PIECE ON EARTH

LARRY SMITH

URANIUM

- Uranium has a half-life of 4.5 billion years.
- If you find a rock that's half Uranium and half Lead (which is what Uranium decays into), you know that that rock (and the surrounding rock) is 4.5 billion years old.
- Other proportions imply different ages.

OKLO

- In 1972, in Gabon in Africa, while mining uranium there, scientists found less U-235 than expected.
- By analyzing the decay products around it, they deduced that it had already been in 16 naturally occurring nuclear reactors over 1.7 billion years ago!
- And no, they weren't attributable to alien technology – the sites were patches of centimeter-sized ore layers.
- See https://en.wikipedia.org/wiki/Oklo and https://en.wikipedia.org/wiki/Natural_nuclear_fission_reactor
- Also https://www.iaea.org/newscenter/news/meet-oklo-the-earths-two-billion-year-old-only-known-natural-nuclear-reactor

RETROGRADE MOTION

- If you were to watch the position of Mars every night, you'd see its position relative to the constellations proceed smoothly from west to east!
- Except that occasionally you'd see it back up in its tracks and go from east to west and then back again!
- Is Mars really backing up in its orbit?!?

RETROGRADE MOTION

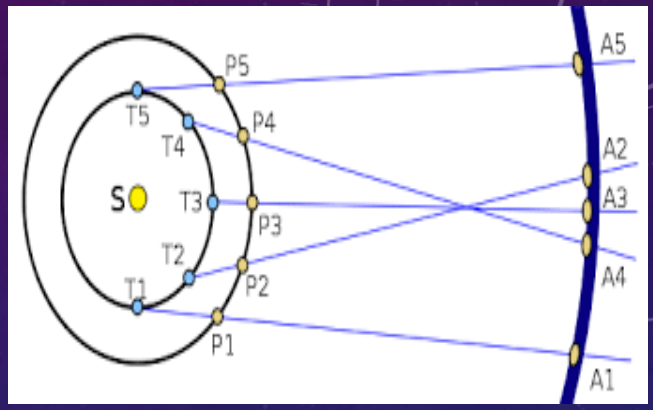
- Maybe Jupiter and Saturn's gravity is dragging it back?!?
- But Jupiter, Saturn, Uranus and Neptune can also show retrograde motion.
  - Even Pluto!
- But Mercury and Venus don't show the effect.
- Is this a clue? What's different between the inner and outer planets?
  - Would an observer on one of Mars' moons see Earth go retrograde
- Just what the heck is going on here?!?

RETROGRADE MOTION

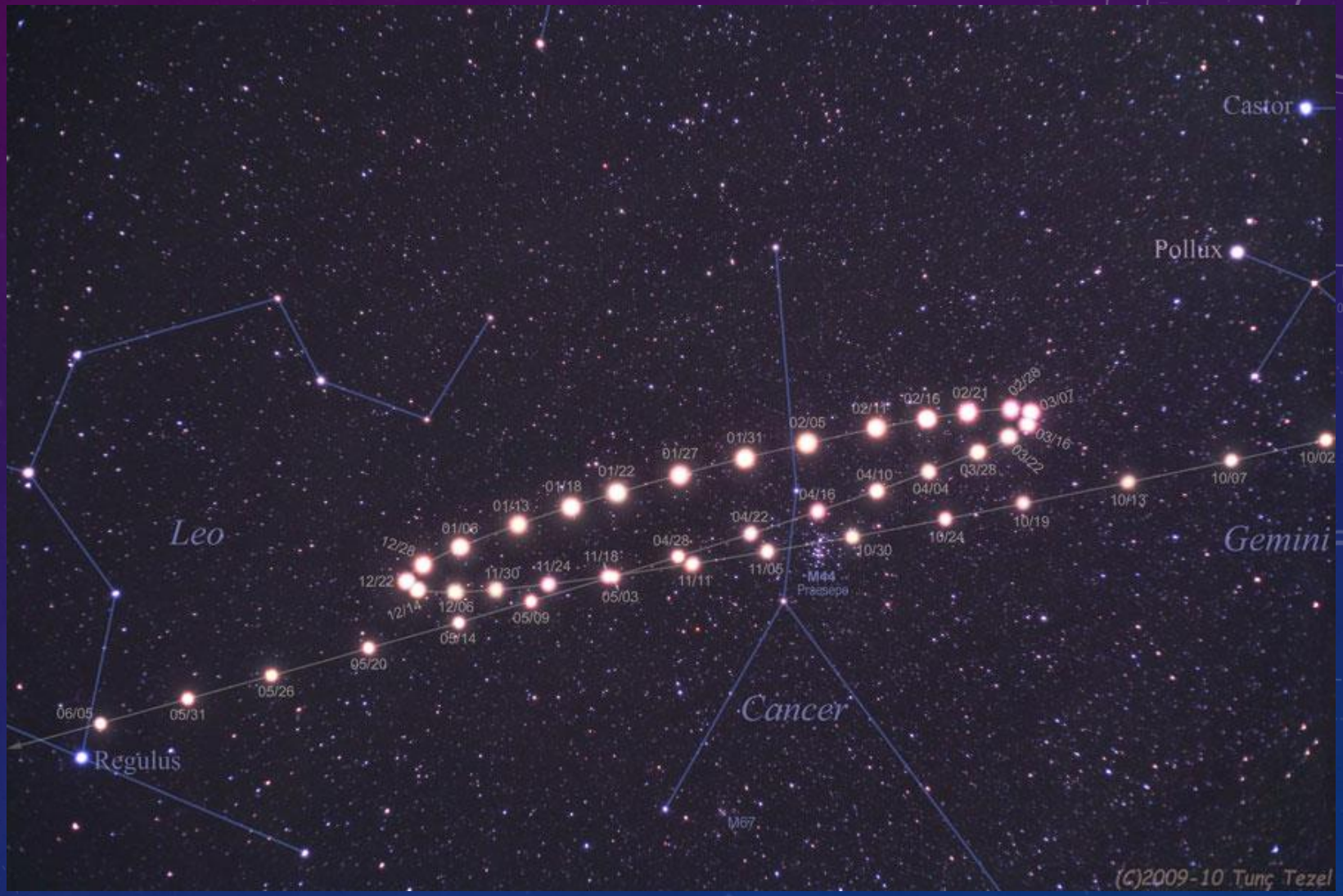
- First, let's do some calculations…
- Earth is 150 million km from the Sun which means its orbit is 2 * pi * 150 million km = 942 million km.
- Divide that by 365 get km/day, then by 24 for km/hr, which means that our speed around the Sun is over 107,000 km/hour. Whew!
  - See, you only *think* you're sitting at rest in your nice comfy chair!
- Doing the same for Mars gives it a speed of almost 87,000 km/hr, about 80% of Earth's speed.
  - Remember, Mars' year is 687 Earth days.
- So while Mars plods along in its orbit, Earth catches up with it and passes it.

RETROGRADE MOTION

- In the diagram we have the Sun in the middle, with the inner ellipse representing Earth and the outer ellipse representing Mars.



- So at Time 1 (T1), Mars is at P1 and appears at point A1 in the sky.
- At T2, Mars appears at A2.
- At T3, Earth has caught up to Mars and appears at A3.
  - *So Mars seems to have moved backwards in the sky!*
- At T4, Earth has rocketed forward and Mars appears at A4, but is about to do another about-face.
- Finally at T5, it has moved forward again.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Gemini
Cancer
Regulus
M44
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ANALEMMAS

- Assuming sunny days and all that, take a picture of the Sun at the same time (e.g. noon) once a week for a year.
- Now overlay all the images and you'll see how the Sun changes its position during the seasons.
- Personal side note: I used to live in an apartment building on one side of the Hudson river in New York. On the other side were cliffs called the Palisades.
- As the year progressed, I could see the Sun set at progressively more southern spots on the Palisades as the days, weeks and months went by.
- Then at the winter solstice, the sunset position would start moving north again until at the summer solstice when it would reach its northern-most position then started heading south again.
- So the point where the Sun sets changes through the year. And we know that the Sun doesn't rise as high in the winter as in the summer.
- So what would our picture look like?

ANALEMMAS

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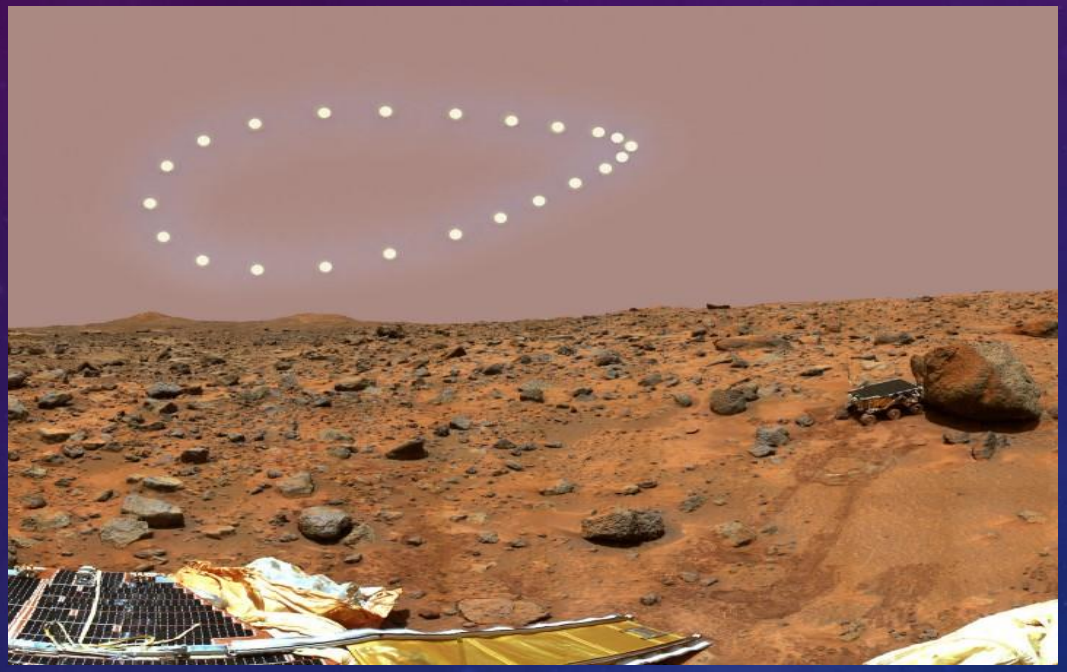
ANALEMMAS

http://antwrp.gsfc.nasa.gov/apod/ap081221.html

See https://en.wikipedia.org/wiki/Analemma

ANALEMMAS

Of course, things are different on Mars!



On Mars (calculated image)

http://antwrp.gsfc.nasa.gov/apod/ap061230.html

WHERE TO FIND THIS

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