The Science of Light

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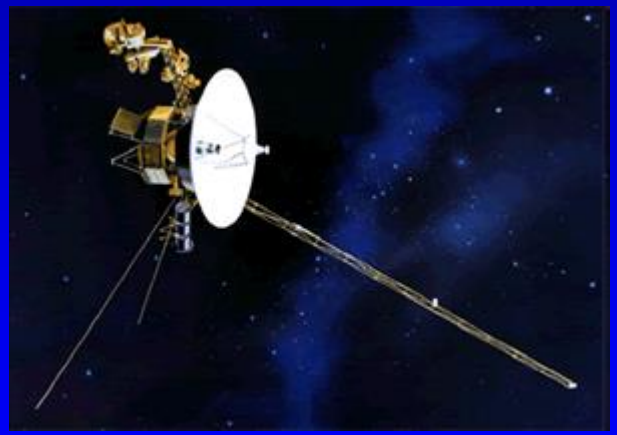
Can We Touch A Star?

- How do we learn more about things we can't touch?



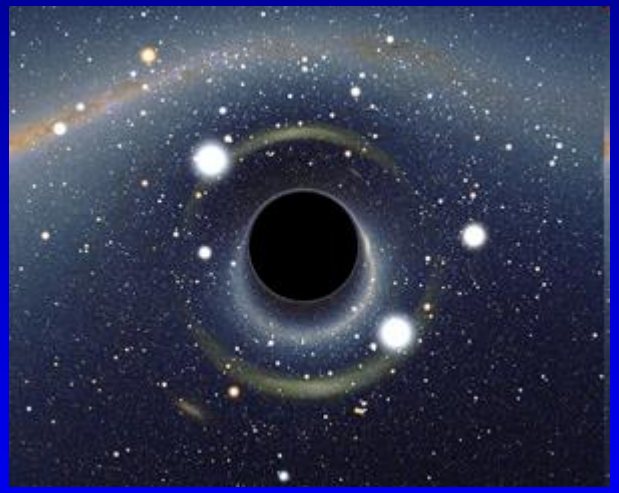
Send a robot?

Robots Don’t Always Work

- Robots can touch planets, moons, comets, and asteroids or at least get really close
- But, stars and other objects we’d like to learn about are:
  - Too far away!
  - Too hot!
  - Too dangerous!

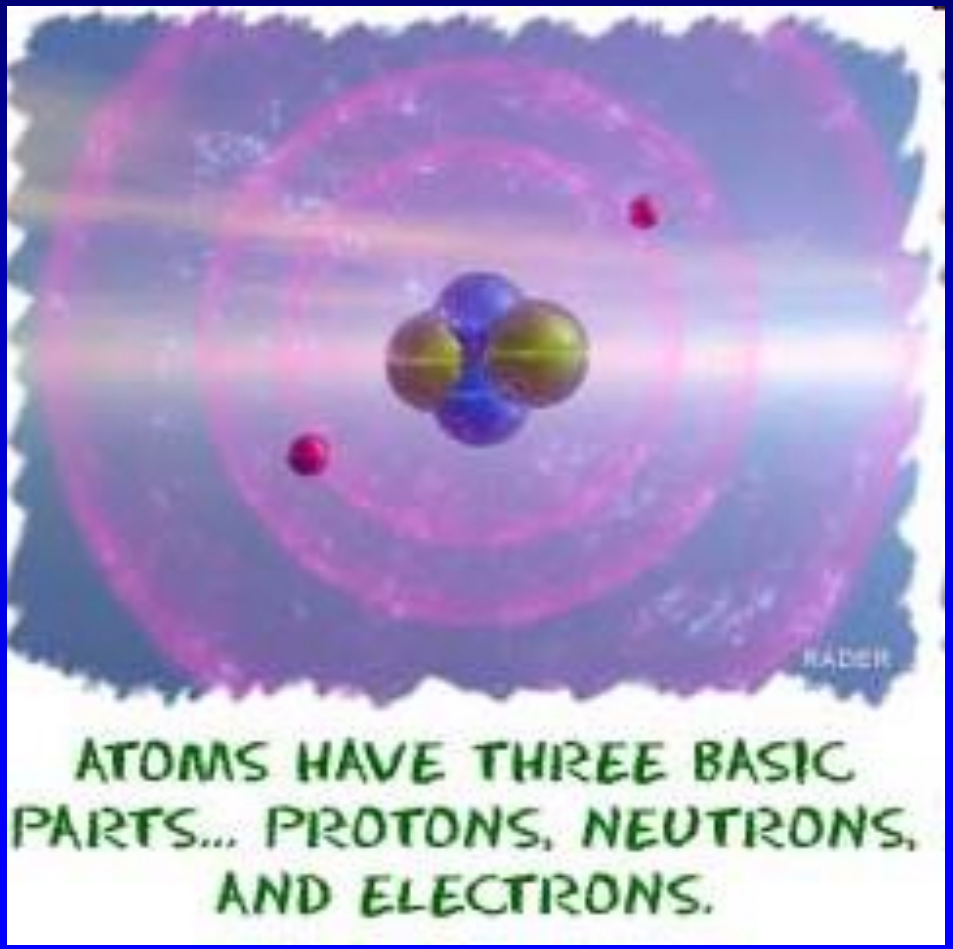
So How Do We Know...

- If we can't touch something, how do we know...
  - How far away it is?
  - How big it is?
  - What it's made of?



... The answer is, we have learned to use LIGHT from far away objects to learn these things!

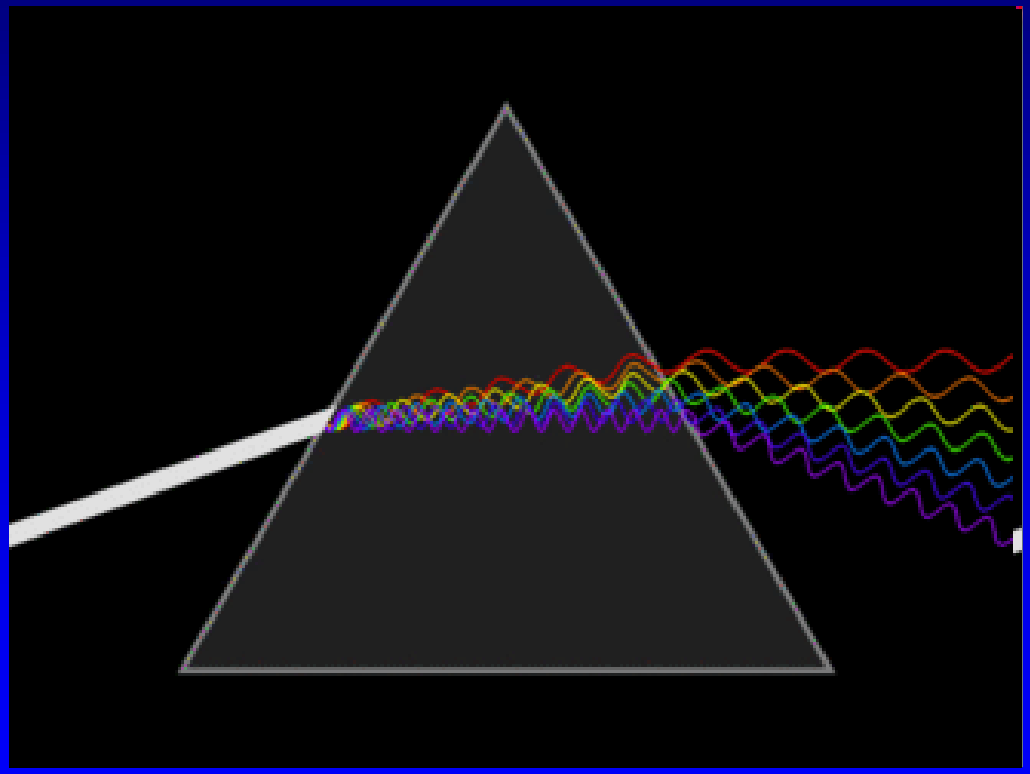
Whats an Atom?



But What Is Light?

- Light is two things
  - It acts like a thing (like an little ball)
  - But it works like a wave (like on the beach)

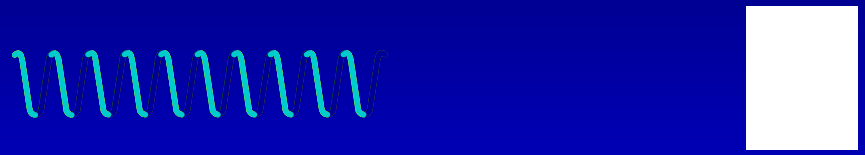
Whats Light Made Of?



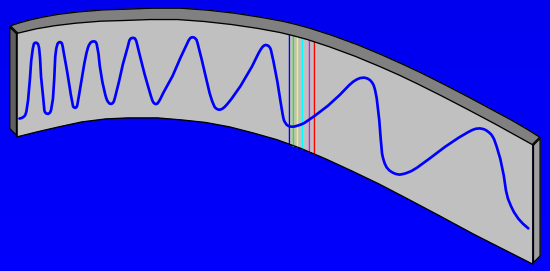
What is Light?

Theory...

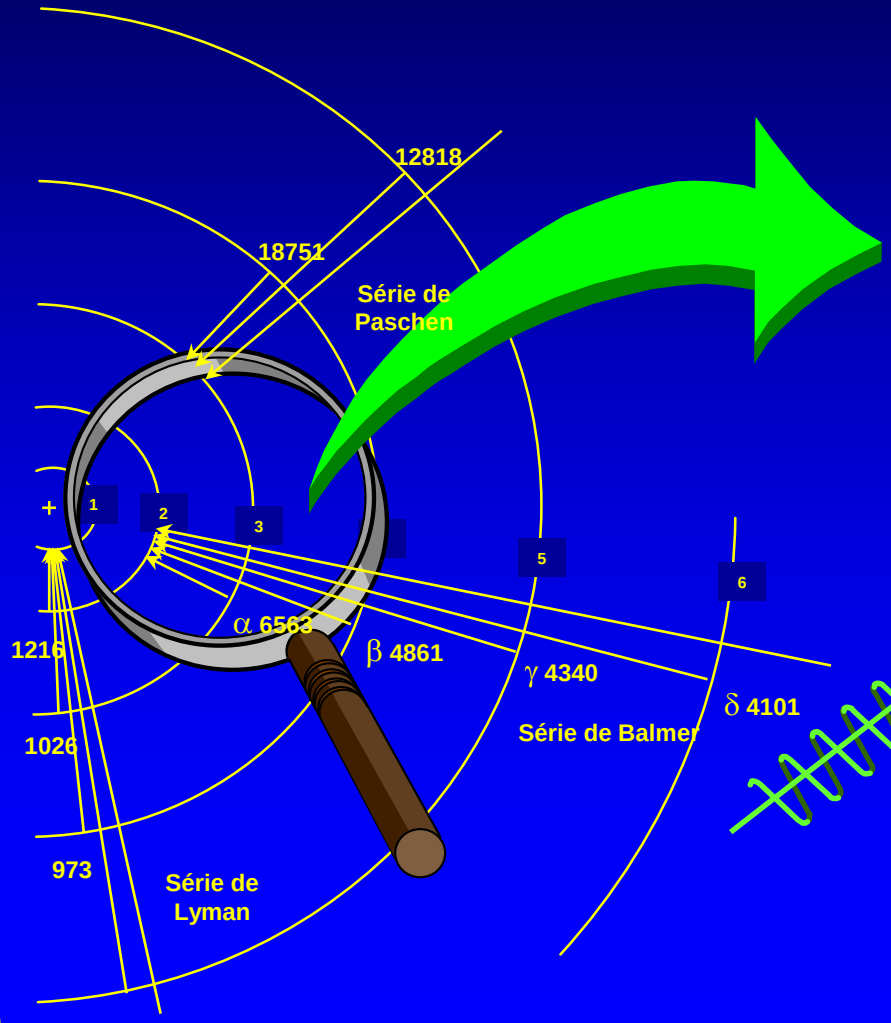
- Light is made of multiple colors

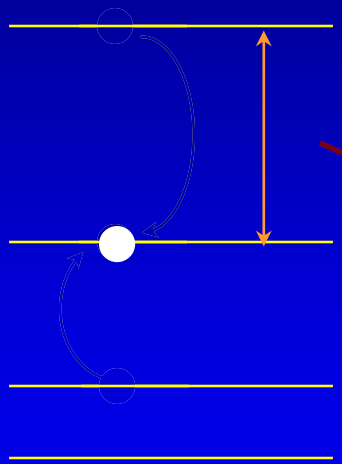


- Color is defined by its wavelength
- A spectrum is the split of the light by its wavelength λ grating

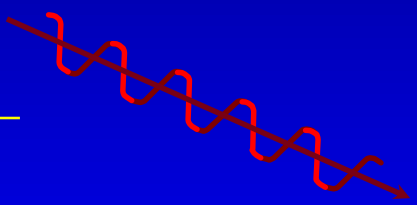


Atomic mysteries...



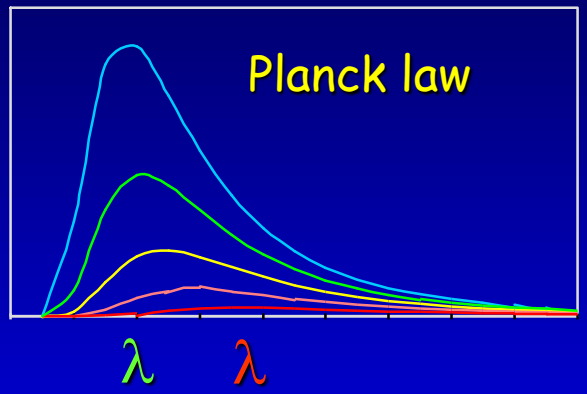


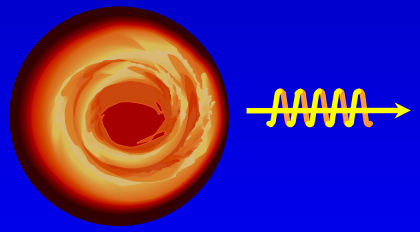
$E=h\nu = hc/\lambda$

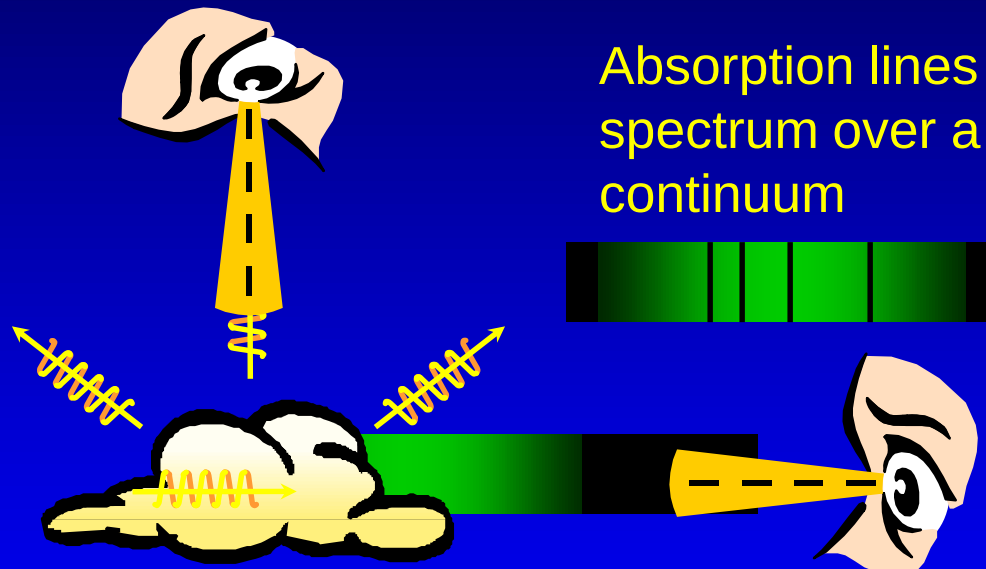


λ

Emission or absorption





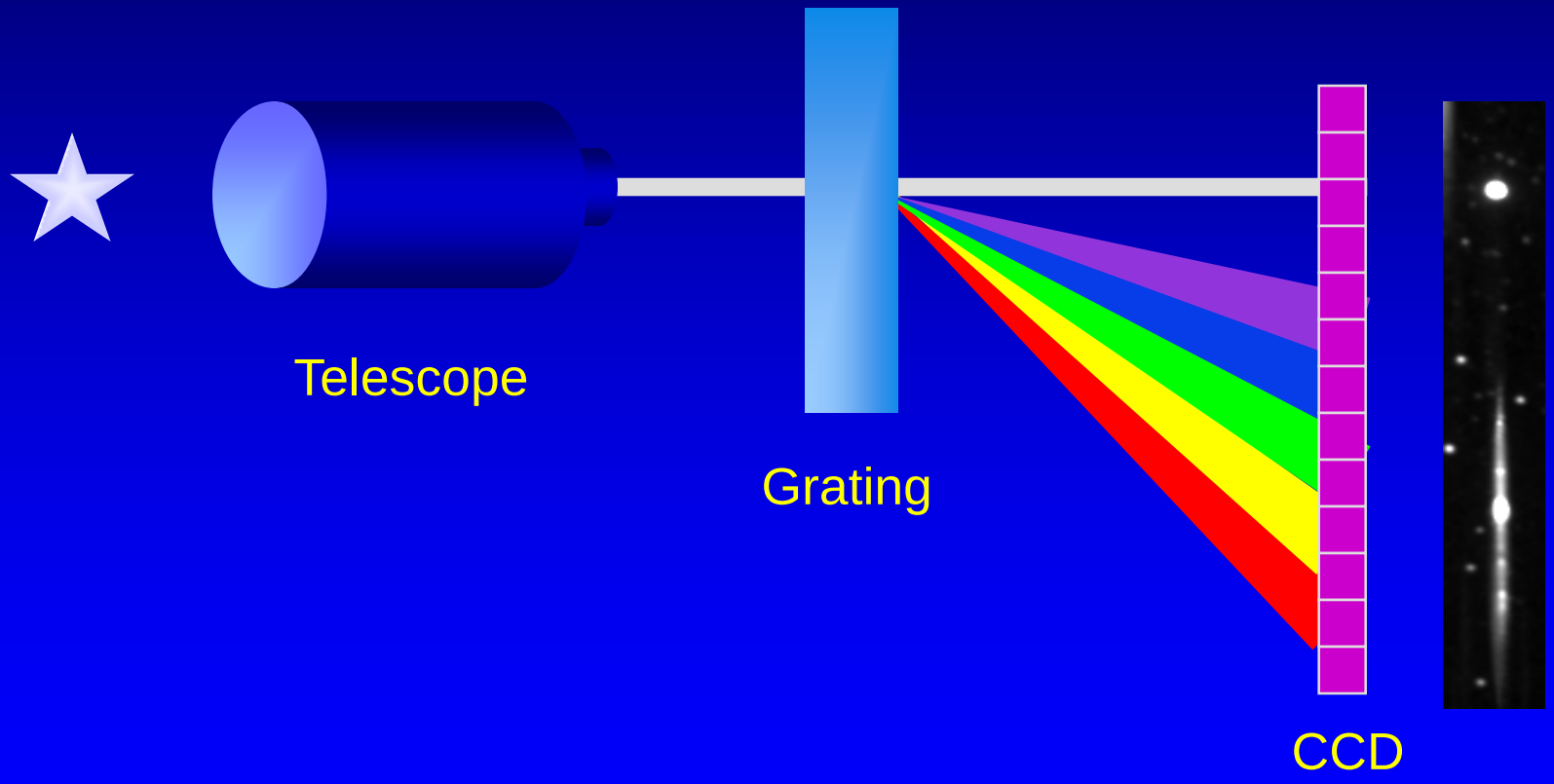


Absorption lines spectrum over a continuum

Emission lines spectrum

How do we see Spectra?

Dispersing system



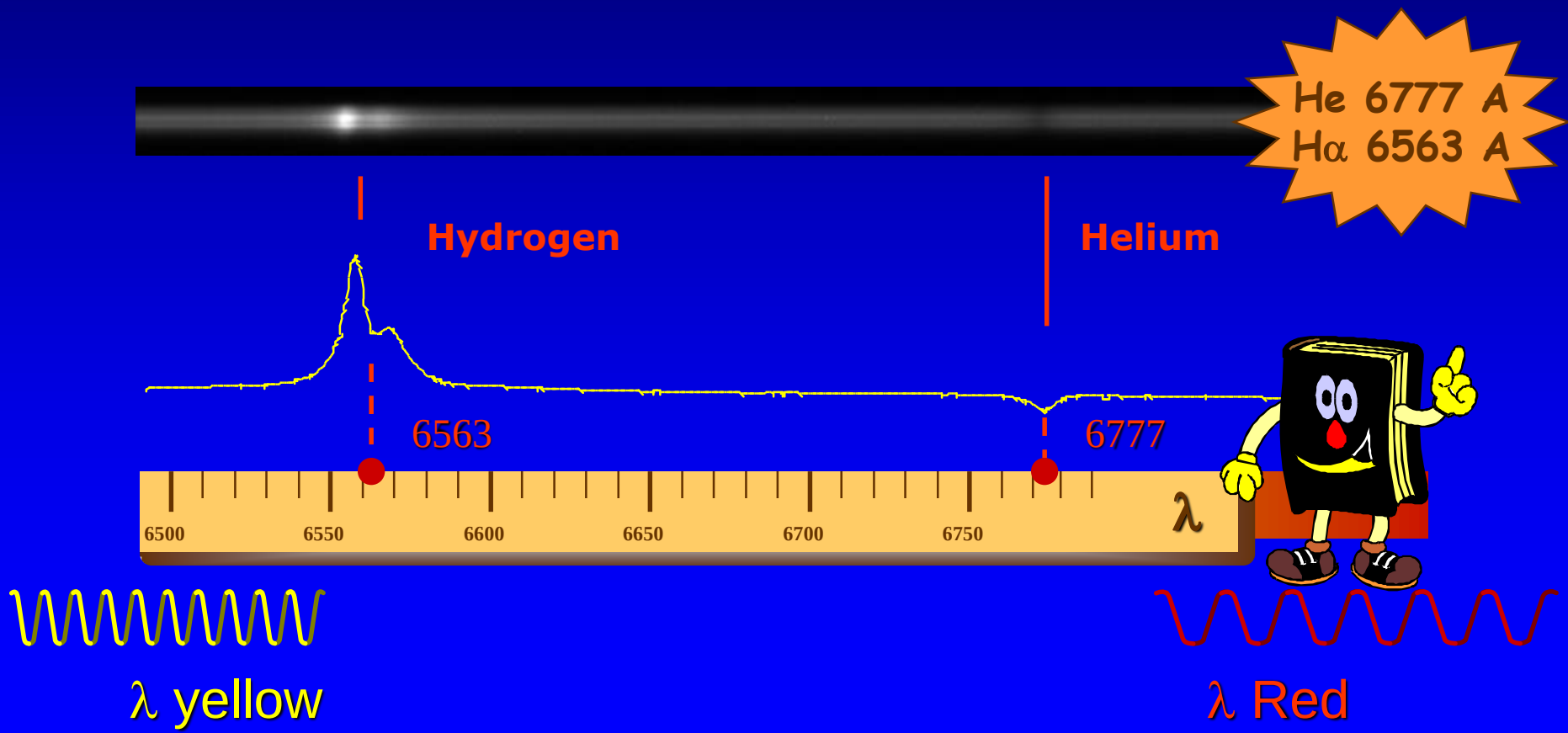
The spectral image

- **What do we see ?**
  - Energy is not spread regularly
  - Some radiations are missing
  - Some intensities are stronger than others
  - Lines position can vary

Temperature
Chemical signature
Physical conditions
Relatives speed

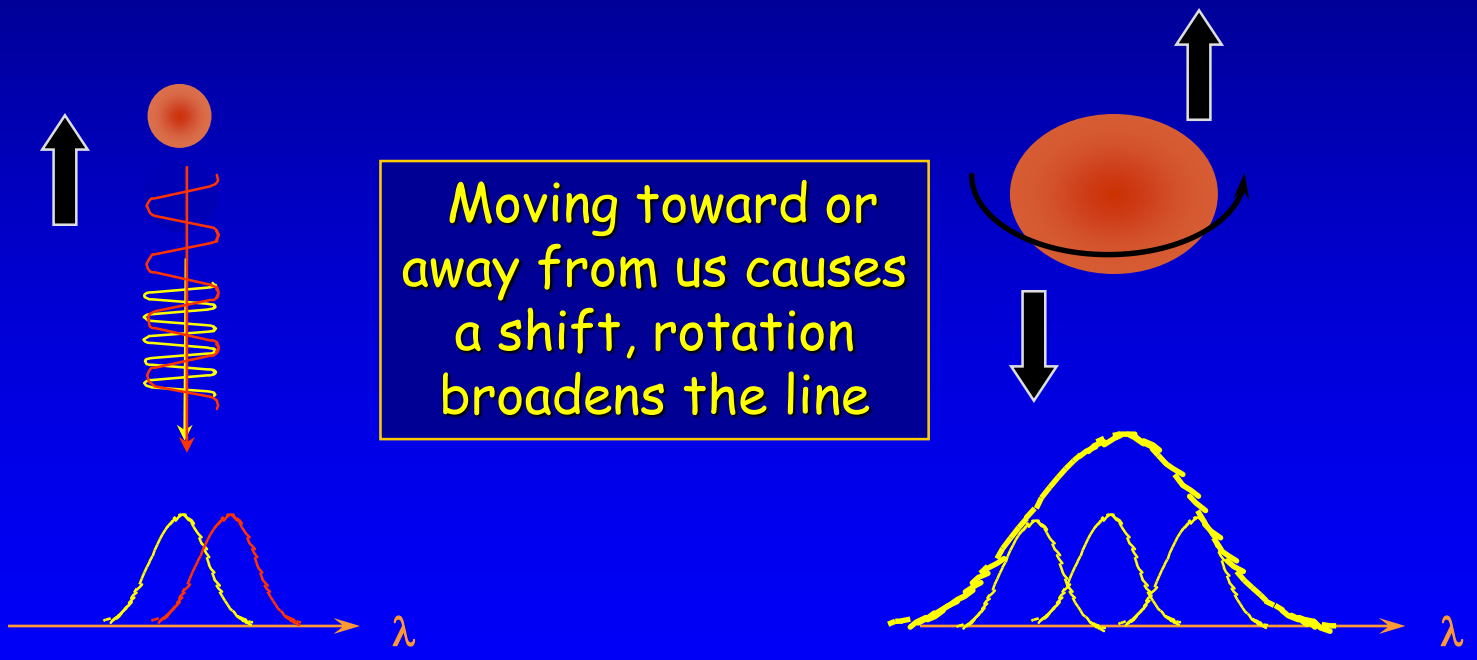
A mutiple set of physical informations...

The spectral profile



Doppler Effect

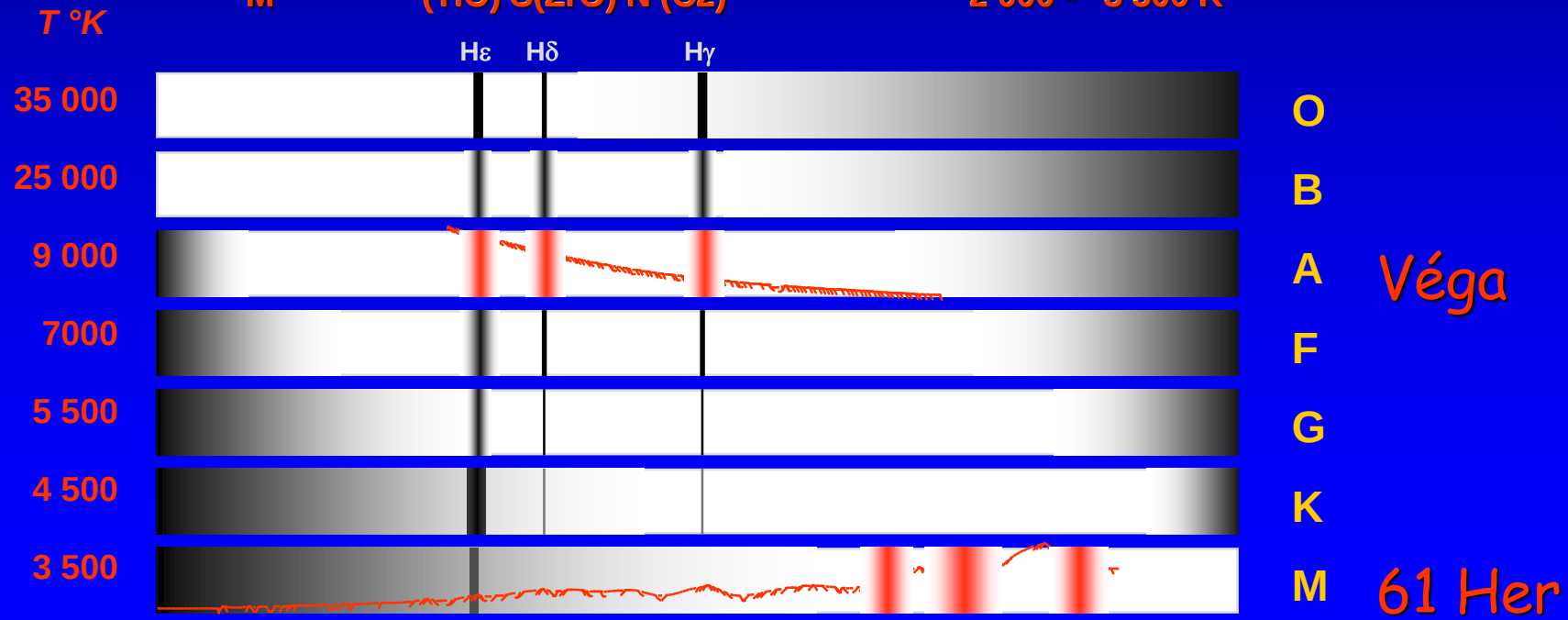
- Due to the Doppler effect, the movement shift the line position on the wavelength



Widening or shift measurement = speed measurement

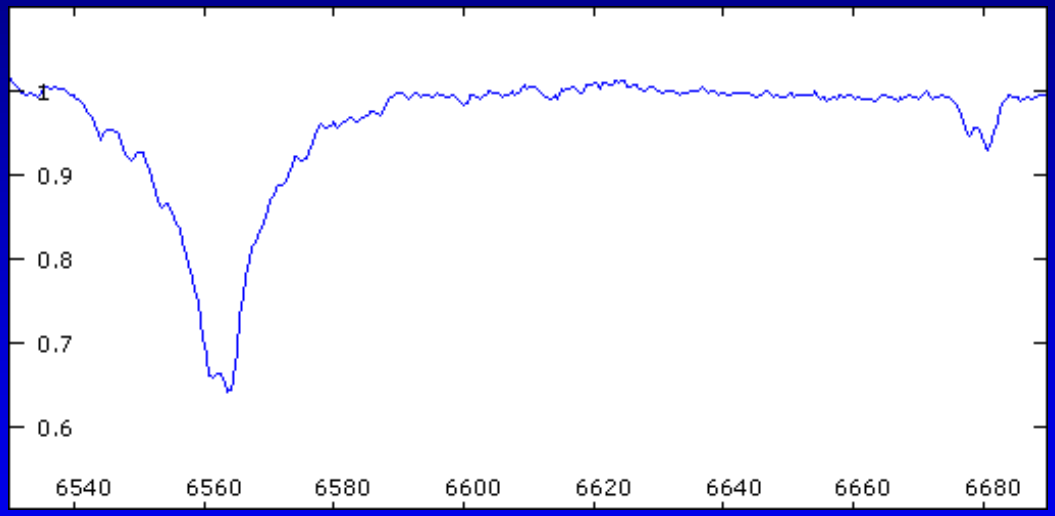
Spectral classes

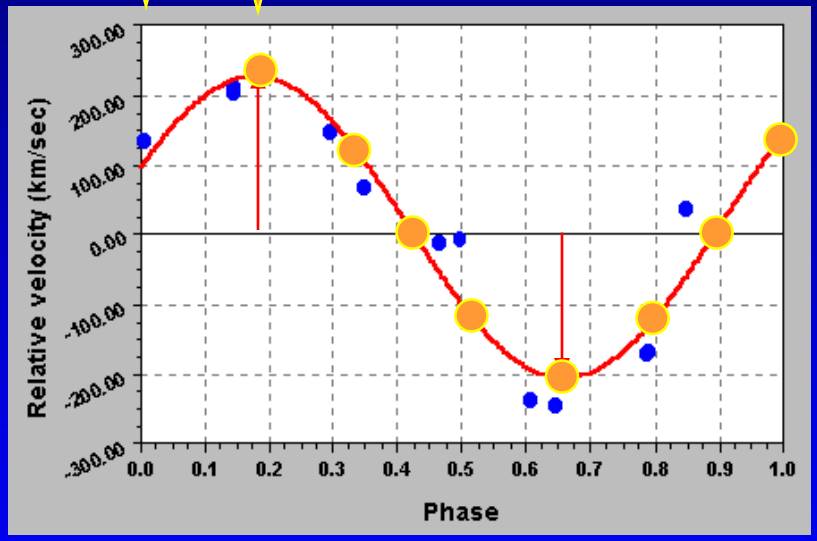
O	He II, continous emission	28 000 - 50 000 K
B	He I	9 900 - 28 000 K
A	H	7 400 - 9 900 K
F	metals, H	6 000 - 7 400 K
G	Ca II, metals	4 900 - 6 000 K
K	Ca II, Ca I, molecules	3 500 - 4 900 K
M	(TiO) S(ZrO) N (C2)	2 000 - 3 500 K



Spectroscopic Binary

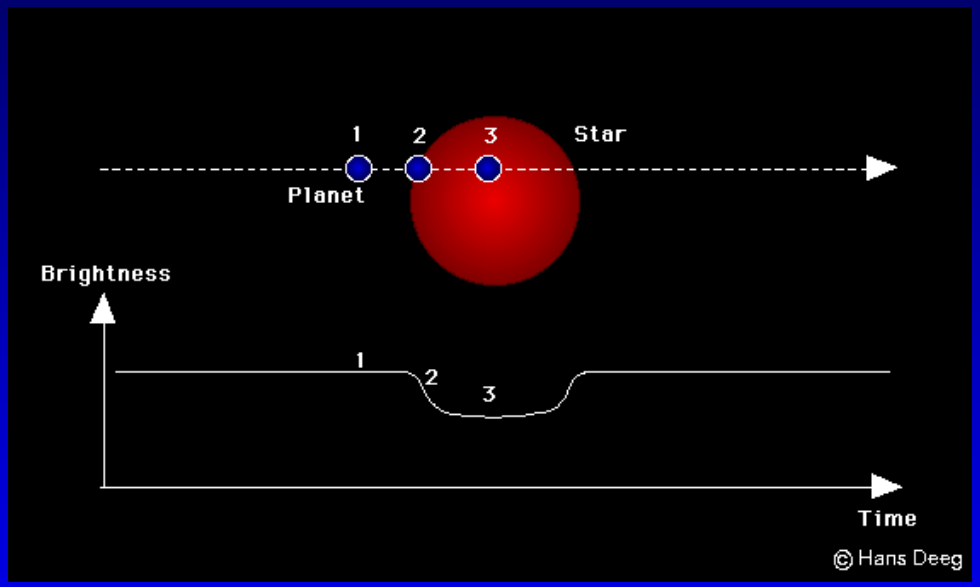
57 Cyg





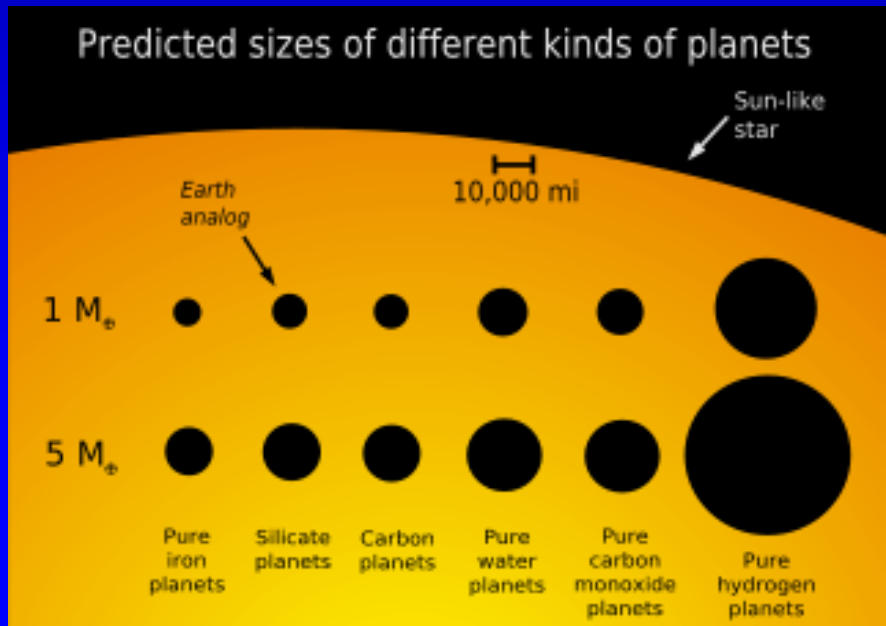
Spectral type: B5V+B5V - Period: 2.8548 days
Half modulation of the radial shift: 111.9 km/s to 126.0 km/s

Planets Around Other Stars



We can see the brightness of stars dip when planets orbit in front of the star

As our detecters get better we'll be able to see earthsize planets this way!



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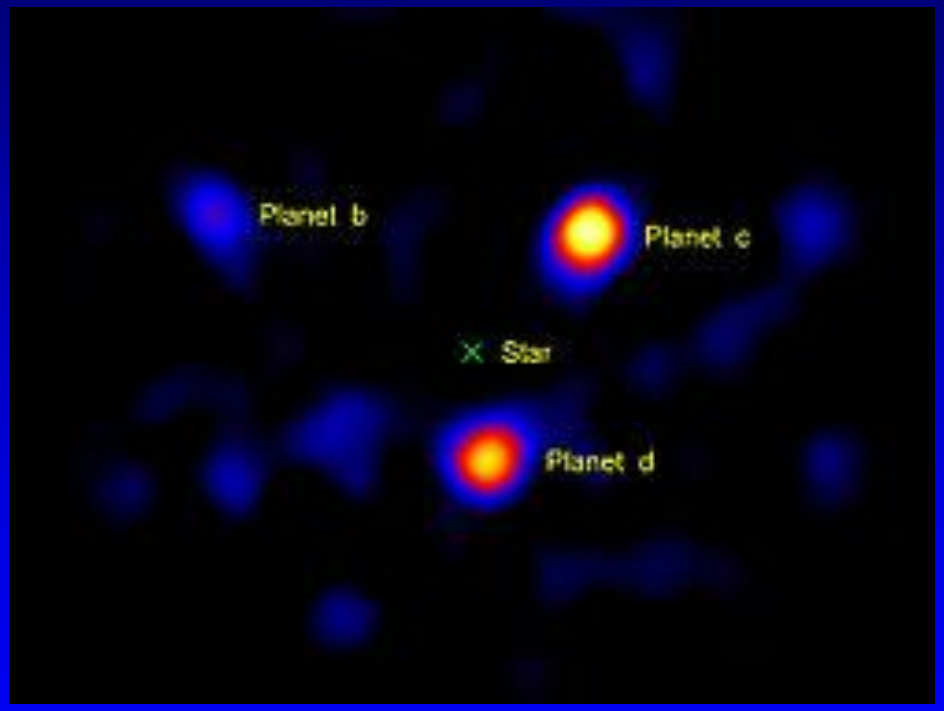

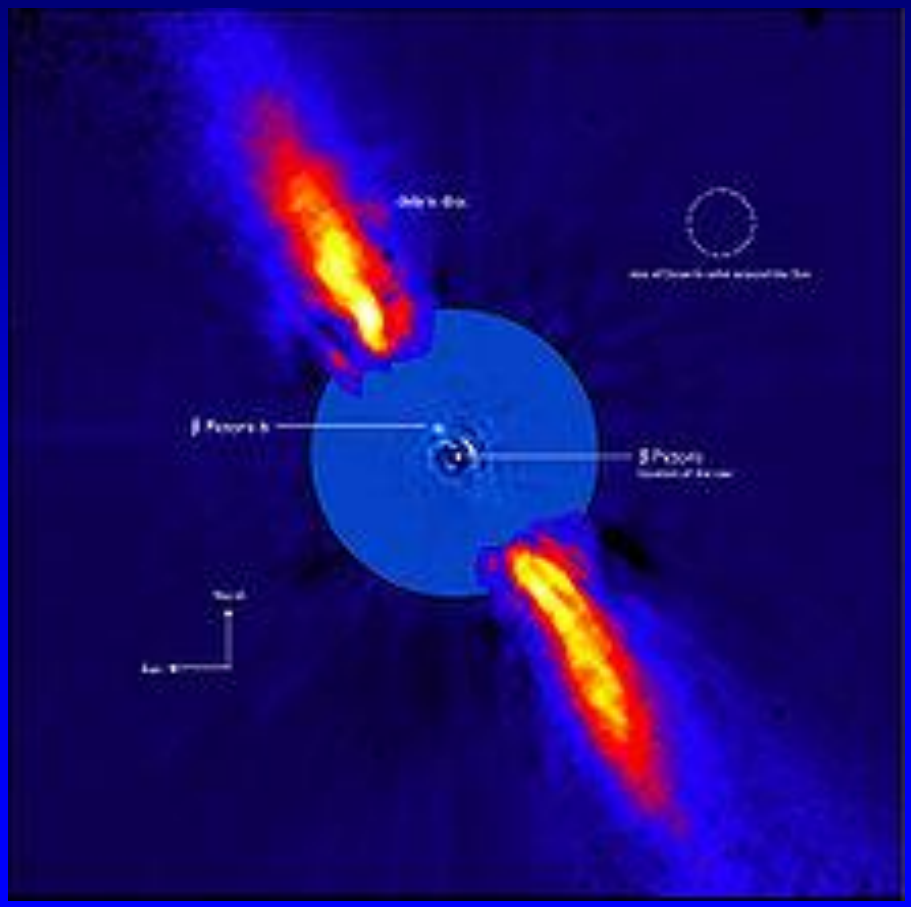

We can even see exoplanets directly!

Thank you…

Questions?