

University of London

EXAMINATION FOR INTERNAL STUDENTS

For The Following Qualifications

Astronomy PHAS2521 Techniques in Astronomy and Interstellar Astronomy

UNIT VALUE:

DATE:

TIME:

TIME ALLOWED:

PHAS2521/2008

PLEASE TURN OVER

Answer THREE questions from Section A and THREE questions from Section B.

You are advised to spend no more than 10 minutes on each Section A answer and about 30 minutes on each Section B answer.

The numbers in square brackets on RHS indicate the provisional allocation of maximum marks for sub-sections of the question.

SECTION A

Q1

Draw and annotate two diagrams of the optical layout of elements in a refracting telescope with a single lens eyepiece. Indicate the focal lengths of the two elements.

[3]

On one diagram show the path of rays which indicate the focus of the system and on the other diagram the rays which show the angular fields.

[4]

Q2

List, with a brief description of each, the advantages and disadvantages of

a) reflecting telescopes

[4]

b) refracting telescopes

[3]

Q3

List up to seven of the main characteristics of a modern CCD. For your answer consider the following: areas, size, resolving ability, ease of use, efficiency, dynamic range and any problems they can suffer from.

[7]

Q4

List the four main phases of the Interstellar Medium (ISM) and contrast the difference between them using the parameters of temperature, density and the hydrogen ionisation state within each phase. [5]

Quote the percentage (by number) of hydrogen atoms, helium atoms, and heavier elements (metals) in the generic ISM. [2]

Q5

State what types of atomic transitions are observed as interstellar absorption lines. [1]

List the two types of bright objects that can be used as background sources to probe interstellar atomic gas in the line-of-sight to the near and distant Universe. [2]

Explain how the Equivalent Width of an absorption line is calculated. You may illustrate your answer with an annotated diagram. [4]

Q6

Describe the only way in which dark nebulae can be identified in the optical regime. In which part of the electromagnetic spectrum would you expect to see emission lines from dark nebulae, and from what type of particle do they arise? [3]

Briefly describe the four mechanisms that compress the ISM and trigger star formation. [4]

SECTION B

Q7

With the aid of a sketch to represent the range of the EM spectrum, indicate on it the approximate wavelengths associated with the main bands of EM radiation. Also indicate on this sketch approximate blackbody temperatures of sources and finally plot a curve indicating how the atmospheric transparency changes through the different wavelength regions.

[10]

Describe the techniques (which instruments and which detectors) are used to make studies of objects in each of the main bands of EM radiation. [10]

Q8

A telescope of 200mm diameter has a focal length of 3000mm.

- a) What would be the magnification with a 25mm eyepiece? [4]
- b) In that same case, what would be the size of its exit pupil? [5]
- c) If the eyepiece has an apparent angular field of 60 degrees, what would be the angular field observed in the sky? [5]
- d) What would be the resolving power of this telescope in arcseconds and in micrometres at the focal plane for yellow light at 550nm? [6]

Show your calculations, explain how you get your answers.

Q9

Describe in detail four different techniques (ground and space based) used to detect the presence and/or to image extra solar planets. Include information about their present achievements, challenges and limitations (regarding what they can detect), advantages, disadvantages and expected future developments, especially in space observatories.

(Total mark will be out of [20], 5 marks for each technique described.)

Q10

Describe the dominant heating and cooling mechanisms in a pure hydrogen HII region, with reference to photoionisation, thermalisation, and recombination. What energy does a photon need to have to photoionise hydrogen? Describe (with the aid of a diagram) how these mechanisms operate in a hydrogen atom. Include in your diagram a description of Lyman, Balmer and Paschen series.
[8]

What are the dominant sources of heating and cooling in a diffuse cloud where hydrogen is mostly neutral?
[3]

Discuss briefly how forbidden lines form and why forbidden lines cannot be observed on Earth. Why are forbidden lines very efficient at cooling gas?
[9]

Q11

Describe what is meant by Hydrostatic Equilibrium for a gaseous body, and Jeans' Mass of an interstellar cloud. What interstellar temperatures are most conducive to star formation and why?
[5]

Briefly describe the mechanism through which a protostar gains mass, with reference to the accretion disk. Where does the surplus angular momentum of the accreting matter go?
[4]

How do protostars lose mass as they are forming? Describe in simple terms the physical mechanism that channels the outflow. At approximately what speeds is the mass ejected, and how long do these ejection episodes last? What is the name of a protostar that is losing mass in this way? What is the main observation evidence that stars lose mass?
[7]

Sketch a simple cartoon of an idealised protostar and its surroundings, labelling the components discussed above.
[4]

Q12

Outline the basic approach used to determine gas element abundances from measurements of interstellar absorption lines. [7]

What would be the difference between observing an interstellar cloud with strong forbidden lines and weak forbidden lines? How would this affect the nebular cooling rate? [3]

What is found when the abundances of metals in the ISM is compared to those in the Sun? How does this help in determining the chemical composition of interstellar dust? [2]

At what specific wavelength does neutral hydrogen in the ISM emit EM radiation in the radio region? In simple terms, explain how this emission process occurs? You may use a diagram to illustrate your answer. [6]

Hydrogen in its molecular form (H_2) is hard to detect. Emission from what molecule is commonly used to trace its existence? On average, in what proportions are H_2 and this molecule found? [2]