Observational Astronomy

How we make the EM spectrum our bitch

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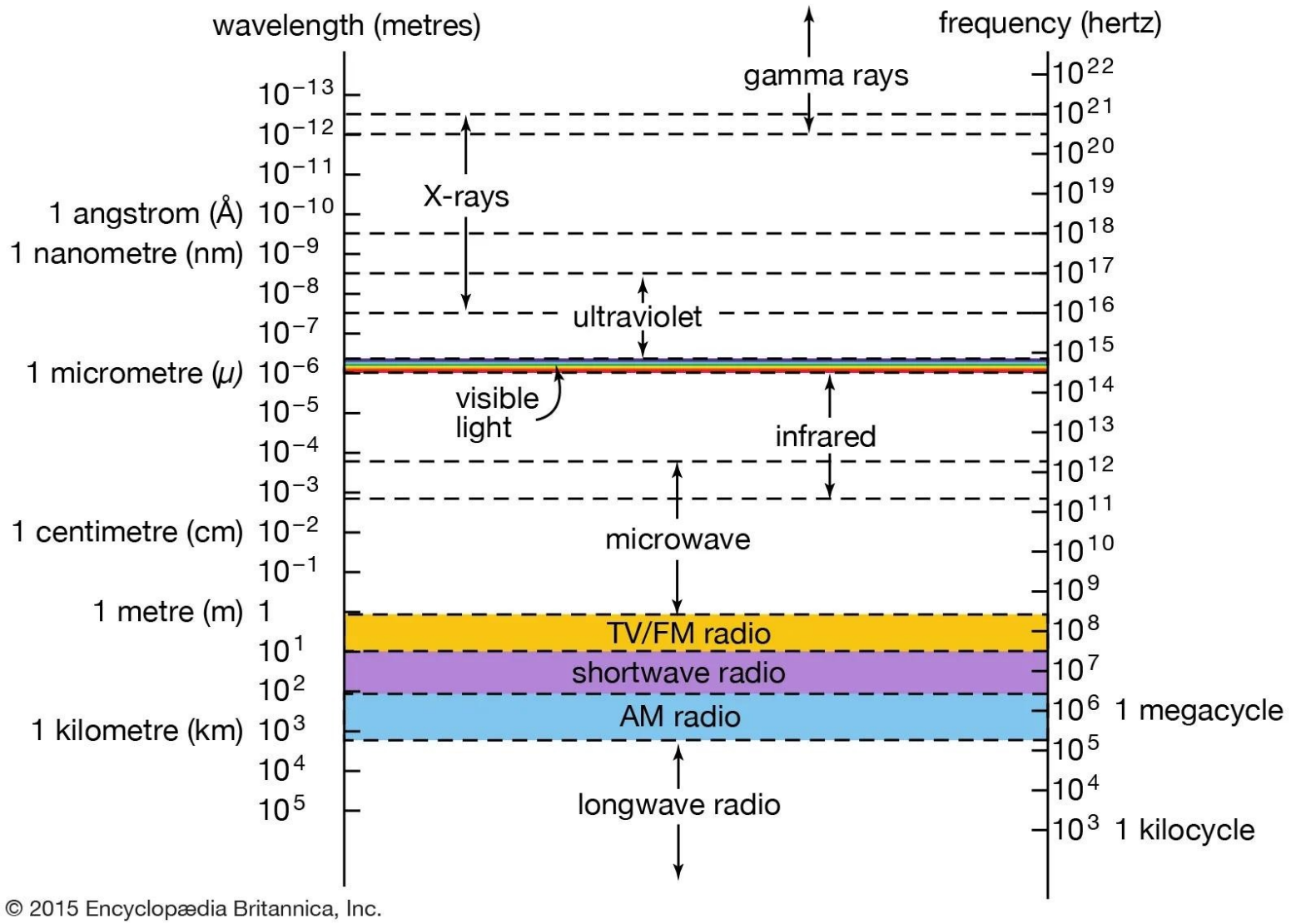
Light spectra

Electromagnetic spectrum



How is electromagnetic radiation created

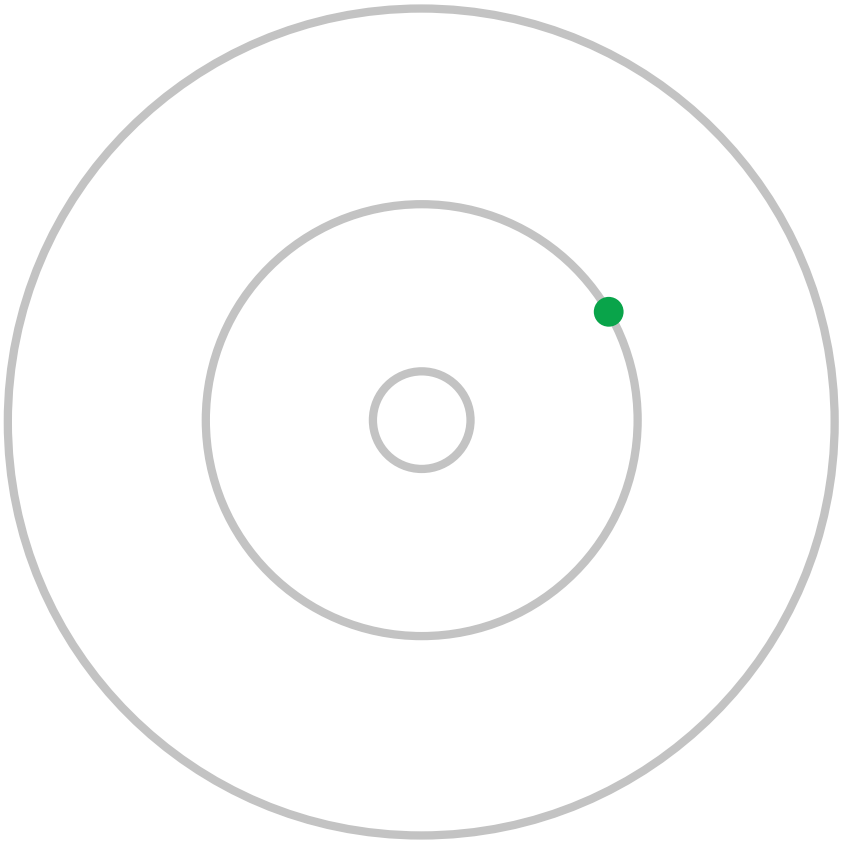


Figure: Bohr model of a hydrogen atom

How is electromagnetic radiation created

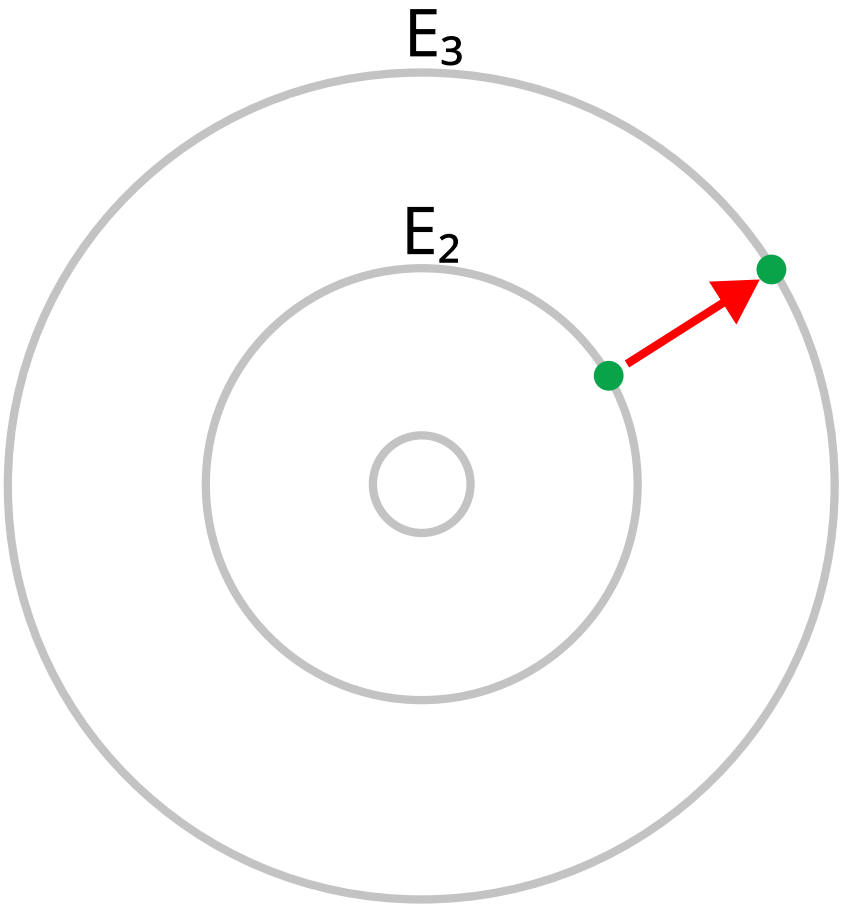


Figure: Absorption

How is electromagnetic radiation created

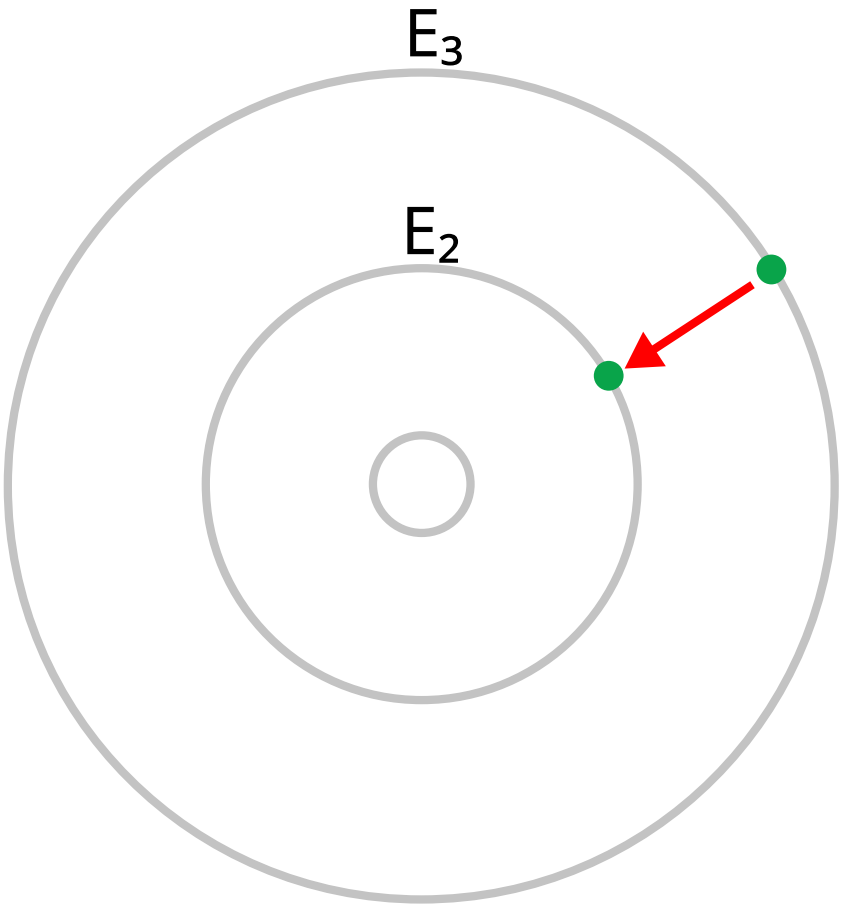


Figure: Emission

Photon energy

$$E_3 - E_2 = \text{Energy of the photon} = hf$$

where $h = 6.626 \cdot 10^{-34} J \cdot Hz^{-1}$

Photon energy

$E_3 - E_2 =$ Energy of the photon $= hf$

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$$E = \frac{hc}{\lambda}$$

$c = 3 \cdot 10^8 m \cdot s^{-1}$

Let's do an example

$$E_n = \frac{-hcR_\infty}{n^2}$$

$$R_\infty = \frac{m_e e^4}{8\epsilon_0^2 h^3 c}$$

$R_\infty = 10\,973\,781.568160\ m^{-1}$	Rydberg constant
$n_e = 9.11 \cdot 10^{-31}\ kg$	Electron mass
$e = 1.602 \cdot 10^{-19}\ C$	Elementary charge
$\epsilon_0 = 8.854 \cdot 10^{-12}\ F \cdot m^{-1}$	Permitivity of free space

Lets's do an example (continued)

The Rydberg constant for hydrogen can be calculated using the reduced mass of the electron.

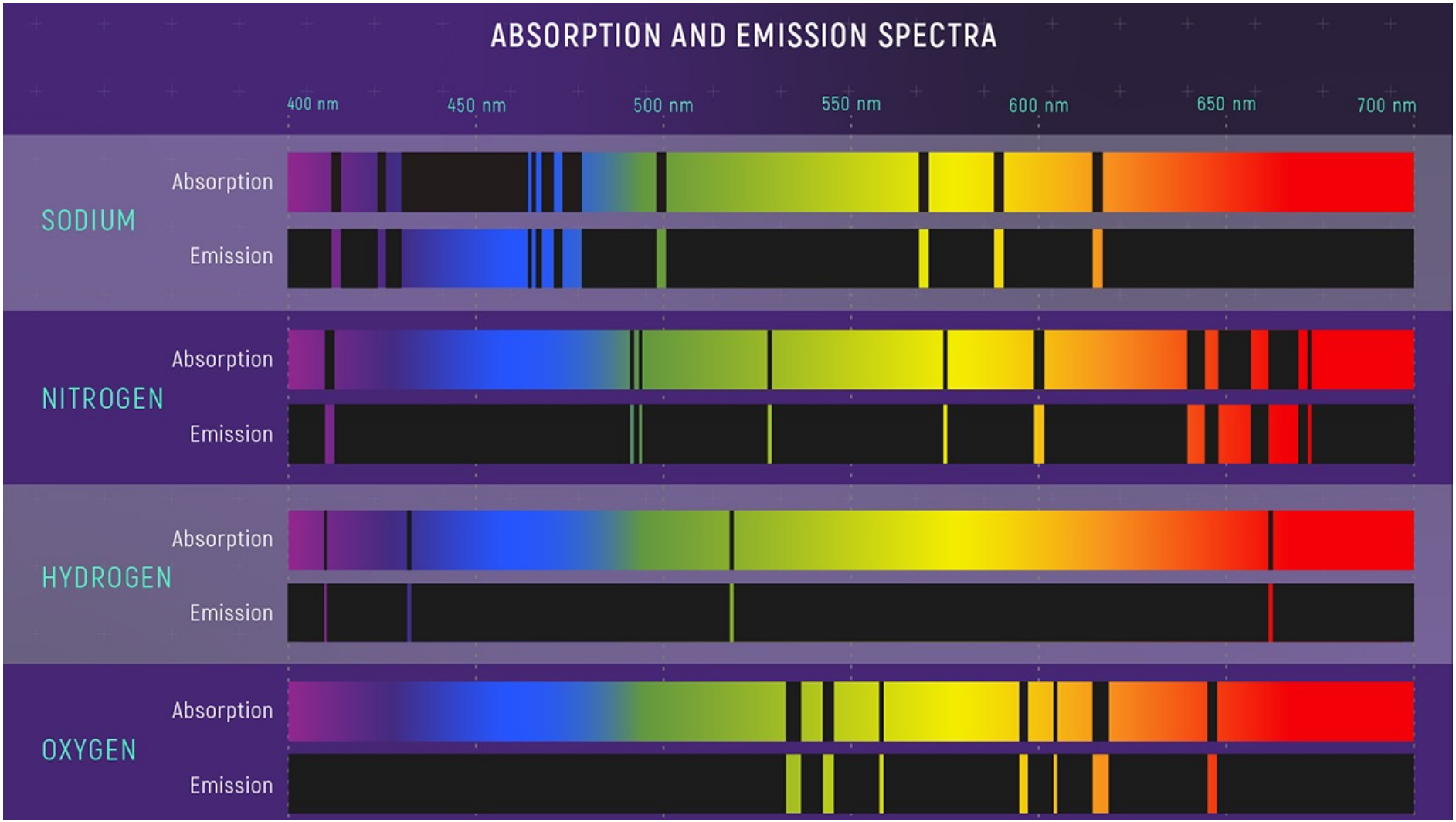
$$R_H = R_\infty \frac{m_p}{m_e + m_p}$$

$$R_H = 0.999\ldots R_\infty$$

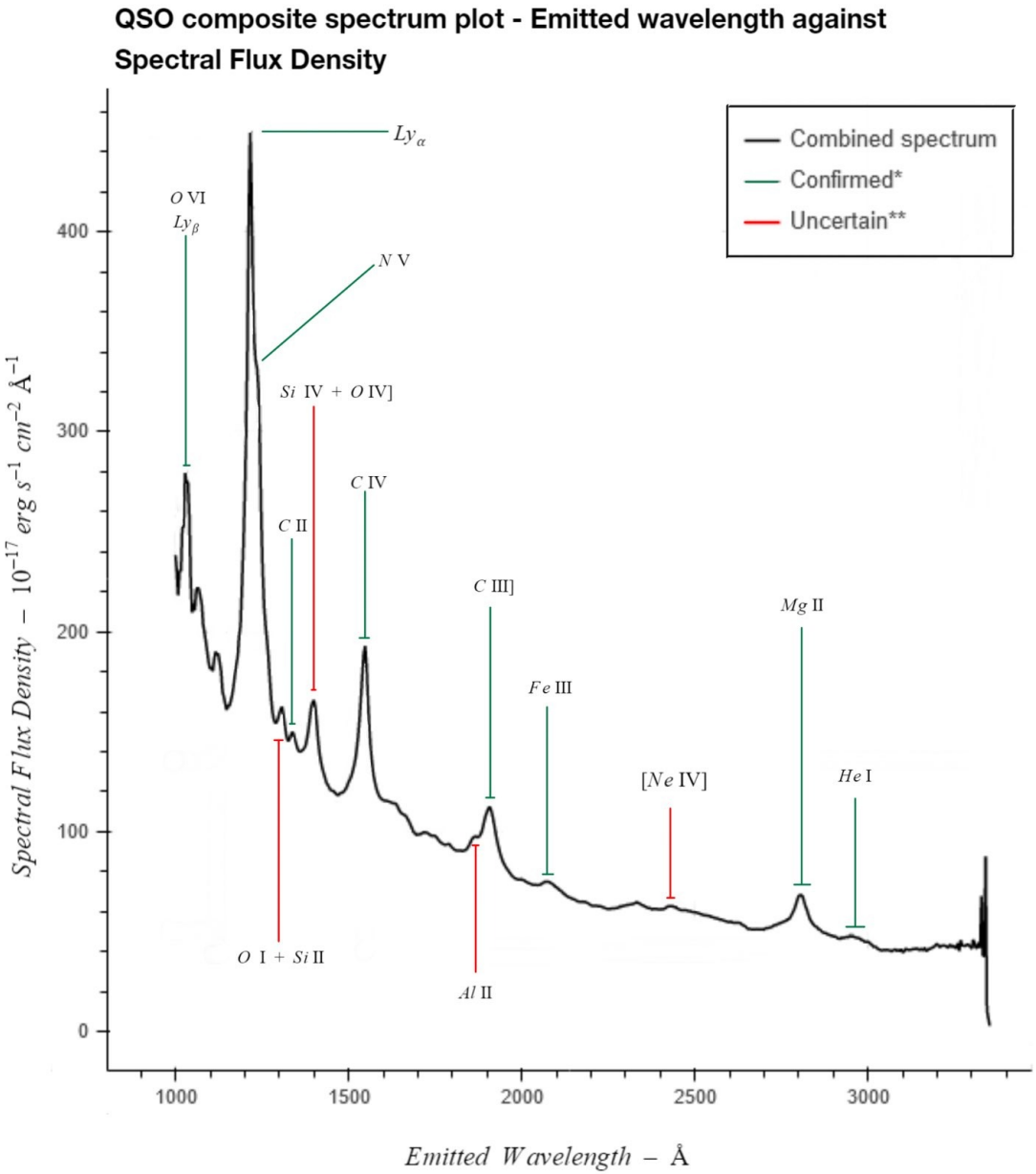
Lets's do an example (continued)

$$
\begin{aligned}
E_3 - E_2 &= 3.027 \cdot 10^{-19} \\
E &= \frac{hc}{\lambda} \\
\lambda &= \frac{hc}{E} \\
&= 6.5611 \cdot 10^{-7} m \\
&\therefore \\
\lambda &= 656\ nm\ (3\ s.f.)
\end{aligned}
$$

Emission and absorption spectra



A real emission spectrum



Redshift and the expanding universe

$$
\begin{aligned}
z &= \sqrt{\frac{c+v}{c-v}} - 1 \\
&= \frac{\lambda_{obs} - \lambda_{emit}}{\lambda_{emit}}
\end{aligned}
$$