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:

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 indicate the provisional allocation of maximum marks for sub–sections of the question.

SECTION A

Q1
Draw and annotate two diagrams of a simplified optical layout of a refracting telescope with a single biconvex lens eyepiece. Indicate the focal lengths and diameters of the entrance and exit pupils. [3]

In the first diagram, show the path of rays which indicate the focus of the system, and in the other diagram show the rays which show the angular fields. [4]

Q2
List, with a brief description of each, five advantages and five disadvantages of

a) refracting telescopes [3]

b) reflecting telescopes [4]

Think in terms of size, cost, quality, practical application in astronomy, etc

Q3
List seven of the main advantages and disadvantages of a modern Charge-Coupled Device. For your answer consider the following: areas, size, resolving ability, ease of use, efficiency, dynamic range and any problems they can suffer from (one point mark for each correct answer) [7]

Q4

If you looked at the spectrum of a reflection nebula, would you see absorption lines, emission lines, both, or no lines? Explain your answer. As part of your explanation, describe how the spectrum demonstrates that the light was reflected from nearby stars. [4]

Why are observations at millimetre wavelengths so much more useful in exploring interstellar clouds than observations at visible wavelengths? [3]

Q5

Define the terms *HII region* and *Strömgren Sphere* describing interstellar gas around a hot star. [3]

What spectral types of stars produce Strömgren Spheres? [1]

Indicate how the radius of a Strömgren Sphere will change with (a) increasing density of the interstellar gas, (b) increasing effective temperature of the central OB star, and (c) increasing number of stars. [3]

Q6

State the upper wavelength limit for photons able to ionize atomic hydrogen, and the energy (in any system of units) associated with that limit. [1]

What do the terms *photoionization* and *recombination* mean in the context of a pure hydrogen nebula? During which process is radiation emitted? [3]

State the two main types of emission line that dominate the spectra of photoionized nebulae. What type of emission lines do hydrogen and helium produce in typical photoionized nebulae? [3]

SECTION B

Q7

Draw a sketch of the electromagnetic spectrum, and indicate on it the approximate wavelengths associated with the main bands of EM radiation, from gamma rays to long radio waves. Also indicate on this sketch the approximate blackbody temperatures of sources at each band and finally plot a curve indicating how the atmospheric transparency/opacity changes through the different wavelength regions. [10]

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

Q8

A telescope of 300mm diameter has a focal length of 2000mm.

a) What would be the magnification with a 20mm 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 65 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, including definitions of symbols used.

Q9

Describe in detail at least four different kinds of information that we can get from the light received from a variety of celestial objects (make your own choice, like stars, planets, nebulae, etc) and the corresponding instrumentation and techniques required for such detection. Include a description of the physical, chemical and positional knowledge that we gain from such objects after this analysis.

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

Q10
List the four main temperature phases of the general interstellar medium and indicate for each typical values for gas temperature, density and hydrogen ionisation state. [10]

Discuss the observational evidence for the presence of dust in the general interstellar medium. [6]

Sketch the form of the interstellar extinction law from the near infrared through the visible to the ultraviolet regions of the spectrum. Label the axes, including the location of the V band. [4]

Q11
Describe what is meant by *Hydrostatic Equilibrium* for a gaseous body, and the Jeans' Mass of an interstellar cloud. What interstellar temperatures are most conducive to star formation and why? [5]

List the four main classes of low- and intermediate-mass protostars corresponding to the various stages of star formation, and outline the basic physical processes characterising each class. [5]

With which of the above classes are the T-Tauri stars associated? What are `proplyds', and which famous nebula is known to contain many of these objects? [4]

Briefly describe the mechanism through which a protostar accretion disk forms. How is the surplus energy of the accreting matter lost? [4]

What is the main observational signpost indicating that protostars lose mass? [2]

Q12
Define what is meant by the terms (i) *Column Density* of an absorbing species, (ii) *Equivalent Width* of an absorption line, and (iii) a Curve of Growth for an interstellar absorption line. [7]

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

Cold neutral hydrogen emits light at a specific wavelength in the radio region of the electro-magnetic spectrum, which is used to map radial velocities of our and other galaxies. What is that wavelength and, in simple terms, explain how this emission process occurs. You may use a diagram to illustrate your answer. [6]

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