

Wave at the Stars...  
Somebody may be  
waving back!

**How We Figured Out the NATURE  
of the Points of Light, and Their  
Significance to Life**

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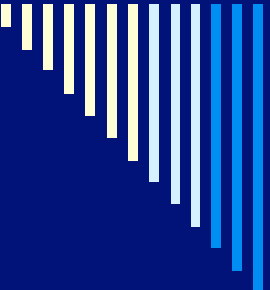


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# Today's Program

1. Introduce Stellar Observing...what and how
  2. Consider the three observable features
  3. Consider the observed properties of the bright dots
  4. What the dots must be
  5. How the objects develop
  6. Why they shine brightly for long time
  7. Implications for us on Earth
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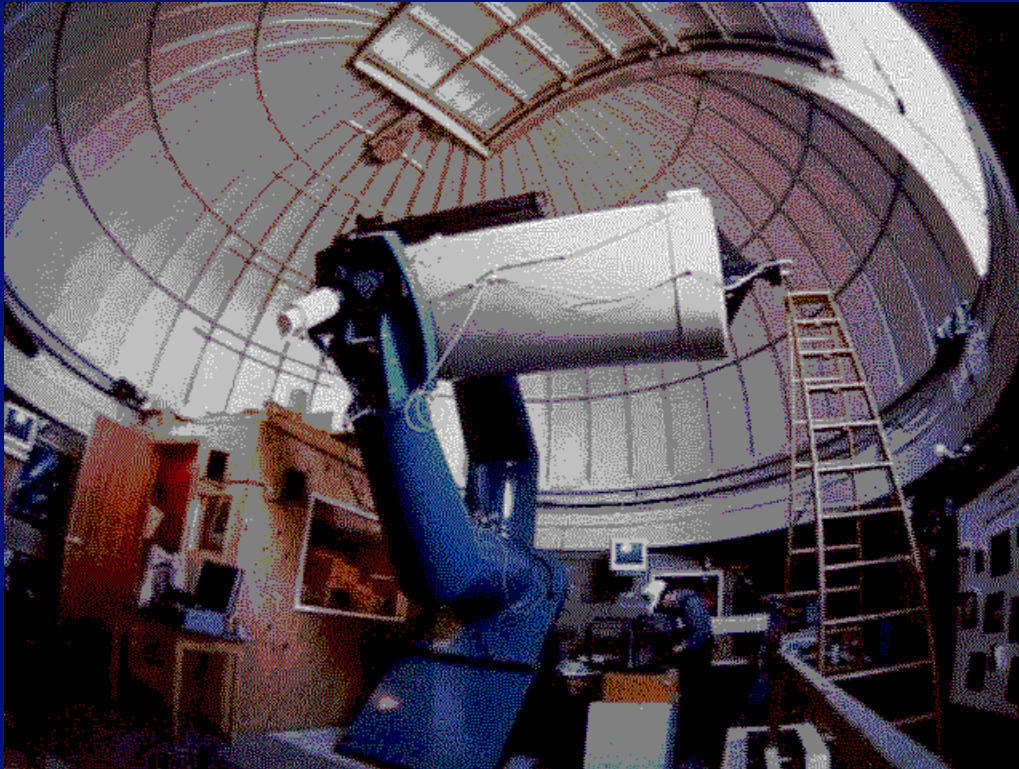
# What can we measure from Deep Space?

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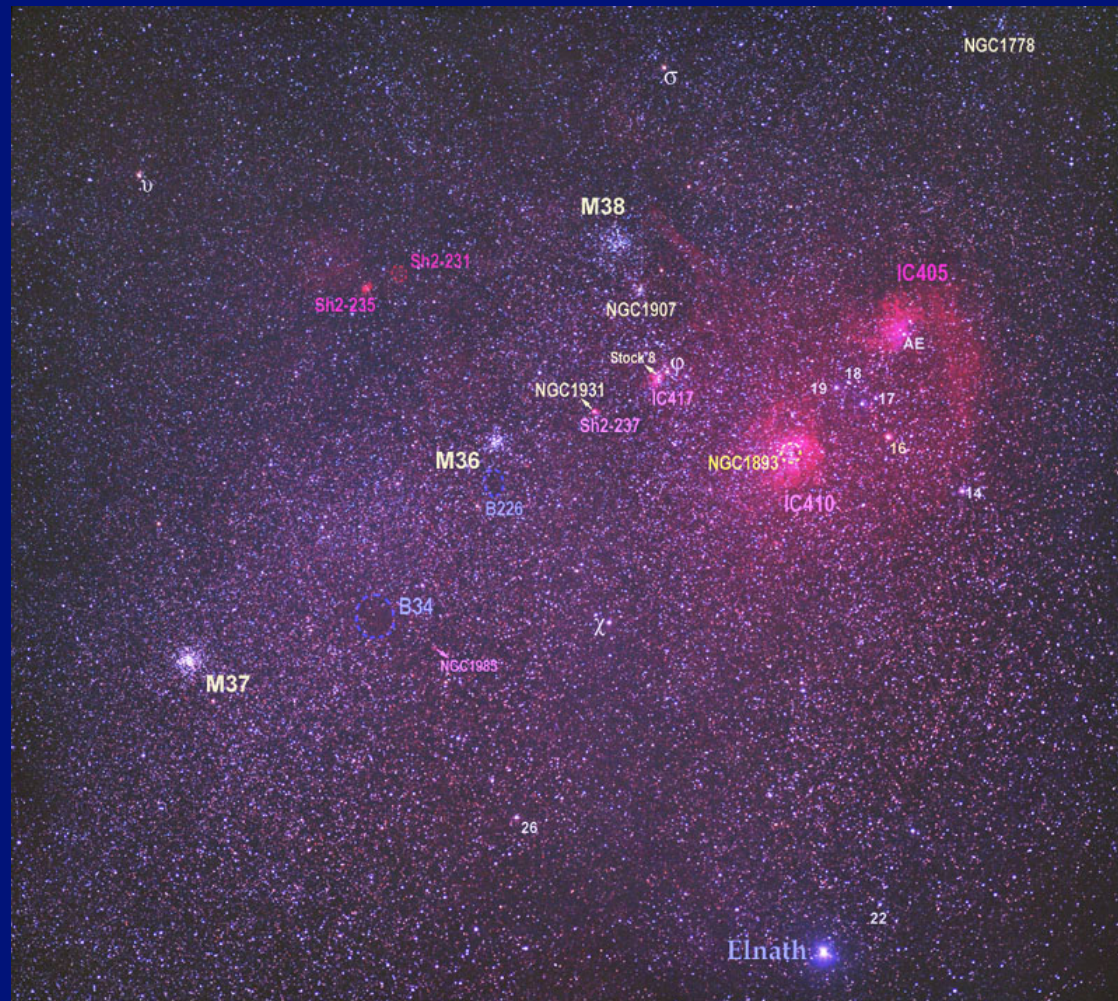


# The PHOTONS are the Data. (light)



- TELESCOPES COLLECT PHOTONS and feed them to
- DIGITAL CAMERAS (CCDs) that DETECT and MEASURE them.

# Literally, WHAT DO YOU SEE (OBSERVE)?



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# The PHOTONS are the Data. (light)

1. Brightness – number of photons
2. Color – energy of photons
3. Coordinates – position of photons

That's all we can see/measure!

We must INFER the science!

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# The dots in the night sky appear

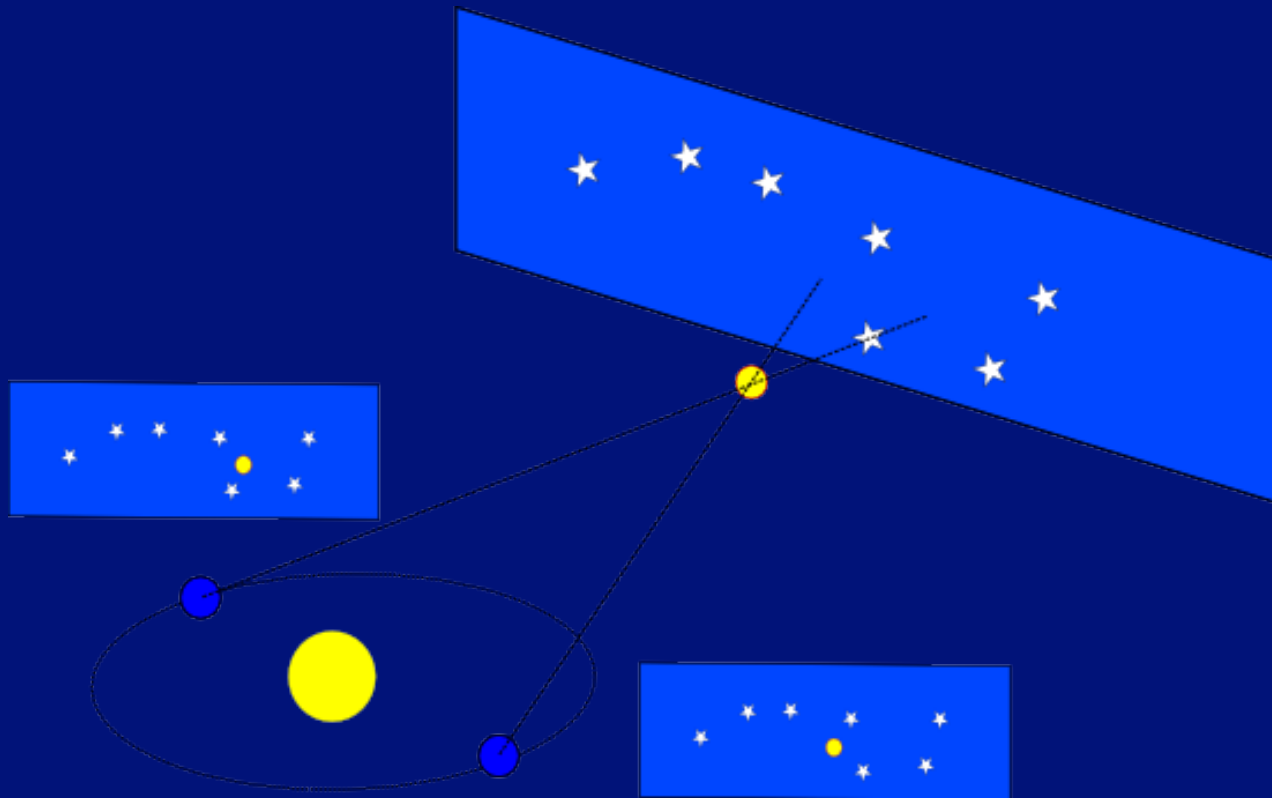
1. As tiny dots even in the world's biggest/best telescopes.
2. To not move relative to most of the other dots (entire sky moves over time...why?)
3. Extremely faint...we only see the very bright ones with our eyes!

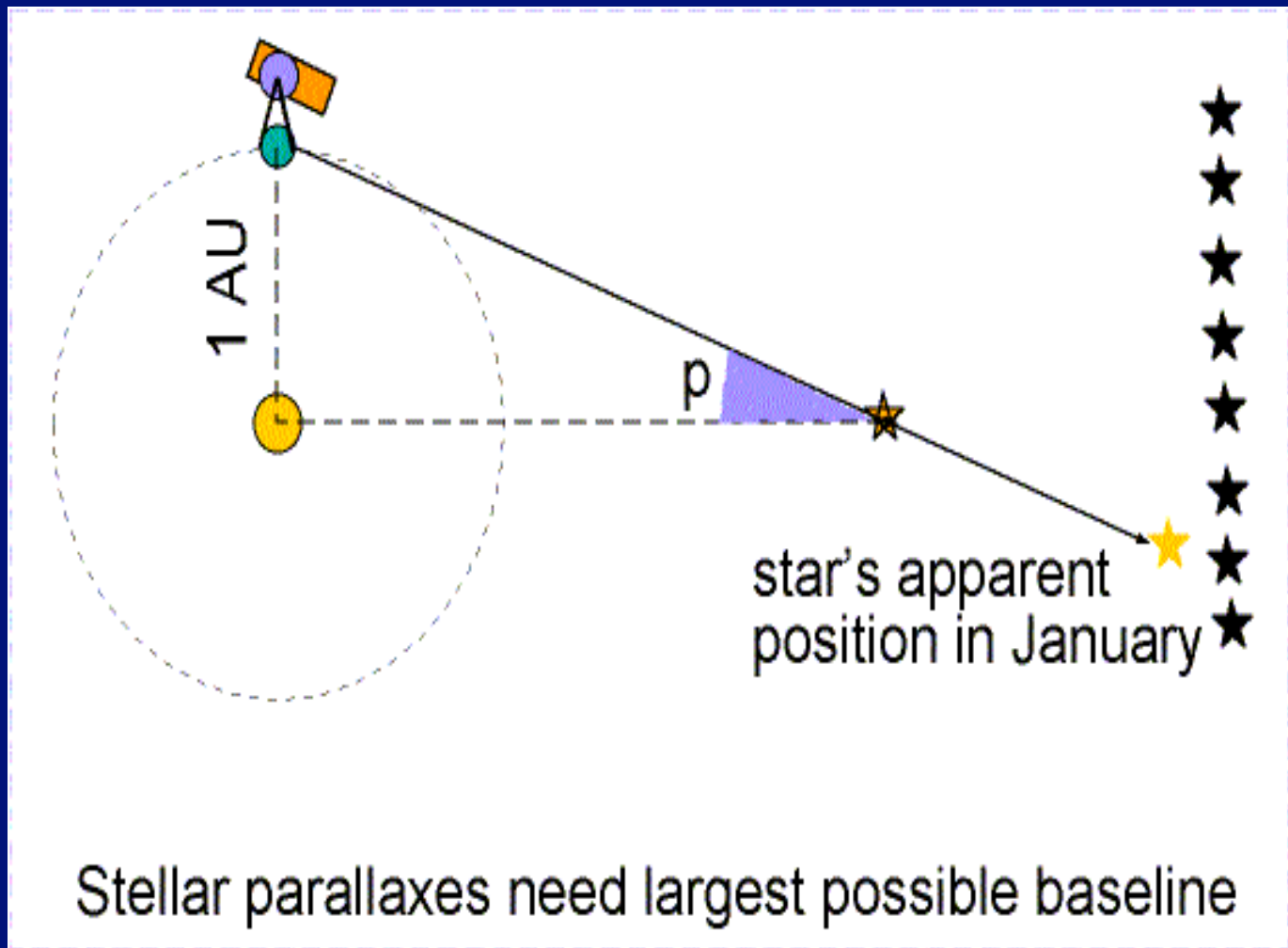
What do these three observations imply about  
**DISTANCE?**

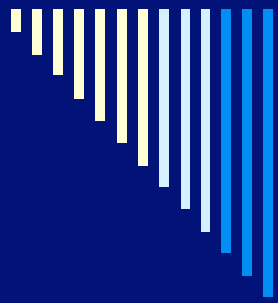
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# Bessel measures Parallax Shift in 1859







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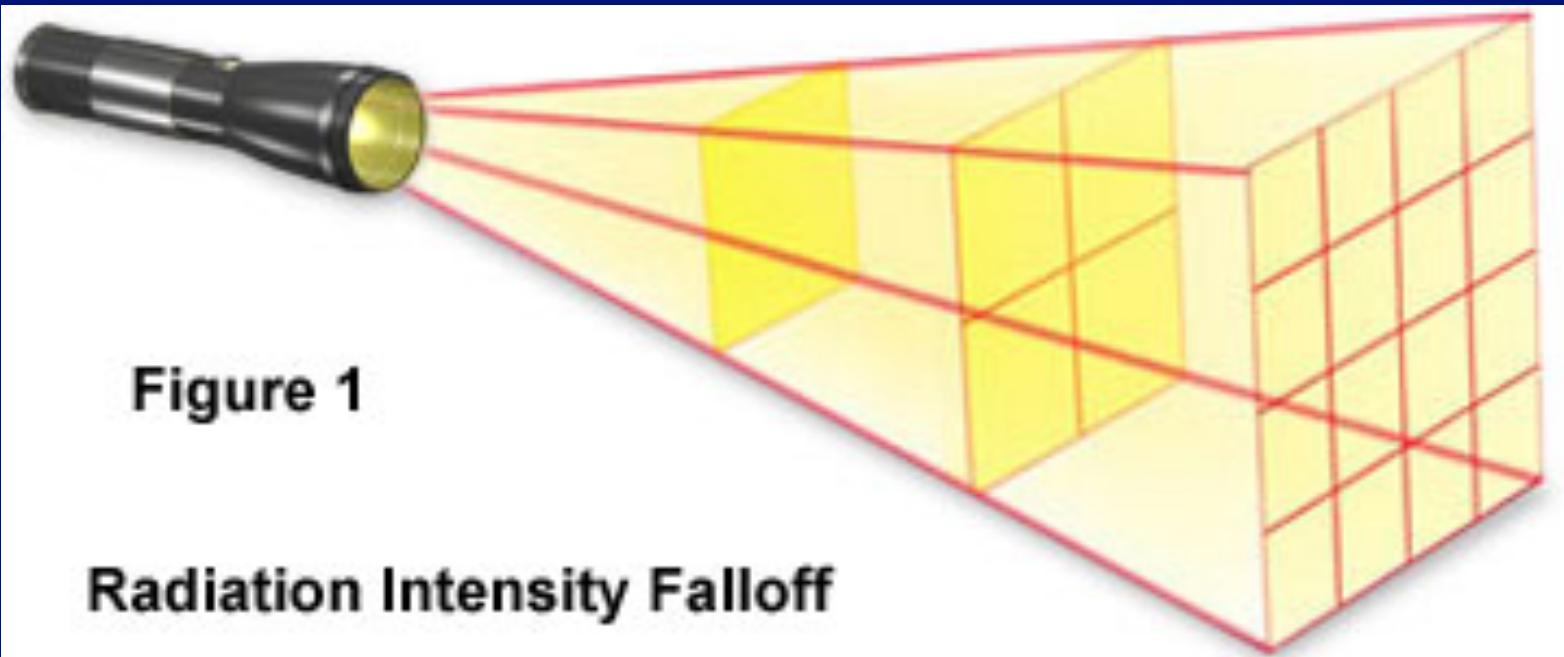
Farthest objects ever found!

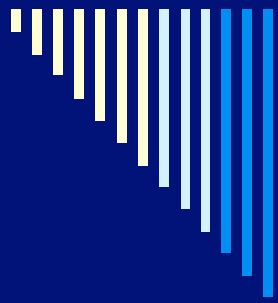
Ridiculously  
large distances!

- Dozens to Hundreds of LIGHT YEARS away...
  - LIGHT YEAR = DISTANCE a photon travels in 1 year, at 186,000 MILES EACH SECOND
  - Would take you and I about 30,000 ACTUAL YEARS to TRAVEL 1 Light Year currently.
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But, those distant dots are putting out LOTS of photons...objects are actually very bright!

- Dim from a distance due to inverse square law!



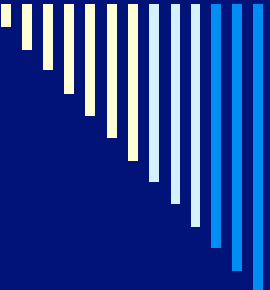


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How can they appear bright from afar? Consider how photons are created...

- Heating matter...
- Lots of photons imply

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How can they appear bright from afar? Consider how photons are created...

- Heating matter...

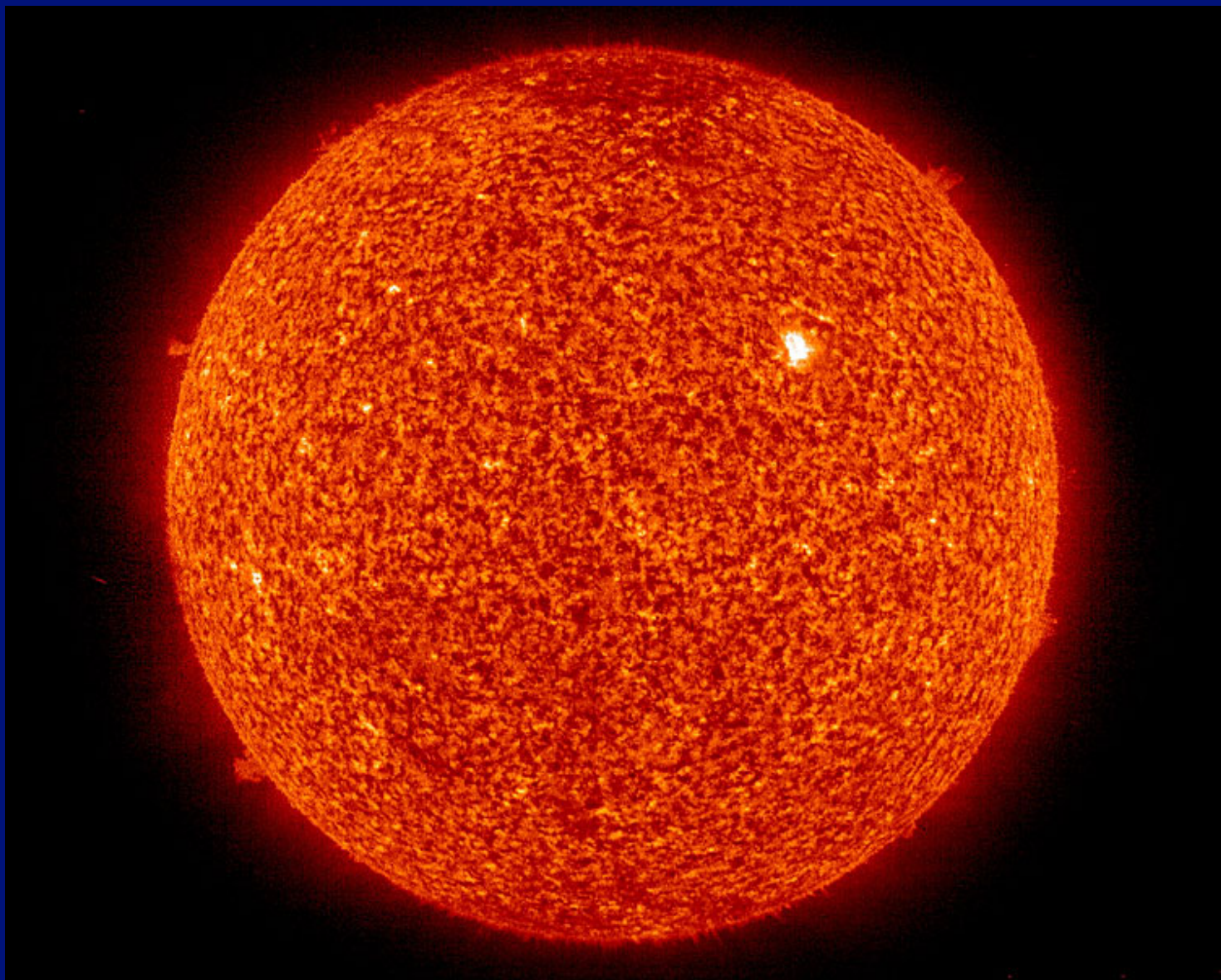
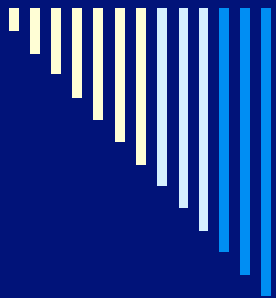
- Lots of photons imply

- VERY HOT

- VERY LARGE (SURFACE AREA)

- Anything local like that???

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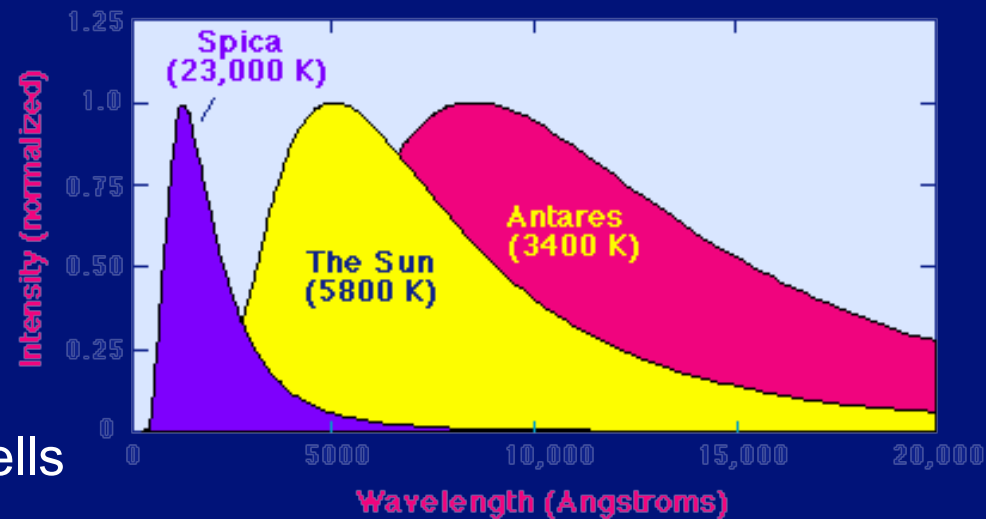
# SOL...our home star, our SUN!

- ~800,000 miles wide
  - ~5500 degrees outer layer, Millions of degrees internally and in Corona!
  
  - If you pushed the Sun way far away, what would it look like?
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# Distant Sun = STAR !

- Now we know what these bright dots must be...
- Their COLOR tells us their TEMPERATURE
- Their BRIGHTNESS tells us their DISTANCE, DIAMETER, TEMPERATURE, INTERVENING DUST

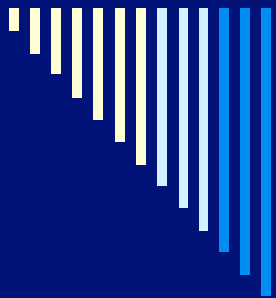


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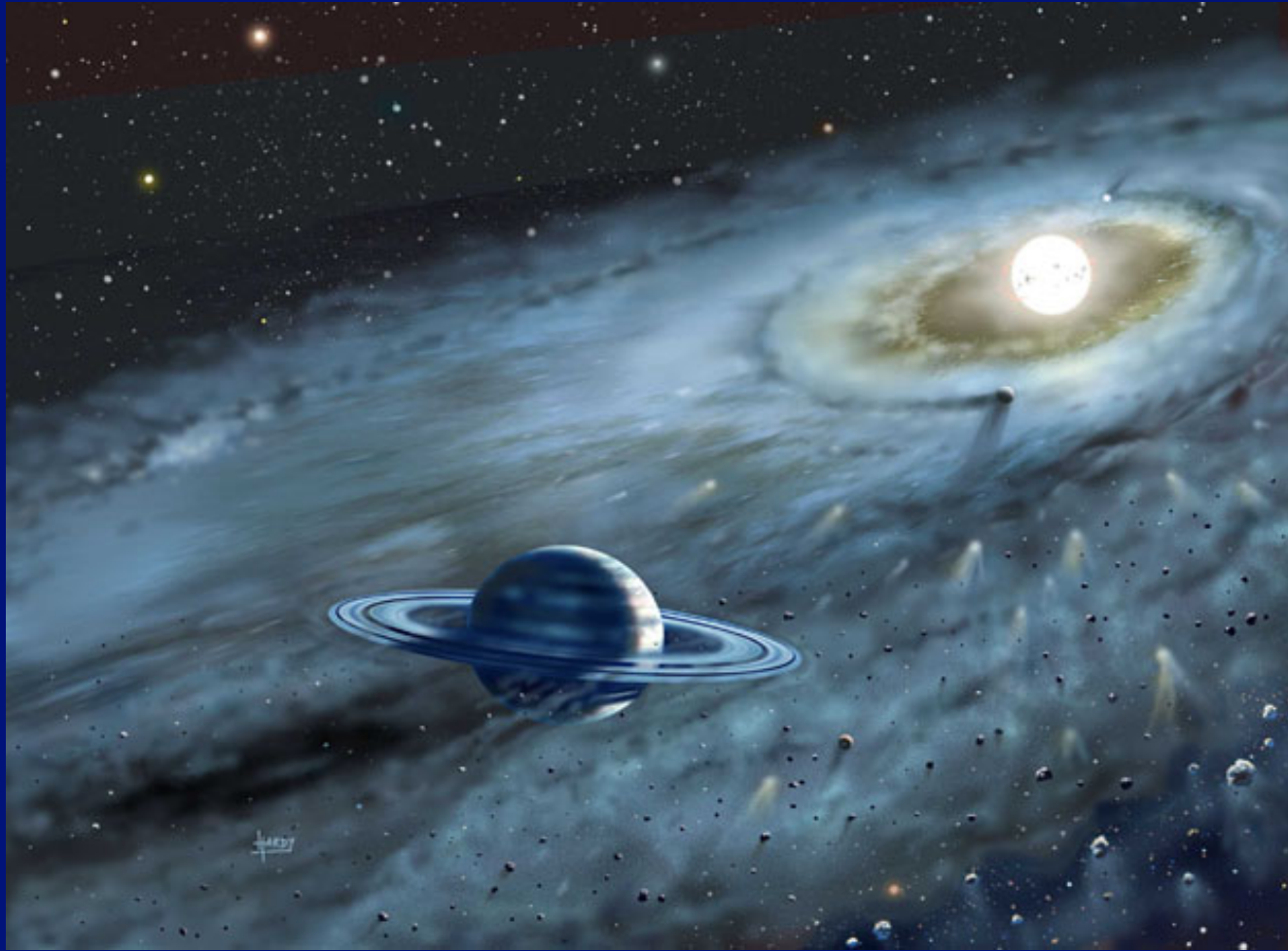


# What do STARS do? (as they live and evolve)

- Stars are built from the original HYDROGEN GAS in our GALAXY
  - GRAVITY is the force responsible for how stars operate
  - Stars are enriched when they incorporate DUST recycled from older stars in our Galaxy
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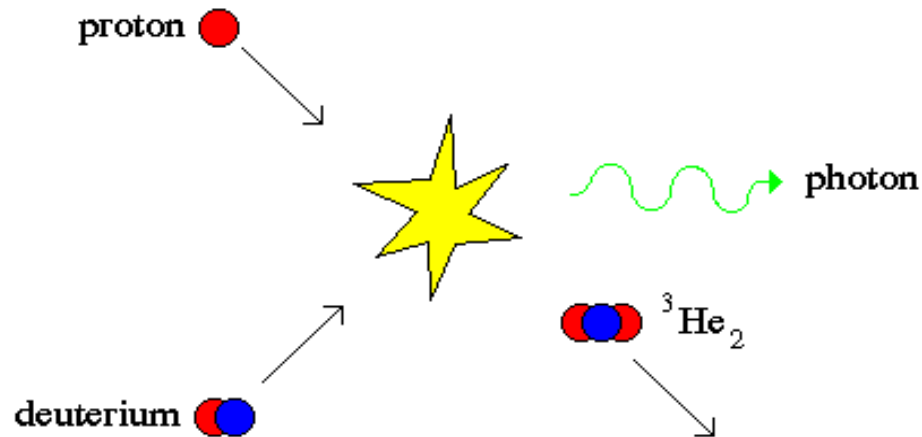
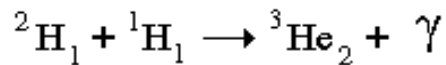


# Star Pizza story: Planets form!



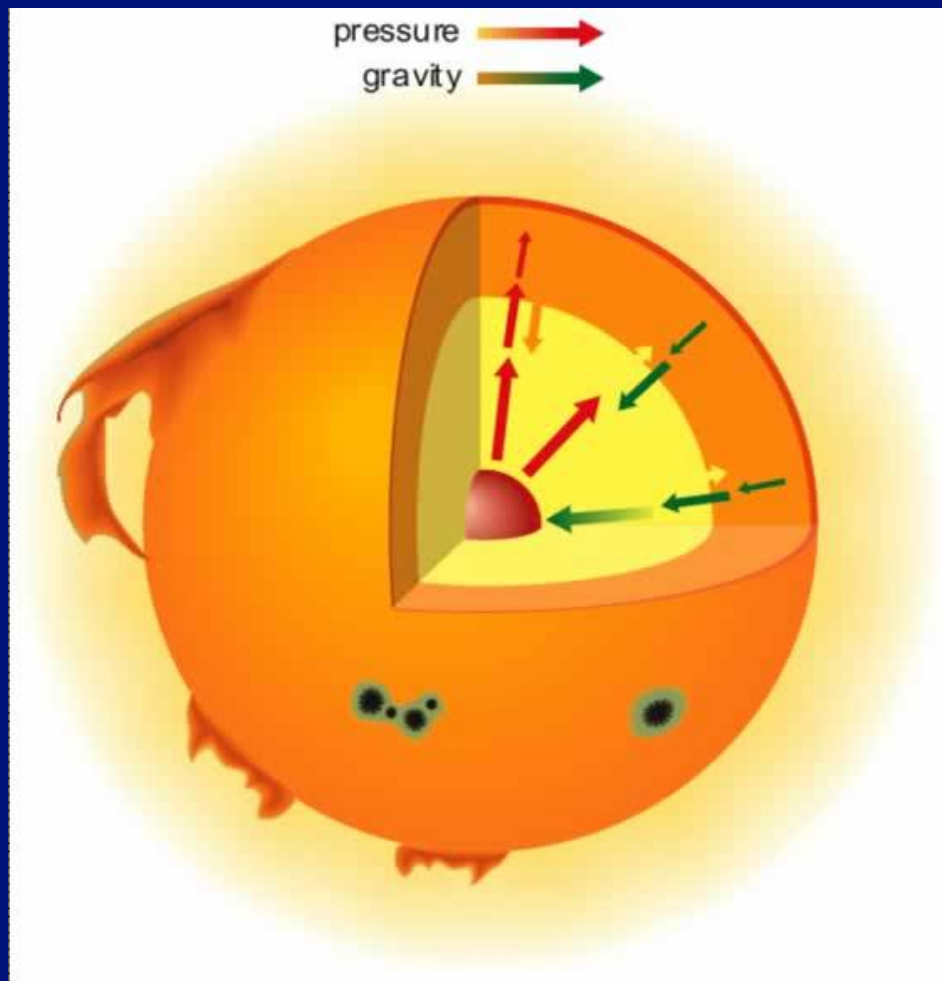
# Nucleosynthesis: FUSING new Chemical Elements

proton-proton chain: stage 3



the 3rd stage to the proton chain used the deuterium from stage 1 and another proton to produce tritium (an isotope of helium) and energy in the form of another gamma-ray – isotopes are protons and neutrons combined to produce a nucleus, but usually missing a proton or neutron needed to make a complete element – isotopes tend to decay in short times

# Lots of energy



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**STARS PROVIDE:  
Planets, Chemicals, Energy:  
The Ingredients for LIFE!**





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# How many Planets? C, H, N, O chemistry abundant!

- Over 100 billion stars per Galaxy.
  - Over 100 billion galaxies in our Universe
  - If each STAR just has ONE PLANET, there will be quadrillions of planets!
  - Data shows us that MOST stars have multiple planets!
  - How many are HABITABLE????
  - Even if only a small fraction...
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# A small fraction of a HUGE NUMBER is still

- A HUGE NUMBER...
  - EXTREMELY LIKELY THERE'S LIFE OUT THERE!
  - TOO FAR TO EASILY COMMUNICATE WITH, YET...Many Light Years away.
  - But, wave, anyhow, you never know who's looking back!
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