ASTR/GEOL-2040: Search for life in the Universe: Lecture 19

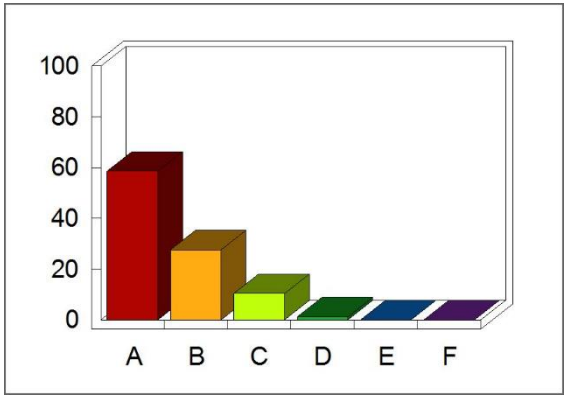
- Mars: another world
- Observations, canali, etc
- Liquid water: why not?

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

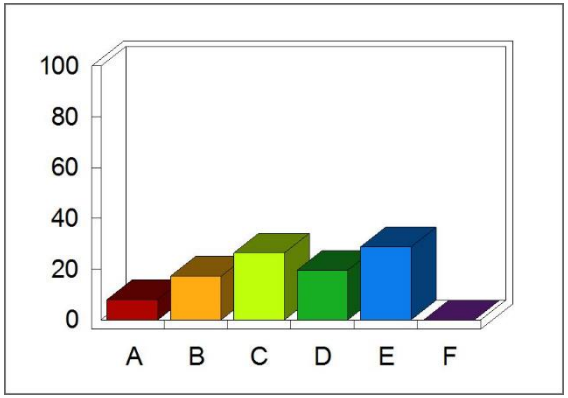
Comments from the grader:

1. Please ***buy a stapler***. I promise you as a fellow undergrad that this is a handy thing to have and a great investment. Plus, it's about $2 for a tiny one at the bookstore.
2. Please ***rip off the notebook fringe*** when you rip it out of your notebook. This makes it easier to organize then so that corners don't get frayed in my (very full) backpack. It takes like 2 seconds, and I promise I will wait to leave until the first 10 minutes of class are over which gives you plenty of time. :)
3. If you are working with someone for homeworks, please make a note of it on the bottom of your homework. ***I encourage you to work with others!*** It definitely helps. This is exclusively so that I can check the consistency of my grading.
4. If you don't want ***anyone to see your grade*** when I pass the homework back, ***then*** attach the ***question sheet on the front***. I won't write your grade on it to honor this. If you don't care, then you don't need to bother.
5. If you have questions about something on the homework, you can make a ***note of it on there, and I will do my best to help you***, or you can go to the astronomy help room! There are flyers posted for it on all the stairwells of Duane.

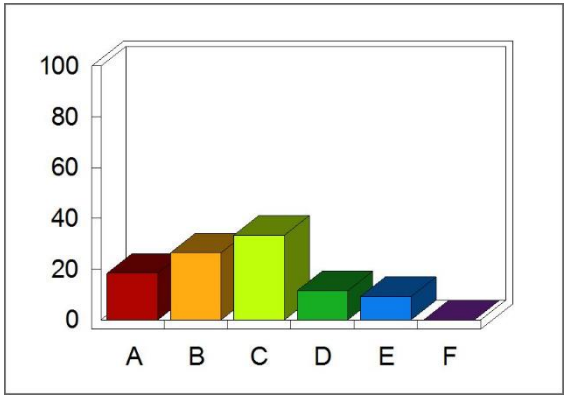
Thanks for your FTEP feedback



Asks questions of students



Knows if class is understanding



Has students apply concepts

- Apply concepts that we learnt
- Need to stand back & rethink
- Also, ask me more questions
- &, by the way, I'm happy to write letters…

What is an organic molecule?

A. At least one C and one O

B. At least one C and one H

C. At least one H and one O

D. All of the above

What is an organic molecule?

A. At least one C and one O

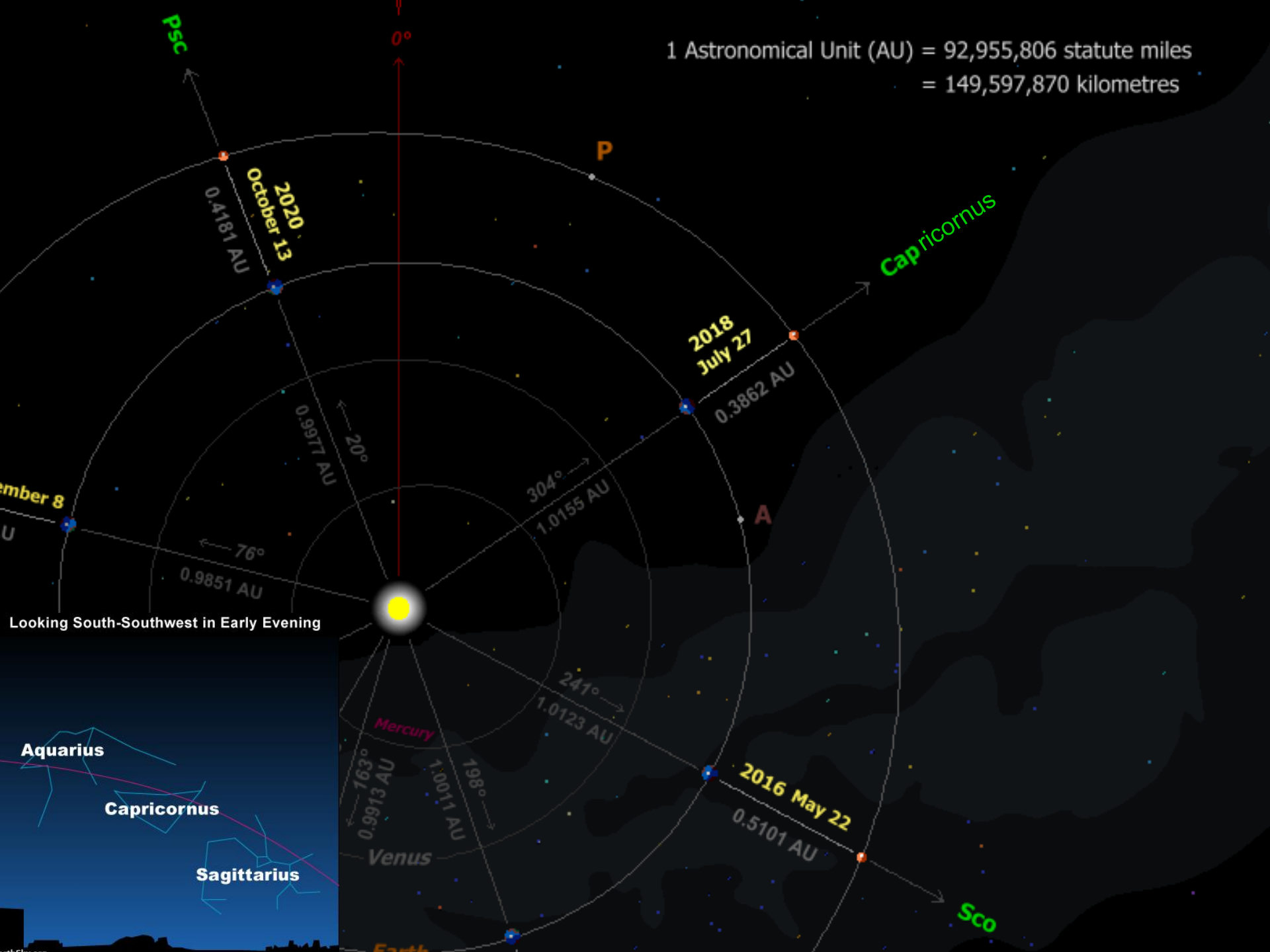
B. At least one C and one H

C. At least one H and one O

D. All of the above

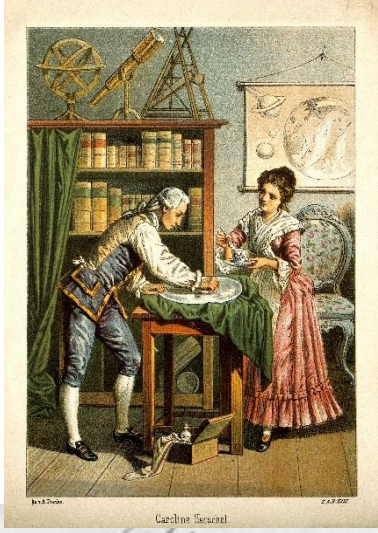
This week

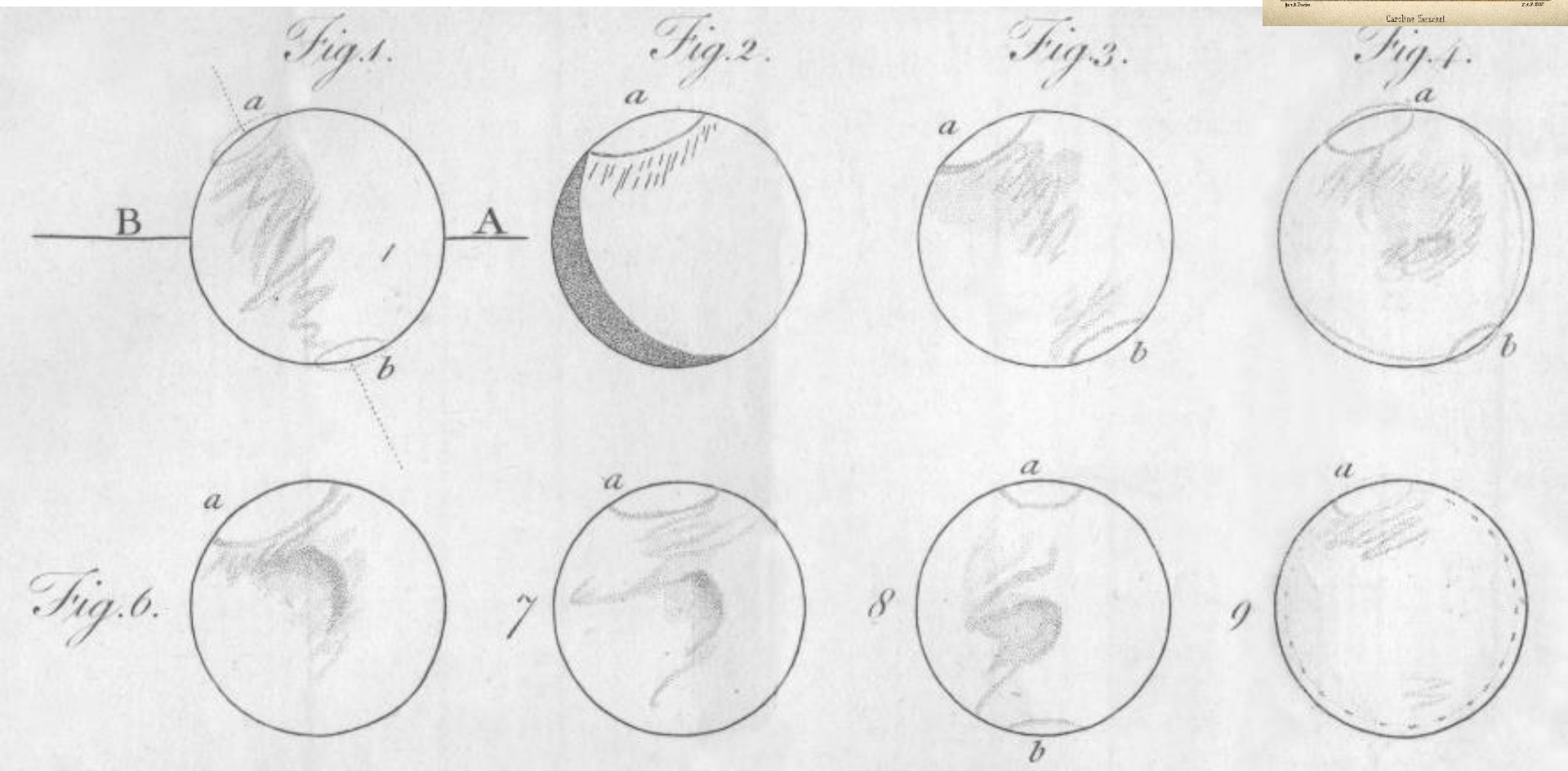
- Mars, RGS 85-96, Lon 255-288, BS 267-301
- Viking experiments: BS 287-291


1 Astronomical Unit (AU) = 92,955,806 statute miles
= 149,597,870 kilometres
Psc
0°
P
2020 October 13
0.4181 AU
Capricornus
2018 July 27
0.3862 AU
0.9977 AU
20°
304°
1.0155 AU
A
ember 8
76°
0.9851 AU
Looking South-Southwest in Early Evening
241°
1.0123 AU
Mercury
2016 May 22
0.5101 AU
163°
0.9913 AU
198°
1.0011 AU
Venus
Sco
Earth
Aquarius
Capricornus
Sagittarius

Early Mars Exploration

- Kepler: highly elliptic orbit (5x Earth's orbit)
- Christian Huygens (Mars axis inclided)
- William & Caroline Herschel (1784)
- Coroline (his sister): 1st woman paid for science!





Result of the contents of this paper.

The axis of Mars is inclined to the ecliptic 59° 42′.

The node of the axis is in 17° 47′ of Pisces.

The obliquity of the ecliptic on the globe of Mars is 28° 42′.

The point Aries on the martial ecliptic answers to our 19° 28′ of Sagittarius.

The figure of Mars is that of an oblate spheroid, whose equatorial diameter is to the polar one as 1355 to 1272, or as 16 to 15 nearly.

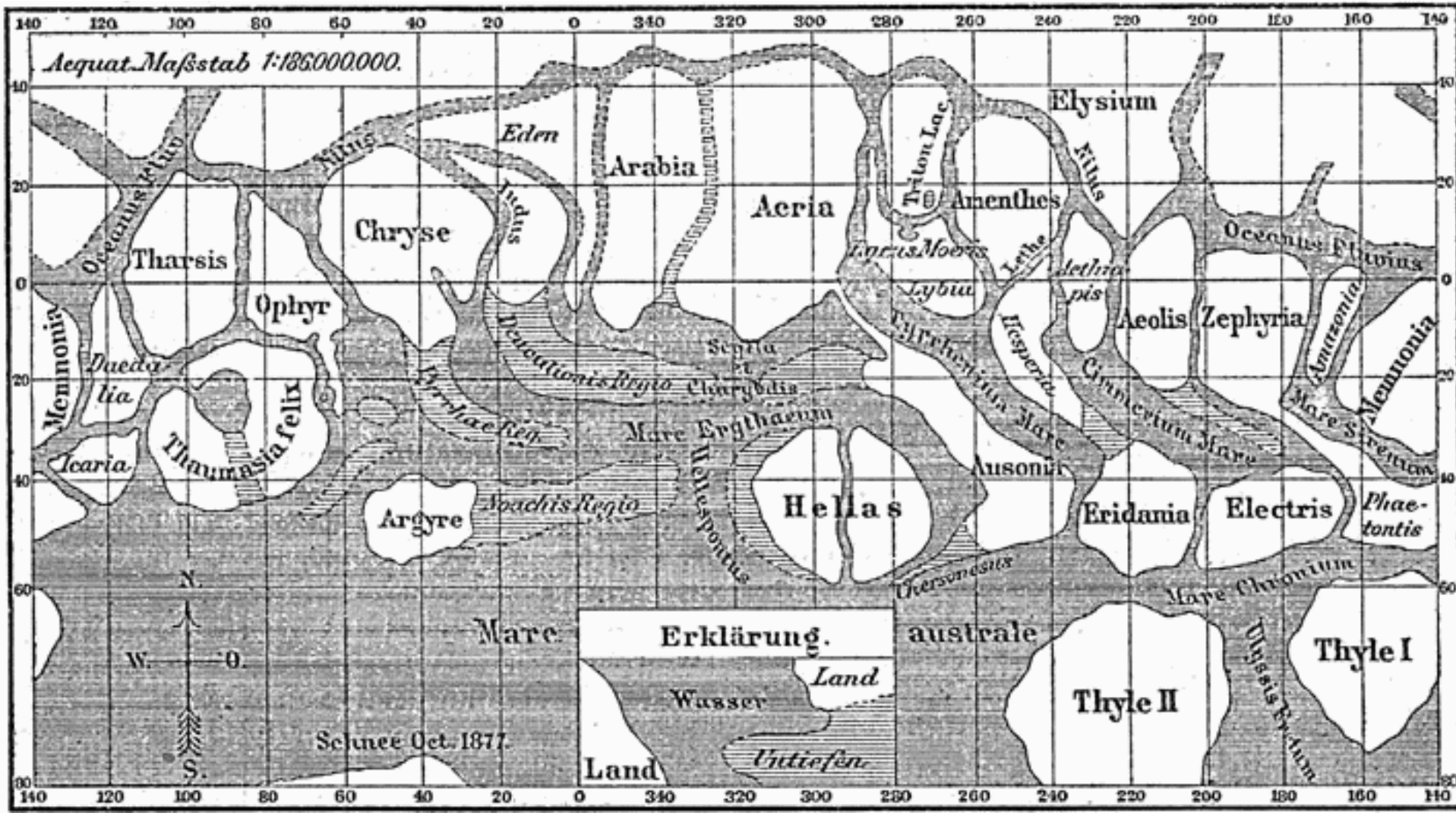
The equatorial diameter of Mars, reduced to the mean distance of the earth from the sun, is 9″ 8‴.

And that planet has a considerable but moderate atmosphere, so that its inhabitants probably enjoy a situation in many respects similar to ours.

Datchet, Dec. 1, 1783.

W. HERSCHEL.

Schiaparelli (1899)



Schiaparelli (1899) on canali

- Were his observations correct?
- Did he over-interpret them?
- Excerpt:

> A considerable portion of the work is devoted to the phenomenon which is called, according to usage, the *canals* of Mars, the nature of which is still entirely obscure, despite the theories, oftentimes pretty and very ingenious, which they have occasioned.

First Photographs of the Canals of Mars

By Professor Percival Lowell, Flagstaff Observatory, Arizona.

(Communicated by Sir Norman Lockyer, K.C.B., F.R.S. Received September 27, —Read November 16, 1905.)

[Plate 1.]

To make the canals of Mars write their own record on a photographic plate, so that astronomers might have at first hand objective proof of their reality, has long been one of the objects of this observatory. The endeavour has at last succeeded. Unnecessary as such corroboration was to the observers themselves, it is different with the world at large; for the work of the

λ = 194° May 20, 10 h. 42½—45 m.

λ = 190° May 20, 10 h. 25—40 m.

λ = 171° May 22, 10 h. 20—30 m.

Newcomb (1907) in Astrophys. J.

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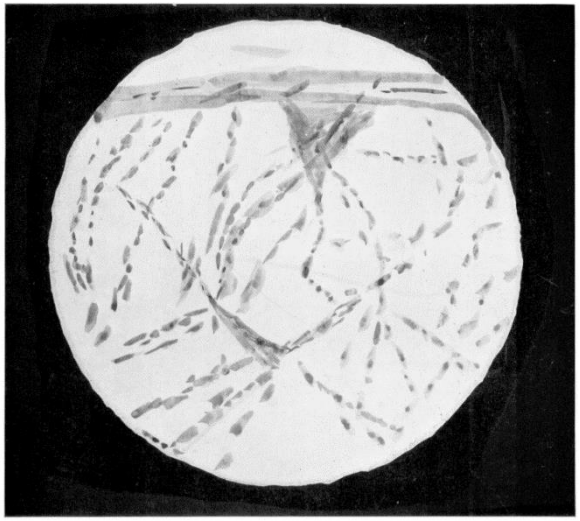
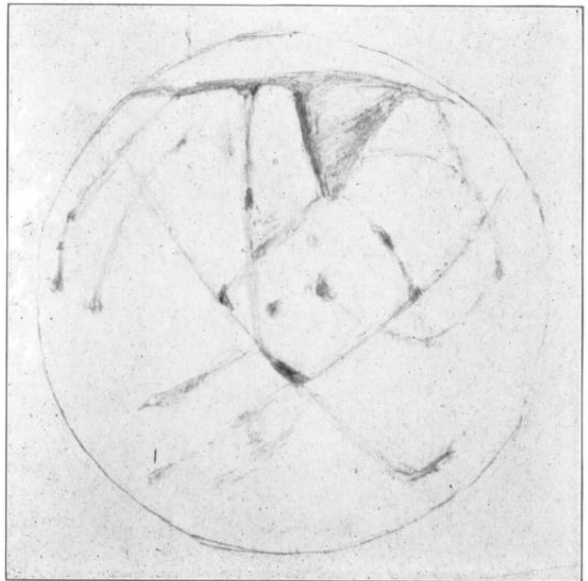


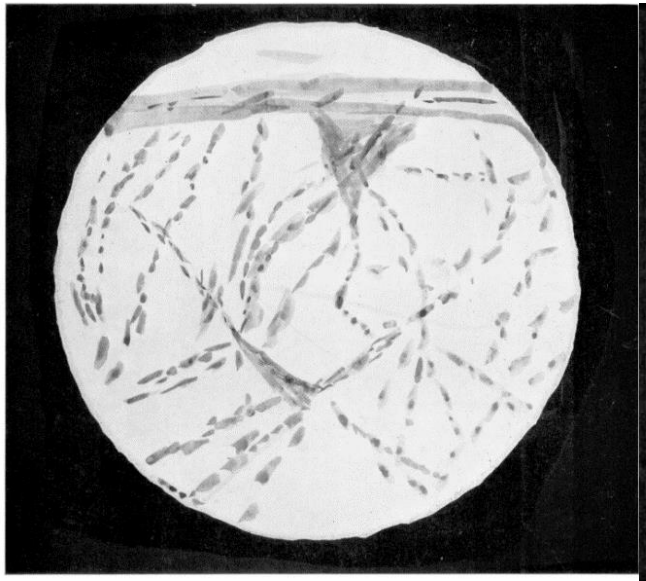


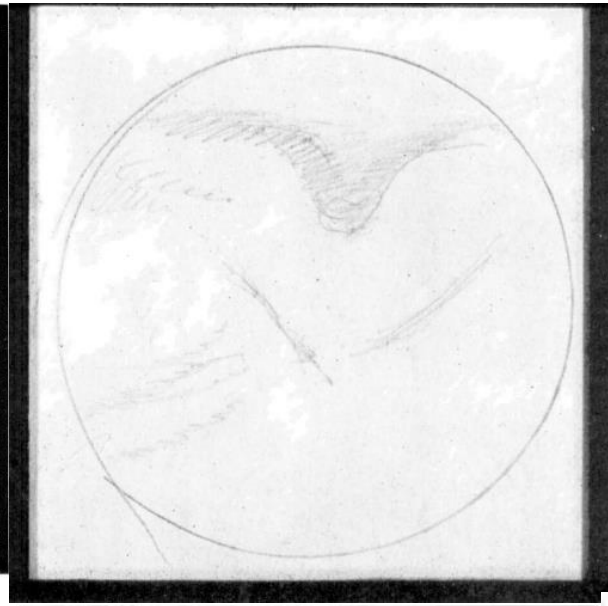
THE OPTICAL AND PSYCHOLOGICAL PRINCIPLES INVOLVED IN THE INTERPRETATION OF THE SO-CALLED CANALS OF *MARS*

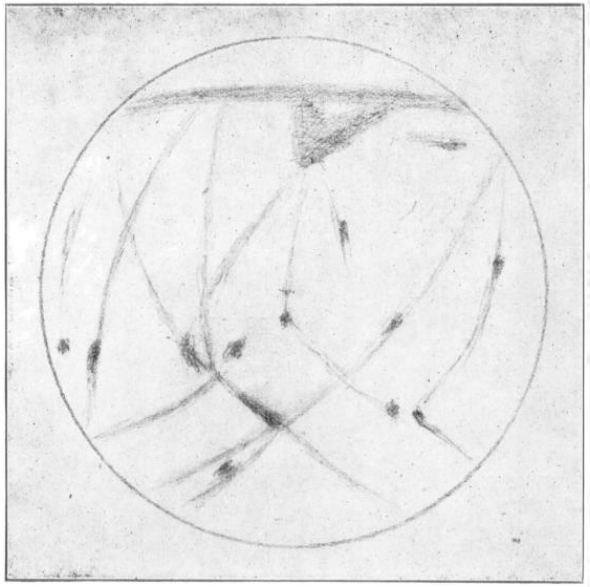
By SIMON NEWCOMB

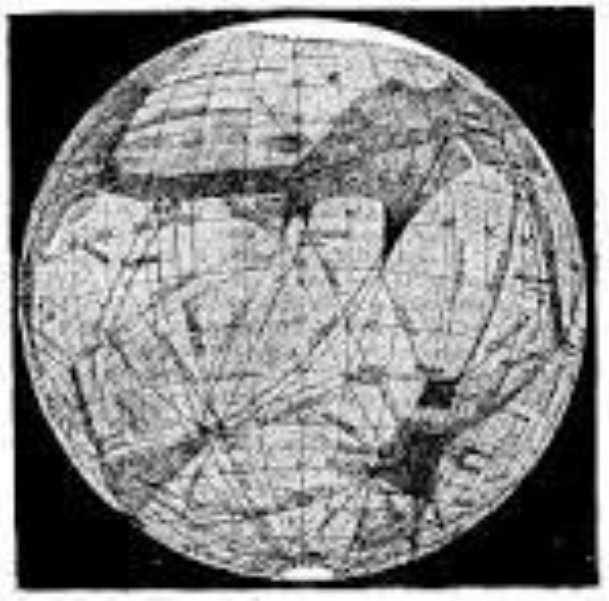
The features of the planet *Mars* as described by Schiaparelli, Lowell, and other observers are so remarkable that the question of their interpretation is of great interest. The divergence between the descriptions and delineations of these features emanating from different observers is well known, and seems scarcely normal. Ac-

Newcomb (1907) in Astrophys. J.









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THE CANALS OF MARS, OPTICALLY AND PSYCHOLOGICALLY CONSIDERED

A REPLY TO PROFESSOR NEWCOMB

By PERCIVAL LOWELL

By Philip Fox

Accurate rotation period!

His mistake lay in including the early drawings of the seventeenth and eighteenth centuries and in giving them an altogether disproportionate weight.

The present result, V, is: $24^{h.}\ 37^{m.}\ 22^{s.}.58$.

PERCIVAL LOWELL.

LOWELL OBSERVATORY,
April 29, 1914.

Current value: $24^h37^m22^s.663$

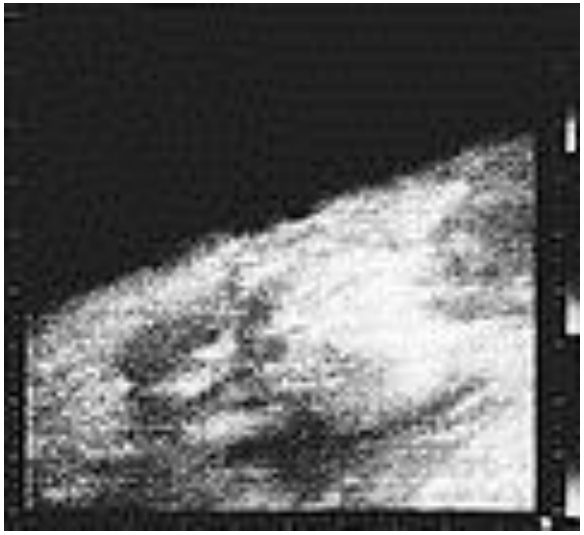
Wird beiden letzten Mitteln gleiches Gewicht beigelegt; das vom 14. Oktbr. aber, der schwierigen Schätzung wegen, ganz übergangen, so ergiebt sich

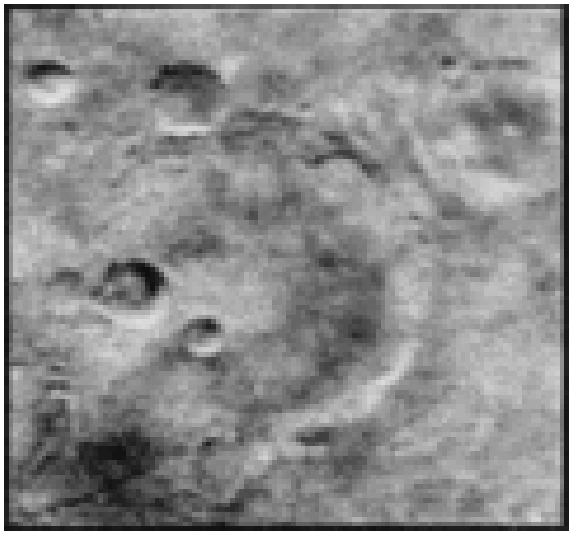
	h	′	″
	24	37	11,5
Corr. wegen der Lichtgleichung	—		1,6
Mittel	24	37	9,9

Rotation v. W nach O.

Beer & Maeder (1830)

Mariner 4 (1964)





- Craters, no canals
- Thin atmosphere
- No intelligent life
- Microbial life?

A Search for Life on Earth at Kilometer Resolution

STEVEN D. KILSTON

Harvard College, Cambridge, Massachusetts

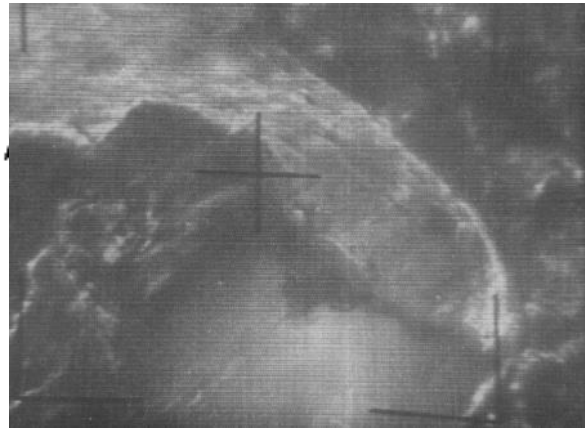
ROBERT R. DRUMMOND

Goddard Space Flight Center, National Aeronautics and Greenbelt, Maryland

AND

CARL SAGAN

Harvard University and Smithsonian Astrophysical Observatory, Cambridge, Massachusetts



Received July 20, 1965

A search for life on Earth at kilometer resolution, using several thousand photographs obtained by the Tiros and Nimbus meteorological satellites, has been undertaken. No sign of life can be discovered on the vast majority of these photographs.

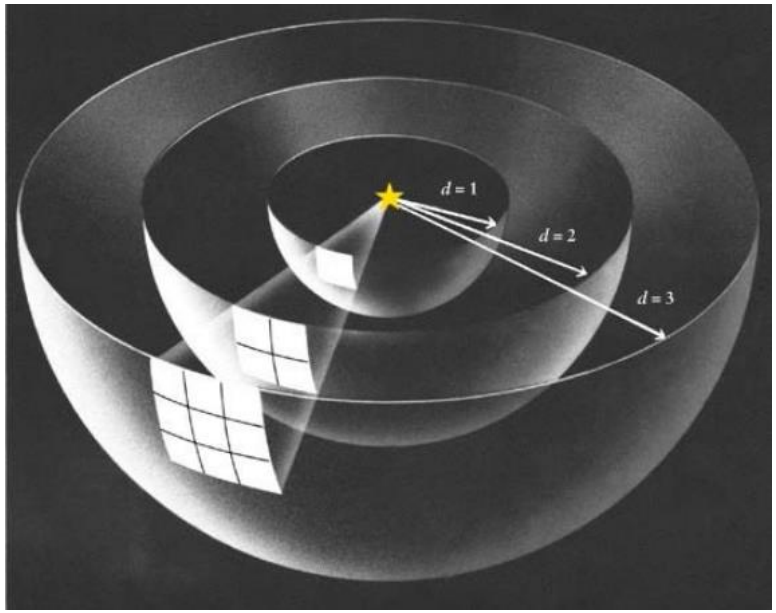
Later Mars missions

- 1969 Mariner 6+7 (flybys)
  - Atmospheric measurements
  - missed volcanoes & canyon
  - Week after Apollo 11…
- Mariner 9, first orbiter
  - Discovered volcanic activity
  - LASP involvement (UV spectrometer)

Mars further away

$$T_{\text{planet}} = T_{\text{Sun}} \left(\frac{R_{\text{Sun}}}{2d} \right)^{1/2}$$

$$T_{\text{planet}} = \frac{280\ \text{K}}{\sqrt{d\ [\text{AU}]}}$$



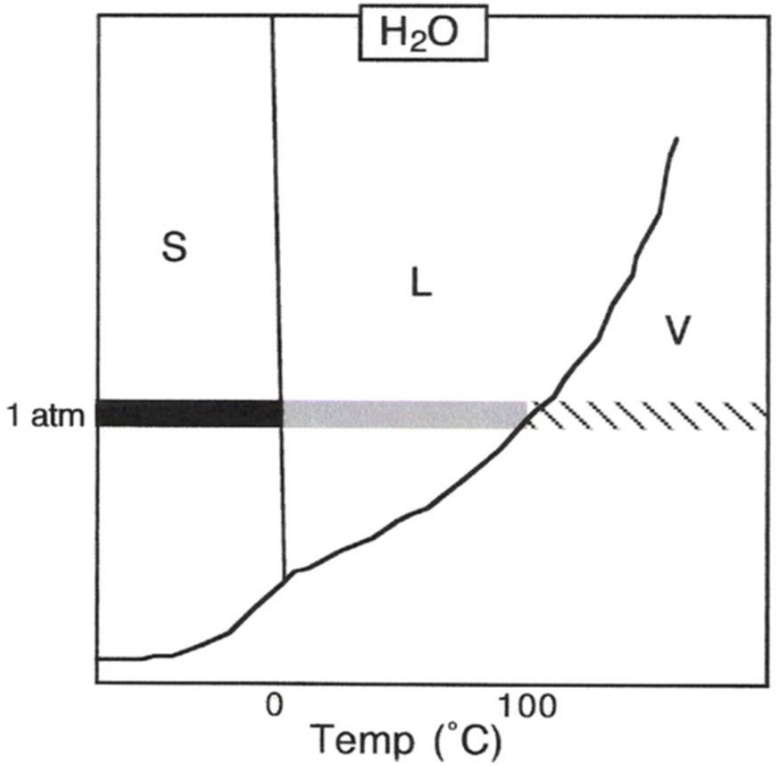
Distance to Sun *d* is 1.4 – 1.7 AU

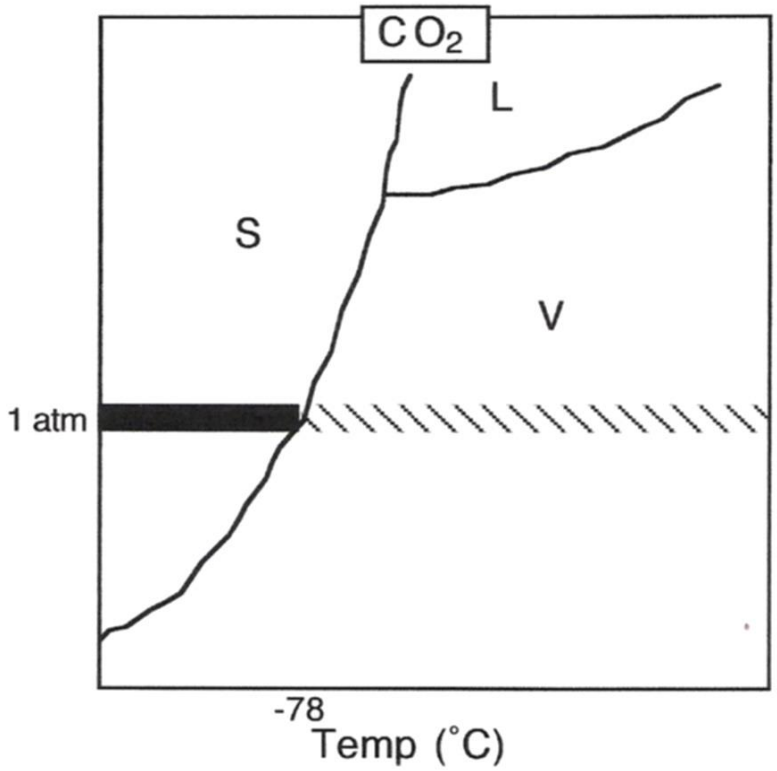
- sqrt(1.4) = 1.2
- about 20% less then 280 K
- subtract 56 K → 224 K
- 273 K – 224 K = 49 K,
- so T = – 49 C = – 56 F

Another difference between Earth & Mars

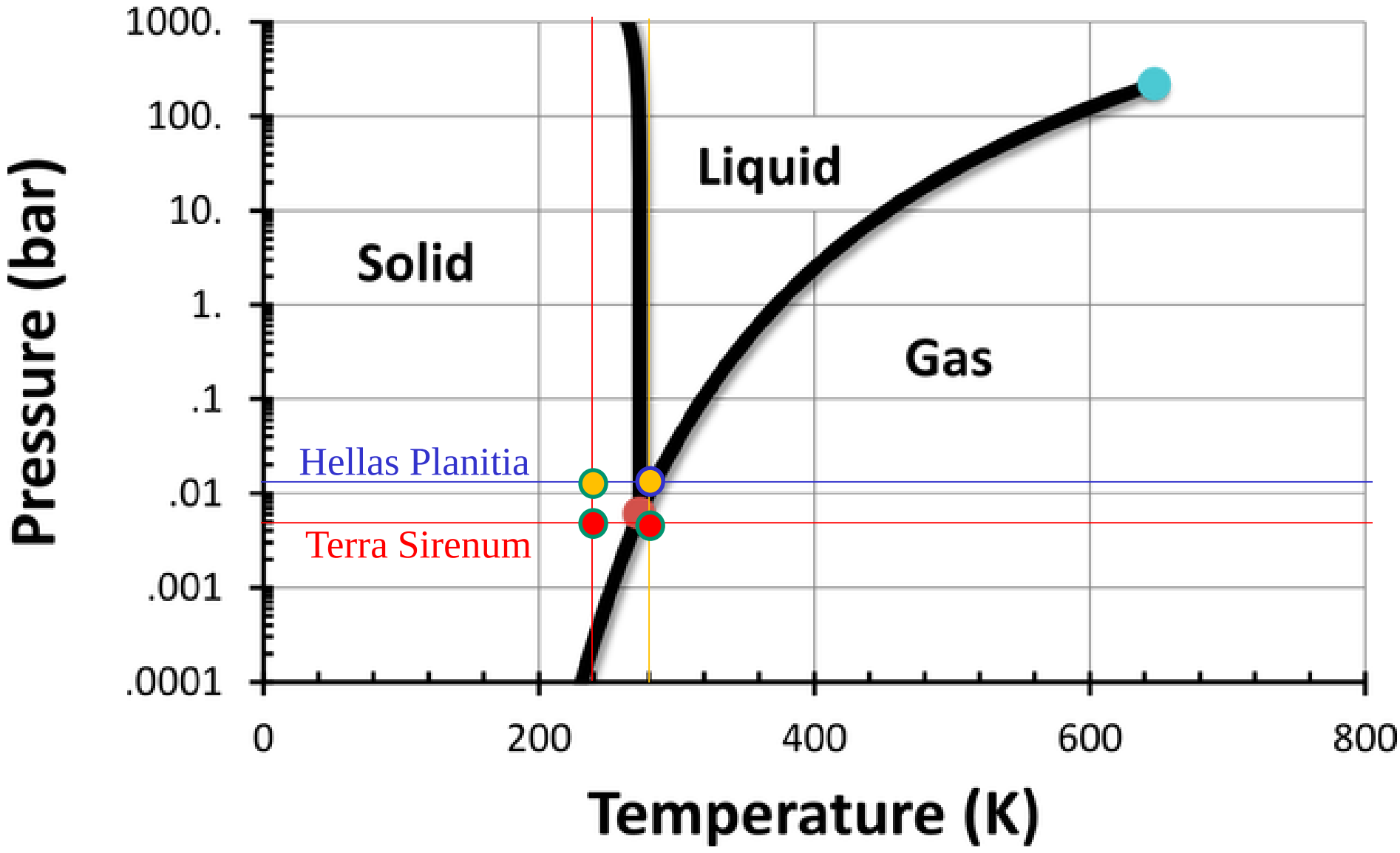
- Analogy with “dry ice”
- Doesn’t get wet!
- Yes, can be liquid
- When?

Phase diagram of water





Phase diagram of water



For Wednesday

- Mars, RGS 85-96, Lon 255-288, BS 267-301
- Viking experiments: BS 287-291