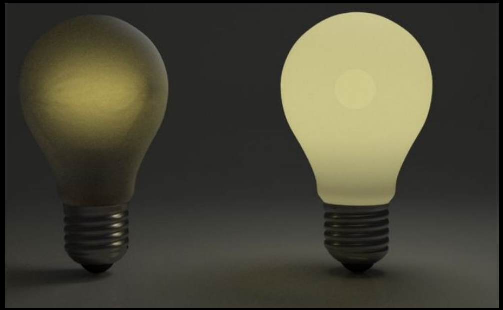
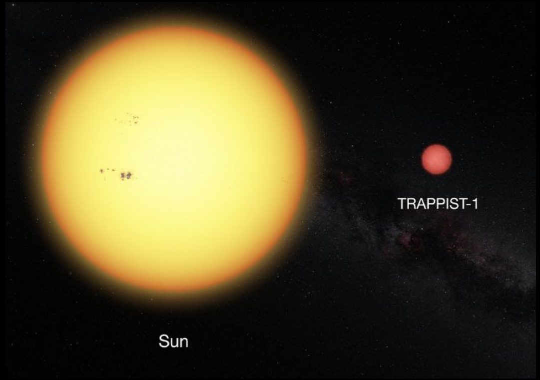
demilune academics

Stars in Our Galaxy and Beyond

What is a star?

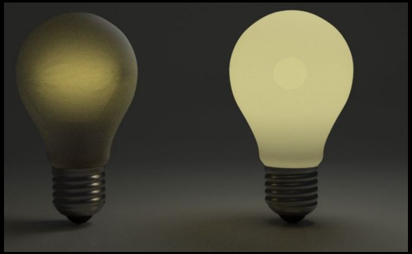
- There are a few different stars present in our night sky, the most common being a red dwarf star. Red dwarf stars usually have about 9% ~ the radii of the sun.
- Red dwarf stars have very low masses and hence a low fusion rate/low temperature(3000 K).They also only produce about 1/9,000 the amount of light than our star. Think of the comparison like a new, bright light bulb rather than a dim older one. Keep this thought in mind for later!

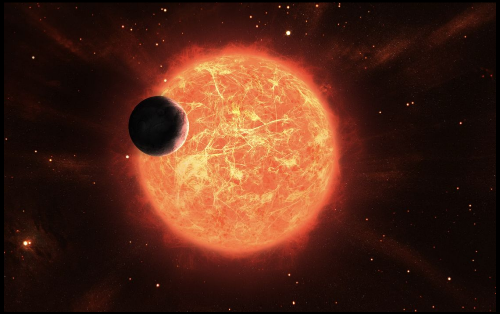




What is a star?

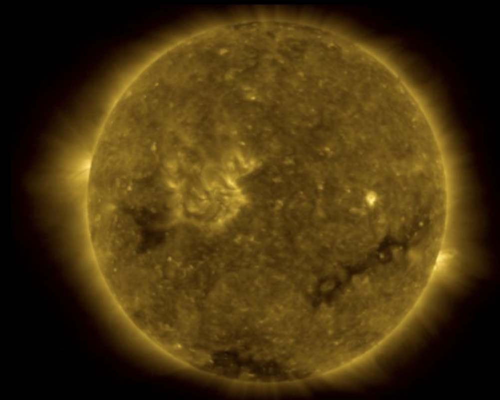
- Red giant stars, contrary to red dwarfs, are massive luminous stars that have begun thermonuclear fusion of hydrogen, which we will come back to on the dynamics of star death slide. They have radii hundreds of times larger than that of the sun! The average temperature is 5000K
- Discussion: what do you think it might be like to have our sun replaced by a red giant? What would it be like to live on Earth?
- Back to our lightbulb comparison, a red giant star is more like a fluorescent ceiling light you'd see in a classroom.





What is a star?

- Our star is what's called a yellow dwarf, which has a temperature of 5,000-6,000 K (why do we measure in Kelvin and not C or F?). To sum it up, our star is a a medium-sized, main-sequence star that emits light mainly in the yellow wavelengths. It’s the most likely cultivator for habitable ecretian planes for exoplanets
- Discussion: Despite the difference in size, why might the yellow dwarf be hotter in temperature than the red giant?

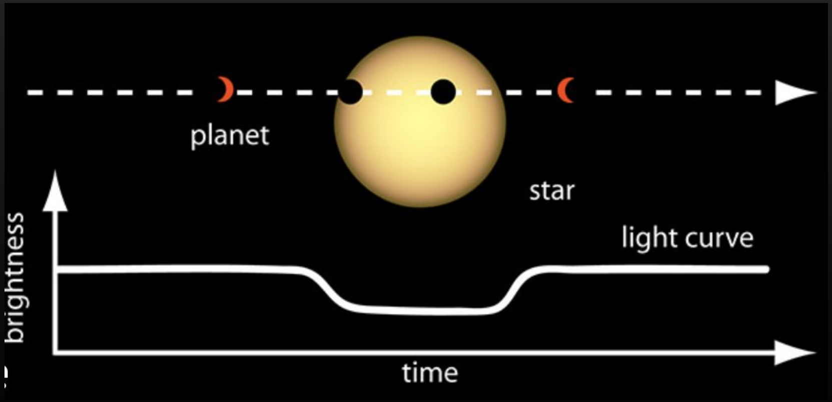


What is a star?

- A white dwarf is a star that has exhausted its nuclear fuel. Losing nuclear fuel after star death is what creates a creates a white dwarf! It is just about the size of Earth, so quite small. However, it is very dense!
- A white dwarf is about 100,000K. Think about all that energy that has been expelled in the process of star death!!

Finding a planet with transit photometry!

- It's time for a little experiment! Remember our example with the different light bulbs a little while ago, I want you to find a light somewhere, close one eye, and put your fist in front of the light.
- Discussion: Why would the size of a star impact our observations of a planet?



Now it's time for a game!

What kind of star do you think this is just from looking at it?

- Red dwarf
- Red giant
- Yellow dwarf
- White dwarf

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Now, here is a trick question…

What kind of star is this?

It's a black hole!

- Black holes are collapsed stars. It is a region in space where forces are so strong that nothing can possess enough energy to escape it. They are formed at the end of a stars life cycle, where it can either become a white dwarf or a black hole. Black holes are undetectable by their surroundings, so often times, once something realizes it's near to a black hole, it's too late!
- The best way to think about a black hole is if you have a wide object lodged in a small space. Think about trying to pull a dollhouse out through a hole that's two inches wide. You can't without breaking the dollhouse apart into much smaller pieces.

Here's the mathematical equation of a black hole, just for fun :)

In[1]:= DefManifold[M, 4, {α, β, γ, δ, μ, ν}]

In[2]:= DefMetric[−1, g[−μ, −ν], cd]

In[3]:= DefMetricPerturbation[g, h, ϵ]

In[4]:= Perturbed[Riemanncd[−α, −β, −γ, δ], 3]

Out[4]= $\epsilon\,\Delta\left[R_{\alpha\beta\gamma}{}^{\delta}\right] + \frac{1}{2}\epsilon^2\,\Delta^2\left[R_{\alpha\beta\gamma}{}^{\delta}\right] + \frac{1}{6}\epsilon^3\,\Delta^3\left[R_{\alpha\beta\gamma}{}^{\delta}\right] + R_{\alpha\beta\gamma}{}^{\delta}$

In[5]:= Collect[ExpandPerturbation[%], ϵ, Simplification]

Out[5]=
$$R_{\alpha\beta\gamma}{}^{\delta} + \frac{1}{2}\epsilon\left(-h^1{}_{\gamma}{}^{\delta}{}_{;\beta;\alpha} - h^1{}_{\beta}{}^{\delta}{}_{;\gamma;\alpha} + h^1{}_{\beta\gamma}{}^{;\delta}{}_{;\alpha} + h^1{}_{\gamma}{}^{\delta}{}_{;\alpha;\beta} + h^1{}_{\alpha}{}^{\delta}{}_{;\gamma;\beta} - h^1{}_{\alpha\gamma}{}^{;\delta}{}_{;\beta}\right) +$$
$$\frac{1}{4}\epsilon^2\left(-h^2{}_{\gamma}{}^{\delta}{}_{;\beta;\alpha} - h^2{}_{\beta}{}^{\delta}{}_{;\gamma;\alpha} + h^2{}_{\beta\gamma}{}^{;\delta}{}_{;\alpha} + h^{1\delta}{}_{\mu;\alpha}\,h^1{}_{\gamma}{}^{\mu}{}_{;\beta} - h^1{}_{\gamma}{}^{\mu}{}_{;\alpha}\,h^{1\delta}{}_{\mu;\beta} + h^2{}_{\gamma}{}^{\delta}{}_{;\alpha;\beta} + h^2{}_{\alpha}{}^{\delta}{}_{;\gamma;\beta} -\right.$$
$$h^2{}_{\alpha\gamma}{}^{;\delta}{}_{;\beta} + 2\,h^{1\delta\mu}\left(h^1{}_{\gamma\mu;\beta;\alpha} + h^1{}_{\beta\mu;\gamma;\alpha} - h^1{}_{\beta\gamma;\mu;\alpha} - h^1{}_{\gamma\mu;\alpha;\beta} - h^1{}_{\alpha\mu;\gamma;\beta} + h^1{}_{\alpha\gamma;\mu;\beta}\right) -$$
$$h^{1\delta}{}_{\mu;\beta}\,h^1{}_{\alpha}{}^{\mu}{}_{;\gamma} + h^{1\delta}{}_{\mu;\alpha}\,h^1{}_{\beta}{}^{\mu}{}_{;\gamma} + h^1{}_{\gamma\mu;\beta}\,h^1{}_{\alpha}{}^{\mu;\delta} + h^1{}_{\beta\mu;\gamma}\,h^1{}_{\alpha}{}^{\mu;\delta} -$$
$$h^1{}_{\alpha}{}^{\mu}{}_{;\gamma}\,h^1{}_{\beta\mu}{}^{;\delta} - h^1{}_{\gamma\mu;\alpha}\,h^1{}_{\beta}{}^{\mu;\delta} - h^1{}_{\alpha}{}^{\mu;\delta}\,h^1{}_{\beta\gamma;\mu} + h^1{}_{\alpha}{}^{\mu}{}_{;\gamma}\,h^1{}_{\beta}{}^{\delta}{}_{;\mu} +$$
$$h^{1\delta}{}_{\mu;\beta}\,h^1{}_{\alpha\gamma}{}^{;\mu} + h^1{}_{\beta\mu}{}^{;\delta}\,h^1{}_{\alpha\gamma}{}^{;\mu} - h^1{}_{\beta}{}^{\delta}{}_{;\mu}\,h^1{}_{\alpha\gamma}{}^{;\mu} - h^1{}_{\gamma\mu;\beta}\,h^1{}_{\alpha}{}^{\delta;\mu} -$$
$$\left.h^1{}_{\beta\mu;\gamma}\,h^1{}_{\alpha}{}^{\delta;\mu} + h^1{}_{\beta\gamma;\mu}\,h^1{}_{\alpha}{}^{\delta;\mu} - h^{1\delta}{}_{\mu;\alpha}\,h^1{}_{\beta\gamma}{}^{;\mu} + h^1{}_{\gamma\mu;\alpha}\,h^1{}_{\beta}{}^{\delta;\mu}\right) + \frac{1}{24}\epsilon^3$$
$$\left(-2\,h^3{}_{\gamma}{}^{\delta}{}_{;\beta;\alpha} - 2\,h^3{}_{\beta}{}^{\delta}{}_{;\gamma;\alpha} + 2\,h^3{}_{\beta\gamma}{}^{;\delta}{}_{;\alpha} - 6\,h^{1\mu\nu}\,h^{1\delta}{}_{\nu;\alpha}\,h^1{}_{\gamma\mu;\beta} + 3\,h^{2\delta}{}_{\mu;\alpha}\,h^1{}_{\gamma}{}^{\mu}{}_{;\beta} - 3\,h^2{}_{\gamma}{}^{\mu}{}_{;\alpha}\,h^{1\delta}{}_{\mu;\beta} +\right.$$
$$6\,h^{1\mu\nu}\,h^1{}_{\gamma\mu;\alpha}\,h^{1\delta}{}_{\nu;\beta} + 3\,h^{1\delta}{}_{\mu;\alpha}\,h^2{}_{\gamma}{}^{\mu}{}_{;\beta} - 3\,h^1{}_{\gamma}{}^{\mu}{}_{;\alpha}\,h^{2\delta}{}_{\mu;\beta} + 2\,h^3{}_{\gamma}{}^{\delta}{}_{;\alpha;\beta} + 2\,h^3{}_{\alpha}{}^{\delta}{}_{;\gamma;\beta} -$$
$$2\,h^3{}_{\alpha\gamma}{}^{;\delta}{}_{;\beta} + 6\,h^{2\delta\mu}\left(h^1{}_{\gamma\mu;\beta;\alpha} + h^1{}_{\beta\mu;\gamma;\alpha} - h^1{}_{\beta\gamma;\mu;\alpha} - h^1{}_{\gamma\mu;\alpha;\beta} - h^1{}_{\alpha\mu;\gamma;\beta} + h^1{}_{\alpha\gamma;\mu;\beta}\right) +$$

Thank you for listening!!

If you liked…

The red dwarf: Come get a reese's cup!

The red giant: Come get a mini hershey's bar!

The yellow dwarf: Come get a york!

The white dwarf: Come get a kit kat!

The black hole: Come get a rice krispies bar!