OzGrav
ARC Centre of Excellence for Gravitational Wave Discovery

MISSION: GRAVITY

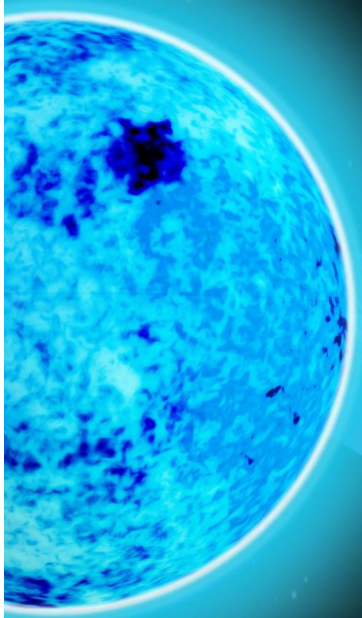
MISSION MANUAL

TEMPERATURE

SCIENCE OFFICER MISSION:

MODEL THE TEMPERATURE OF THE STAR USING LIGHT

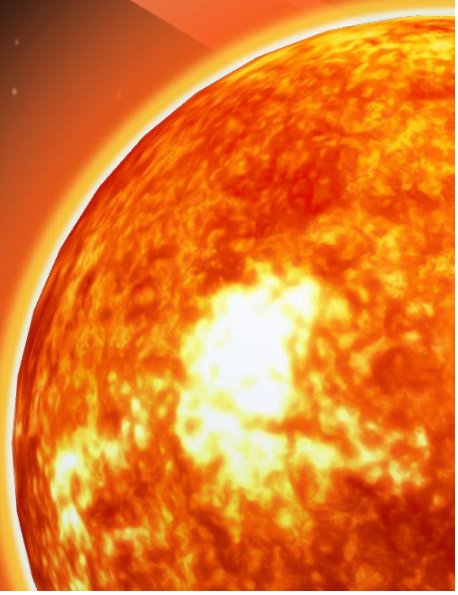
Hot objects such as stars
Radiate energy in the form
of **light** and **heat**



Light is a wave

The **colour** of the light depends on
the **wavelength** of the light wave.

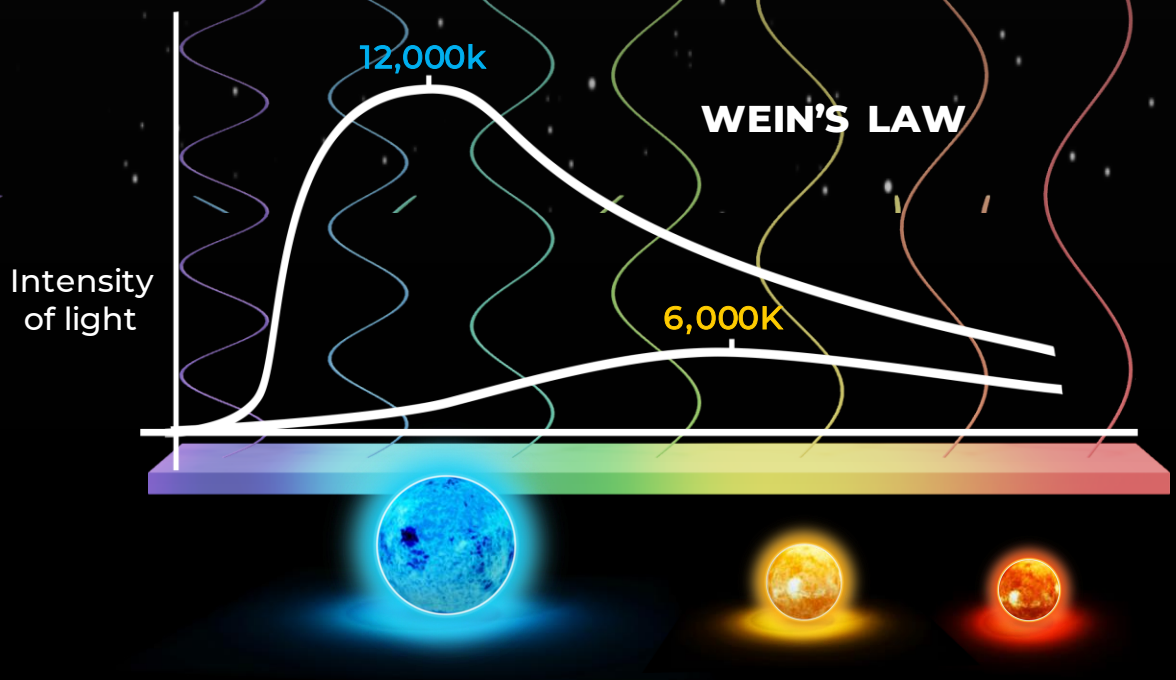
Blue light has a short wavelength
compared to red light which is long



The **wavelength** of the light can provide **the temperature** of the star

Shorter wavelength light waves are more energetic and indicate hotter stars

The VR Spectrometer will provide the measure of the most dominant (peak) wavelength in the star



The following relation (Wien's displacement law) relates the peak wavelength (in nanometers) and the temperature (in degrees Kelvin)

$$Temperature\ (K) = \frac{2{,}900{,}000\ K \cdot nm}{Wavelength\ (nm)}$$

Example: **if the peakwavelength is 500 nm**

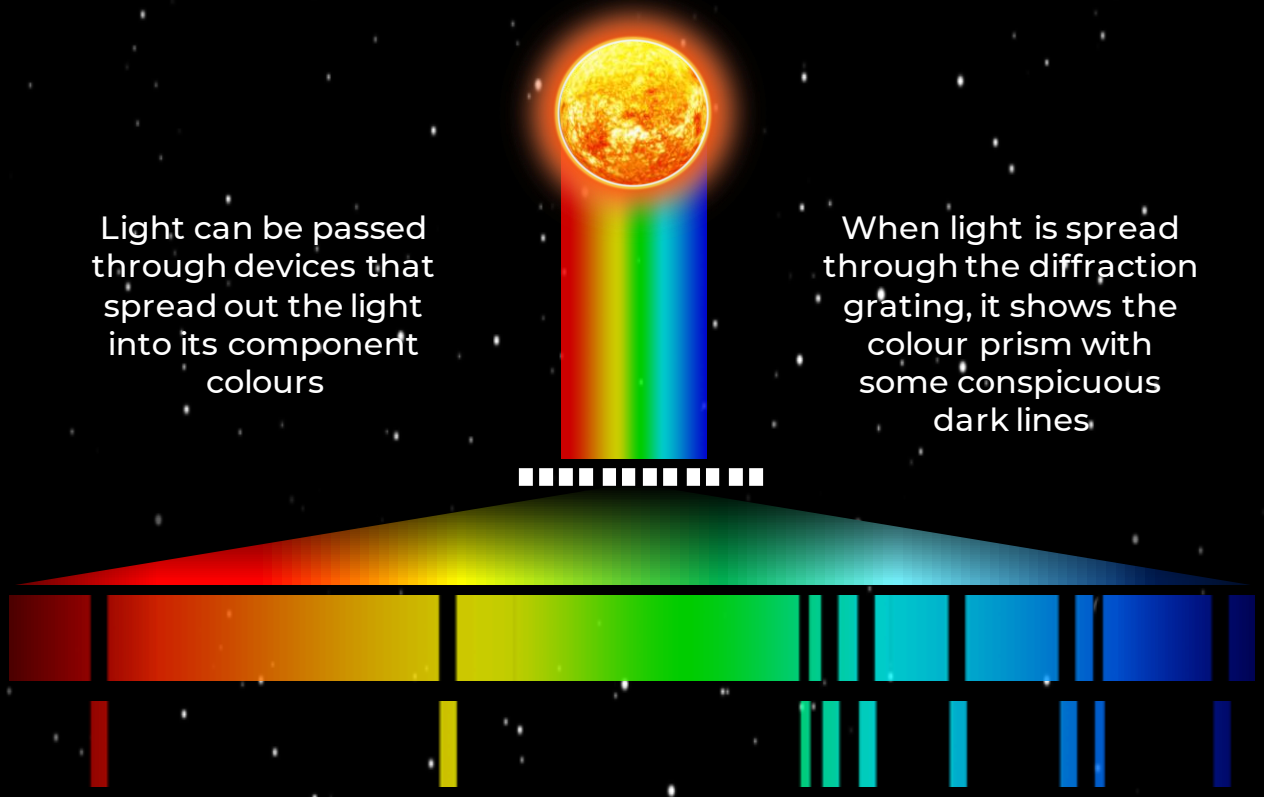
$$T(K) = \frac{2{,}900{,}000\ K \cdot nm}{500\ nm} = 5{,}800\ K$$

COMPOSITION

MISSION SPECIALIST MISSION:

MODEL THE CHEMICAL COMPOSITON USING SPECTRA

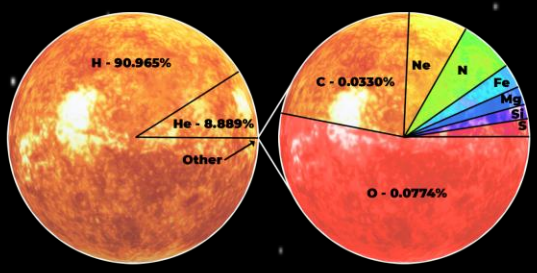
Light from a star is a combination of many colours (wavelengths) of light



Light can be passed through devices that spread out the light into its component colours

When light is spread through the diffraction grating, it shows the colour prism with some conspicuous dark lines

The location of these bright lines in the spectrum correspond to the dominant elements in the stars. From the spectrum, scientists can determine how much of each element is in a star. Stars are mostly hydrogen, with a lesser amount of helium, and a small bit of everything else. The 'everything else' is called metallicity.



For the mission, focus on the breakdown (in % of the star's total matter) of composition of:
Hydrogen, Helium, and Metallicity (other heavier elements)

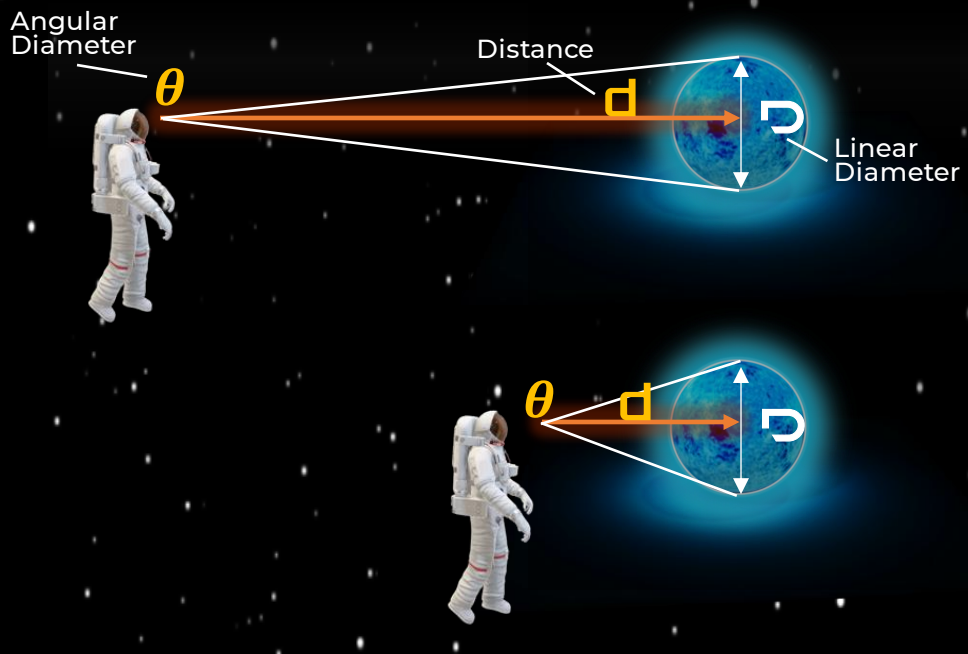
DIAMETER

FLIGHT COMMANDER MISSION:

USE ANGLAR SIZE TO FIND DIAMETER

Geometric relationships are used to find the size of objects in the universe

The apparent (linear) diameter of the star will change depending on how far away the observer is



To find the diameter of the star, use the following trigonometric relation for small angles

$$D = d \times \theta$$

The VR device will measure apparent angular diameter (α in degrees) and the distance to the star (d in solar radii). There are 360o in 2π radians.

MASS

FLIGHT ENGINEER MISSION:

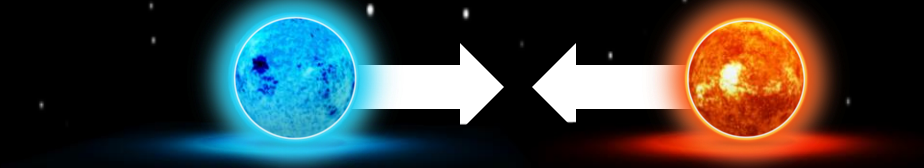
USE ORBITAL MOTION TO MEASURE MASS

The motion of an orbiting object provides information about the object being orbited.

Newton's Law of Gravitation models the motion of orbiting objects

The gravitational force between two objects depends on the masses of the objects and how far apart they are.

The force of gravity acts between all objects

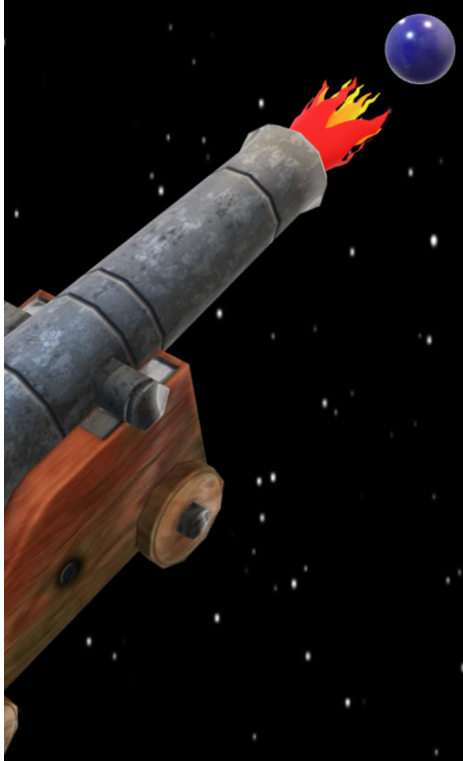


If mass increases, the force of gravity increases

If distance increases, the force of gravity decreases

The gravitational force determines the motion of the object as Newton's Second Law relates forces on a mass with its acceleration

A VR cannon will fire a ball near the star.



Use the
VR accelerometer
And
VR range finder
to find
Acceleration
(in Solar Newtons/Solar Mass)
and
Orbital Distance
(in solar radii)

These and Newton's Law of motion provide the following relationship to determine the mass of the star

$$\text{Mass (in Solar Mass Units)} = \frac{\text{Acceleration} \times (\text{Orbital Distance})^2}{G}$$

Example:

$$\text{Mass (in Solar Mass Units)} = \frac{0.04573 \times (4.676)^2}{1}$$