The Open University

Science Supplementary Material
S281 Astronomy and Planetary Science

S281 TMAs 01, 02
CMA 41

Course and assignment number:

Tutor Marked Assignment

S281 01

Make sure you know how to complete and send in your TMA and PT3 form; detailed instructions are given in your student handbook (or supplement).

Covering: **Block 1, Chapters 1–3**

Cut-off date: **Friday 25 March 1994**

This assignment consists of four questions.

Question 1

This question relates to Block 1, Chapter 1, and carries 28% of the marks for this assignment.

(a) (*18 marks*) The visible-light photons from the Sun that bombard us out of doors are the outcome of a fascinating sequence of events. In no more than *about 300 words* summarize these events, in the following order:

(i) the generation of photons in the solar core,

(ii) the photons' journey from the core to the photosphere,

(iii) the photons' journey from the photosphere to the Earth's surface.

In your summary take care to include journey times, and to describe and account for any changes in the photon spectrum.

(b) (*10 marks*) Let us imagine that we can retrace much of the photons' journey in a truly incredible spacecraft! Before it has to turn back, the spacecraft reaches a depth in the Sun where the density is about that of the Earth's oceans (1 000 kg m^{-3}).

(i) Obtain the distance from the centre of the Sun at which the craft turns back. Express your answer in fractions of the solar radius, and in Earth radii (6 378 km). Show your working.

(ii) In a couple of sentences, quote the composition of the Sun at this depth as three mass fractions, and state whether the fluid is churned by convection.

(iii) Calculate the temperature at this depth as a fraction of the temperature at the centre of the Sun. Show your working. In a sentence, state why, at this depth, there is no significant fusion of hydrogen.

Question 2

This question relates to Block 1, Chapter 2, and carries 28% of the marks for this assignment.

Various observations have been made of the star β Fictitio ('Fictishio').

(a) (*6 marks*) Its ionized calcium spectral lines are about the same strength as its hydrogen Balmer lines. On this basis, estimate its photospheric temperature, and hence list the various types of star that it could be, illustrating your answer with a sketch of a Hertzsprung–Russell diagram. (*3 or 4 sentences*)

(b) (*5 marks*) Its spectral absorption lines are very narrow. Why does this observation indicate that β Fictitio is a supergiant? (*3 or 4 sentences*)

(c) (*6 marks*) Detailed analysis of the shape of its spectral lines leads to an estimate of its luminosity of $1.5 \times 10^4 L_\odot$. Calculate the radius of the star, expressing your answer in metres *and* in solar radii. Show your working.

(d) (*11 marks*) For β Fictitio, the Hubble Space Telescope obtains an estimate of 2×10^{-9} W m^{-2} for the flux density over all wavelengths.

(i) Calculate the distance to the star, expressing your answer in metres, light years, and parsecs. Show your working.

(ii) Why is this an upper limit to the distance? (*1 sentence*)

(iii) State whether this distance could be obtained at present using the method of geometrical parallax. (*2 or 3 sentences*)

1.1 JM/W

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