Formation and Evolution of Galaxies 2023/2024

Mock Exam

This exam will be evaluated on a scale 0-10, and the overall mark will count 60% of the course final grade. This exam is strictly individual, so any interchange of material with other people is forbidden. The use of a tablet/laptop is allowed during the exam, but only to read the course notes/slides, which must be downloaded in advance. The use of internet is strictly forbidden during the exam. No mobile phones are allowed.

There are 20 questions in this exam, each with a maximum grade of 0.5 points. Your reply to each question should be brief, containing only 1-3 short sentences.

1a) The growth of matter structures can be studied at different redshifts. Is it easier at low or high redshifts? Justify your answer.

1b) When was the comoving number density of dark matter haloes with mass $10^{13}\,M_\odot$ higher, at redshift z=1 or z=7? When was it higher for haloes with mass $10^{7}\,M_\odot$? Explain.

2a) What is the main discrepancy between the (Λ-CDM) theoretically predicted and observed matter density profiles of dwarf-galaxy dark-matter haloes?

2b) Briefly explain a main discrepancy between a Λ-CDM theoretical prediction for the Milky Way and the results of observations. Propose an explanation for such a discrepancy.

3a) What main problem arises when galaxy formation models include only prescriptions for gas cooling and star formation? What is the solution to this problem?

3b) What kind of observational study allows us to statistically infer the masses of the host dark matter haloes in which galaxies live?

4a) Mention two characteristic properties of galaxy surveys that allow for the study of large-scale structure in the Universe.

4b) How can we separate stars and QSOs from normal galaxies in shallow blank sky images (like SDSS images)? How can we differentiate the stars and the QSOs?

5a) If you want to estimate the star formation rates of low-redshift galaxies, which tracer would you use? And for high-redshift galaxies? Justify your answers.

5b) What complicates the determination of galaxy gas metallicities at high redshifts ($z > 1$)?

6a) Describe the physical processes involved in the formation of a spiral galaxy in a few sentences.

6b) Ennumerate two possible origins for the stars found in galaxy haloes. Are they typically formed in situ?

7a) Imagine that you have images in different optical filters corresponding to two galaxy surveys of comparable depths, one for a blank field and another one for a cluster field. Do you expect galaxies to have the same colour distribution in both surveys? Explain.

7b) Can you search for galaxy clusters at far-IR/millimetre wavelengths? If so, explain how.

8a) The extragalactic background light has similar intensities at optical and mid-/far-infrared wavelengths. However, the majority of galaxies in the local Universe are much brighter in the optical than in the mid-/far-infrared. How can this apparent discrepancy be explained?

8b) Mention one reason why a far-IR galaxy might not follow the IR-radio correlation.

9a) What is the condition for a gas outflow produced by an AGN to escape the host galaxy?

9b) The growth of a black hole can be self-regulated. Explain how this could happen.

10a) Mention two mechanisms that can trigger changes in a galaxy morphology.

10b) Some disc galaxies develop a pseudo-bulge at some point in their lifes. How does this typically happen?