

CAIE Physics A-level

25 - Astronomy and Cosmology

Flashcards

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What is meant by the term luminosity?



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Luminosity is an absolute measure of the total power of the electromagnetic radiation emitted by a star.



Define the mathematical relationship between flux intensity and luminosity (hint: inverse square law).



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$$F = L / 4\pi d^2$$

Where 'F' is the flux intensity, 'L' is the luminosity and 'd' is the distance between the radiation source to the receiver.



What is meant by the term ‘standard candle’?



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A standard candle is an object of known luminosity.



Give a common astrophysical use of standard candles?



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Standard candles are often used in order to determine the distance to far off galaxies.



What is a blackbody?



What is a blackbody?

A blackbody is a perfect emitter and absorber of all possible wavelengths within the EM spectrum. Stars can be modelled as blackbodies.



State Wien's displacement law in words.



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Wien's displacement law states that the blackbody radiation curve, for bodies of different temperature, will peak at different radiation wavelengths such that the wavelength at the peak radiation is inversely proportional to the source body surface temperature.



State Wien's displacement law
mathematically.



State Wien's displacement law mathematically.

$$\lambda_{\text{peak}} = b/T$$

Where 'b' is Wien's displacement constant = $2.898 \times 10^{-3} \text{mK}$, ' λ_{peak} ' is the radiation wavelength at the peak radiation intensity and 'T' is the surface temperature of the source body.

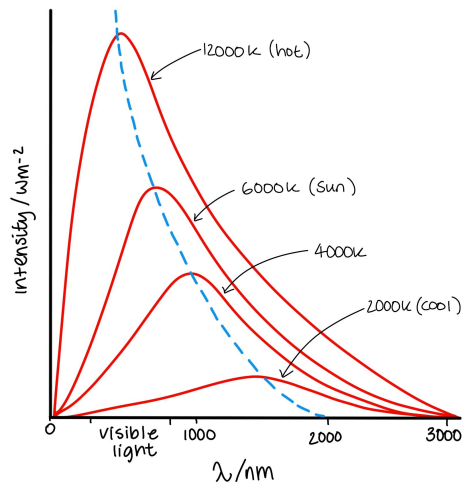


Sketch a graph of radiation intensity against wavelength in order to depict the relationship outlined by Wien's displacement law.



Sketch a graph of radiation intensity against wavelength in order to depict the relationship outlined by Wien's displacement law.

The dashed blue line runs through λ_{peak} : the wavelength of peak intensity for each temperature curve.



Give the equation that defines the Stefan-Boltzmann law rearranged for luminosity.



Give the equation that defines the Stefan-Boltzmann law.

$$L = 4\pi\sigma r^2 T^4$$

Where 'L' is radiating body's luminosity, ' σ ' is the constant of proportionality = $5.67 \times 10^{-8} \text{ Wm}^{-2}\text{K}^{-4}$, 'r' is the radius of the body, and 'T' is its surface temperature.

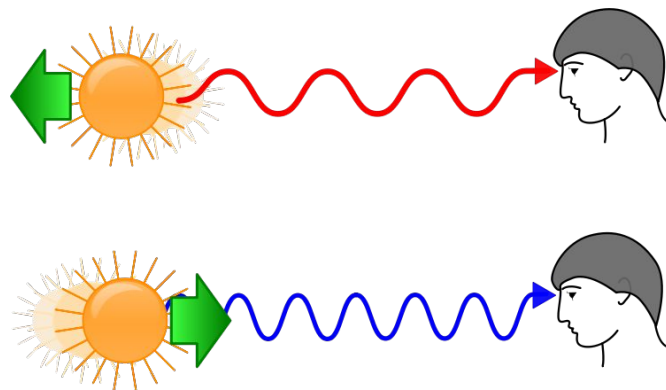


What is redshift? Draw a diagram to illustrate what you mean.



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Redshift is the phenomenon resulting from an increase in wavelength of EM radiation (light) emitted by an object that is moving away. Light is instead 'blueshifted' (shortened wavelength) if the object is moving from the observer.



The vast majority of galaxies have a higher observed wavelengths on their observed emission spectra, than the known wavelength values. Can you explain why this might be?



The vast majority of galaxies have a higher observed wavelengths on their observed emission spectra, than the known wavelength values. Can you explain why this might be?

The EM radiation emitted by these galaxies has been redshifted. This suggests that many more galaxies are moving away from the Earth, than moving towards, which provides evidence that the universe is expanding and in favour of the Big Bang Theory.



Calculate the velocity of a stream of light that has an observed wavelength of $6 \times 10^{-7} \text{ m}$ but was emitted with a wavelength of $5.5 \times 10^{-7} \text{ m}$.



Calculate the change in velocity of a luminous object that has an observed wavelength of $6 \times 10^{-7} \text{ m}$ but emitted light with a wavelength of $5.5 \times 10^{-7} \text{ m}$.

$$\Delta\lambda/\lambda \approx \Delta f/f \approx v/c$$

$$\text{So } v \approx c\Delta\lambda/\lambda$$

$$v \approx (3 \times 10^8)(6 \times 10^{-7} - 5.5 \times 10^{-7})/(5.5 \times 10^{-7})$$

$$v \approx 2.7 \times 10^7 \text{ ms}^{-1} \text{ (3.s.f.)}$$



State Hubble's law.



State Hubble's law.

$$v \approx H_0 d$$

Where 'v' is the velocity with which a stellar body is moving away from the Earth, 'H₀' is Hubble's constant and 'd' is the distance of the body from Earth.



Why does Hubble's law suggest the universe is expanding?



Why does Hubble's law suggest the universe is expanding?

Hubble's law draws a directly proportional relationship between the distance of stellar bodies from Earth and the velocity with which they are travelling away from Earth. This implies that stellar objects are moving away from one-another as well as away from Earth, suggesting that the universe is expanding.



Why does Hubble's law give evidence to support the big bang theory?



Why does Hubble's law give evidence to support the big bang theory?

Instead of using Hubble's law to forecast the expansion of the universe, we can use it to extrapolate back in time. If we go back in time, the universe will decrease in size, according to Hubble's law. If we extrapolate things back far enough, all mass can be considered to originate from a single point. The origin of the universe from such a singularity is the essence of the Big Bang theory.

