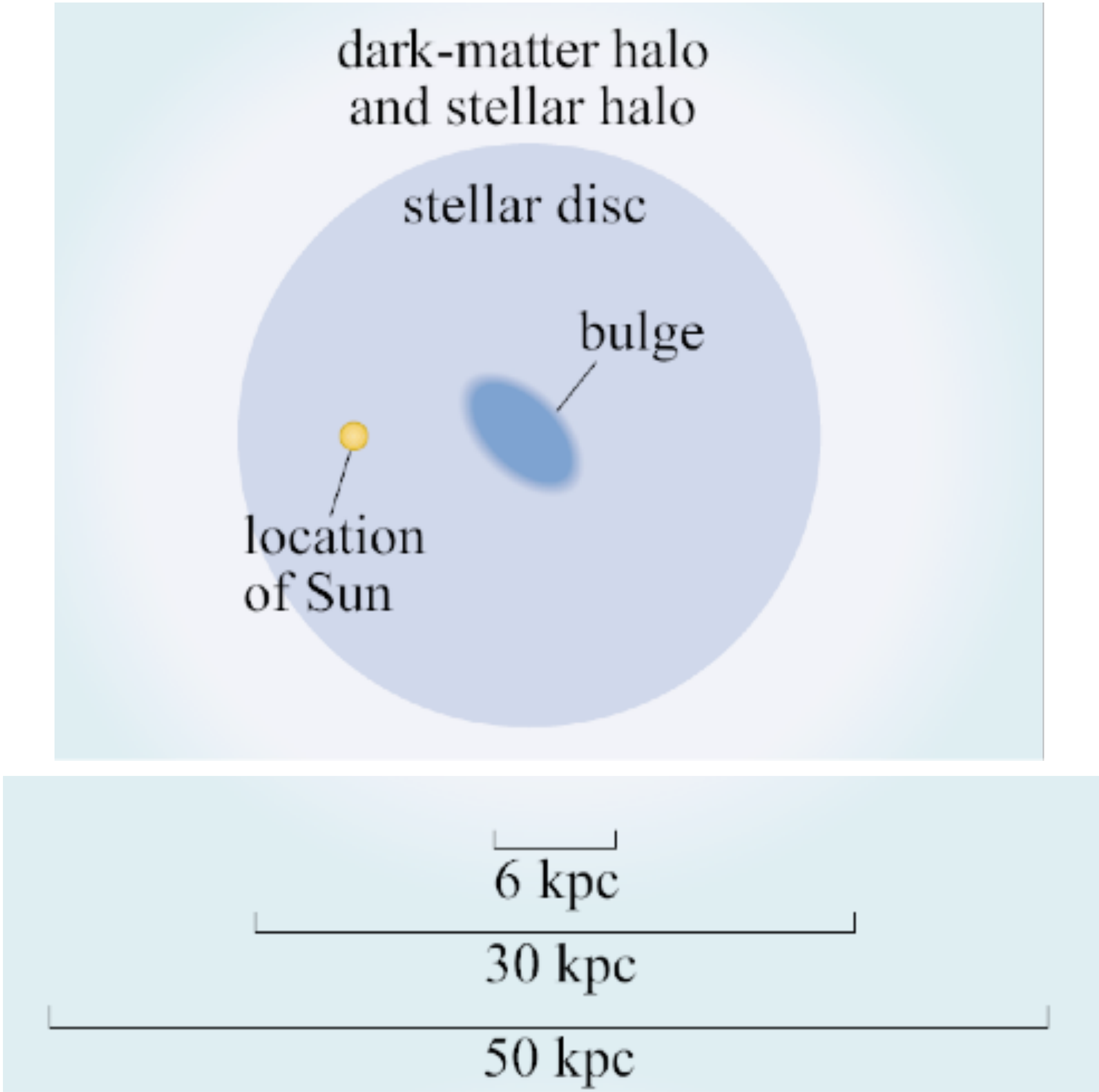


Figure 1.5 (a) Edge-on and (b) face-on schematic views of the four major structural components of the Milky Way: the dark-matter halo, the disc, the stellar halo and the bulge. The sizes indicated in this figure are expressed in kiloparsec (kpc), where 1 kpc ≈ 3260 ly.


dark-matter halo
and stellar halo
stellar disc
bulge
location
of Sun
6 kpc
30 kpc
50 kpc

CORRESPONDENCE.

To the Editors of 'The Observatory.'

Asymmetry in the Distribution of Stellar Velocities.

Gentlemen,—

In the September issue of your journal there appeared a letter from Dr. Gustaf Strömberg, tending to show that there is considerable asymmetry in the moderately high velocities. I cannot agree with him in all respects, and it may be well, therefore, to state a little more fully what the difference between us amounts to and also to give a summary of the arguments.

In Dr. Strömberg's opinion there exists a simple relation, valid for practically all classes of objects, between the group-motion projected along a certain axis and the internal velocity dispersion along the same axis. However, I believe that observations would be better represented by stating that there are two distinct classes of stars, the members of one of which all move systematically towards a limited part of the sky with respect to the centre of gravity of the other class. The former class consists mainly, if not entirely, of stars with velocities higher than about 65 km./sec. It is the differences in the mixture of the two classes and in the sizes

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Leiden Observatory,
Holland,
1926, Sept. 24.

I am, Gentlemen,
Yours faithfully,
Jan H. Oort.

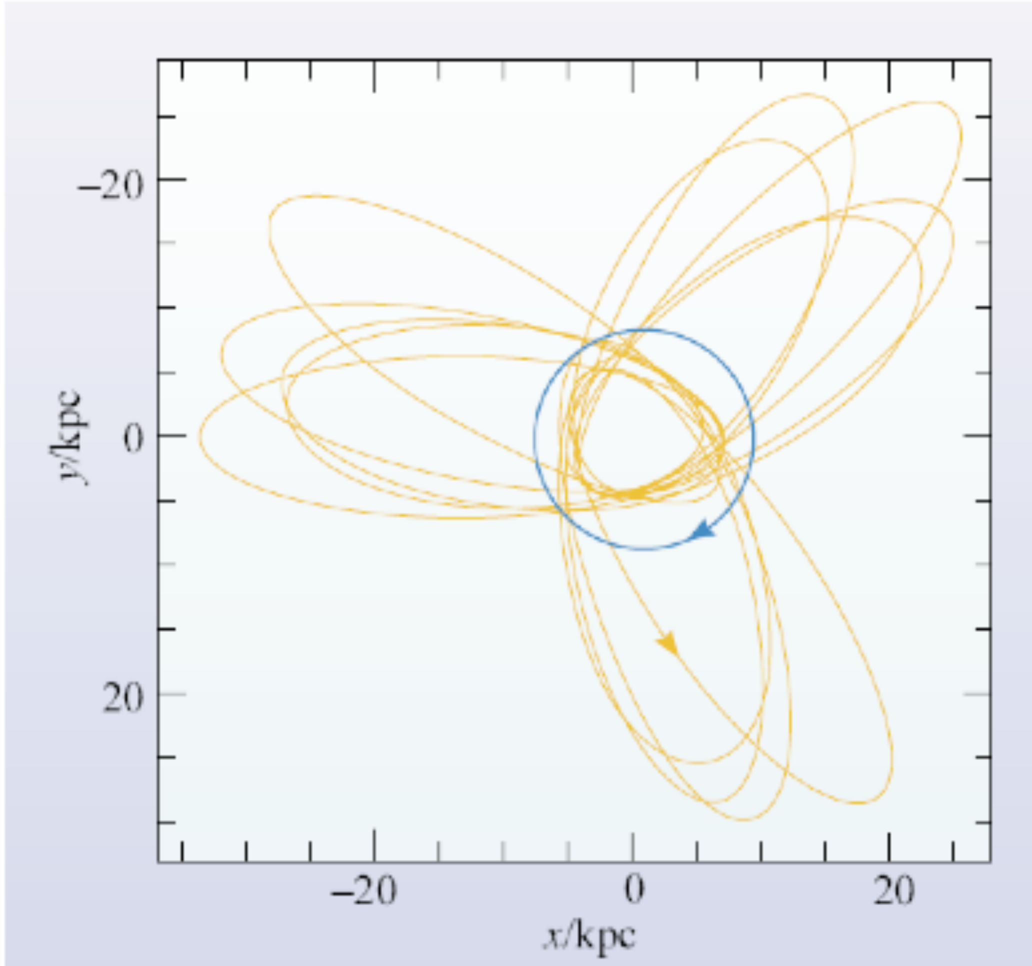


Figure 1.12 A face-on view of the Galaxy showing sample orbits for Pop. I (blue) and Pop. II (orange) stars. Shown is a clockwise, circular orbit for a Pop. I star 8.5 kpc from the Galactic centre, and an anticlockwise (retrograde), three-lobed orbit for a Pop. II star that takes it from 4 kpc to 35 kpc from the centre. This Pop. II star also travels up to 20 kpc above and below the disc, while the Pop. I star remains close to the Galactic plane. (S. Ryan, Open University)

What is HI in chemistry language?

1. H
2. H^+
3. H_2
4. H_2^+

Read JL p11

What is HII in chemistry language?

1. H
2. H^+
3. H_2
4. H_2^+

Read JL p11

HI, HII and H_2 dominate in different environments (listed below).

In which environment is HI usually found?

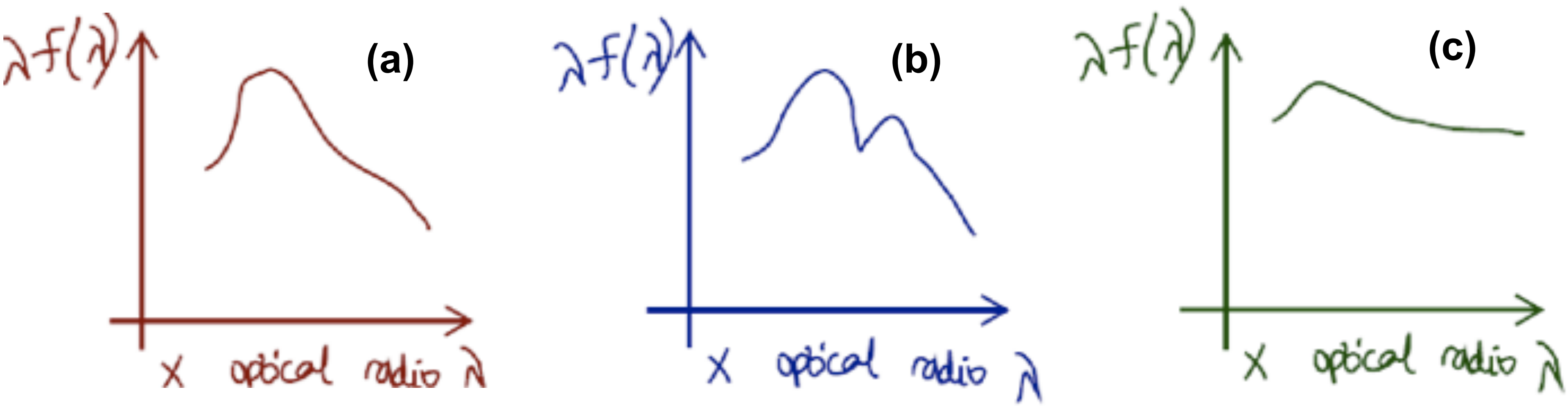
1. High density, low T, low UV
2. High T and/or UV
3. Medium T, low UV

Read JL p11

Match up the SEDs (a)-(c) with each of the below options. Which does SED (a) correspond to?

1. Spiral galaxy
2. AGN
3. Star

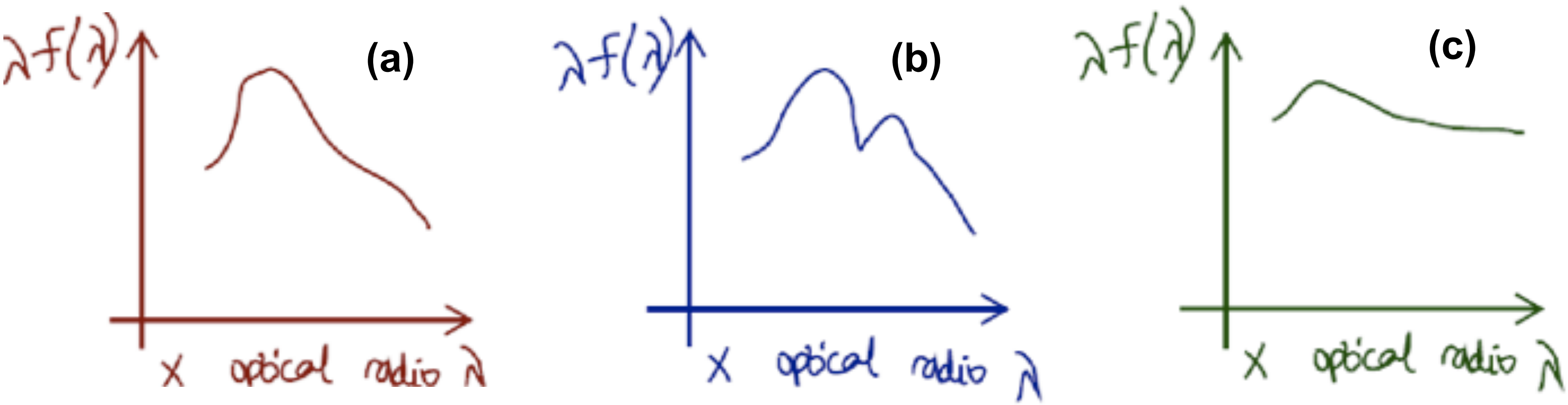
Read section 3.2 of JL



Match up the SEDs (a)-(c) with each of the below options. Which does SED (b) correspond to?

1. Spiral galaxy
2. AGN
3. Star

Read section 3.2 of JL



What Population is (i) a blue star in the Galactic disk

1. Population I
2. Population II
3. Population III

What Population is (ii) a red star in a globular cluster

1. Population I
2. Population II
3. Population III

1.2 The Galactic Disk

List of topics:

- Gas in the disk
- Different wavelengths probe different components
- Populations as a function of position
  - The scale height
- Spiral arms

All covered in JL p26-40

http://adc.gsfc.nasa.gov/mw/milkyway.html

Galaxy ESO 510-G13

An unusual galaxy with a warped dusty disk – a recent merger?

NASA and The Hubble Heritage Team (STScI/AURA) • Hubble Space Telescope WFPC2 • STScI-PRC01-23

http://hubblesite.org/newscenter/newsdesk/archive/releases/2001/23/image/a

Revision Quiz

Have you done PHAS2112?
(Astrophysical Processes: Nebulae to Stars)

1. Yes
2. No

What do we mean by metals in astronomy?

1. He and heavier elements
2. ✓ Elements heavier than helium
3. Elements heavier than iron
4. Good conductors

Read JL p11

What is the metallicity of the sun?

1. Z=0.002
2. ✓ Z=0.02
3. Z=0.2
4. Z=2.0

Z== mass of elements heavier than helium / total mass

Read JL p11

What do we mean by dust in astronomy?

1. Elements heavier than Fe
2. Molecules
3. Tiny lumps of compounds of metals
4. Dead skin cells

e.g. graphite coated in water ice, ammonia and CO
Typically ~100 to 1000 nm across ~ optical light λ

Read JL p11

How many stars are there in our galaxy?

1. $\sim 10^9$
2. $\sim 10^{10}$
3. ✓ $\sim 10^{11}$

Which are the brightest stars in our galaxy?

✓ 1. O
2. B
3. A
4. F
5. G
6. K
7. M

Which are the most numerous stars in our galaxy?

1. O
2. B
3. A
4. F
5. G
6. K
7. M ✓

How much dark matter is there?

1. ~1 %
2. ~10 %
3. ~30 %
4. ~90 % ✓

(As a percentage of the total matter in Universe)

See 1st year lecture notes

Is dark energy a type of dark matter?

1. Yes
2. No ✓

See 1st year lecture notes

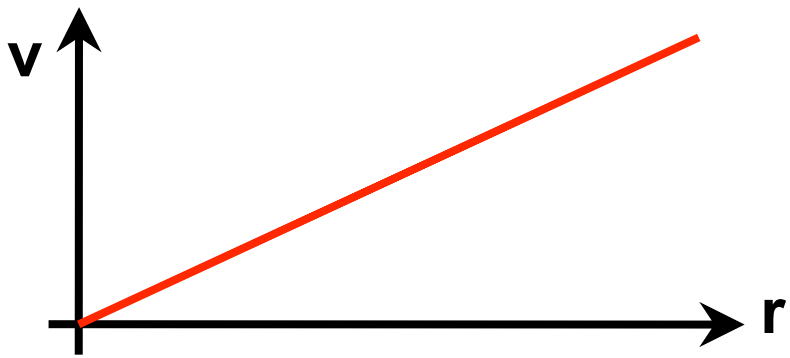
How old is the Universe?

1. ~10 000 000 years
2. ~100 000 000 years
3. ~1000 000 000 years
4. ~10 000 000 000 years

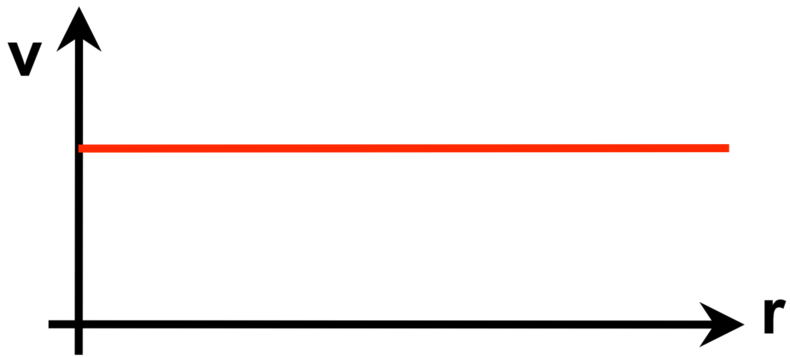
See 1st year lecture notes

Which of the below describes rotation about the center of our galaxy?

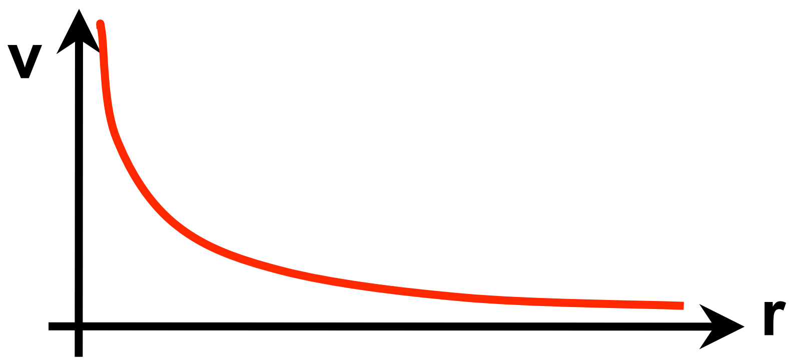
1. A



2. B



3. C



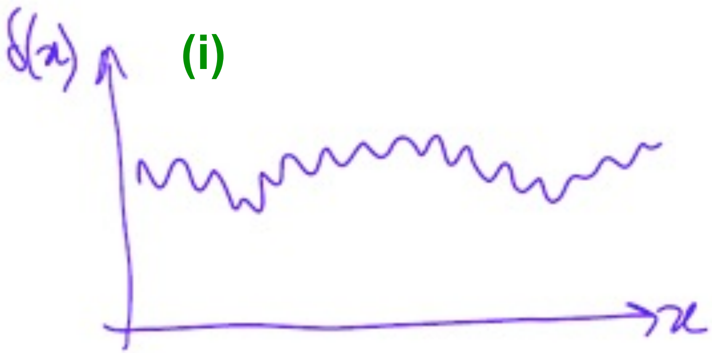
See JL p21

Have you studied Fourier Transforms?

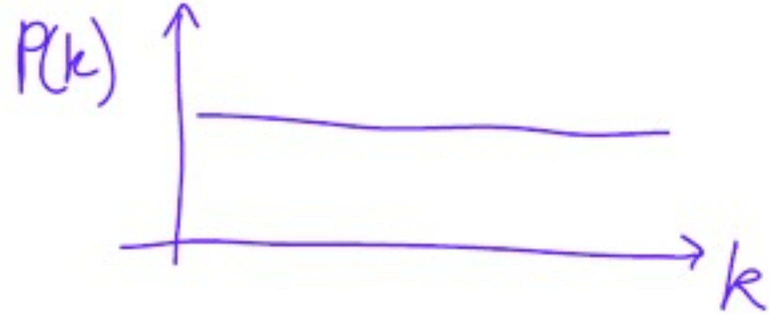
1. Yes
2. No

Match up the FT pairs. Which goes with (iii)?

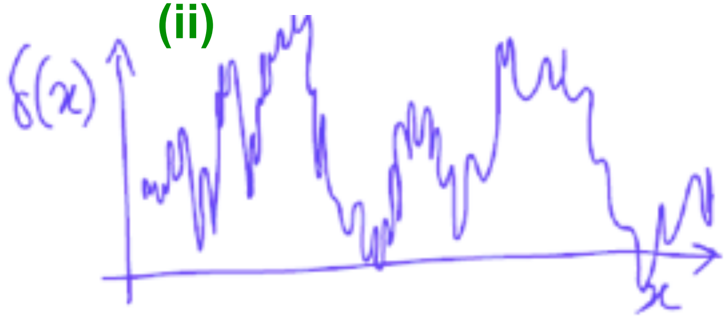
(i)



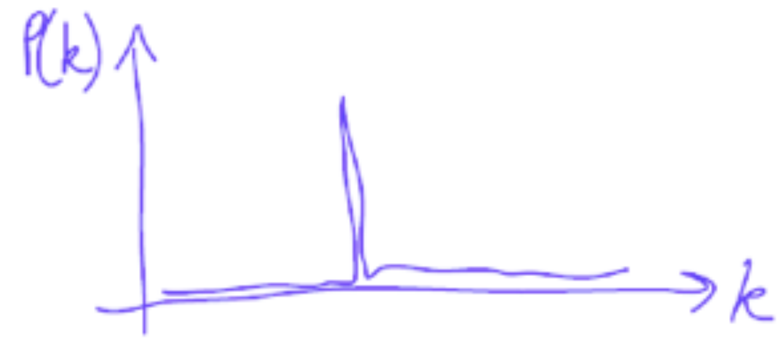
1. A



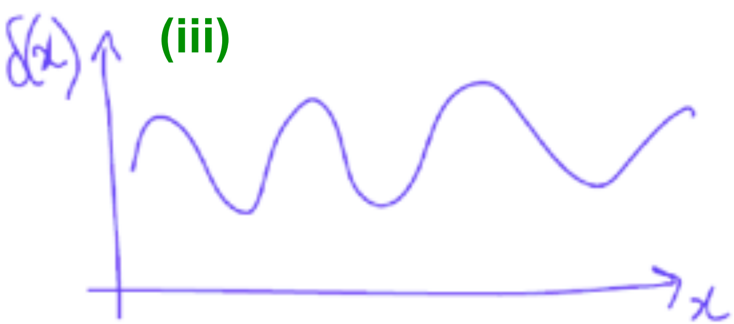
(ii)



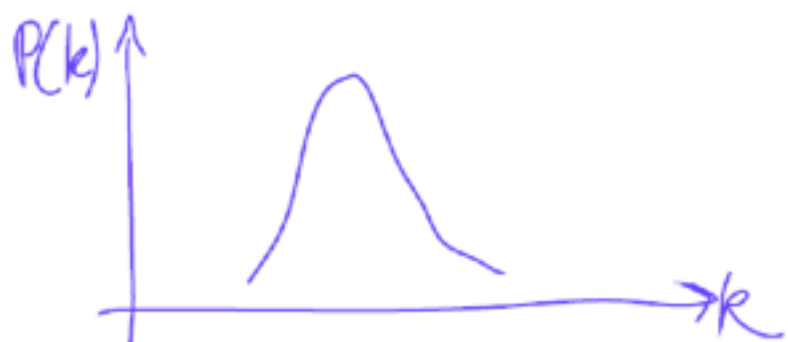
2. B



(iii)



3. C



What do you think the dark matter is?

1. There is none: gravity should be modified
2. Neutrinos
3. Planets
4. Particles from the standard model of particle physics

See Cosmology lectures

What is the dark energy?

1. Einstein's cosmological constant
2. Fast moving dark matter particles
3. Problem with general relativity
4. We don't know

See Cosmology lectures

Returning to where we stopped