Activity prepared by the KCL EPAP group
Experimental Particle and Astroparticle Physics

How many neutrinos???

Calculation activity

The Sun – a ν_e generating nuclear reactor

How many of those neutrinos reach you?

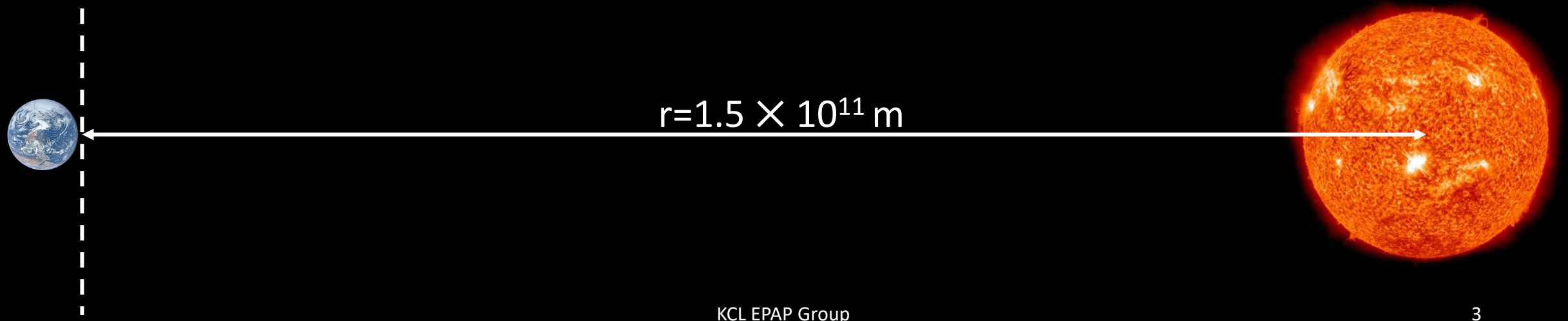
The Flux of solar neutrinos on Earth

- The Sun produces 10^{36} neutrinos per second!
  - These are emitted in all directions (isotropically) so consider them spreading out on the surface of a sphere
- The Sun is 152 million kilometers away from Earth

How many neutrinos per second pass through a $1m^2$ area here?

Surface area of a sphere

$$A = 4\pi r^2$$



Calculations

- How many solar neutrinos travel through you every second?
  - Estimate your area
  - Does it make a difference if you stand up or lie down?
  - Does it make a difference if it is day or night?

- The chance of any single neutrino interacting with you is 1 in 10^{22} = 10^{-22}
  - How likely is it that a neutrino will interact with a person in their lifetime?
    - Average UK life expectancy ~80 years
  - How likely is it that somebody in this room has already had an interaction with a neutrino?

More calculations ☺

Velocity = distance / time

$$c = \frac{d}{t}$$

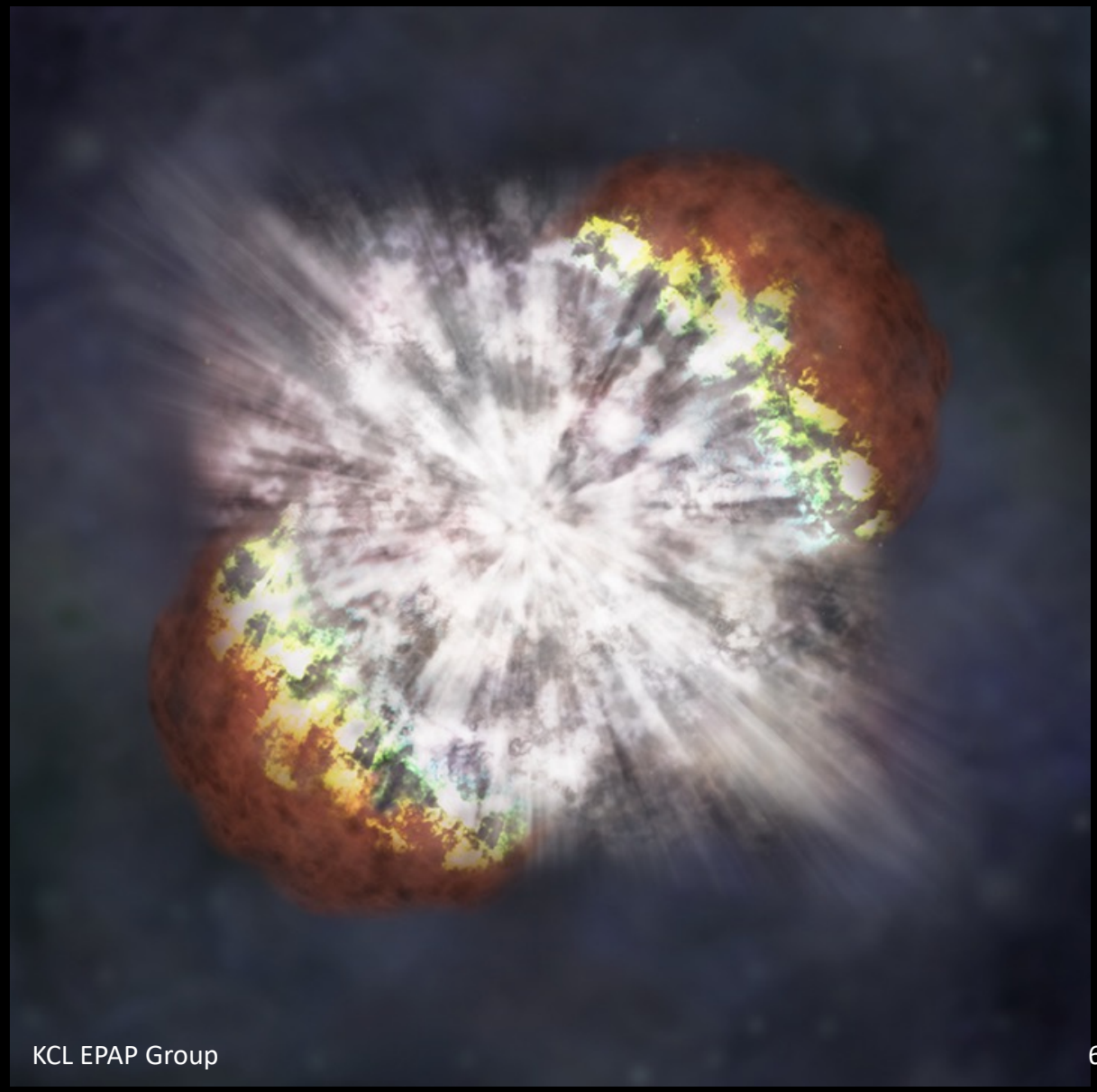
- Neutrinos travel at ~ the speed of light $c = 3\times10^{8} m/s$
- The time each neutrino spends in you $t = \frac{d}{c}$
  - Estimate the average distance through your body
- Given how many neutrinos are passing through you each second, and how long each one spends in you, what is the probability there is a neutrino inside you at one instant?
- What volume box do you need to be sure there is always a solar neutrino in it?

Supernova – an astronomical ν-generating nuclear explosion

A supernova is a powerful explosion when a massive star runs out of fuel.

A supernova can produce 10^{58} neutrinos in just a few seconds!

https://spaceplace.nasa.gov/supernova/en/



Supernova Calculation

- The star IK Pegasi B is the nearest known supernova candidate, located about 150 light-years from our sun and solar system.
- A light year is the distance light (or neutrinos) travelling at $c = 3\times10^{8} m/s$ would travel in a year – how far is this in km?
- If IK Pegasi B went supernova and produced 10^{58} neutrinos, how many would pass through you?