The Energy Budget

To work out which planets are in the 'Habitable Zone' or the 'Goldilock Zone' we'll consider the energy budget
How much energy is receives from its star Vs How much is radiated

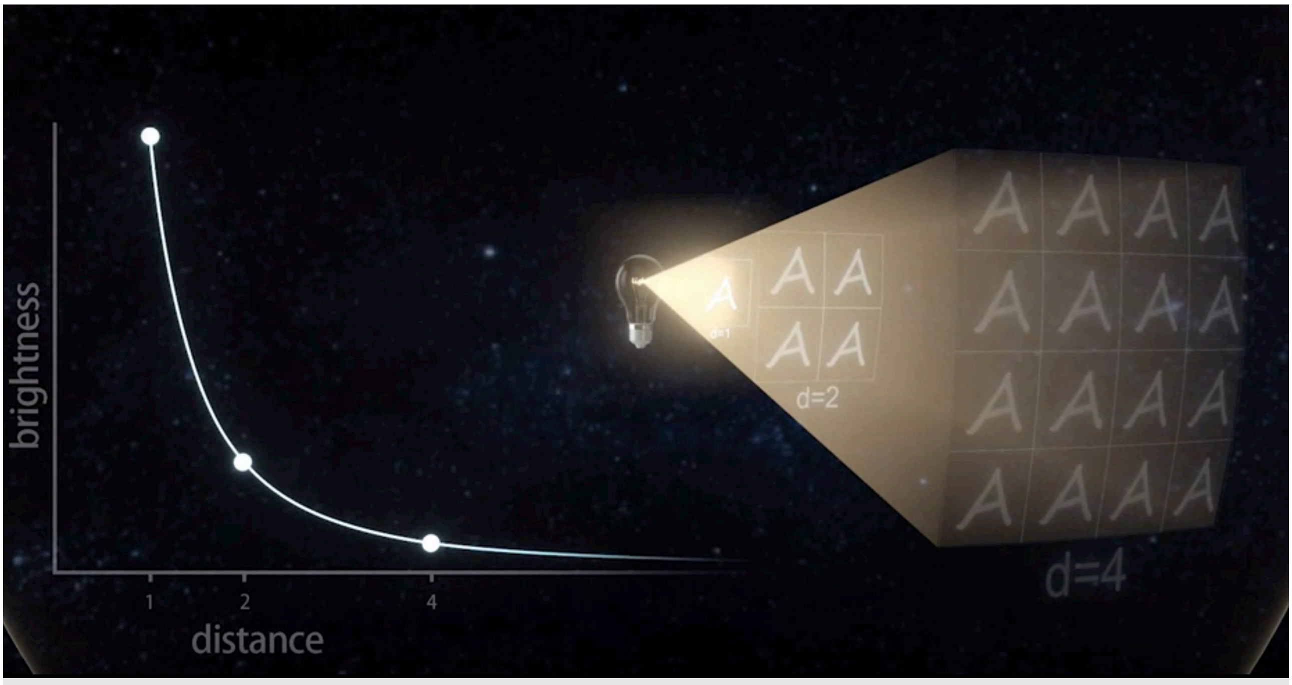
back into space

Stars are very bright objects radiating energy '**ISOTROPICALLY'** means in all directions

only a tiny amount is intercepted by the planets, and how further the planet is to the star the intensity of energy decreases.

This is because of the Inverse Square Law, Which states,

If we increase the intensity of the source by a factor of 'r' then the intensity of the radiation decreasing the 'r Squared'



The Incoming energy budget of the planet clearly depends on brightness of its star and how close it is to the star

These two factors combine to give the **Insulation Flux (intensity of the star light that the planet receives)**

For earth the insulation flux is = 1361W/m.sq which is so close to the constant so we call this as the **solar constant.**

Earlier we saw that the amount of energy intercepted by the planet depends on the area of its cross-section, but we ignored to consider a fact that the energy is also radiated back, since both energy conserved and released is dependent on the factor radius, the radius factor cancels out

Thats why we dont include radius in the Equation for the surface temperature which is

$$T_{\mathrm{p}} = \left(\frac{S_{\mathrm{f}}}{4\sigma}\right)^{\frac{1}{4}}$$

‘Temperature of the planet = whole fourth root of Insulation flux divided by 4 sigma’
Where, sigma is ‘**Stefan Boltzman’s Constant’**

A 10 kelvin difference in temperature itself could be a difference for habitability and sterility

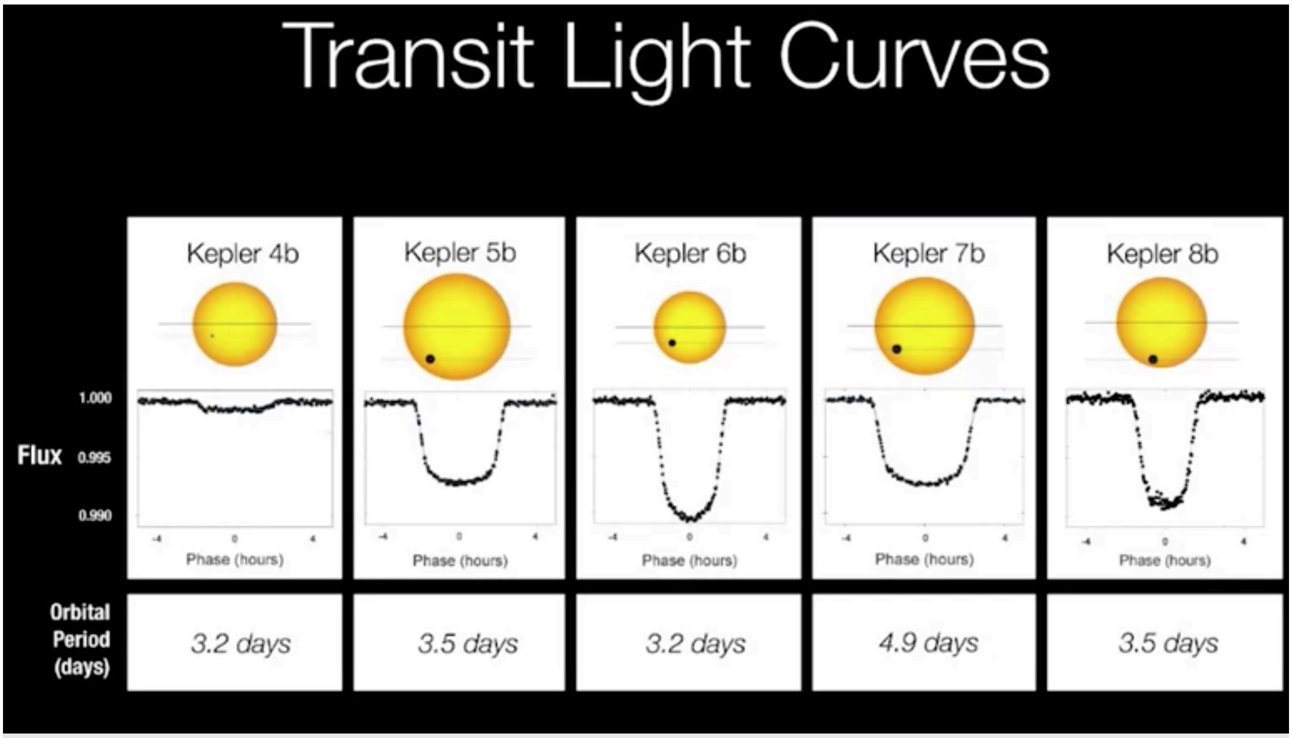
Points we’ve neglected :

- The natural green house effect which depends strongly on the atmosphere composition and the major factor for the surface temperature

  - example : for Venus the natural green house effect is about 500kelvin
- Thick Atmosphere also regulates the temperature such that the difference in the day side and night side are small

To Know whether an exoplanet is "EARTH SIZE" we need to know how big the star is

What we measure in the transit scanning is a fraction of light blocked by the planets so we only know the ratio of the size of the planetary disk to the size of the stellar disk



A small planet orbiting a small star will give you the same signal as of a large planet orbiting a large star

By incorporating the information of the stellar radius, we get the planetary radius using this equation.

$$\frac{R_P}{R_E} = \frac{R_{star}}{R_{sun}} \sqrt{T.D.}$$

"Radius of the planet divided by the radius of earth"(gives you the radius of the exoplanet relative to the earths radii) = radius of the star divided by the radius of sun (which gives you the radius of the star relative to the sun's radii) multiplied by the squared root of the transit depth"

Note that we are taking the squared root of the transit depth because we want the radius not an area

This equation effectively filters out the exoplanets which are of earth size relatively so that there's much probability for hosting life