Intro to Quantum Physics F3241

Dr Lily Asquith (Lily)

Week 3

Blackbody Radiation

This week's topics:

3.1 Blackbody Radiation

3.2 The Ultraviolet Catastrophe, Planck to the rescue

Your homework questions for this week are on canvas - please complete these by the end of the week.

A brief history of radiation

300 BCE : Euclid

1000 CE : al-Haytham

1600 Kepler : inverse square law

17th c. Explosion of activity: Huygens, Hooke, Newton

18th c. Newton (particles) vs Euler (waves)

1800 Young and his slits. Also William Herschel and infrared

1819 Fresnel and his bright spot

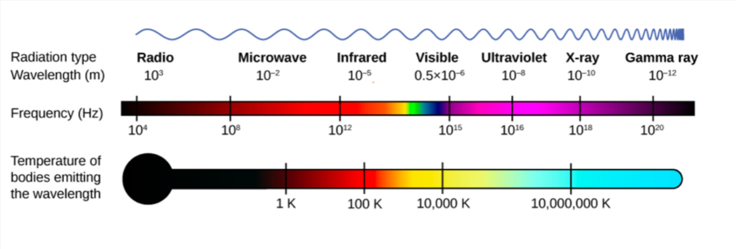
mid 19th c. Faraday and Maxwell - light is an EM wave

1864 Tyndall presented measurements of the infrared emission by a platinum filament and the corresponding colour of the filament

1879 Stefan T4

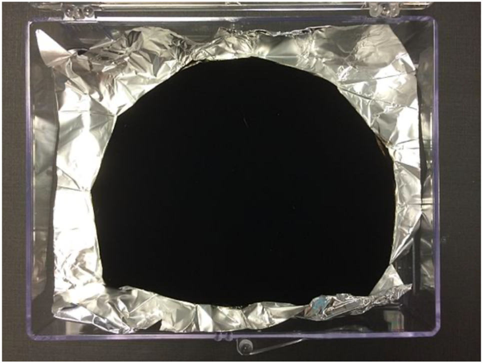
1884 Boltzmann derived Stefan's law using heat engine model

The Electromagetic Spectrum



Blackness

Vantablack absorbs 99.96% of $\perp$ light with $\lambda = 663$ nm.



Good absorbers are good emitters!

If something is an excellent absorber of EM radiation, it is also an excellent emitter of EM radiation. The same physical process is responsible for both.

The blackbody

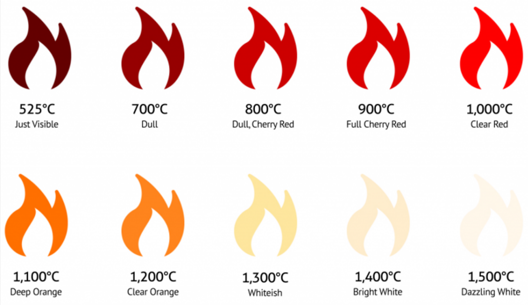
A blackbody absorbs all wavelengths.

A black object absorbs all visible wavelengths.

Recap Power

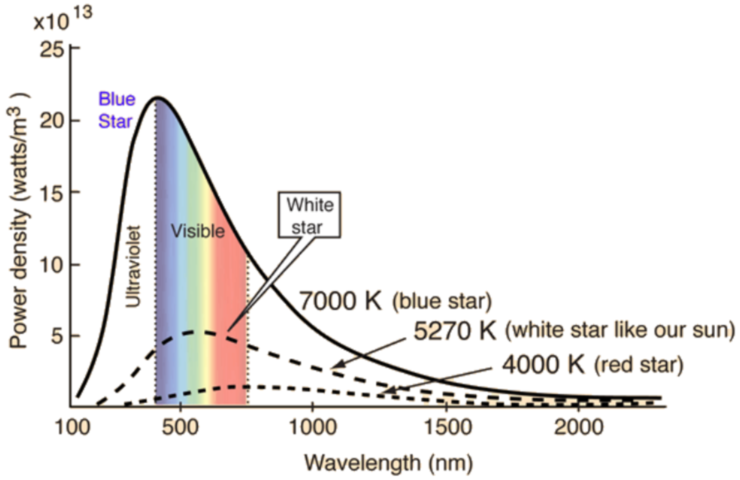
Power is energy transferred per unit time, and is measured in Watts.

Colour and Temperature (Tyndall, 1864)



UNIVERSITY OF SUSSEX

Temperature: observations



Temperature and wavelength: Wien's Law

1. The peak is moving to shorter wavelengths:

Wein's displacement law: $\lambda_{max} T \approx 2.90 \times 10^{-3}$

Find the temperature of a blackbody if its spectrum has its peak at

(a) 700 nm (visible)

(b) 3 cm (microwave region)

(c) 3 m (FM radio waves).

Temperature and power: Stefan-Boltzman law

2. The amount of radiation is dropping.
Stefan-Boltzmann law (stat therm): $R = \sigma T^4$

Stefan's constant: $\sigma = 5.67 \times 10^{-8}\text{W m}^{-2}\text{ K}^{-4}$

(a) For an incandescent lightbulb with a power of $R = 10$ W, what is the temperature of the filament?

(b) What power would the lightbulb have if the temperature of the filament were doubled?