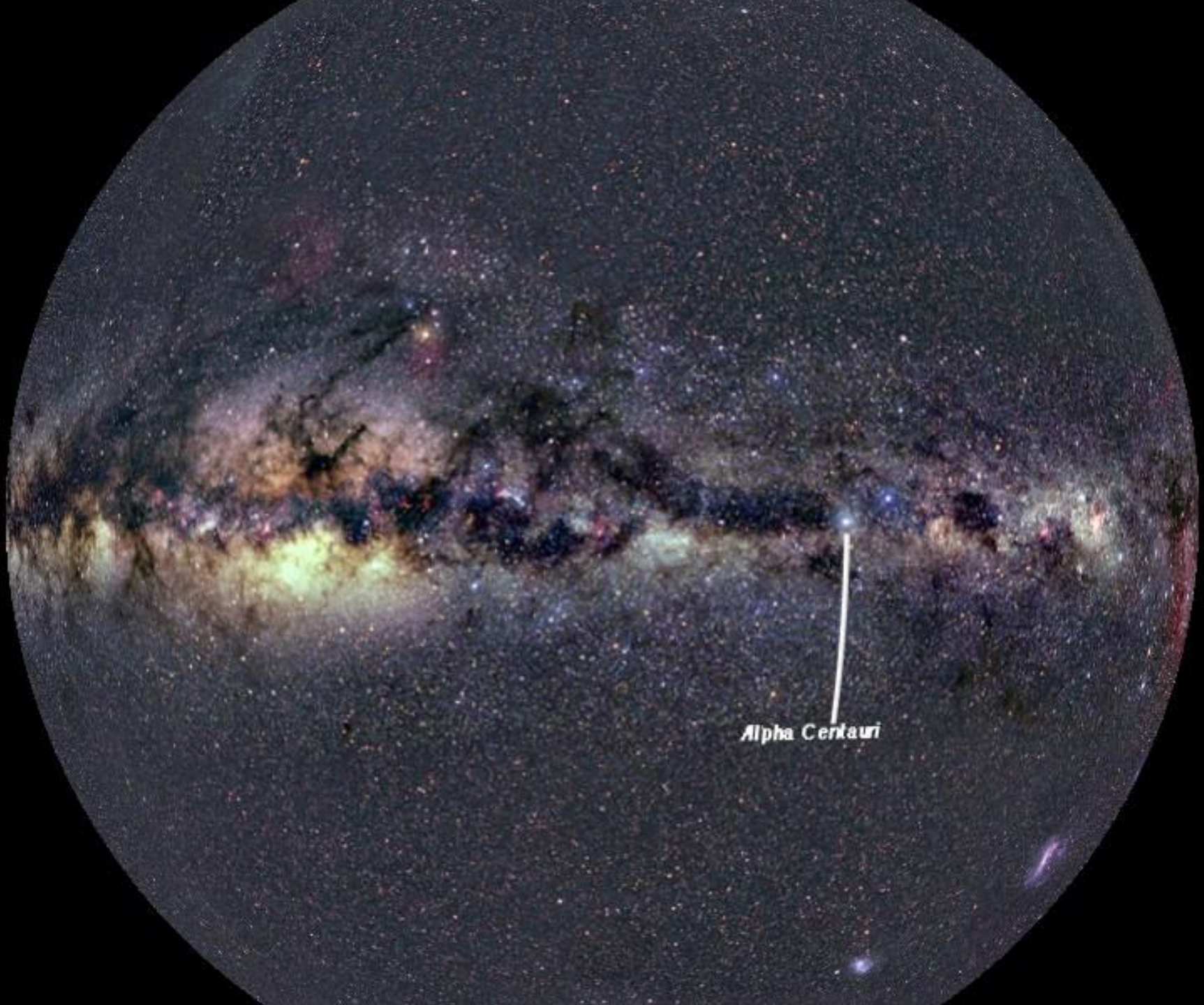
# ASTR/GEOL-2040: Search for life in the Universe: Lecture 18

- Northern/southern skies
- Distances traveled
- Mars, Enceladus, volcanos
- Cryovolcanism

Axel Brandenburg & Nick Conant
(Office hours: Mondays 2:30 – 3:30 in X590 and Wednesdays 11-12 in D230)


Alpha Centauri



Alpha Centauri

-60° declination

# *Distance traveled by Voyager*

A. ~ 1 AU

B. ~ 10 AU

C. ~100 AU

D. ~1000 AU

E. ~10,000 AU

Earth – Sun distance = 1 AU

1 ly = 60,000 AU

# *Distance traveled by Voyager*

A. ~ 1 AU

B. ~ 10 AU

C. ~100 AU

D. ~1000 AU

E. ~10,000 AU

Launch 1977

Saturn flyby 1980

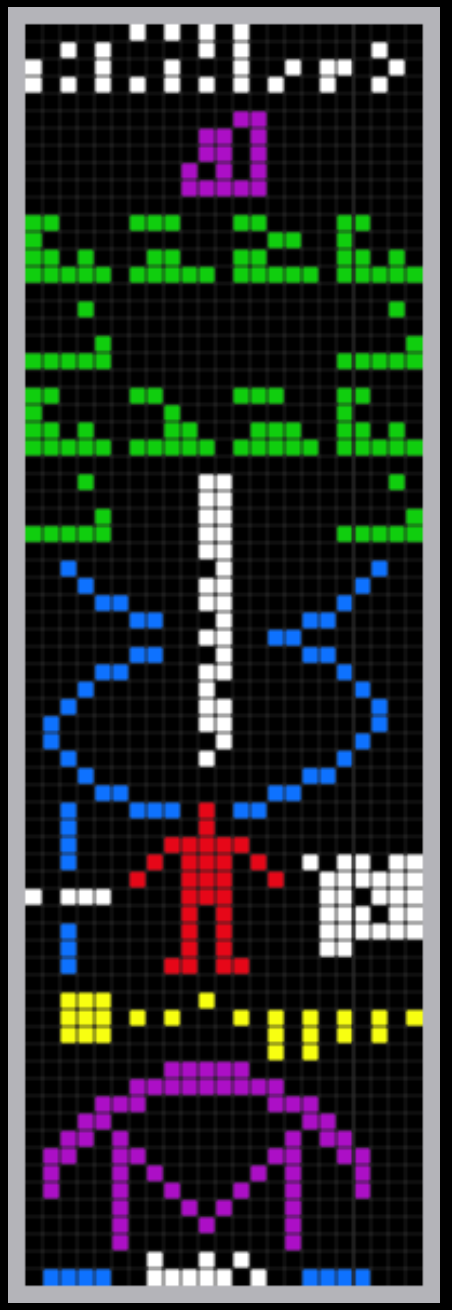
Now 140 AU

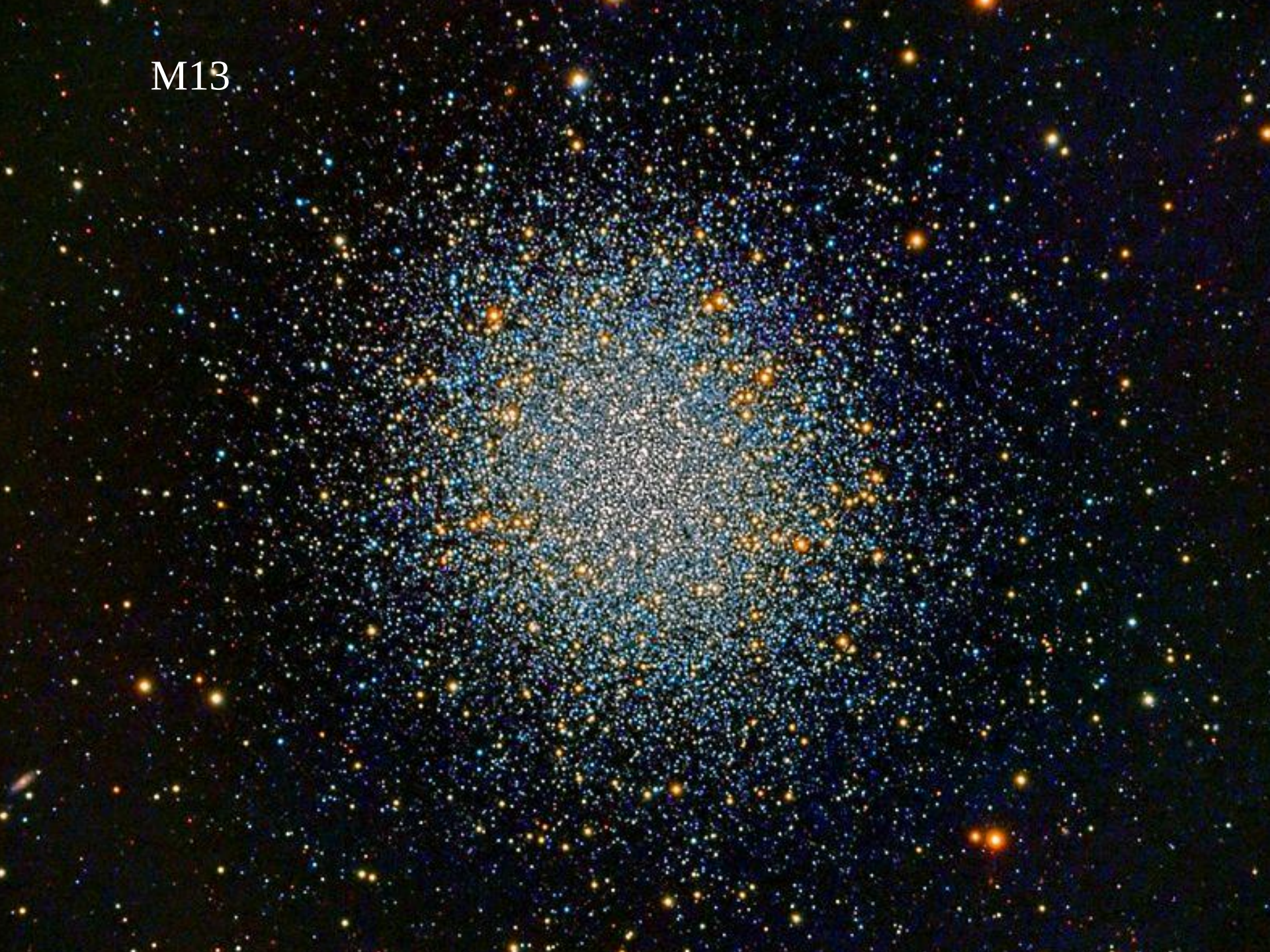
Earth – Sun distance = 1 AU

1 ly = 60,000 AU

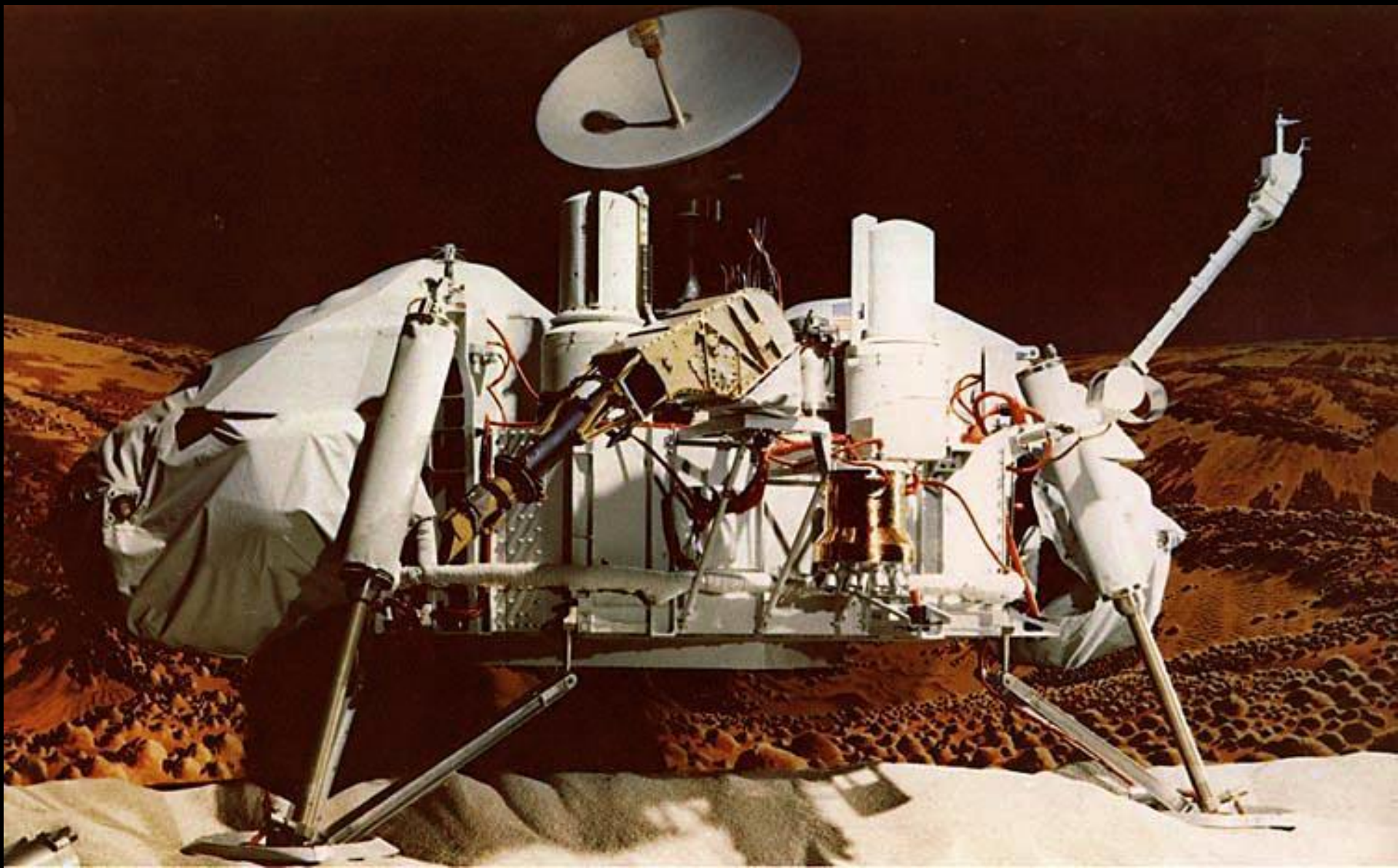
# *Arecibo message*

- Easy decoding?
- Sending back our own TV transmissions?
- Image 1679 = 23 x 73
- 1974 Arecibo message




M13

# *Viking 1+2 experiments (1976)*



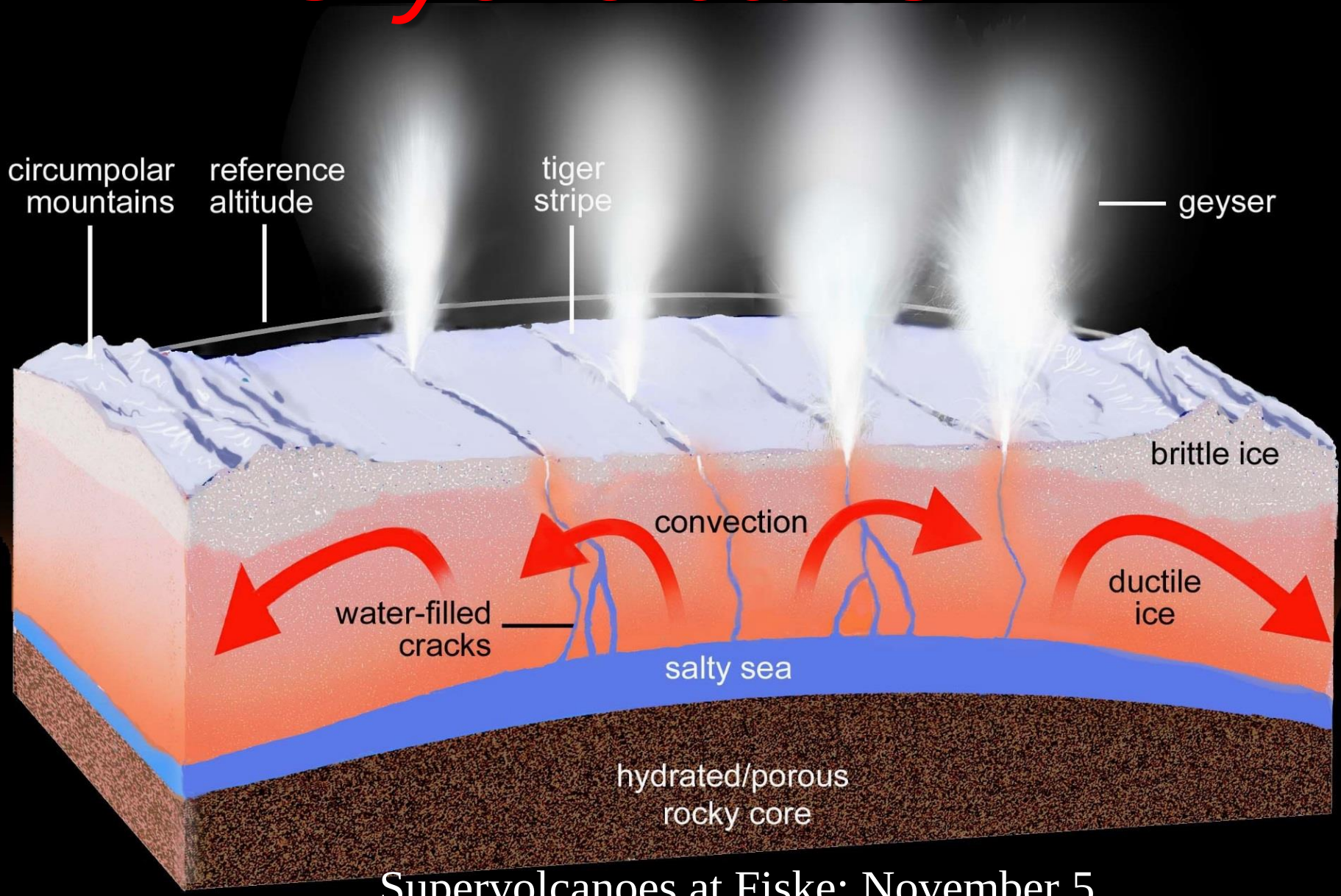
# *Viking 1+2 experiments (1976)*

- Pyrolytic release (PR) experiment
  - Test carbon fixation (soil+water)
- Gas exchange experiment (GXE)
  - Metabolic gas production
  - Soil+water vapor+org → e.g., $O_2$
- Label release (LR) experiment (?false pos)
  - Metabolic activity with supplied organics
  - Soil+moist+$^{14}C$ org → $^{14}C$ gas $CO_2$

# *Moons of Jupiter & Saturn*

| **Jupiter** | **orbit** | **Saturn** | **orbit** |
|---|---|---|---|
| Io | 1.8 d | Enceladus | 1.4 d |
| Europa | 3.6 d | | |
| Ganymede | 7.2 d | | |
| Callisto | 17 d | Titan | 16 d |

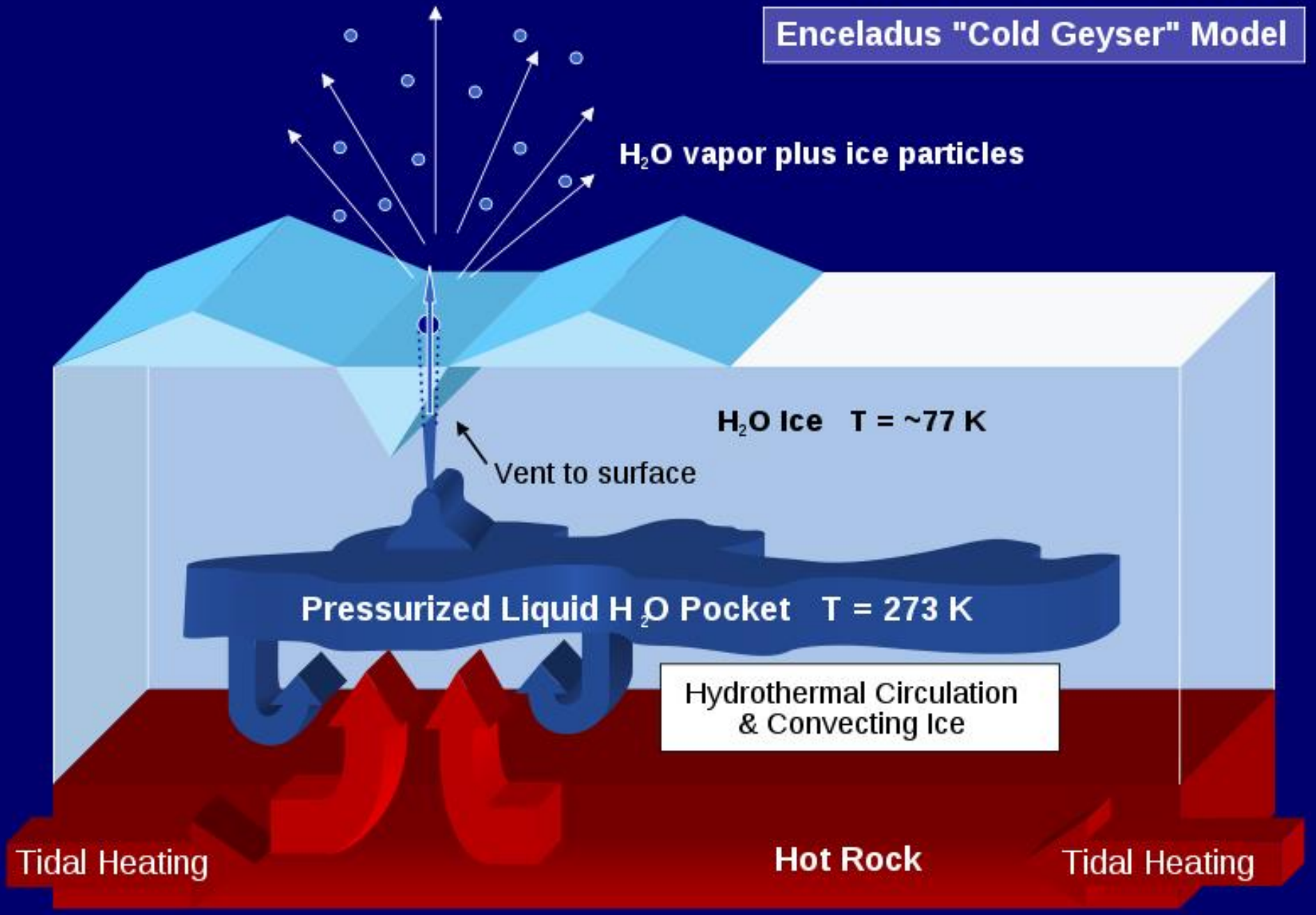
# Cryovolcanism




Supervolcanoes at Fiske: November 5

# Analogies

| | **Rocky planet** | **Icy body** |
|---|---|---|
| Core | Iron | Rock |
| Mantle | Silicate rocky shell | Liquid water |
| Crust | Rock | Water ice |
| Outgassing | $CO_2$ | $CH_4$ |
| Eruption of … | Lava | Slush |
| Aerosols | Dust | Haze |
| Dunes | Sand | Organics |
| Cycles | Water | Methane |
| | | |
| | | |


Enceladus "Cold Geyser" Model
H2O vapor plus ice particles
H2O Ice T = ~77 K
Vent to surface
Pressurized Liquid H2O Pocket T = 273 K
Hydrothermal Circulation
& Convecting Ice
Tidal Heating
Hot Rock
Tidal Heating

# *Analogies: which one is **wrong**?*

A. Iron core (terrestrial) = rocky core (icy)
B. Silicate mantle (terr) = liquid water
C. Rocky crust (terr) = water ice
D. Lava (terr) = slush ice
E. $CO_2$ (terr) = $SO_2$ (icy)

# *Analogies*

| | **Rocky planet** | **Icy body** |
|---|---|---|
| Core | Iron | Rock |
| Mantle | Silicate rocky shell | Liquid water |
| Crust | Rock | Water ice |
| Outgassing | $CO_2$ | **$CH_4$** |
| Eruption of … | Lava | Slush |
| Aerosols | Dust | Haze |
| Dunes | Sand | Organics |
| Cycles | Water | Methane |
| | | |
| | | |

# *Midterm on Friday*

- see sample+solutions
- includes Quiz 1 topics!
- and everything we had so far