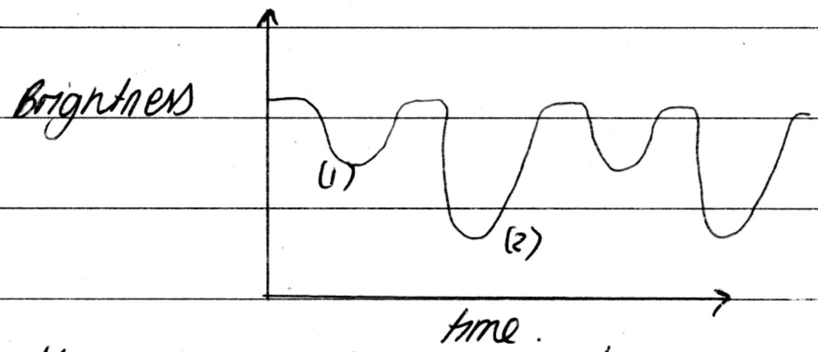
Question 30

(a) (i) The brightness of the star would vary periodically from brighter to duller. The graph of brightness against time would look like this.



With the brighter star eclipsing the duller star at (1) and the duller star eclipsing the brighter star at (2). This observation would allow astronomers to identify it as an eclipsing binary.

(ii) Since the two stars orbit a common centre of mass, their combined mass can be calculated using the formula $m_1 + m_2 = \frac{4\pi^2 r^3}{G T^2}$

Where r is the distance between the stars and T is their period, both of which can be determined by studying

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the stars, either by their spectral, visual eclipses or the 'wobble' in their path across the sky (astrometric binaries).

(b) (i) Lalande 21185

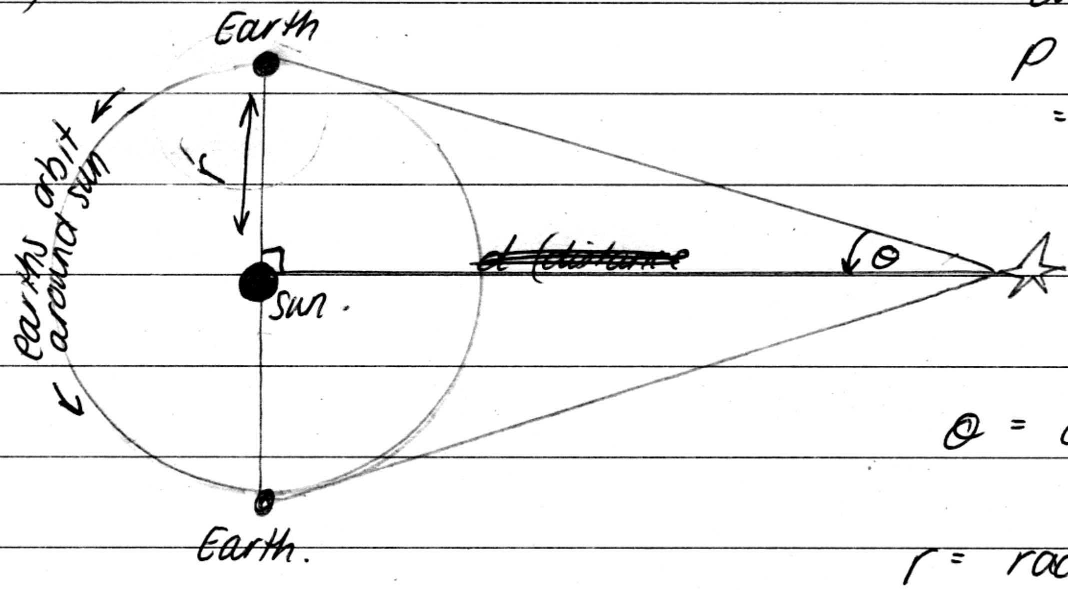
(ii)

$$\frac{I_{ROSS}}{I_{Prox}} = 100^{\left(\frac{11\cdot01 - 10\cdot37}{5}\right)}$$

$$\doteqdot 1\cdot803$$

∴ Ross 154 is approximatly 1·803 times brighter than Proxima Centauri when viewed from earth.

(iii)



$d = \frac{1}{p}$

$p = \frac{1}{d}$

$= 0.55''$

θ = 0.55 seconds of arc.

r = radius of earths orbit around sun.

The apparant shift ~~in~~ of the star relative to the background of distant stars is the principal of parallax used to determine distance, by taking measurements at six monthly periods in earths orbit of the sun and using trigonometry to determind distance.

(c)(i) P, this is the area representing stars of low luminosity and low temperature. This indicates a small star of small mass which are characteristics of a white dwarf.

(ii) white dwarfs are small stars of high density and low luminosity. ~~white~~ As ~~dwarfs~~ ~~[illegible]~~ white dwarfs radius decreases, density ~~increaseds~~ increases this causes Degeneracy. Degeneracy is the compression of atoms, causing the radius of its orbiting electrons to be decreased as they are ~~tight~~ tightly packed together. This exerts an outward force preventing the star from shrinking further and thus the star reaches equilibrium.

(iii) In a star of relatively small size on the main sequence, Hydrogen is being burnt as fuel to make Helium. This is done in a 3 step process as follows:

$$^1_1H + ^1_1H \rightarrow ^2_1H + ^0_{+1}e + \nu + \text{energy}$$

$$^2_1H + ^1_1H \rightarrow ^3_2He + \text{energy}$$

$$^3_2He + ^3_2H \rightarrow ^4_2He + 2\,^1_1H + \text{energy}$$

Over all, four hydrogen atoms are being fused to form one Helium atom and energy. The outward force this exerts on the star is balanced with the gravitational force of the star to create a state of equilibrium on the main sequence. This is called the Proton - Proton reaction and in a smaller star, this will occur at a relatively slow and stable rate.

(d) Adaptive optics has been a major contributor in the development of improved resolution and sensitivity of ground based astronomy.

It involves the use of a reference star to improve the images of new stars.

Adaptive optics assists in negating the distorting effects of the atmosphere on stellar images.

A reference star, of which the image is known, is observed at the same time as a new star.

~~[illegible]~~ When the atmosphere distorts the image of the reference star, a computer measures the changes to ~~[illegible]~~ adjust a flexible mirror onto which the new star is shining, to adapt the image to what it should be. The mirror is ~~[illegible]~~ ~~[illegible]~~ adjusted thousands of times per second and thus resolution is dramatically increased.

Another method used to increase resolution and sensitivity is Interferometry. This involves a number or 'array' of dishes viewing the same star in the sky. The images are converted to an electrical signals which ~~[illegible]~~ ~~[illegible]~~ ~~[illegible]~~ arriven to a computer in phase. The images are thus added together, (i.e. their signals ~~interfere~~ interfere) to ~~increase~~ ~~increase~~ increase resolution and thus overcome the effects of the atmosphere.

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Resolution an sensitivity has also been improved by placing satellite telescopes in space. Thus by being above the atmosphere, a greater range of frequencies of radiation can be detected and the quantity of radiation is increased as the atmosphere does not absorb it. ~~[illegible]~~ This information can then be sent back to ground based astronomers for study.

Another technique to improve resolution and sensitivity is placing telescopes high up above sea level, in clear air and environments free of static (for radio astronomy) and free of ~~[illegible]~~ light pollution. ~~[illegible]~~ By exending the exposure time of the image, more light is also gathered, increasing sensitivity.

A ~~photomultiplyre~~ photomultiplier may also be used to convert weak light into an electrical signal which is then amplified within the photomultiplier to give better resolution and sensitivity for ground based telescopes. This method can ~~increase the~~ significantly increase the quality of the image and can allow astronomers to view stars of up to ~~m~~ magnitude 24 (very low light intensities).