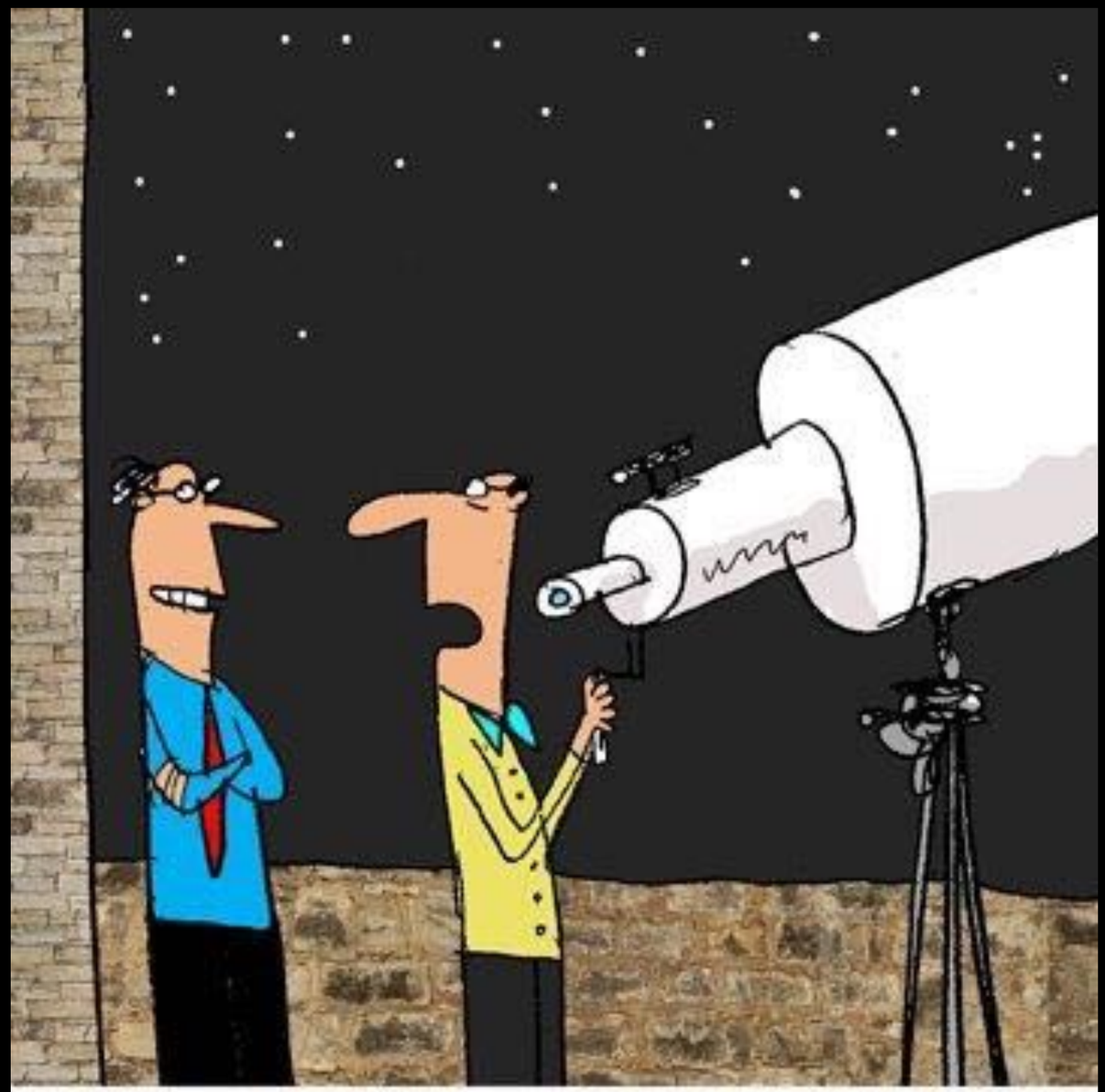
PUBLIC OUTREACH TO KIDS, TEENS AND ADULTS

10+ FUNTASTIC STORIES OF THE NIGHT SKY

Bryon Czarnik
Toronto RASC
August 14,2019

Source: Dave Humphries, Liverpool, UK
https://www.fotopiaimages.com/if-the-planets-were-as-close-as-the-moon-what-would-the-sky-at-night-look-like/

It’s a ✨Party! 🎉



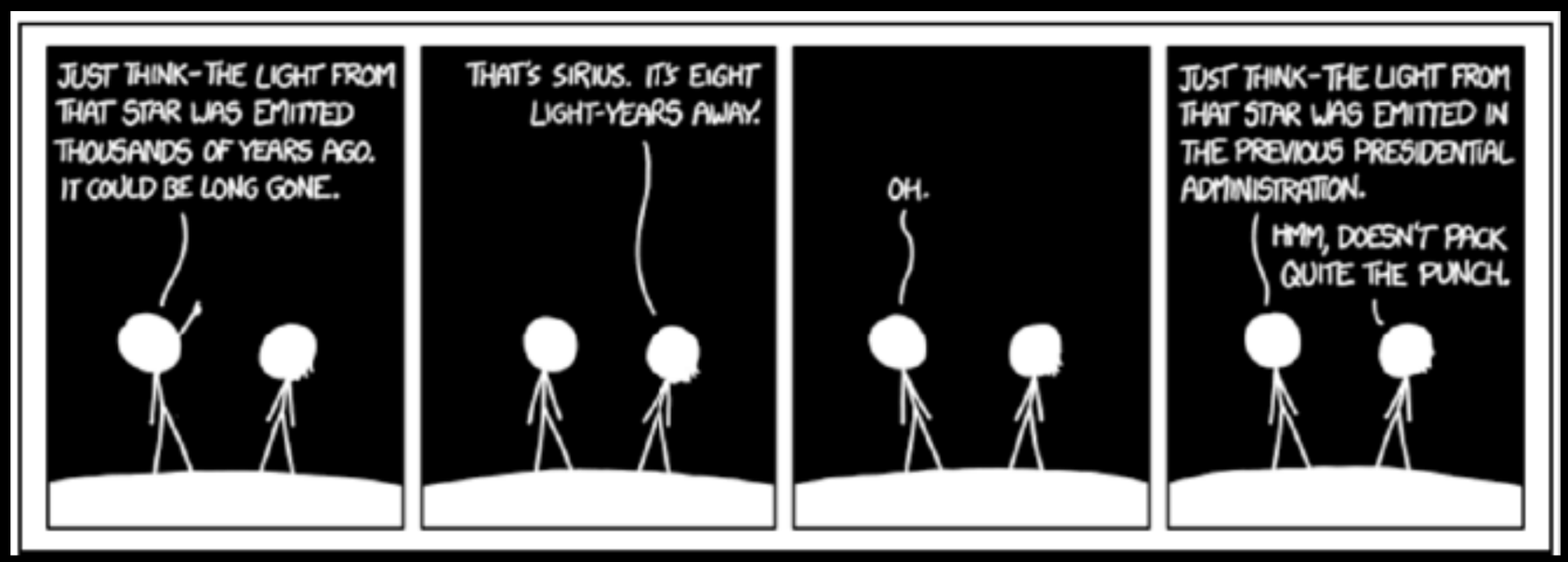
“I love looking at the stars. I think of us as celestial paparazzi”

Just Stars and Fuzzy Blobs?

- ***Targets*** 🎯
- ***Cool*** 🥶 ***Facts***
- ***Props*** 📱

The answer to your question
(and all questions) is …

- ***Fun Story*** 🥳



Ancient Stars

#1. πλανήτης (planēt) or Wanderers

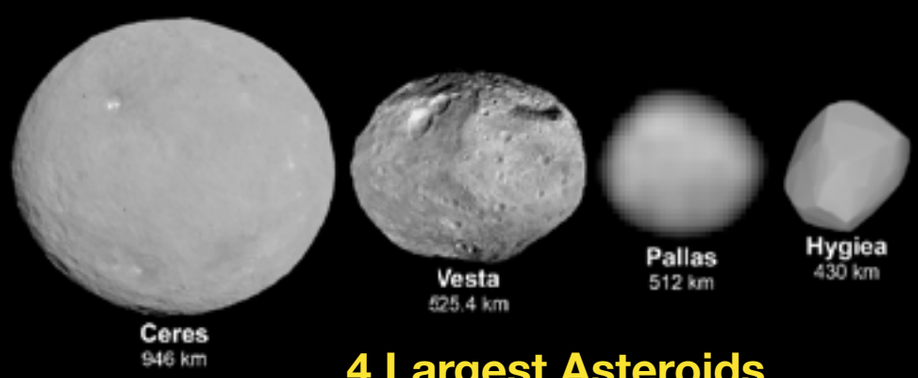
Flip Saturn on its side
and it almost goes from the Earth to the Moon!
p.s. It's less dense than water, the only planet that would float if thrown into a giant swimming pool!

Earth

Moon

Fit all 700,000+ asteroids here since only ≅ 4% Moon's mass!

All this is less is less than 1% of the Solar System!
Sun is 99.86%!!



4 Largest Asteroids

You can fit all the planets in the Solar System back to back into the distance from the Earth to the Moon (about 384,400 km), with room to spare (8,030 km.)

Ref: https://www.universetoday.com/115672/you-could-fit-all-the-planets-between-the-earth-and-the-moon/

#1. πλανήτης (planēt) or Wanderers

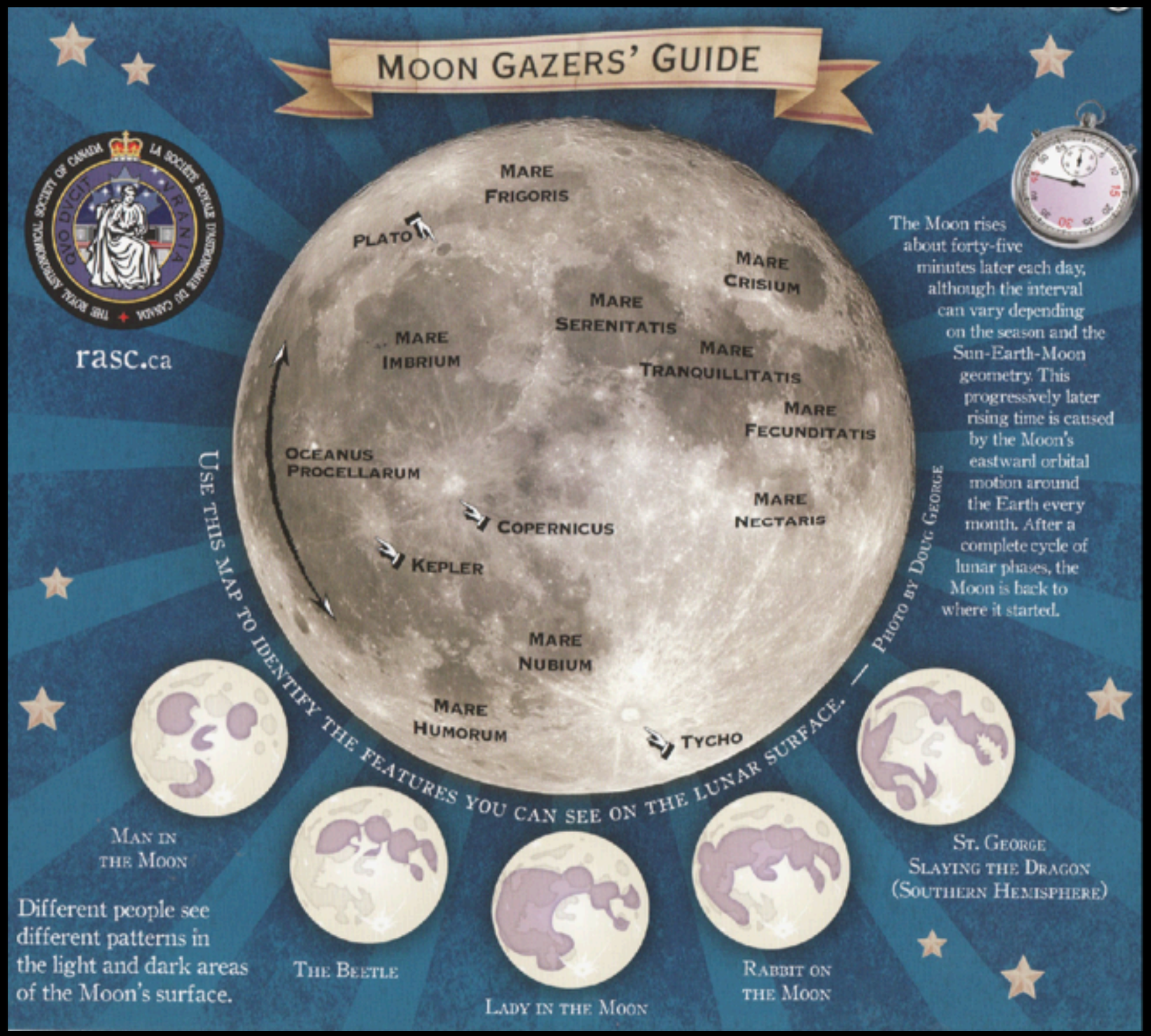
Too Much Information?

#2. If Our Moon was …

Our night sky if the Saturn or Jupiter replaced the Moon … and pesky laws of physics like gravity and mass are ignored

Sources: Dave Humphries, Liverpool, UK
https://www.fotopiaimages.com/if-the-planets-were-as-close-as-the-moon-what-would-the-sky-at-night-look-like/

#3. Man on the Moon



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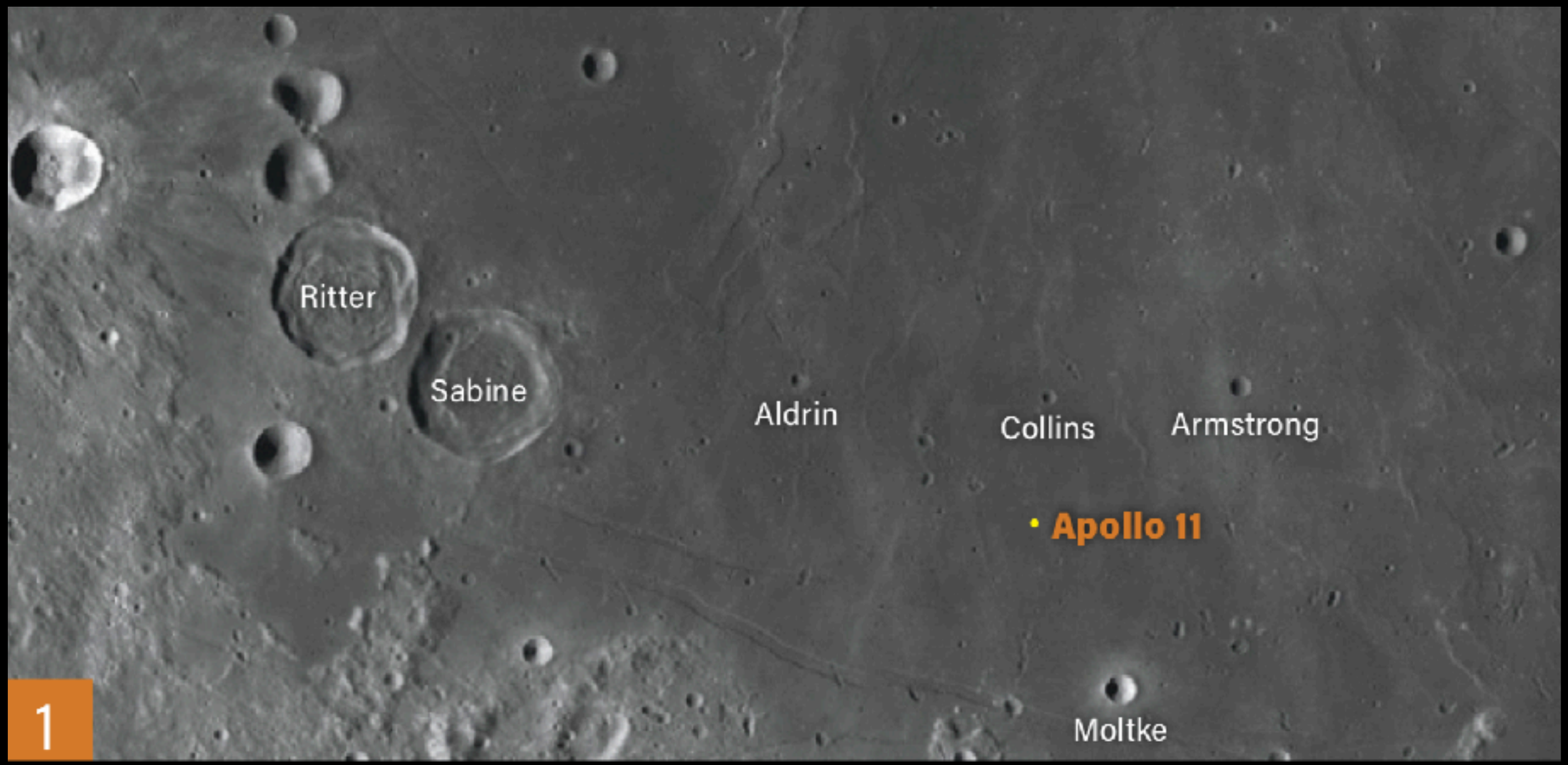
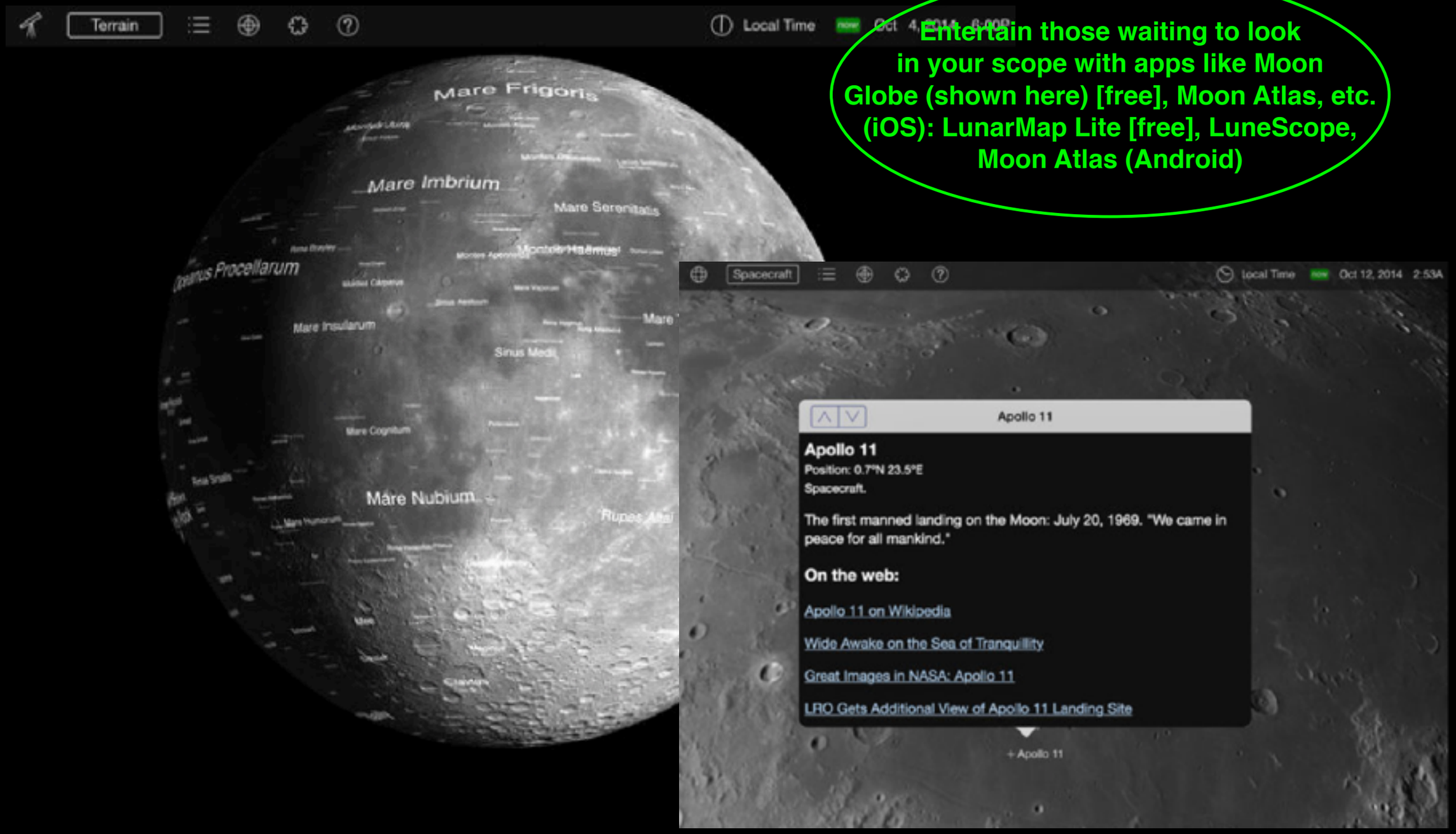


Source: Astronomy Insights, Astronomy Magazine, July 2019, p. 9

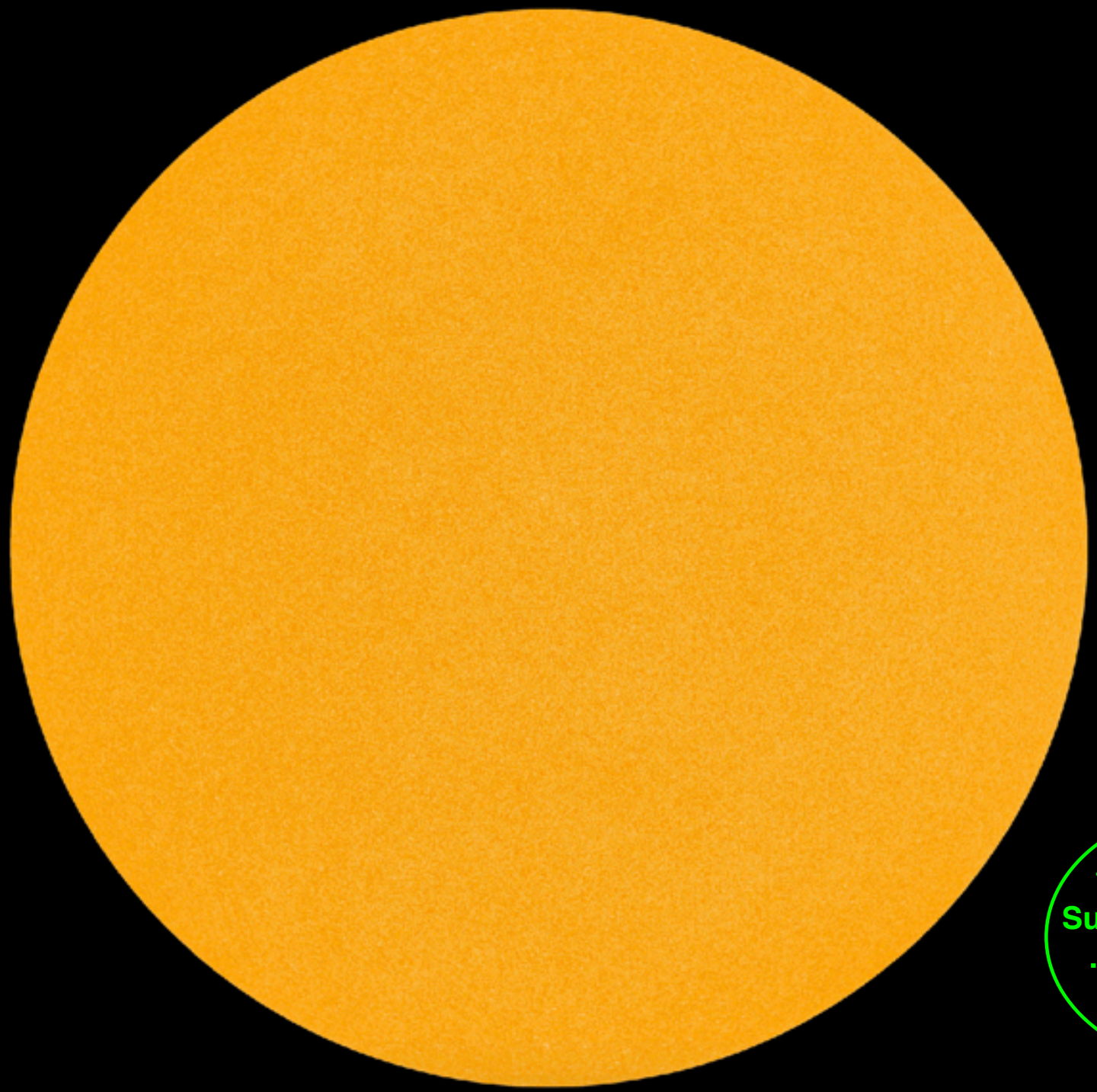
#3. Man on the Moon



Entertain those waiting to look in your scope with apps like Moon Globe (shown here) [free], Moon Atlas, etc. (iOS): LunarMap Lite [free], LuneScope, Moon Atlas (Android)

App: Moon Globe, iOS

#4. Fun with the Sun



1 in 3 chance the Sun will look like this … so maybe have some props

#4. Fun with the Sun

… Solar Glasses always get “oohs” and “aahs”!

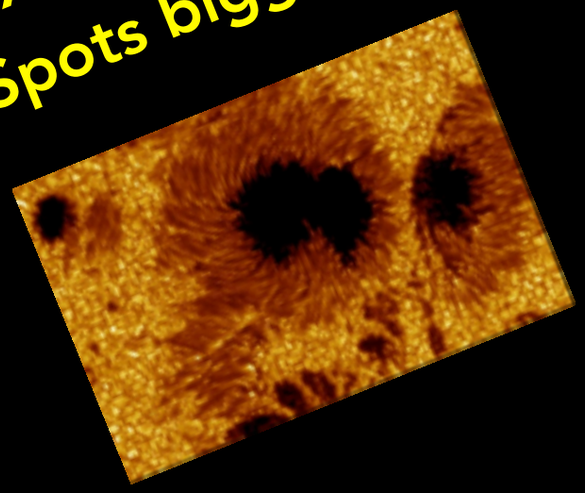
#4. Fun with the Sun

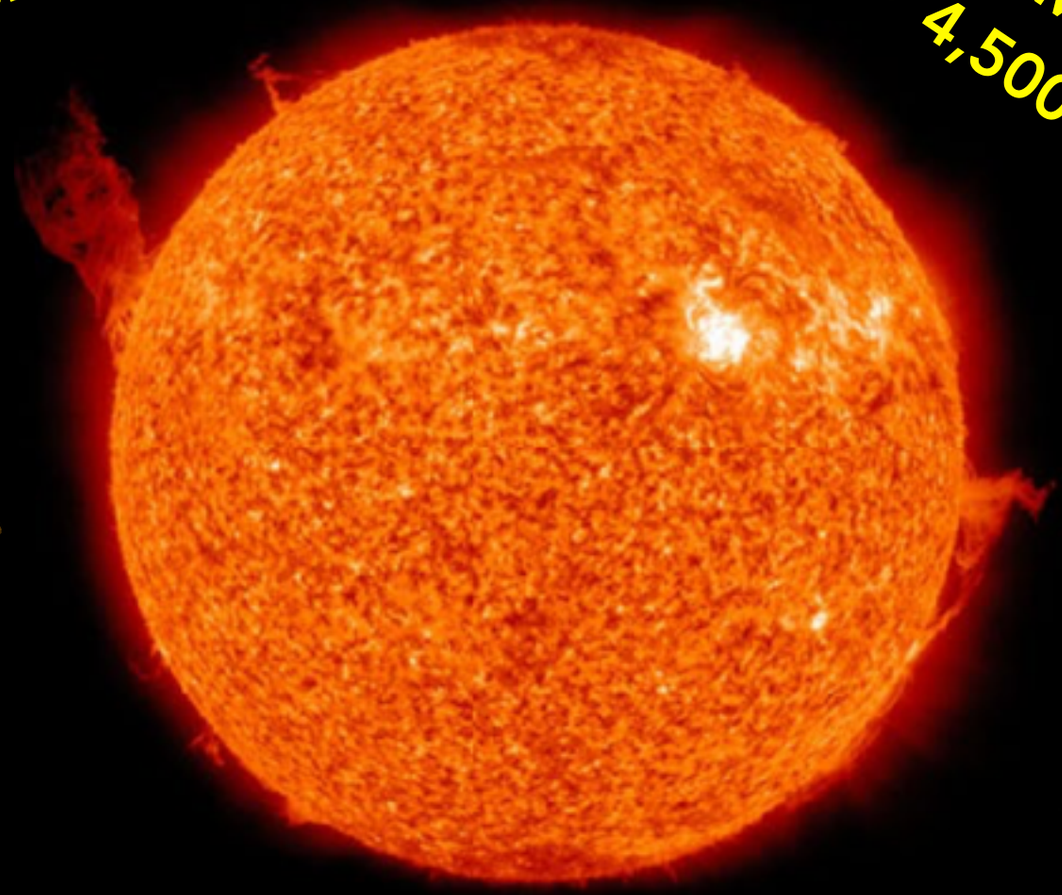
… or if the Ball is the Sun, guess which is Earth?

You might be surprised at people's guesses. (btw … the Bolt is Jupiter)

#4. Fun with the Sun

Size Stuff:
- 108 🌍's Wide
- Holds 1.3M 🌍's
- 99.86% of Solar System
- Spots bigger than 🌍





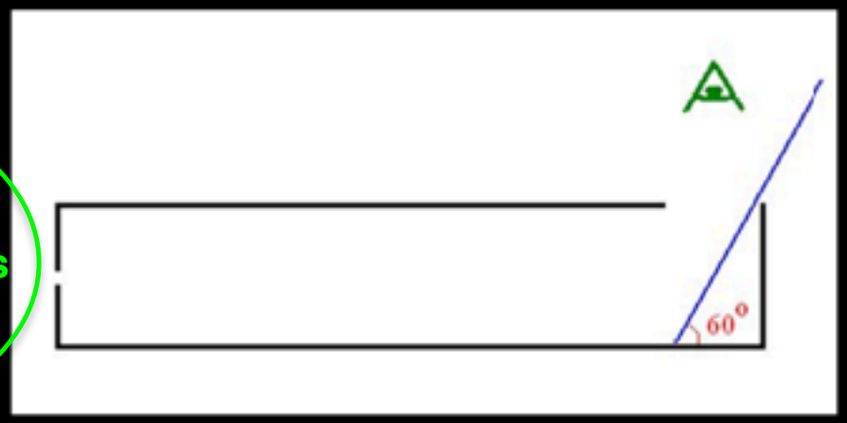
Hot Stuff:
- 15M° C Centre
- 4,500° - 5,500° C Surface

Light Stuff:
- Light takes 10K to 170K years to escape ☀️
- Light takes 8 min 20 sec to 🌍

Circle of Life Stuff:
- Middle-aged @ 4.6B yr
- Red Giant —> White Dwarf size of 🌍 inside 🏀 Nebula

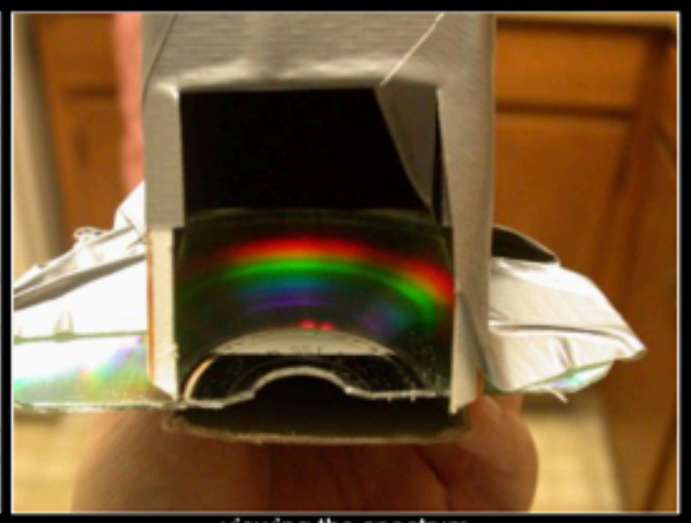
#5. Rainbows in a Box

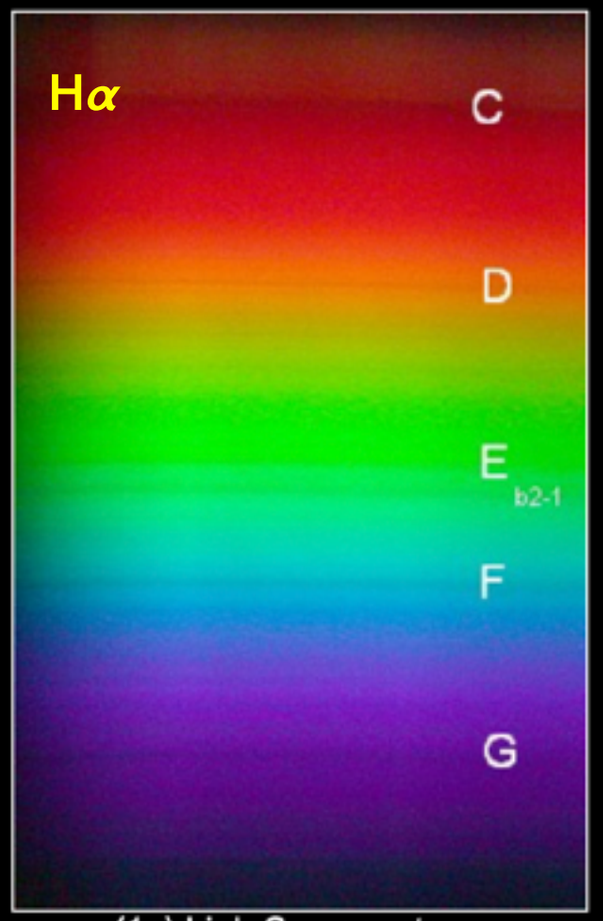
A hit with kids, big and small … and for nightime, see Vega's spectra with a Star Analyzer filter



structure of the CD spectroscope


my cereal box spectroscope (arrow: the slit)


viewing the spectrum



(1c) high Sun spectrum

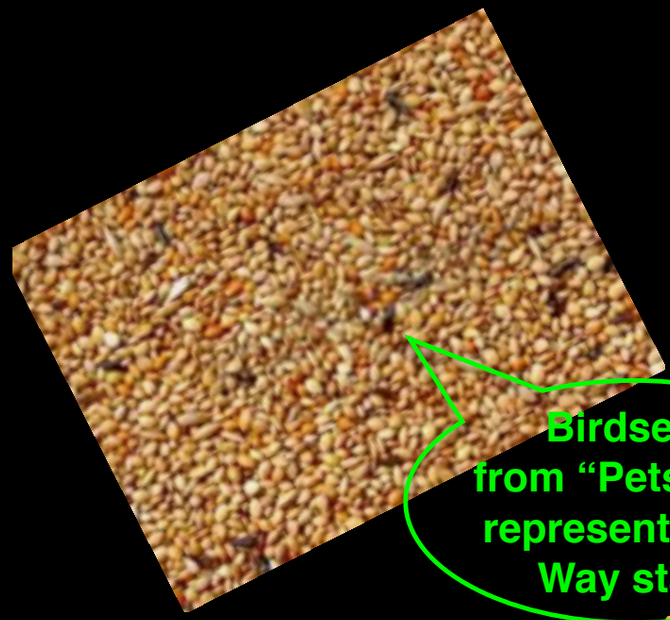
- Don't look directly at the sun
- Don't make one with the slit and eye hole lined up together. 60 deg angle

https://www.cs.cmu.edu/~zhuxj/astro/html/spectrometer.html

#6. Sizing up the Sky

#7. Our Island in the Universe

Excellent way to visualize what 200B looks like and our galaxy shrunk to fit across USA/Canada/Mexico



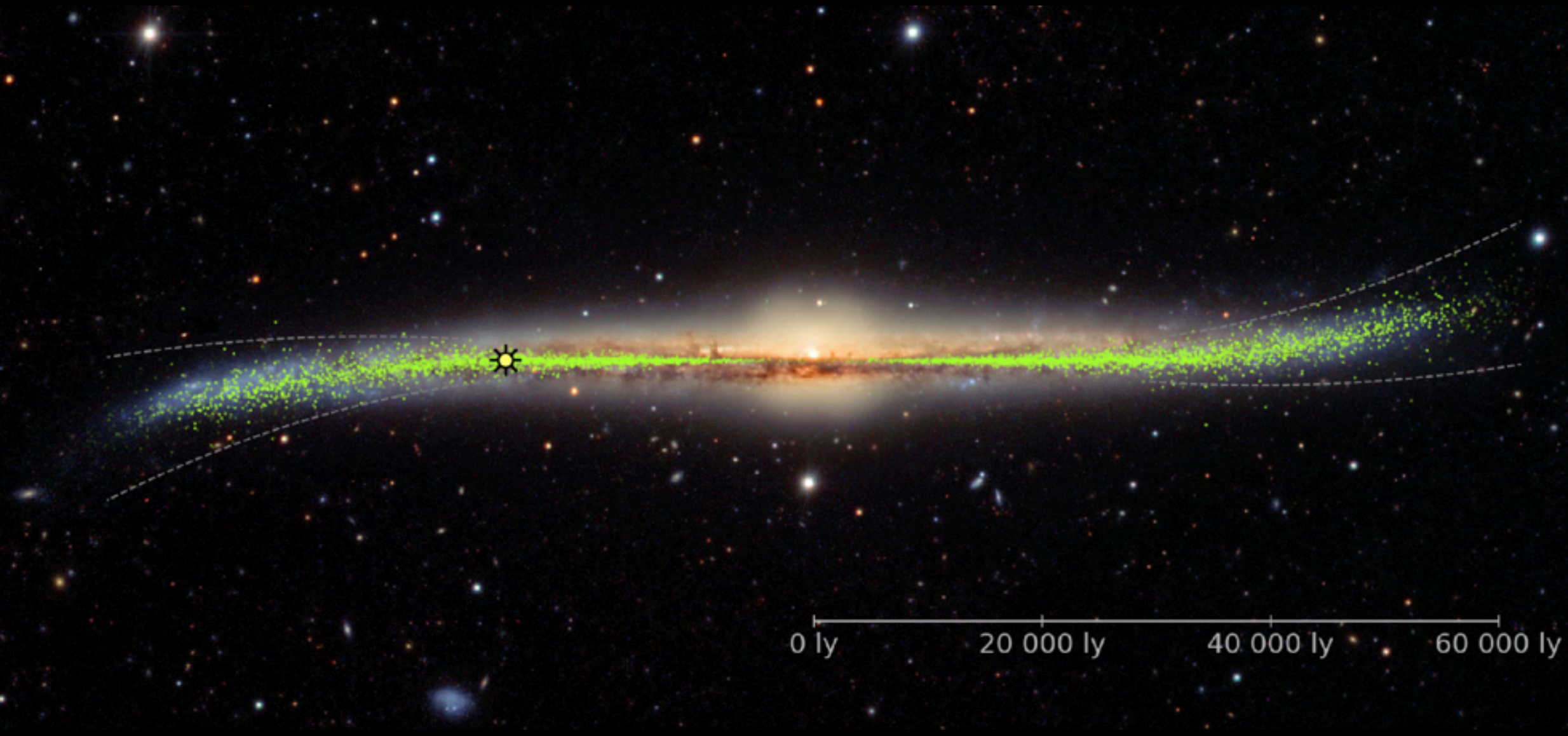
Birdseed from "Petsmart" represent Milky Way stars

4 ft fence / 200B ⭐'s

… our Solar System is a Loonie in Cincinnati with a speck of sand as our Sun

Sources: https://nightsky.jpl.nasa.gov/docs/OGOUOurGalaxy.pdf
https://www.skyandtelescope.com/astronomy-resources/how-many-stars-night-sky-09172014/

#8. You Are Here 👉



#8. You Are Here 👉

Andromeda Galaxy

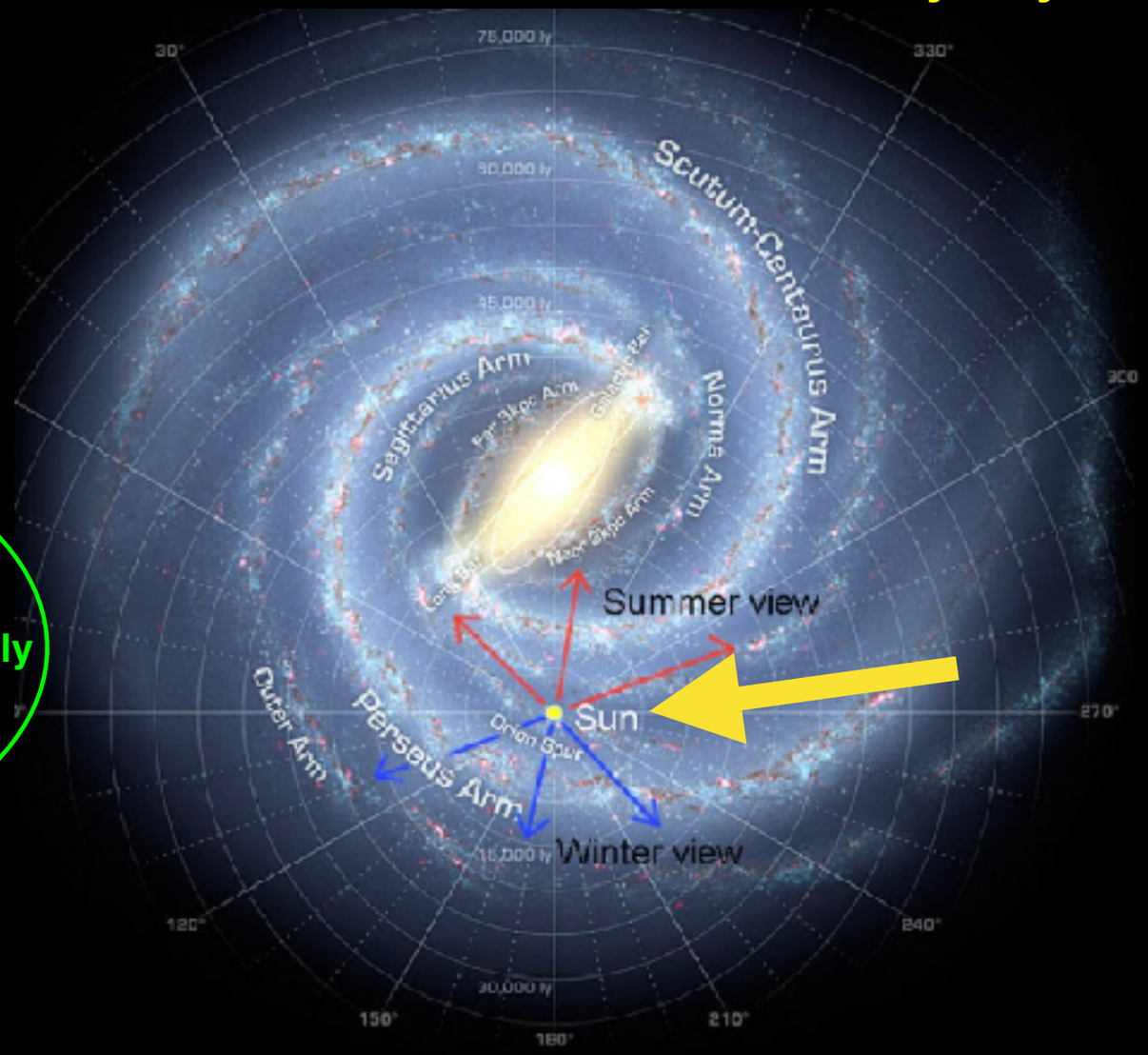
8 ft (2.4 m)

Milky Way Galaxy

CD/DVD is a pretty good model of these galaxy disks. …

Now walk that 8’ (2.5M LY) R-E-A-L-L-Y slowly till they merge in 4B years 😉

p.s. they’re moving together @ 300 km/s!

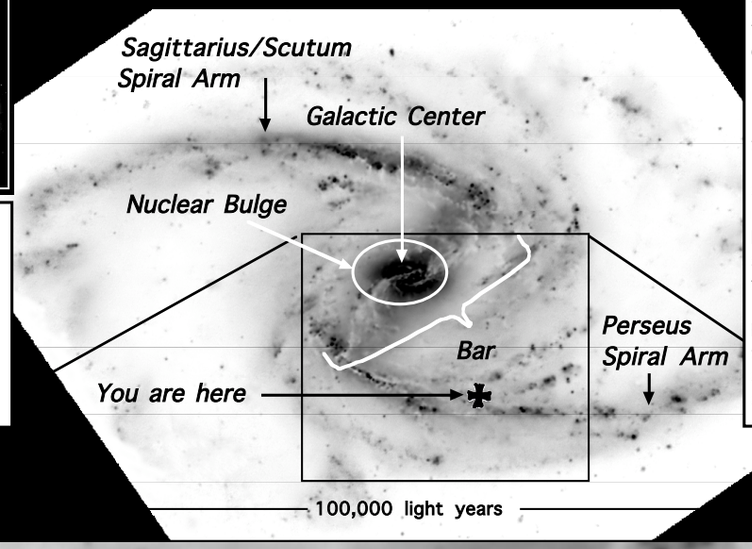


#8. You Are Here

Our barred spiral galaxy

Many astronomers believe that the appearance of the Milky Way Galaxy resembles that of the 60 million light year distant barred spiral galaxy NGC 1365.

Original source image of NGC 1365 courtesy of NOAO/AURA/NSF.



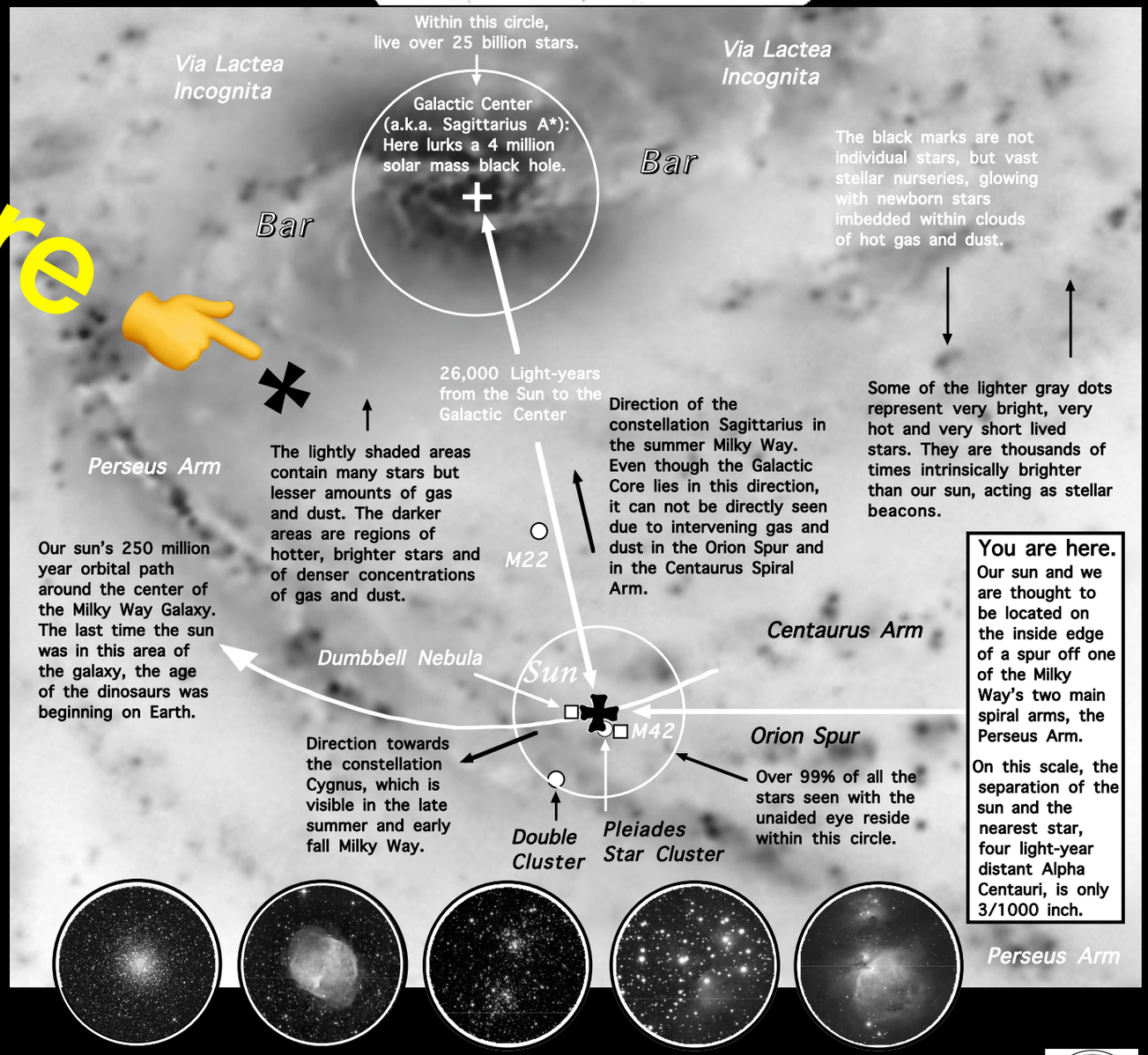
Where is the Milky Way?

Everything that is around you from pencils to automobiles, from people to buildings, from distant mountains to the moon in the sky all are part of the Milky Way Galaxy. Besides our more familiar earthly objects, the galaxy contains at least 200 billion stars along with vast amounts of gas and dust spread unevenly across a disk 100,000 light-years wide and, in the spiral arms, 1000 light-years thick.

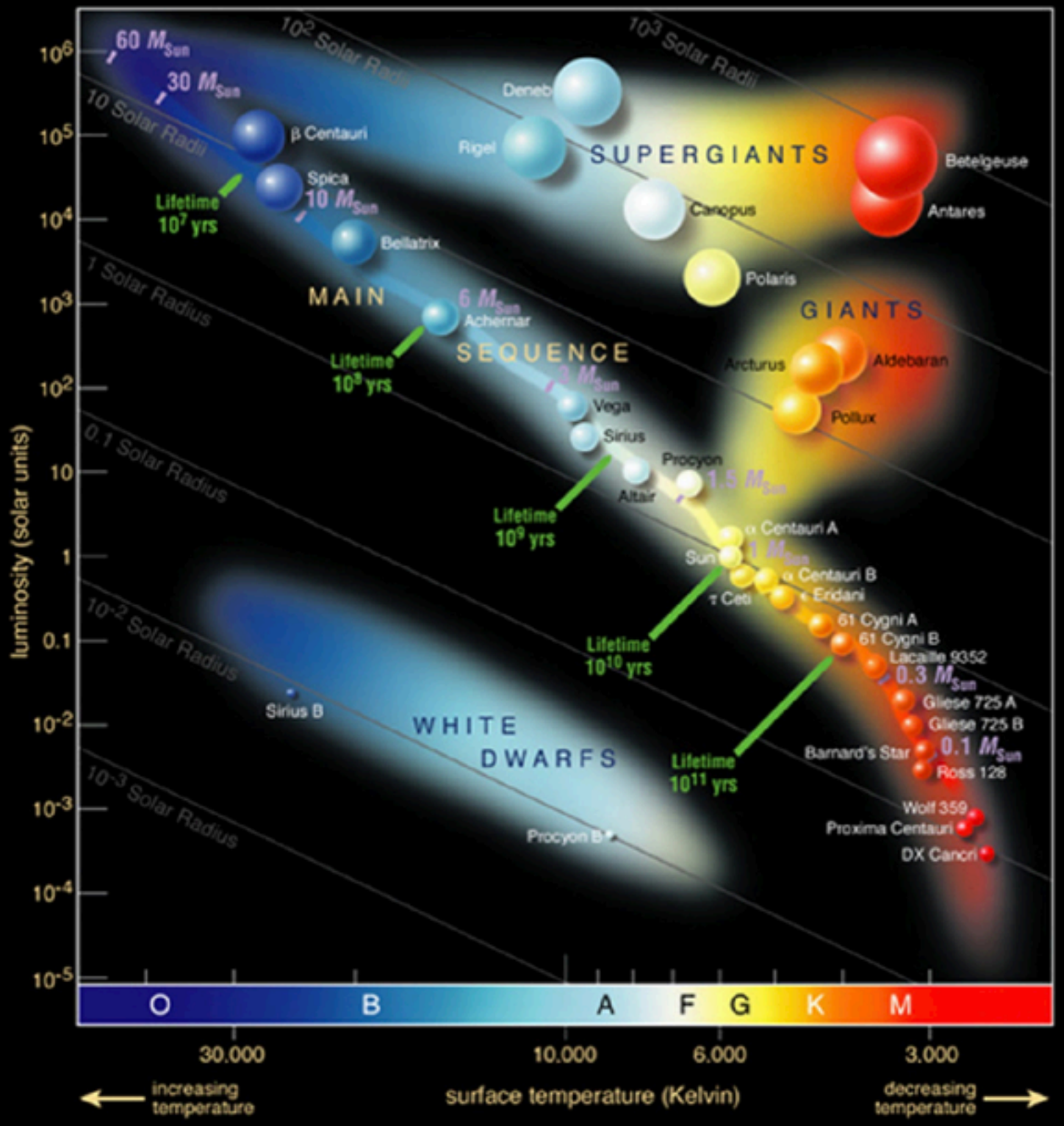
From our Earthbound viewpoint, we see the Milky Way's plane as a softly glowing band stretching across our night sky.

90% of naked eye stars are less than 1,000 LY away!

https://www.astroleague.org/files/outreach/YouareHerePosterG.pdf



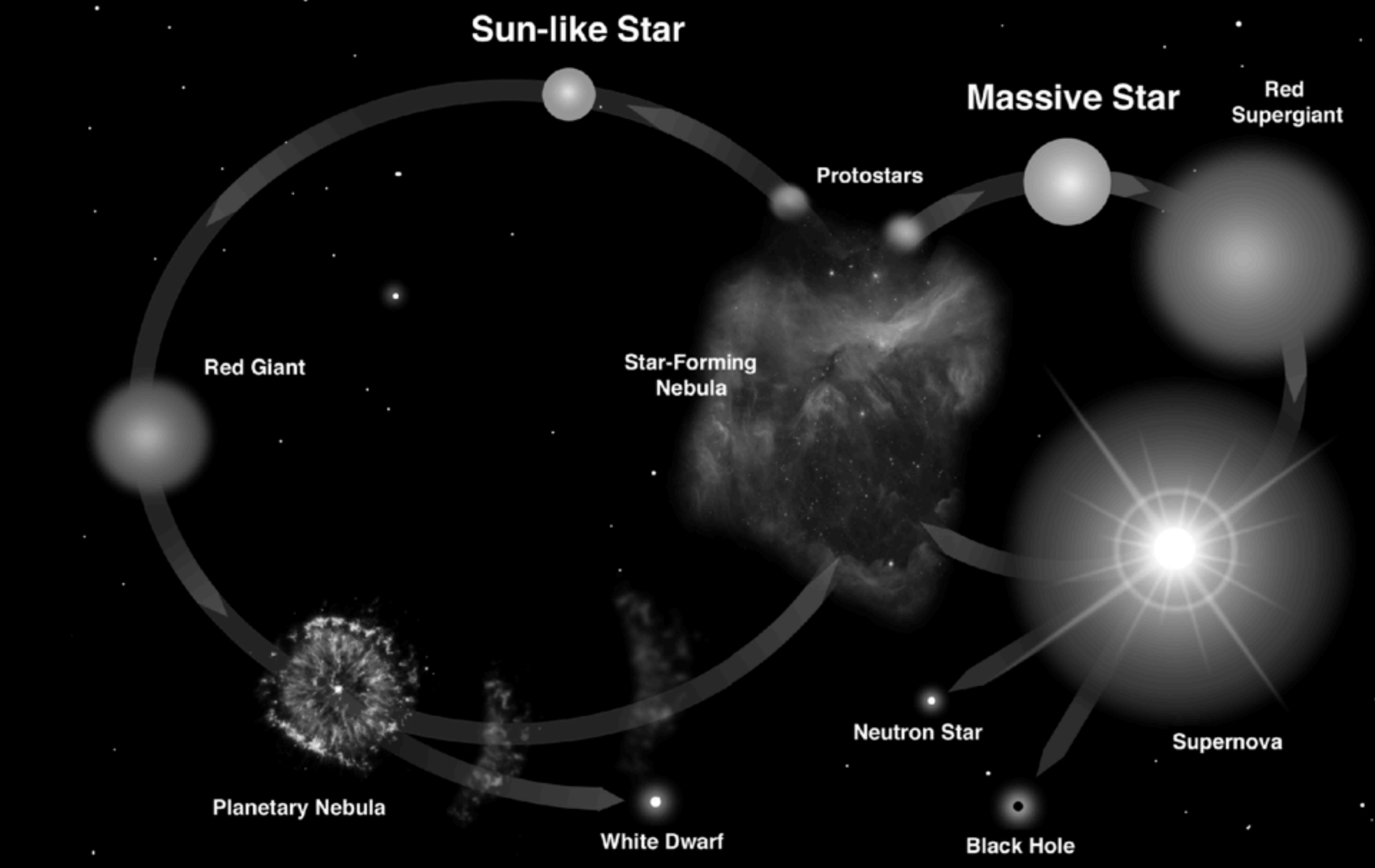
#9· Star Nurseries, Teens & Seniors



Hertzsprung-Russell Diagram from Wikipedia,
original: https://www.eso.org

#9· Star Nurseries, Teens & Seniors

#10. Lives of Stars

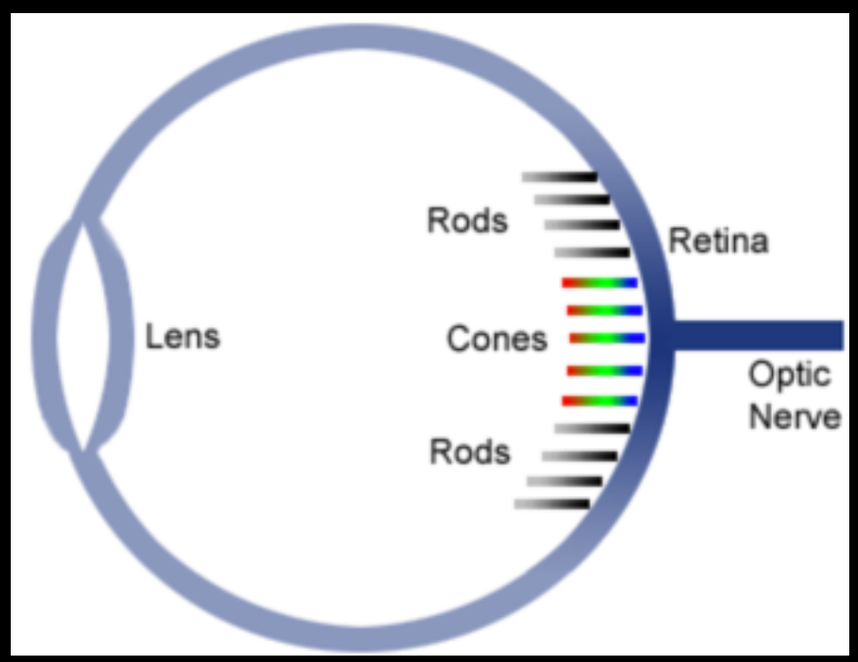


Source: https://nightsky.jpl.nasa.gov/docs/SNLivesofStars.pdf

#11. Blinking Eye Test

Source: james7ca, Cloudy Nights, July 9, 2016

Source: NGC 6826: The Blinking Eye APOD, B. Balick, J. Alexander (University of Washington), et al., NASA



Source: http://www.fortworthastro.com/beginner4.html2016

Rods in Eye
- 120M
- Outer edge, averted vision
- Only dim objects

Cones in Eye
- 6M
- Centre, direct vision
- Only bright objects

… and another story ….
Life Cycle of our Sun!

#12. Made of Star Dust

Stars likely to go SUPERNOVA! AUGUST

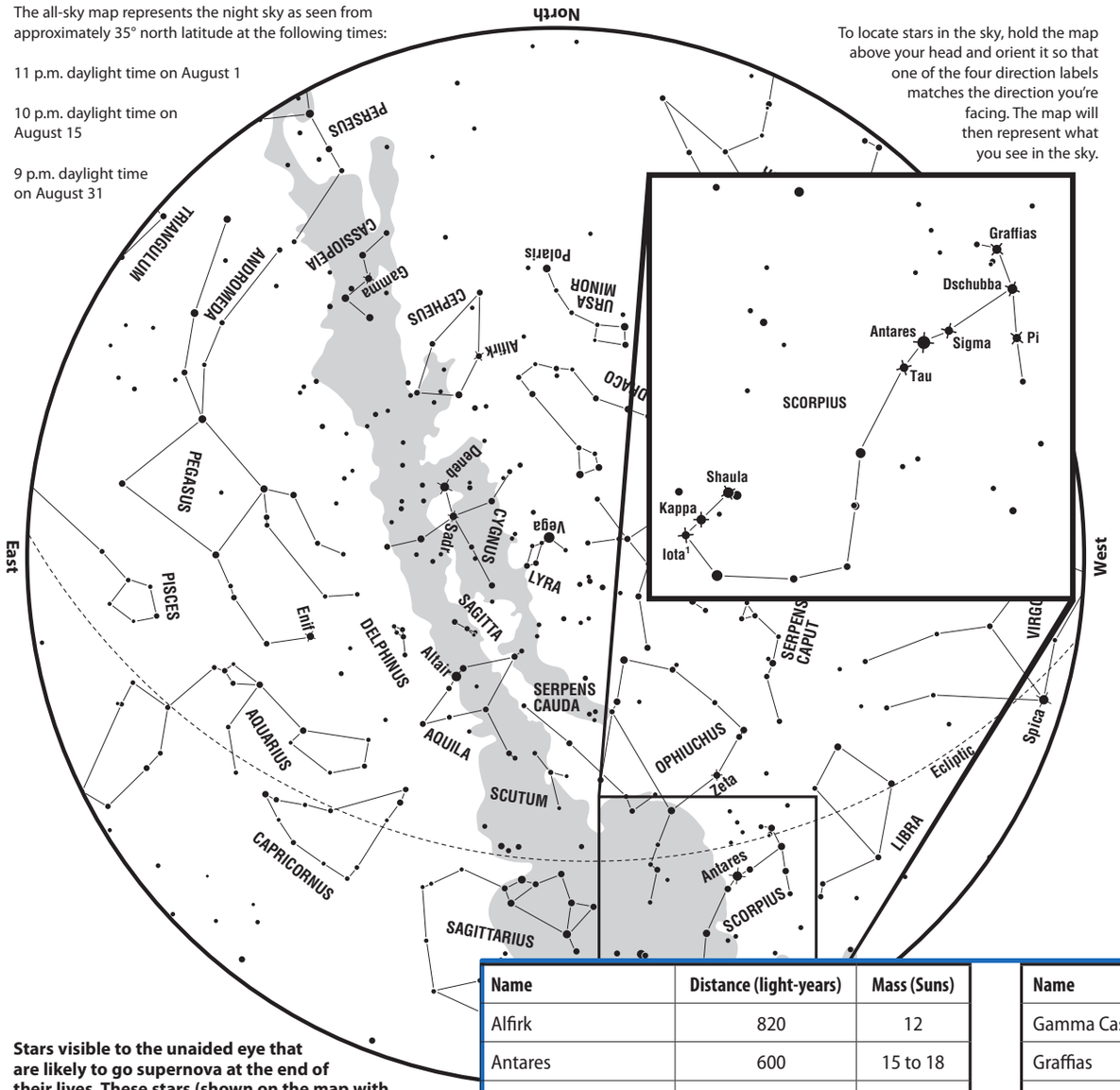
The all-sky map represents the night sky as seen from approximately 35° north latitude at the following times:

11 p.m. daylight time on August 1

10 p.m. daylight time on August 15

9 p.m. daylight time on August 31

To locate stars in the sky, hold the map above your head and orient it so that one of the four direction labels matches the direction you're facing. The map will then represent what you see in the sky.



Stars visible to the unaided eye that are likely to go supernova at the end of their lives. These stars (shown on the map with four spikes) exceed ten times the mass of the Sun.

Name	Distance (light-years)	Mass (Suns)
Alfirk	820	12
Antares	600	15 to 18
Deneb	2,600	25
Dschubba	400	12
Enif	670	10

Name	Distance (light-years)	Mass (Suns)
Gamma Cassiopeiae	610	15
Graffias	530	10
Iota[1] Scorpii	4,000	12
Kappa Scorpii	450	10.5
Pi Scorpii	500	11
Sadr	1,500	12

Name	Distance (light-years)	Mass (Suns)
Shaula	365	11
Sigma Scorpii	520	12 to 20
Spica	260	11
Tau Scorpii	400	12
Zeta Ophiuchi	460	20

Source: https://nightsky.jpl.nasa.gov/download-view.cfm?Doc_ID=341

#12. Made of Star Dust

A Universe without Supernovae

If supernovae never occurred in our universe to disperse the elements made in stars, what would be left in the universe?

Basic Elements in the Universe
(originated in Big Bang)

Hydrogen, Helium

Common Elements that can be made in small stars

Nitrogen
Carbon

Common Elements whose primary source is from stars that go supernova

Aluminum
Calcium
Chlorine
Copper
Gold
Iron
Magnesium
Mercury
Nickel
Oxygen
Phosphorus
Platinum
Potassium
Silicon
Silver
Sodium
Sulfur
Titanium
Uranium
Zinc

Some of the elements found in:

Diamond rings: Carbon, Gold
Computers & Cell Phones: Silicon (computer chips), Carbon, Hydrogen, Oxygen, Sulfur (plastics)
Buildings: Iron (in steel), Calcium, Silicon, Oxygen (in concrete)
Plants, Animals, and People: Carbon, Hydrogen, Nitrogen, Oxygen, Sodium, Magnesium, Phosphorus, Sulfur, Potassium, Calcium, Iron, Zinc
Atmosphere: Nitrogen, Oxygen
Earth: Iron, Oxygen, Silicon, Aluminum, Calcium
Sun: Hydrogen, Helium

www.nasa.gov

Source: https://nightsky.jpl.nasa.gov/download-view.cfm?Doc_ID=341

#13. The Double Double

Epsilon Lyrae imaged with 16" Meade LX-200 at f/10. (M. Ragsdale)

Source: SkySafari

#13. The Double Double

- Just the Facts …
  - *ε1 Lyr* have magnitudes of 4.7 and 6.2, separated by 2.8” or 160 AU, with 1200 yr orbit
  - *ε2 Lyr* have magnitudes of 5.1 and 5.5, separated by 2.2" or 140 AU, with 600 yr orbit
  - ε1 and ε2 Lyr are no closer than 0.16 light years apart, and would take hundreds of thousands of years to complete an orbit

#13. Tim Horton's Double

- Just the Facts …
  - *ε1 Lyr* have magnitudes of 4.7 and 6.2, separated by 2.8" or 160 AU, with 1200 yr orbit
  - *ε2 Lyr* have magnitudes of 5.1 and 5.5, separated by 2.2" or 140 AU, with 600 yr orbit
  - ε1 and ε2 Lyr are no closer than 0.16 light years apart, and would take hundreds of thousands of years to complete an orbit

- … Fun Story?
  - *ε Lyra* aka the *Double Double* … and affectionately known as the *Tim Horton's Double* in Canada
  - If you were in a spaceship at either pair, then
    - Other pair would be < 1° away from each other (twice the Full Moon) and shine as bright as our quarter Moon
    - 100's of years for the stars in each pair to orbit each other
    - 100's of thousands of years for the pairs to orbit each other

Source: Skysafari

#14. Astro-Doodles ♈

Aries the *Ram*?

"Imagineer" = What Astronomers Do

#14. Astro-Doodles

http://www.deep-sky.co.uk/asterisms.htm
https://earthsky.org/favorite-star-patterns/the-coathanger-a-binocular-star-hop-adventure

#15. Finding ET?

Open Cluster NGC 457. Robert Gendler.

Source: ET/Owl Cluster inSkySafari

#15. Finding ET?

Where are the Distant Worlds?

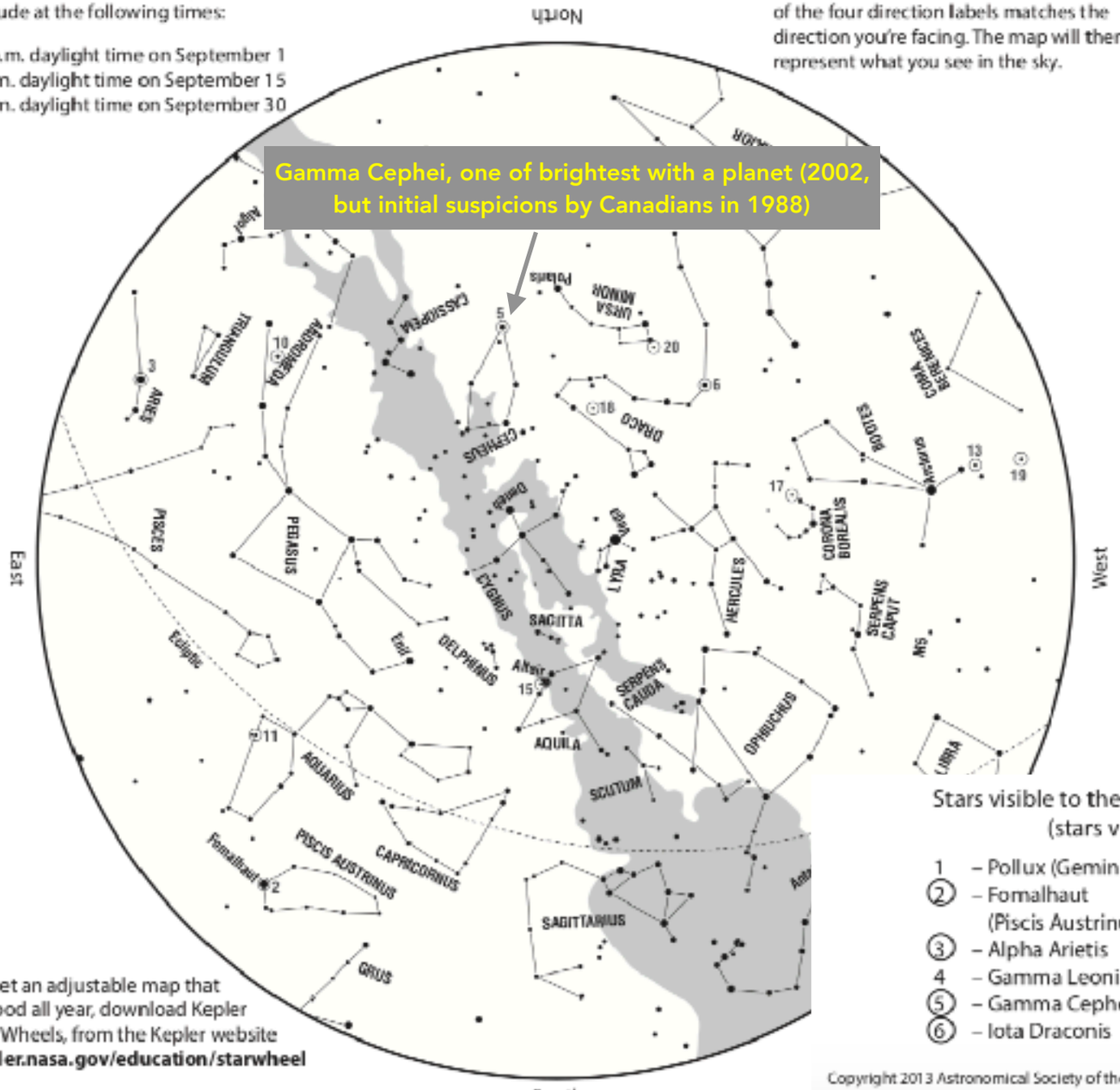
The all-sky map represents the night sky as seen from approximately 35° north latitude at the following times:

10 p.m. daylight time on September 1
9 p.m. daylight time on September 15
8 p.m. daylight time on September 30

September

To locate stars in the sky, hold the map above your head and orient it so that one of the four direction labels matches the direction you're facing. The map will then represent what you see in the sky.

Gamma Cephei, one of brightest with a planet (2002, but initial suspicions by Canadians in 1988)



To get an adjustable map that is good all year, download Kepler Star Wheels, from the Kepler website **kepler.nasa.gov/education/starwheel**

Stars visible to the unaided eye known to have planets — listed brightest to dimmest
(stars visible this month are circled and numbered on the map)

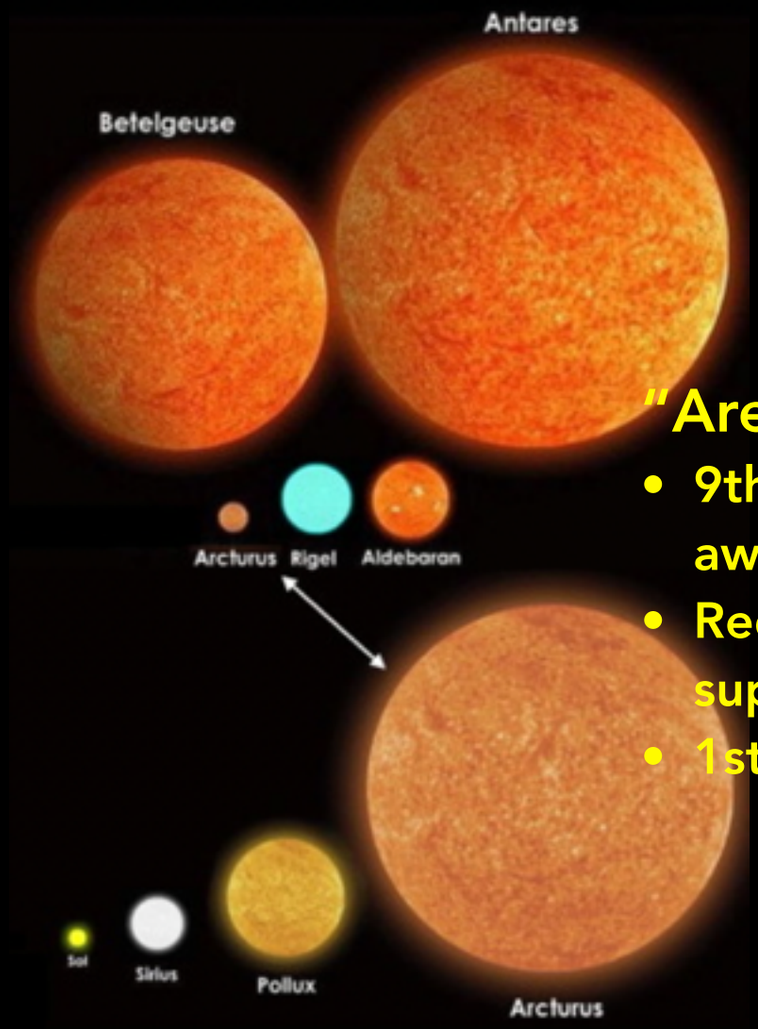
1 – Pollux (Gemini)
(2) – Fomalhaut (Piscis Austrinus)
(3) – Alpha Arietis
4 – Gamma Leonis
(5) – Gamma Cephei
(6) – Iota Draconis
7 – Epsilon Tauri
8 – Epsilon Eridani
9 – NU Canis Majoris
(10) – Upsilon Andromeda
(11) – 91 Aquarii
12 – HD 60532
(13) – Tau Bootis
14 – Chi Virginis
(15) – Xi Aquilae
16 – 61 Virginis
(17) – Kappa Coronae Borealis
(18) – 42 Draconis
(19) – 70 Virginis
(20) – 11 Ursae Minoris

Source: https://nightsky.jpl.nasa.gov/docs/PQDistWorldStarMap13.pdf

#16. What if it's Hazy or Cloudy?

Arcturus has the "*Moves*"

- 5th brightest star only 37 LY away and 26x size of Sun
- Large proper motion … moves 1/2° per 1000 yr
- Opened 1933 Chicago World's Fair, with light from star during the previous Chicago World's Fair



"Are you there, Betelguese?"

- 9th brightest star only 425 LY away and 560x size of Sun
- Red supergiant could have gone supernova already!
- 1st to have disk directly imaged

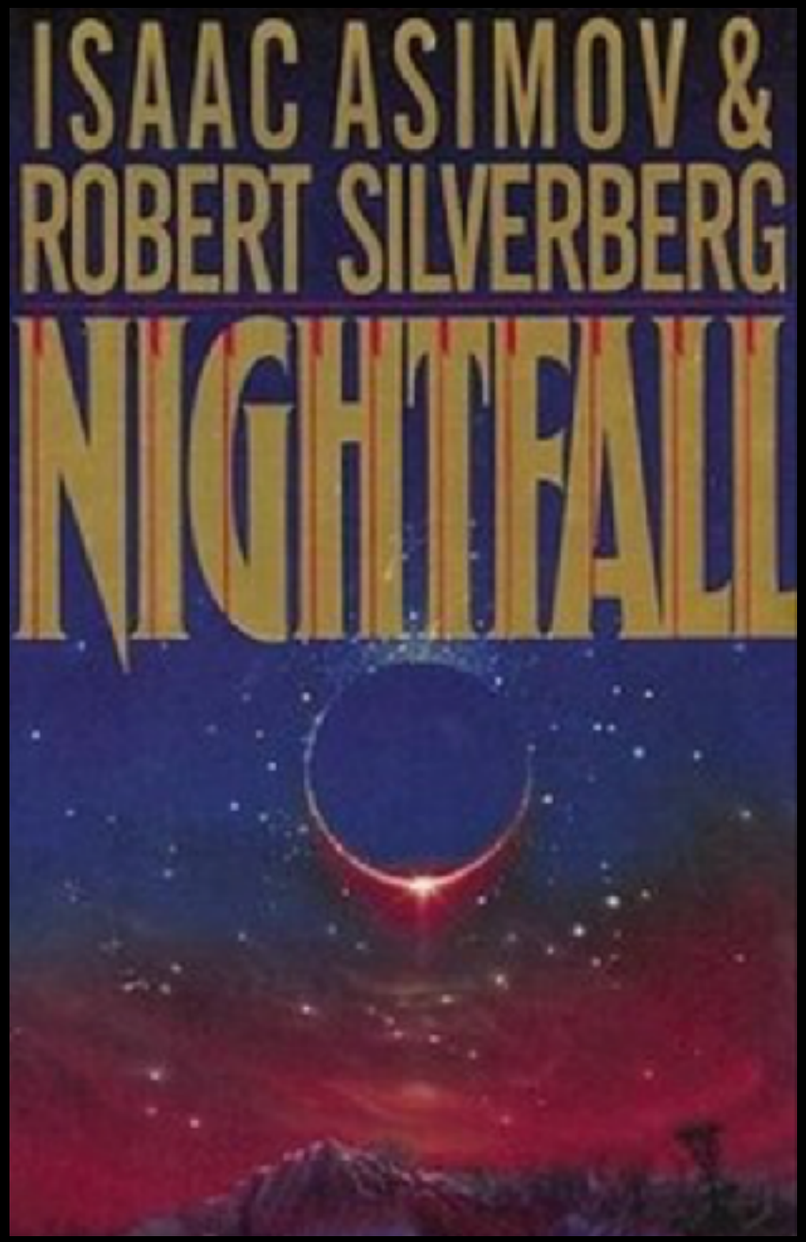
"*Dizzy*" Vega

- 5th brightest only 25 LY away and 2.7x size of Sun
- Spins so fast it bulges (23%) and rotates in 12.5 hr
- 93% of breakup speed

A 2-degree-wide field of view centered on Vega. (Fred Espenak)

Sources: SkvSafari

#17. Inside a Star Cluster! ✨

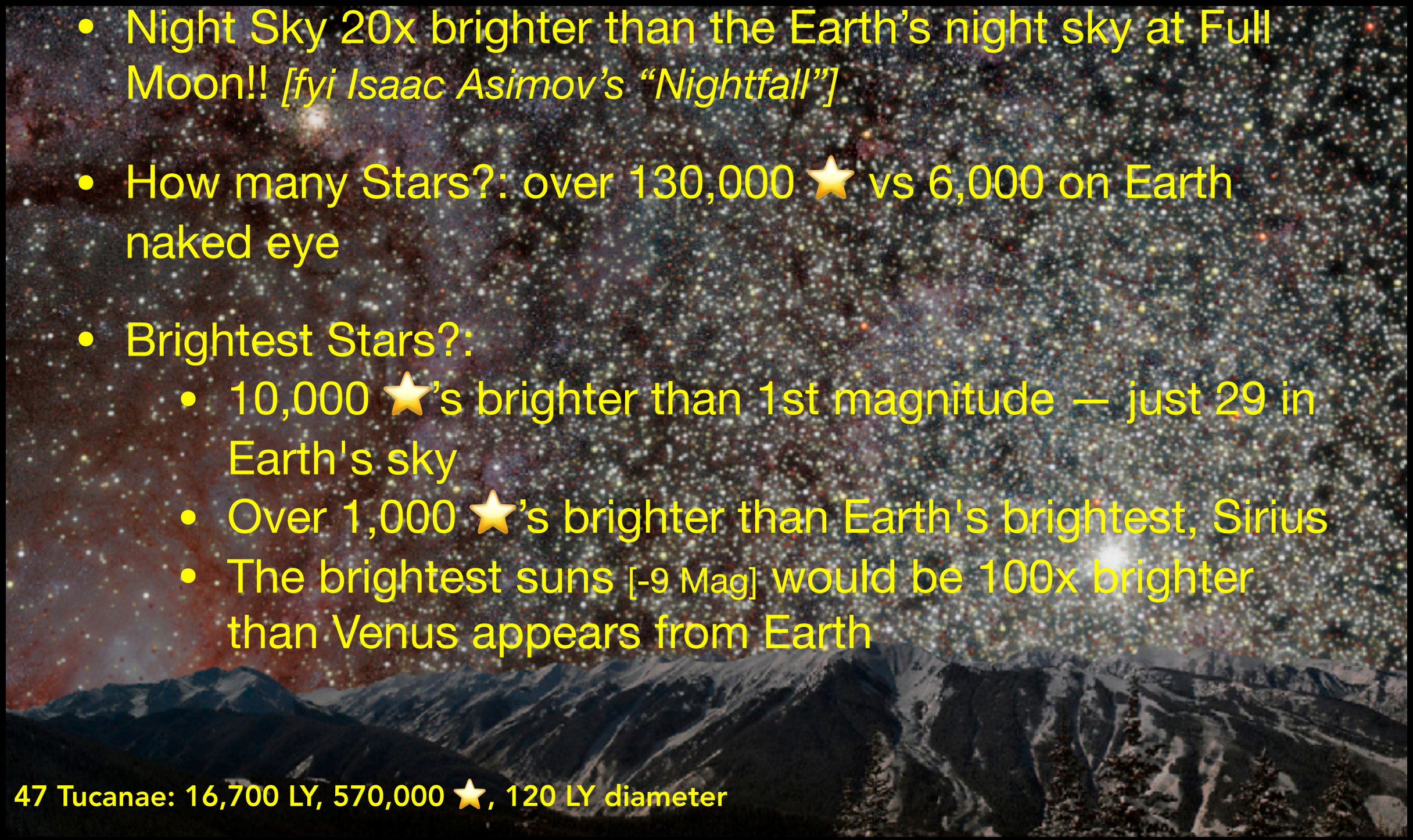


Asimov-approved, stable Kalgash System

A binary-binary pair of Sun-like stars on a ~10 AU-wide orbit (Tano-Sitha and Trey-Patru)

planetplanet.net

#17. Inside a Star Cluster! ✨



- Night Sky 20x brighter than the Earth's night sky at Full Moon!! *[fyi Isaac Asimov's "Nightfall"]*
- How many Stars?: over 130,000 ⭐ vs 6,000 on Earth naked eye
- Brightest Stars?:
  - 10,000 ⭐'s brighter than 1st magnitude — just 29 in Earth's sky
  - Over 1,000 ⭐'s brighter than Earth's brightest, Sirius
  - The brightest suns [-9 Mag] would be 100x brighter than Venus appears from Earth

47 Tucanae: 16,700 LY, 570,000 ⭐, 120 LY diameter

Source: W. Harris & J. Webb, *Life inside a Globular Cluster*, Astronomy magazine, July 2014

Looking Up 🙄

⭐⭐⭐ Lots of great material for Outreach at NASA. Search the *Outreach* section for materials such as the “Birdseed Galaxy”, “Lives of the Stars” , “Supernova Stars” and “Stars with Planets” https://nightsky.jpl.nasa.gov/index.cfm

Planets between the Earth and Moon: https://www.universetoday.com/115672/you-could-fit-all-the-planets-between-the-earth-and-the-moon/

What if the Moon were replaced by a Planet?: https://www.fotopiaimages.com/if-the-planets-were-as-close-as-the-moon-what-would-the-sky-at-night-look-like/

“Man on the Moon” slide: Astronomy Insights, Astronomy Magazine, July 2019, p. 9 (but lots of resources available on the Web)

“Home-Made Spectroscope” slide: https://www.cs.cmu.edu/~zhuxj/astro/html/spectrometer.html (lots of other resources on the Web)

“Blinking Eye Test” slide: https://www.skyatnightmagazine.com/advice/how-to-master-the-art-of-averted-vision/

“Tim Horton’s Double” and “What if its Hazy or Cloudy” slide: See description information for Stars in Skysafari and Epsilon Lyrae, specifically for the Double Double

“Astro-Doodles” slide: lots of Asterisms available on the Web

“Inside a Star Cluster” slide: W. Harris & J. Webb, Life inside a Globular Cluster, Astronomy magazine, July 2014

Some other links: https://www.astroleague.org/files/outreach/YouareHerePosterG.pdf
https://astrosociety.org/education-outreach/
https://science.nasa.gov/learners/wavelength https://www.skyandtelescope.com/astronomy-resources/how-many-stars-night-sky-09172014/

Source: Dave Humphries, Liverpool, UK
https://www.fotopiaimages.com/if-the-planets-were-as-close-as-the-moon-what-would-the-sky-at-night-look-like/