

# SETI -

## *Search for Extra-terrestrial Intelligence*

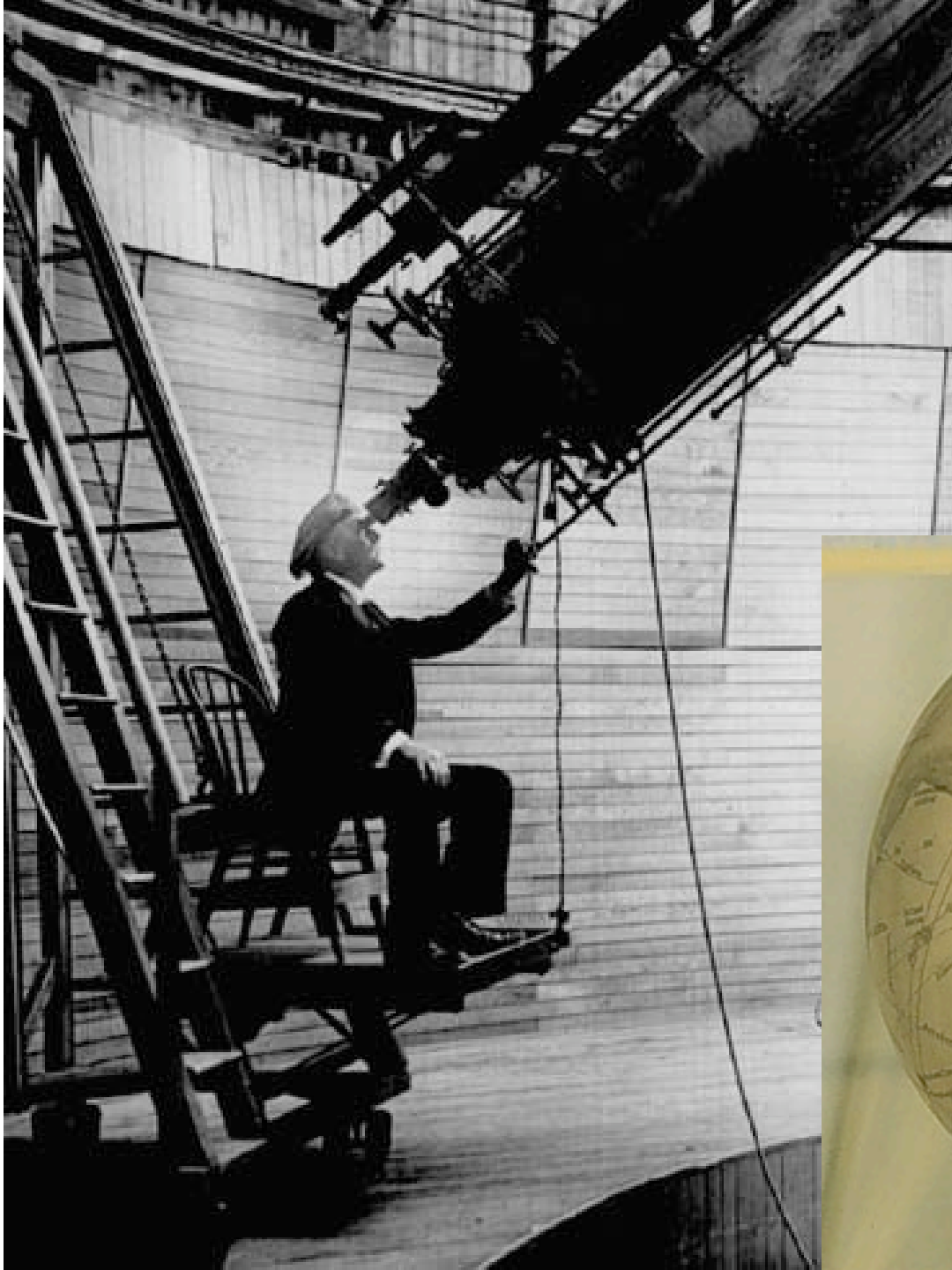
*Donna M. Jurdy  
Northwestern University*



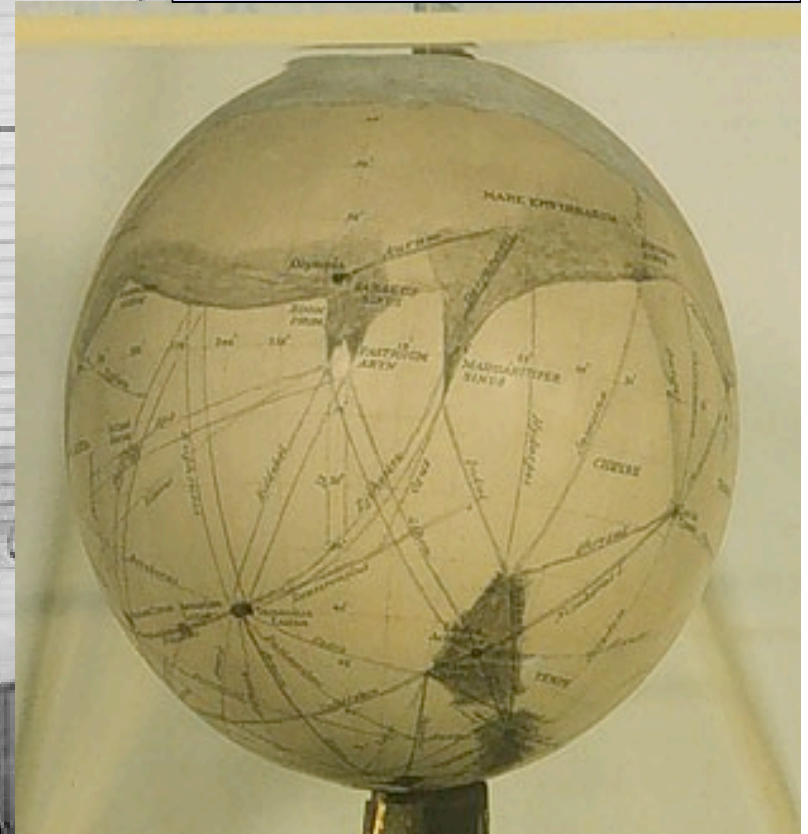




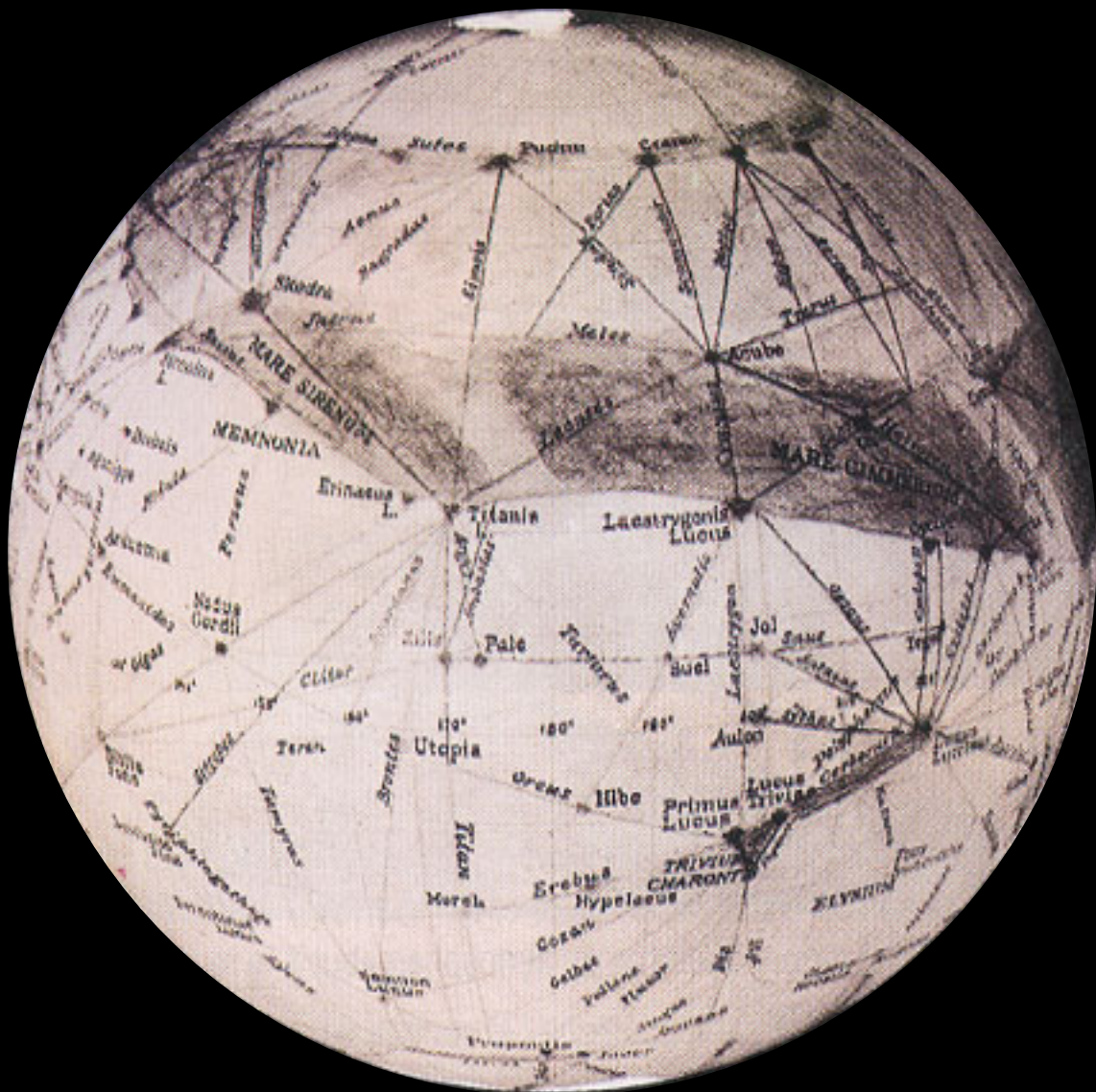




PERCIVAL LOWELL AT THE  
24 INCH REFRACTOR,  
FLAGSTAFF, ARIZONA  
OBSERVING MARS DURING  
FAVORABLE OPPOSITION  
(PERIHELIC OPPOSITION)  
OF 1894  
BELOW IS A GLOBE  
CONSTRUCTED FROM HIS  
DRAWINGS









# The WAR of the WORLDS

By H. G. Wells

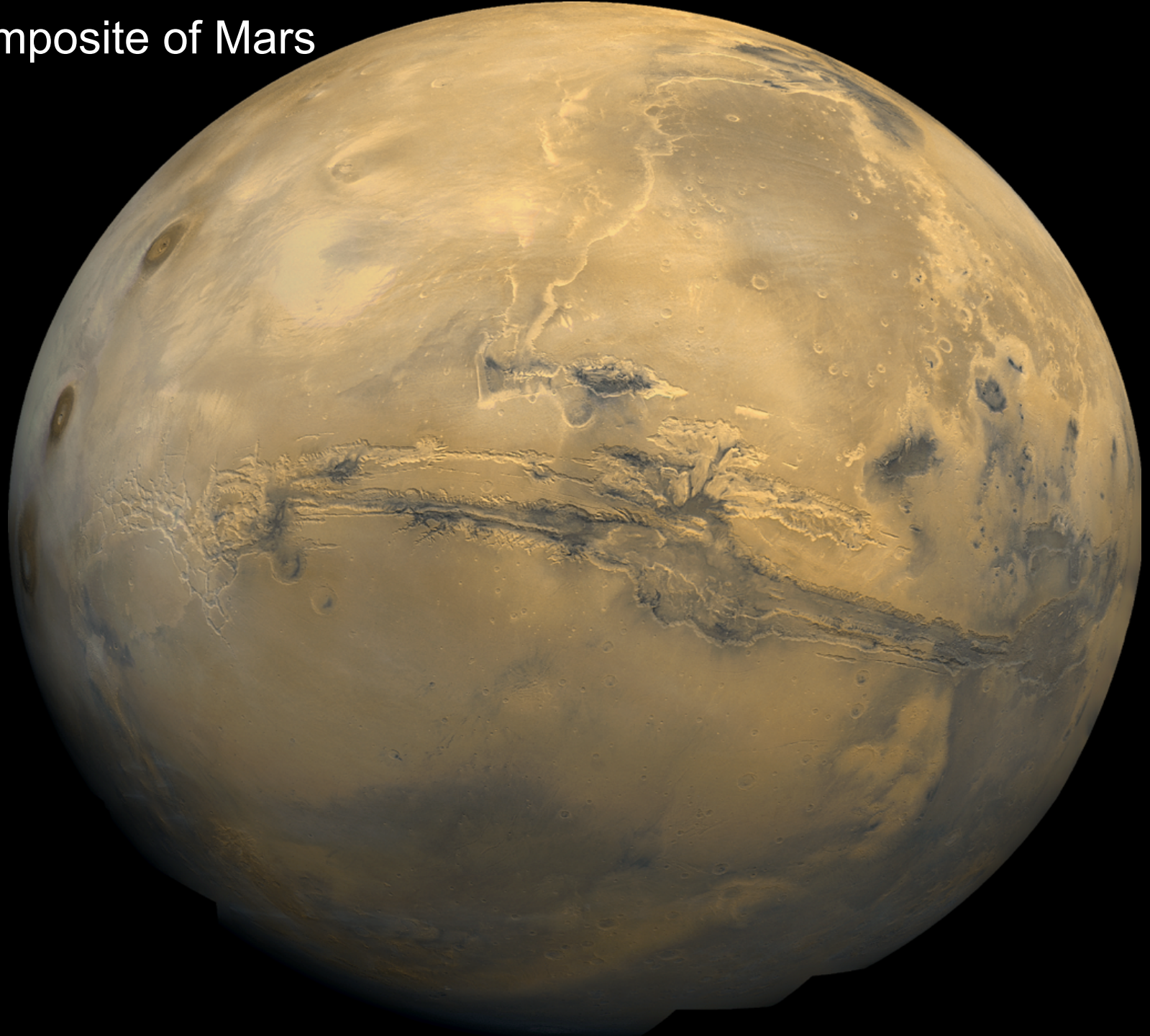
Author of "Under the Knife," "The Time Machine," etc.





# *Viking composite of Mars*

mid 1970's

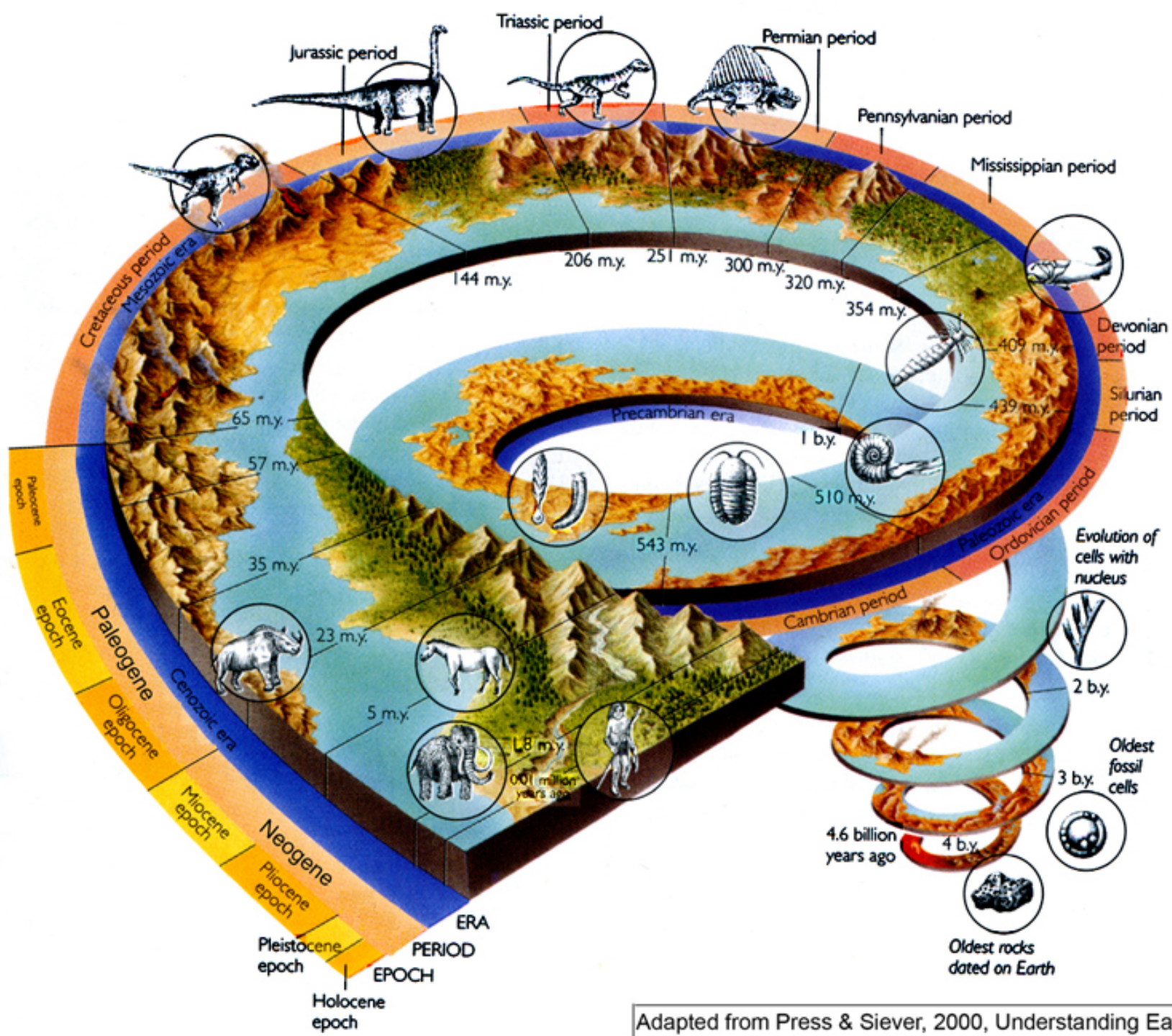




ALH84001,0

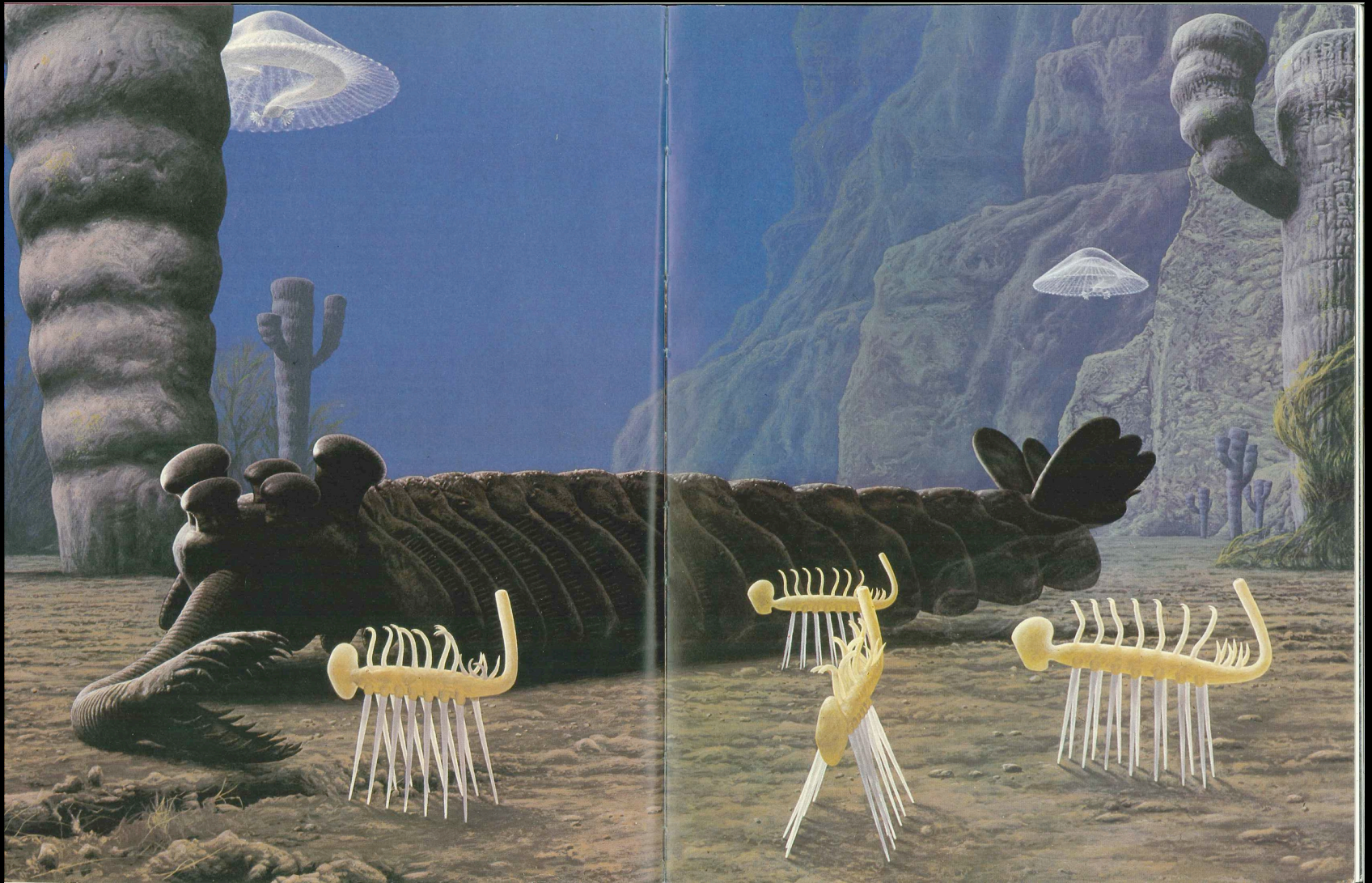






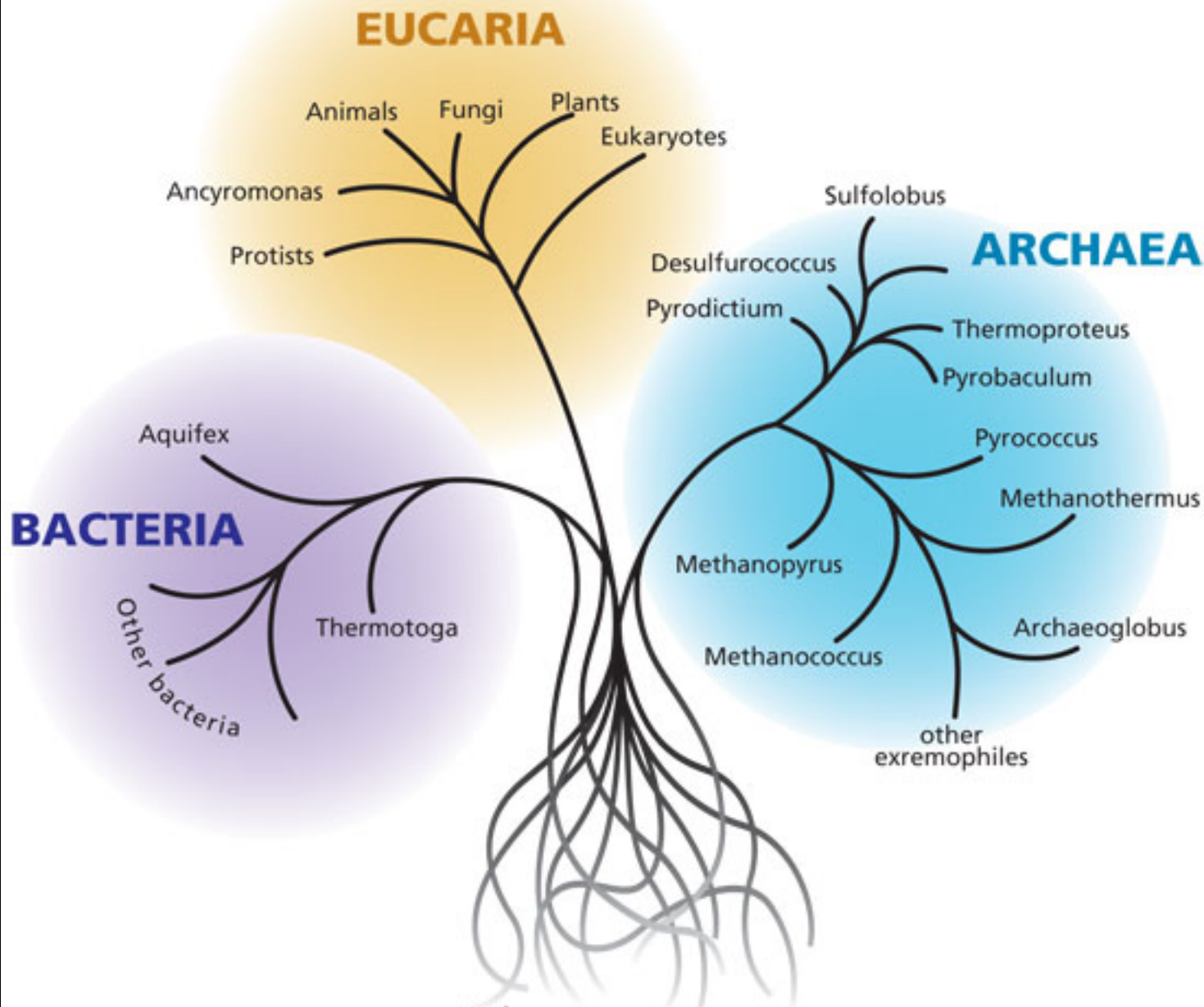
Adapted from Press & Siever, 2000, Understanding Earth









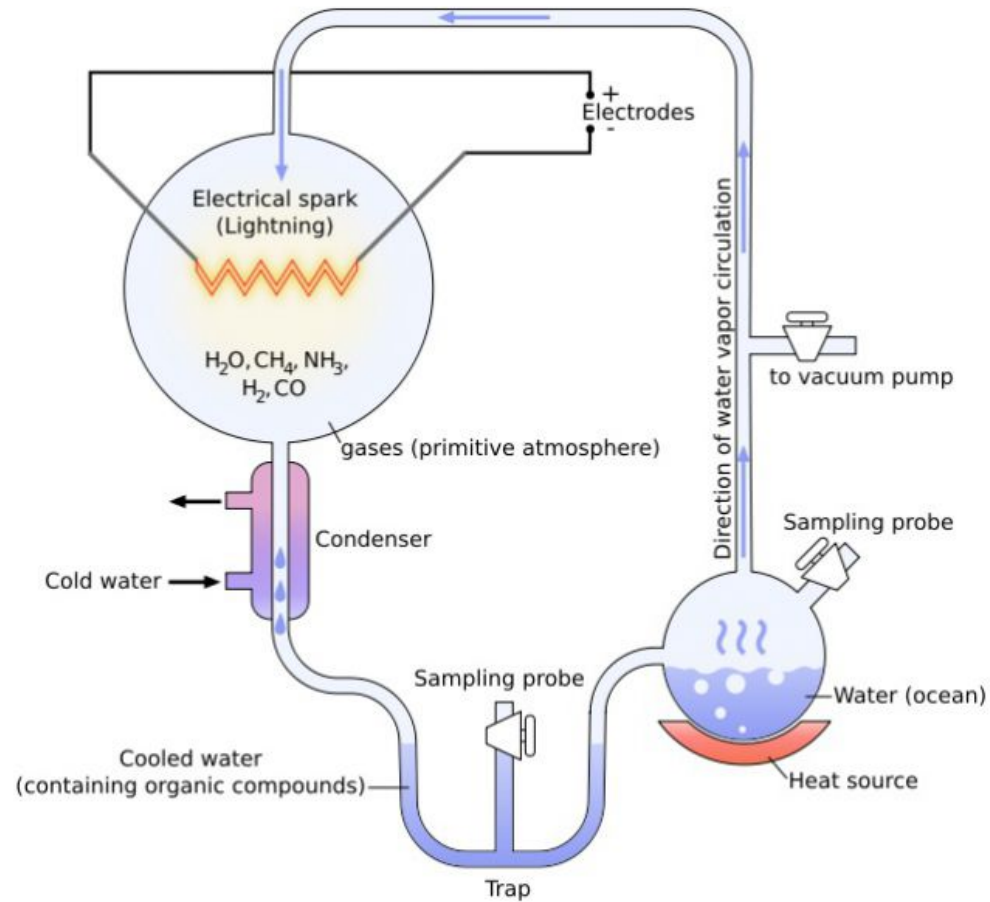




# The Miller-Urey Experiment



Above: Harold C. Urey (1893-1981)



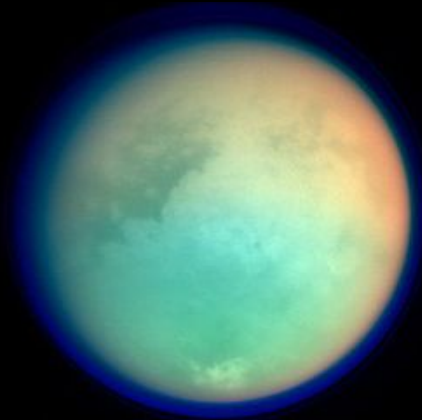
Left: Stanley L. Miller (1930-2007) with a reproduction of the experimental setup he first used in the 1950's to study pathways to the origin of life.

# *Life in the Solar System?*

Pole-to-Equator Temperature Difference on Other Planets



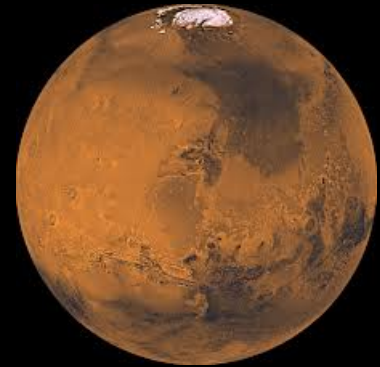
~ 0 K



~ 4 K



a few 10 K



a few (more) 10 K

← Thicker Atmosphere



# *Needed for Habitability?*

Solid surface

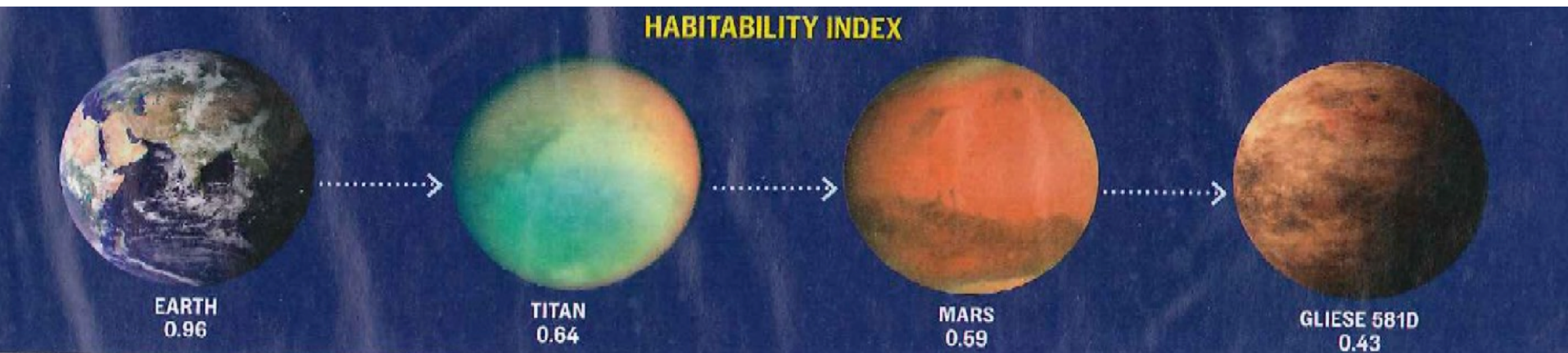
Atmosphere

Liquid on surface:

Need not be water

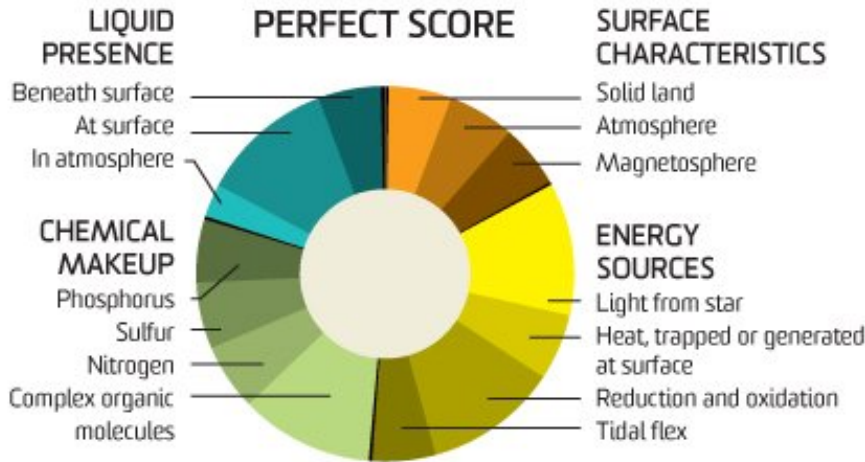


PHI – Planetary Habitability Index:  
Schulze-Makuch et al., 2011





# Habitability Index

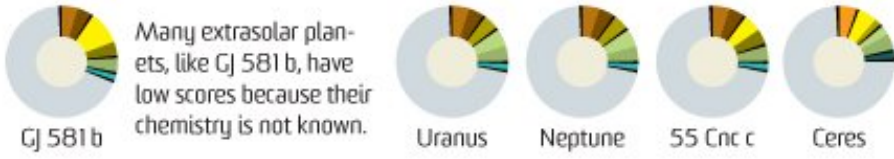
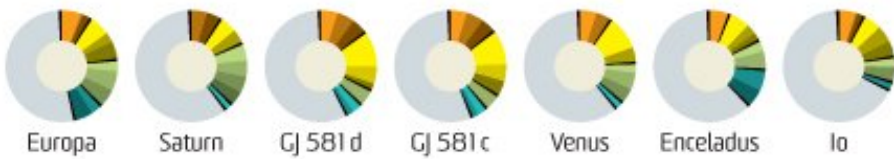
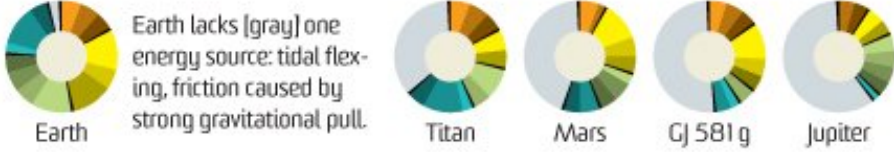


Earth = 0.96

Titan = 0.64

Mars = 0.59

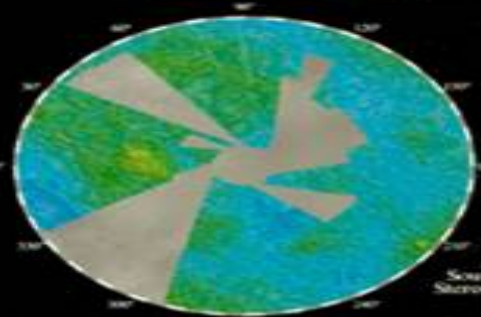
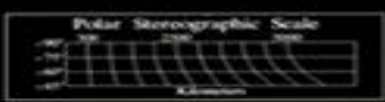
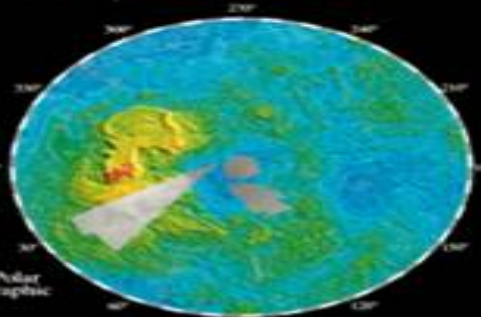
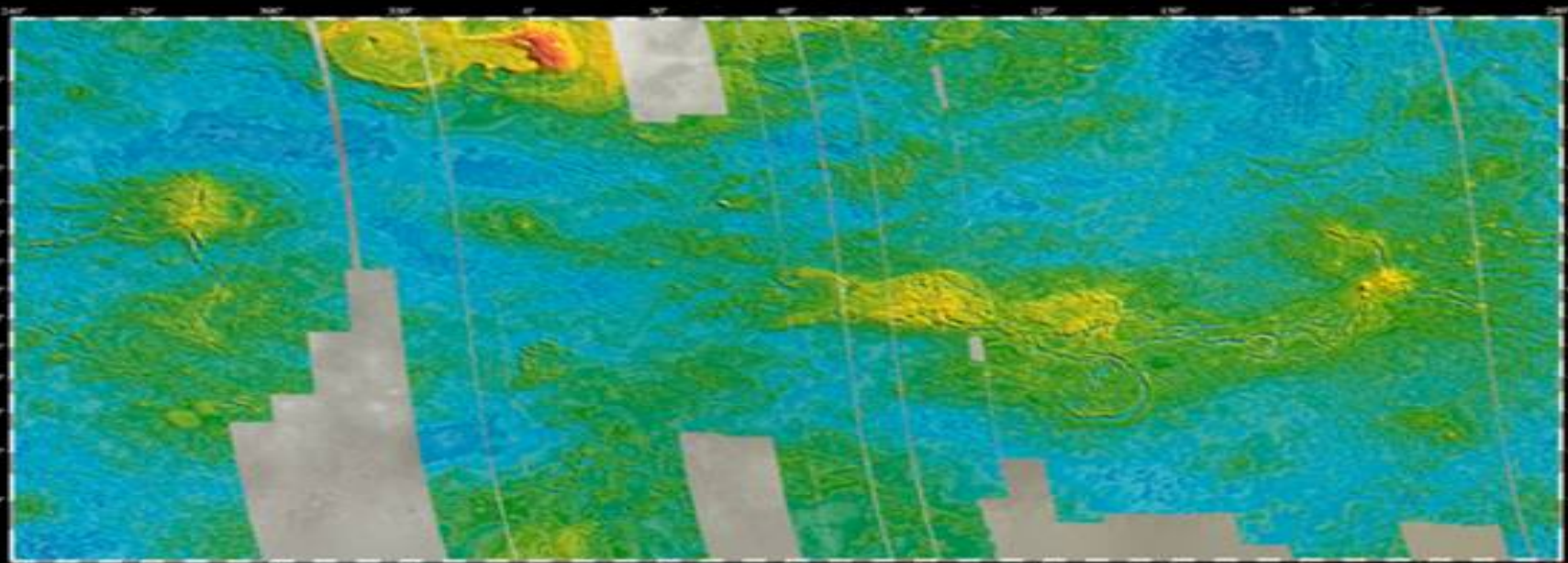
Gliese 581d = 0.43



# MAGELLAN

# VENUS TOPOGRAPHY

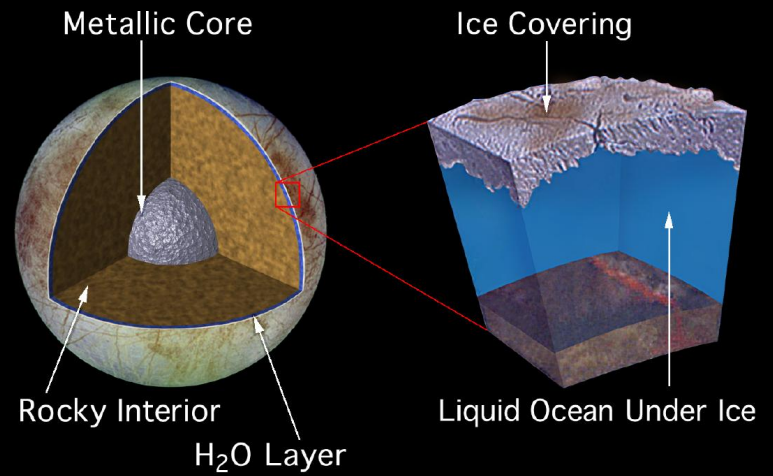
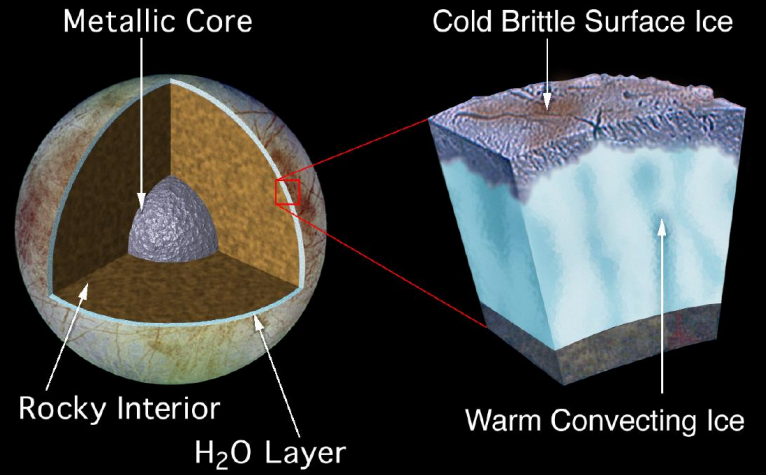
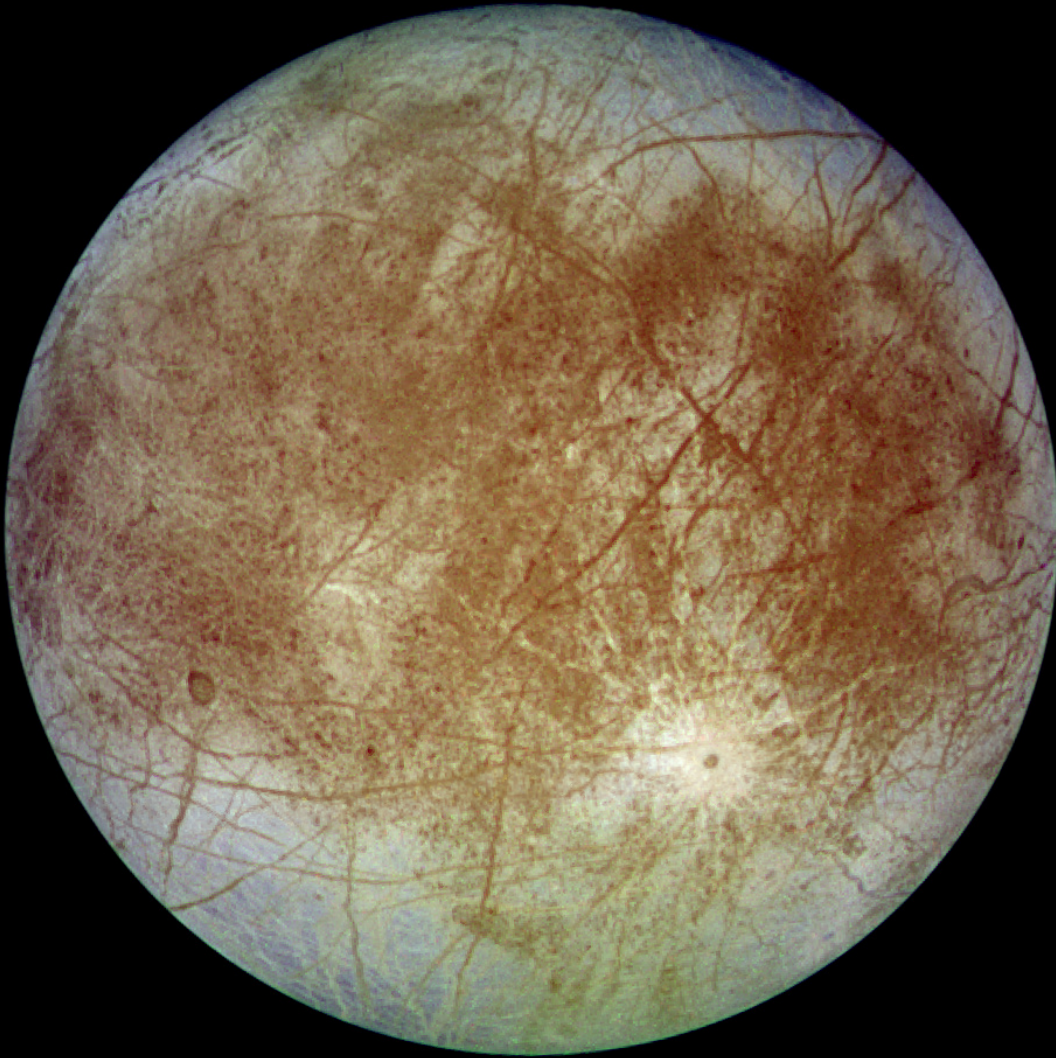
# GTRDP.1;3



PRODUCT ID:	GTRDP.1;3	PRODUCTION DATE:	11/02/91
STARTING ORBIT:	376	PRODUCTION TIME:	13:19:13
ENDING ORBIT:	2586	HARDWARE VERSION:	01
PANEL SIZE:	5x5 km	SOFTWARE VERSION:	02

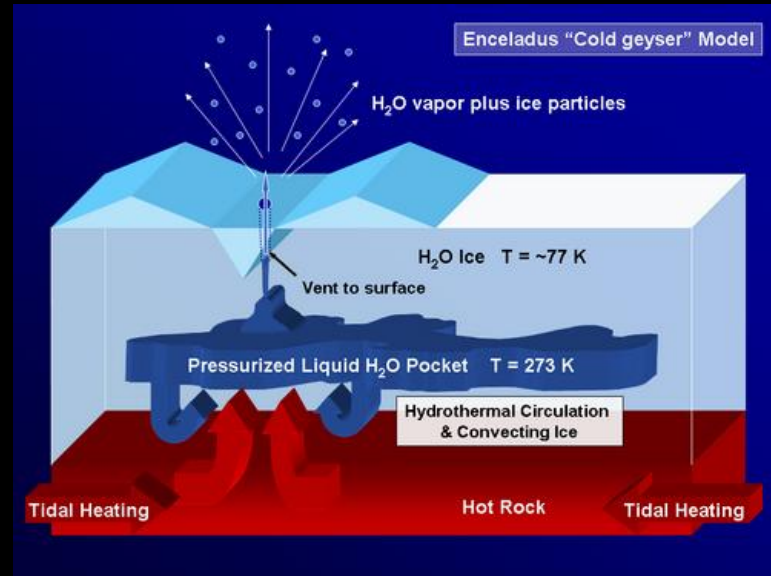
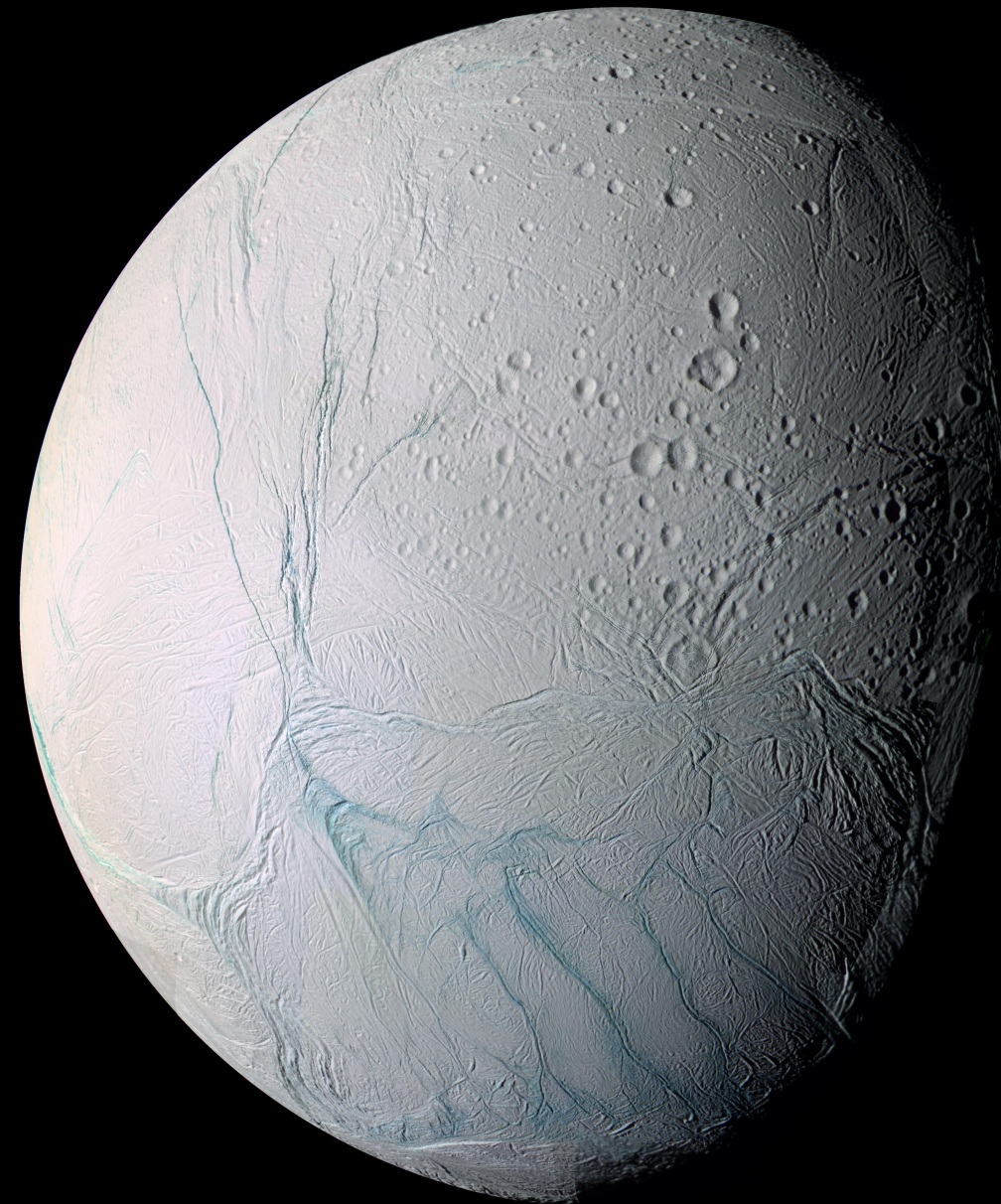


# Europa



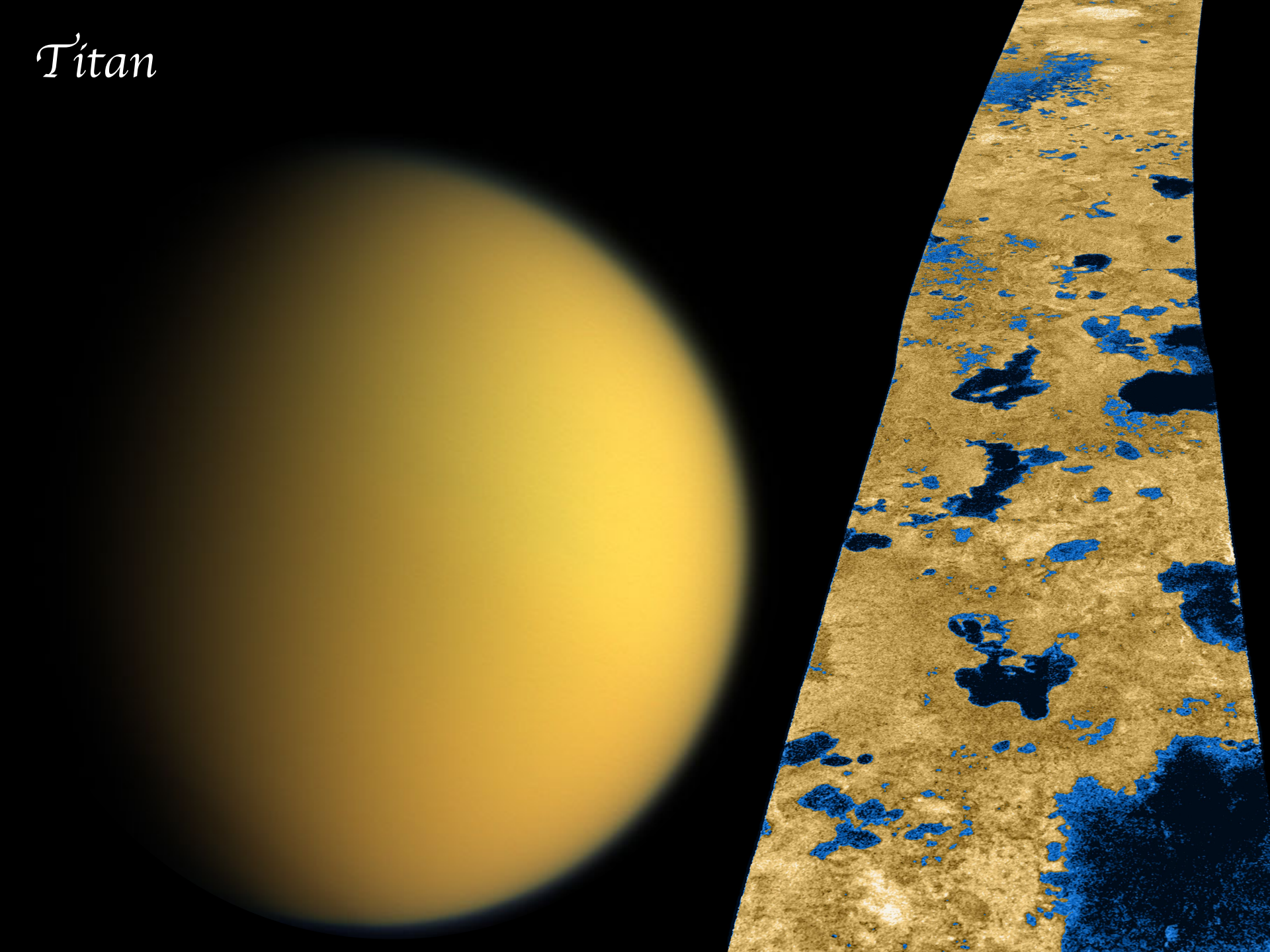


# Enceladus





*Titan*



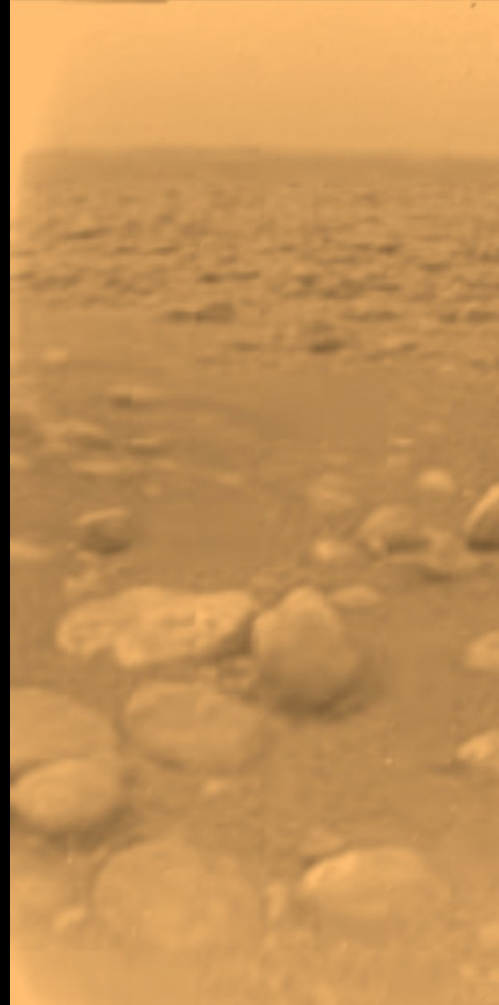
# Huygens Landing Site

Landed January 14, 2005 at 10.2S,  
192.4W

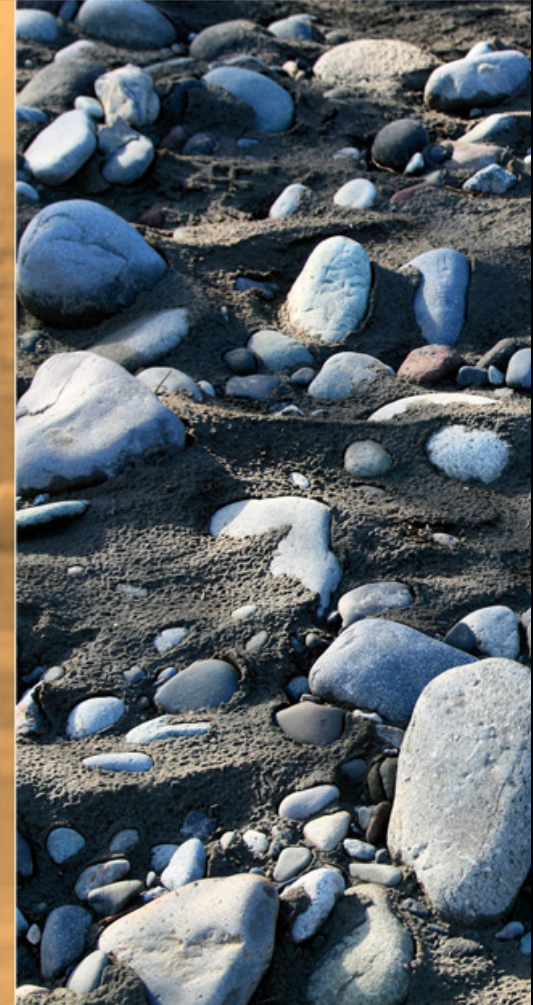
Discovered small “rocks”, possibly made  
of water ice, at the landing site.

Fluvial activity (methane?)

Images taken during descent showed no  
open areas of liquid, but indicated liquid  
had once flowed



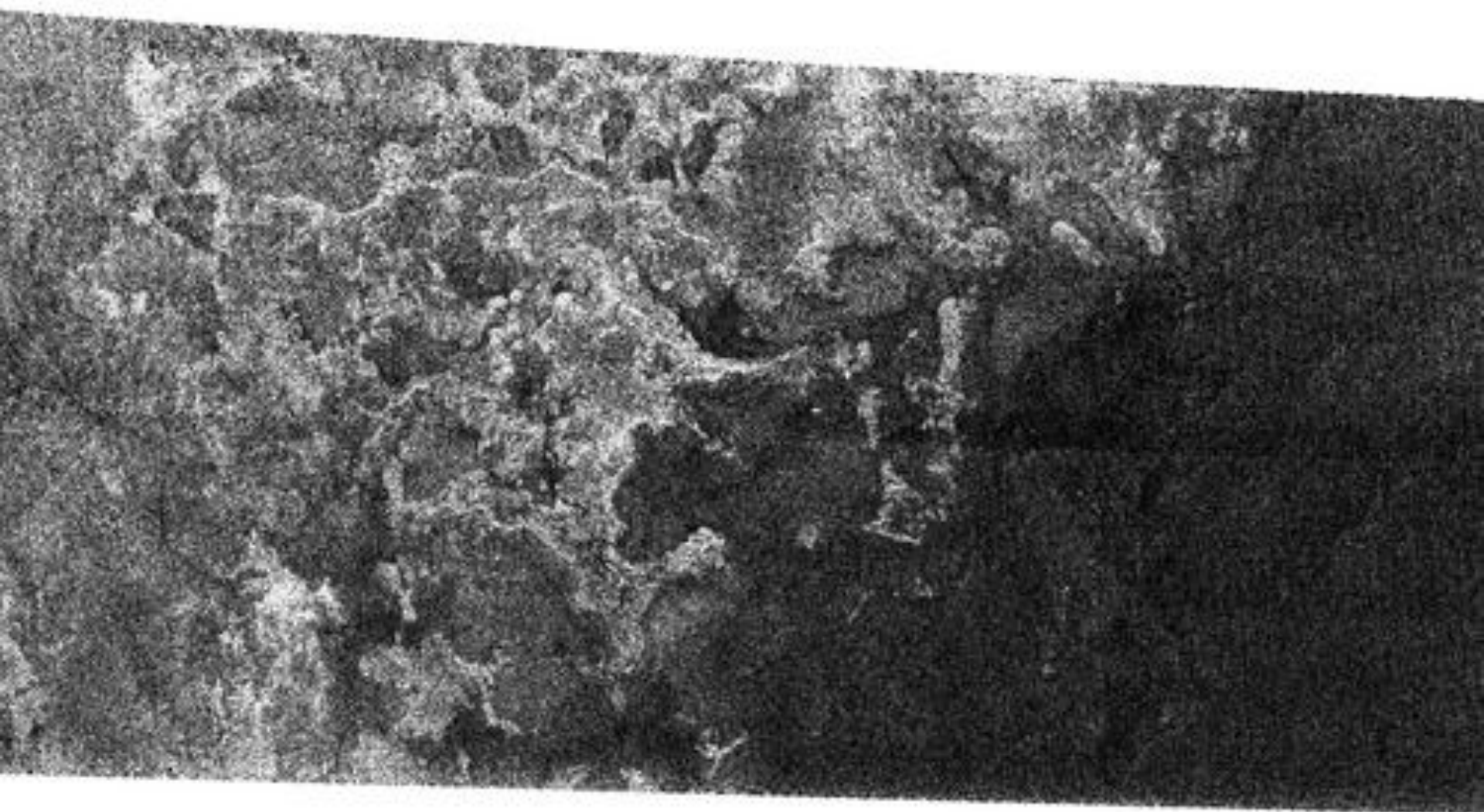
Titan



Earth



# Possible Shoreline



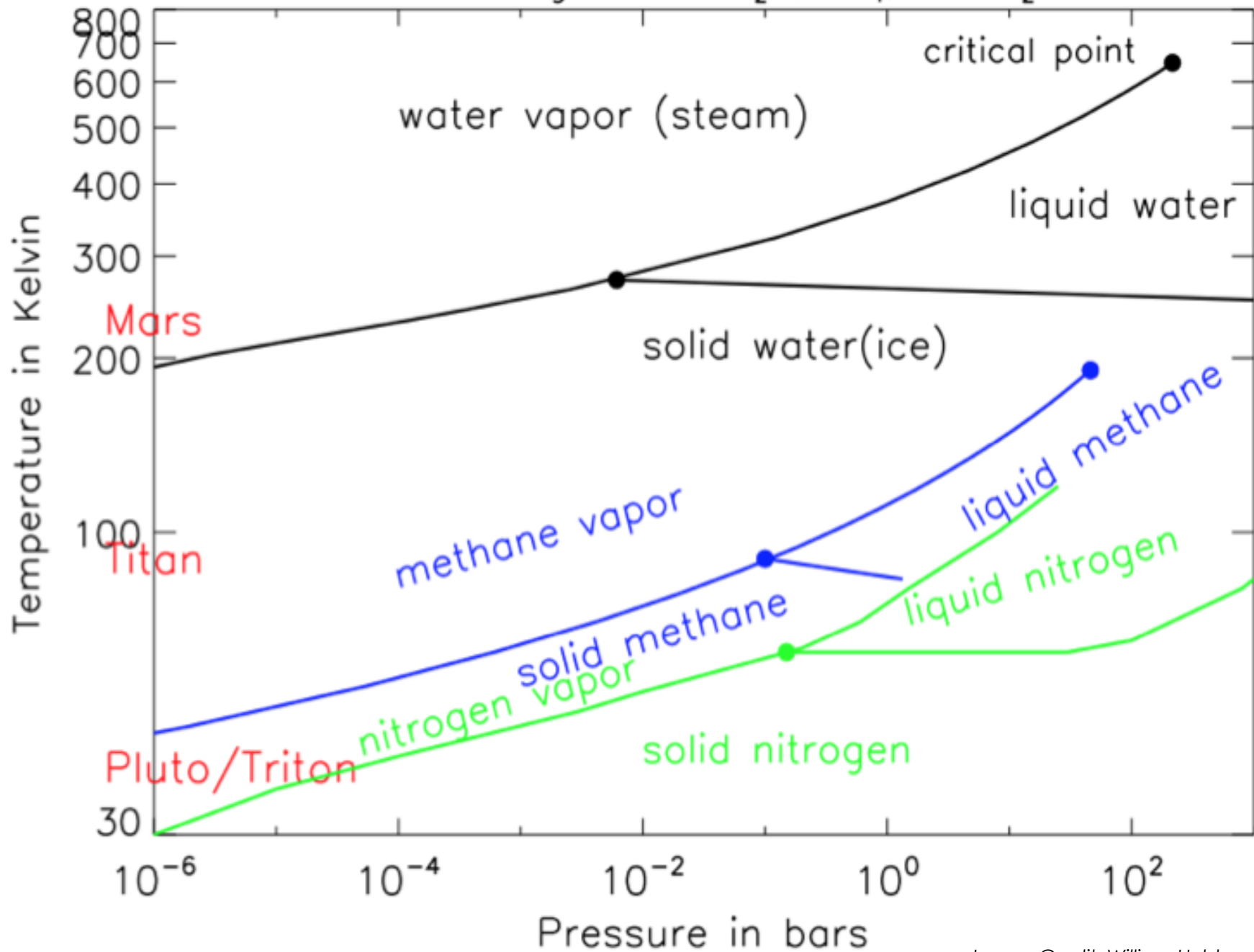
100 km

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# Phase diagrams of H<sub>2</sub>O, CH<sub>4</sub>, and N<sub>2</sub>



# *Life Around Other Stars*

A Star



The Sun  
G Star

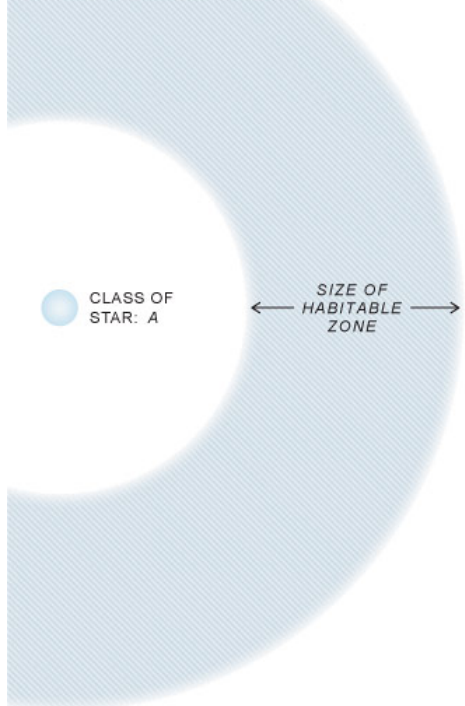


M Star

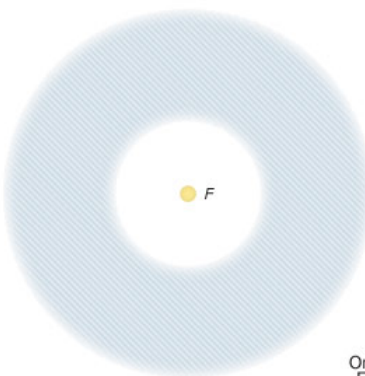




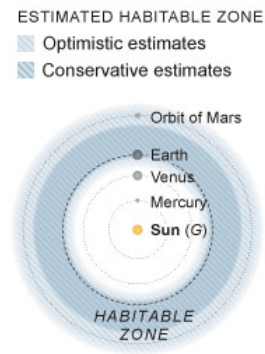
**MASSIVE, CLASS A STARS** are about 20 times brighter than the Sun, with wide habitable zones. But the stars are rare and short-lived, leaving only a billion years for orbiting planets to form and for life to develop.



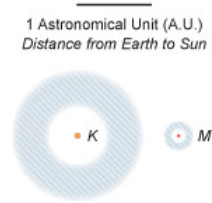
**LARGE, CLASS F STARS** are also rare, making up only 2 percent of all stars. But with a lifetime of several billion years, the stars could provide ample time for life to form, making them tempting targets for planet hunters.



**THE SUN IS A CLASS G STAR.** Earth orbits near the inner edge of the habitable zone, and Venus and Mars come close, depending on whether researchers use optimistic or conservative estimates for the Sun's habitable zone.

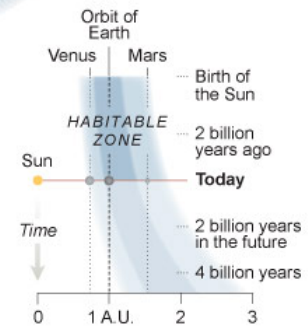


**SMALL, DIM STARS** have relatively small habitable zones but are very numerous and long lived. Class K, G and F stars are thought to be the best candidates for harboring habitable planets.



ESTIMATED HABITABLE ZONE  
 ■ Optimistic estimates  
 ■ Conservative estimates

1 Astronomical Unit (A.U.)  
 Distance from Earth to Sun

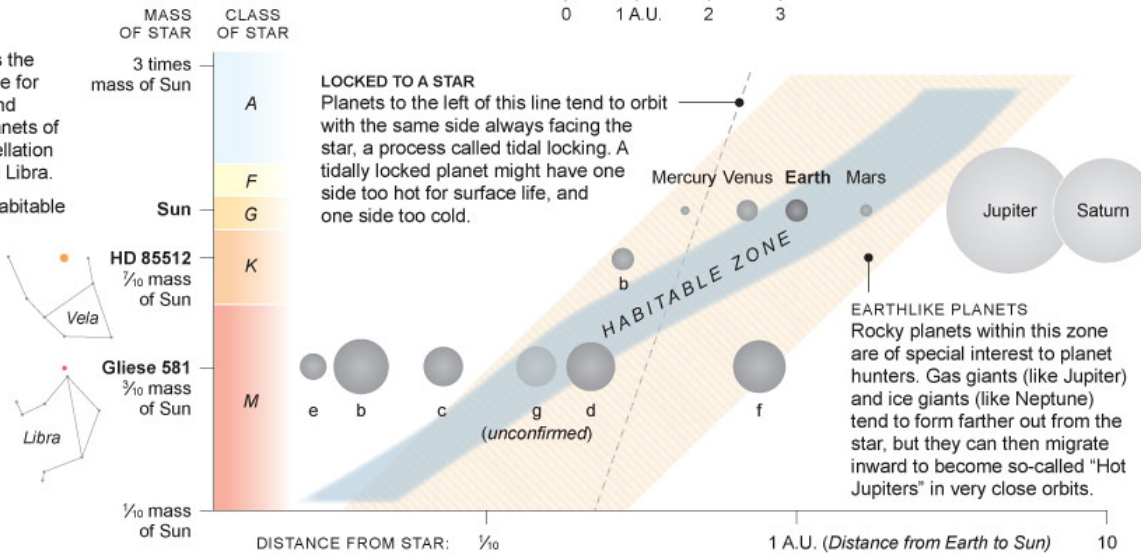


**AN AGING SUN**  
 Stars brighten with age, and the early Sun was about 30 percent less luminous than it is now. As the Sun ages, its habitable zone will continue to shift outward. In several billion years Earth's water will evaporate away, unless future inhabitants relocate or use technology to prevent it.

**A SLIDING SCALE**  
 The chart at right shows the estimated habitable zone for different sizes of star, and highlights known exoplanets of HD 85512, in the constellation Vela, and Gliese 581, in Libra.

An orbit in or near the habitable zone does not ensure surface water. Earth's moon, atmosphere, mass, volcanic and tectonic activity all contributed to habitability.

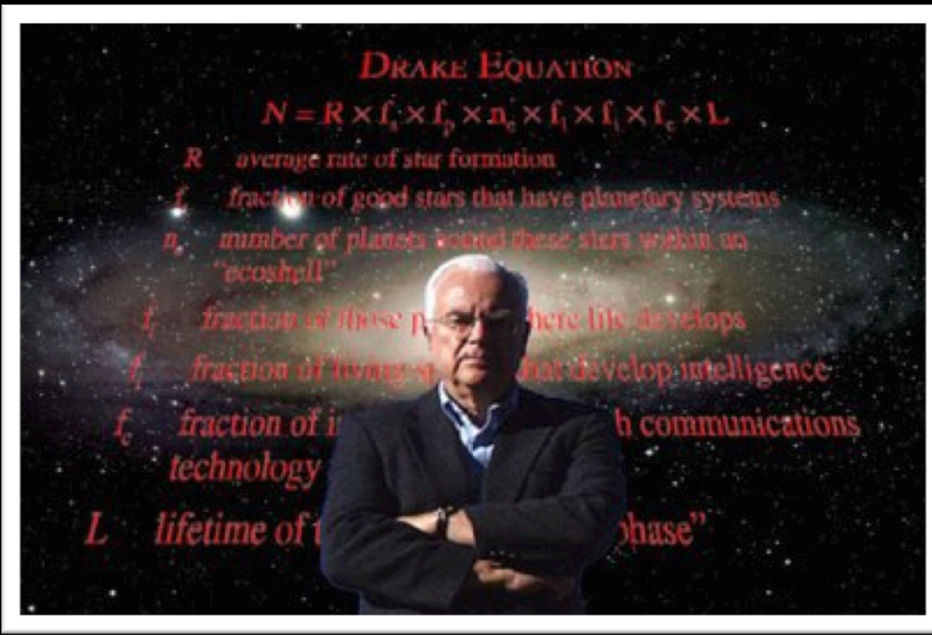
Astronomers stress that distant exoplanets will require more than a good orbit to support surface water and the possibility of life.



**LOCKED TO A STAR**  
 Planets to the left of this line tend to orbit with the same side always facing the star, a process called tidal locking. A tidally locked planet might have one side too hot for surface life, and one side too cold.

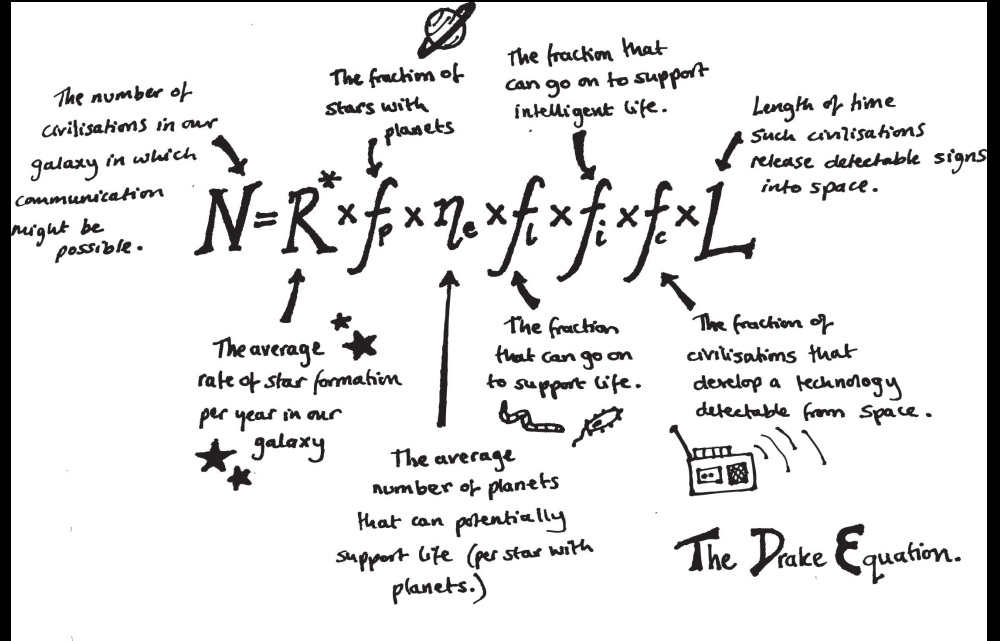
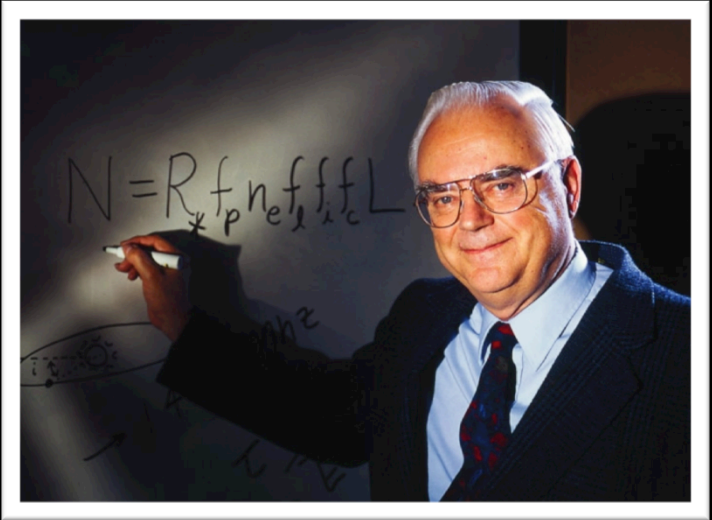
**EARTHLIKE PLANETS**  
 Rocky planets within this zone are of special interest to planet hunters. Gas giants (like Jupiter) and ice giants (like Neptune) tend to form farther out from the star, but they can then migrate inward to become so-called "Hot Jupiters" in very close orbits.





# The Drake Equation

How many civilizations are out there?







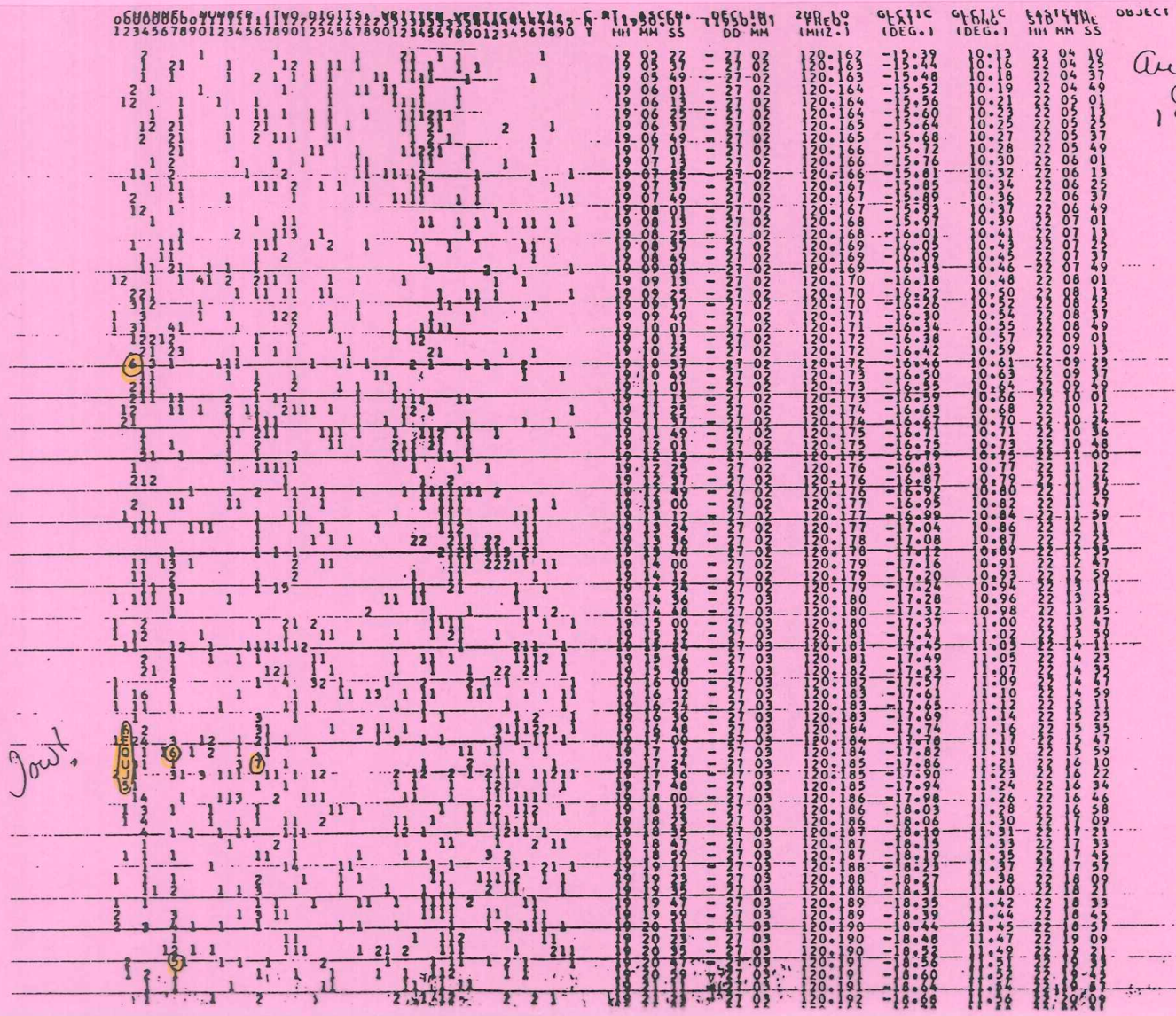
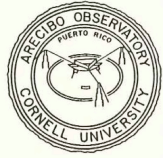


Figure 1. The "Wow!" signal. It was recorded on a computer printout of radio noise intensity from 50 frequency channels (digits and letters at left) at varying sky positions. (Photo: Courtesy Robert Dixon, Ohio State University Radio Observatory.)

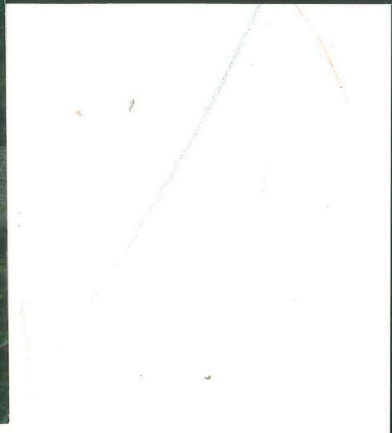
Figure 1



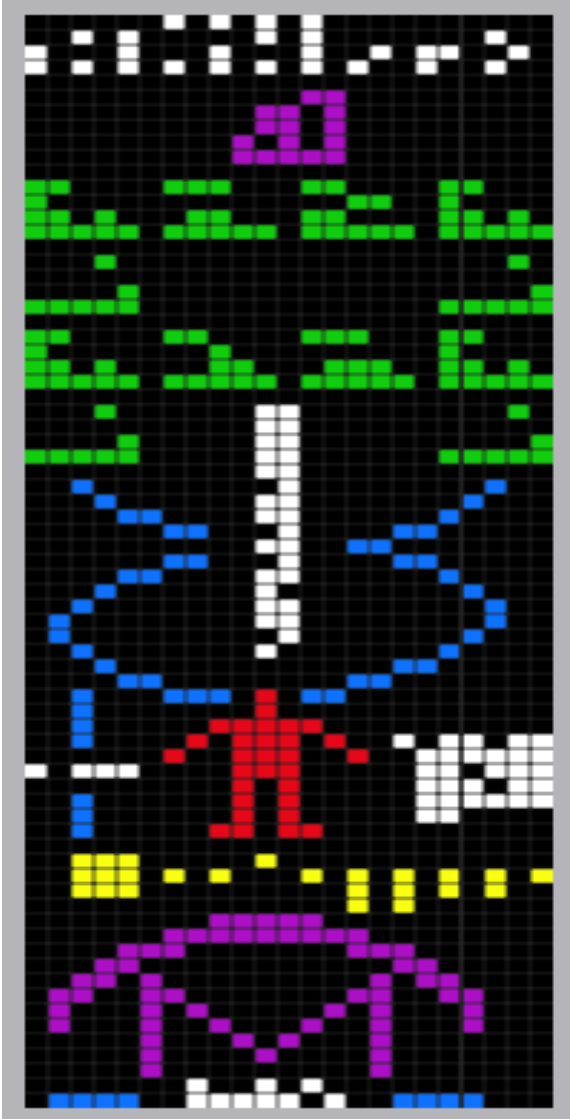
ARECIBO OBSERVATORY  
ARECIBO, PUERTO RICO



NATIONAL ASTRONOMY  
AND IONOSPHERE CENTER  
OPERATED BY CORNELL UNIVERSITY  
UNDER COOPERATIVE AGREEMENT  
WITH THE  
NATIONAL SCIENCE FOUNDATION



# *Arecibo Message*



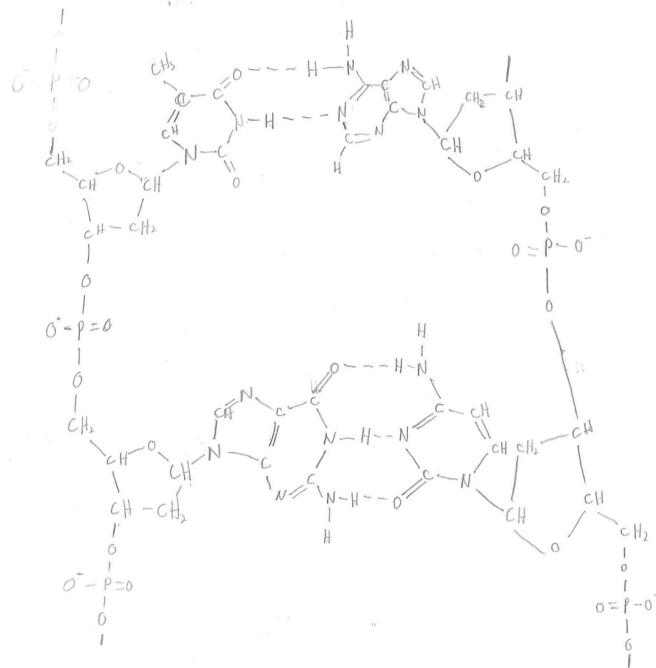
Broadcast on November 16th 1974  
from the Arecibo radio telescope.

Aimed toward globular star cluster  
M13.

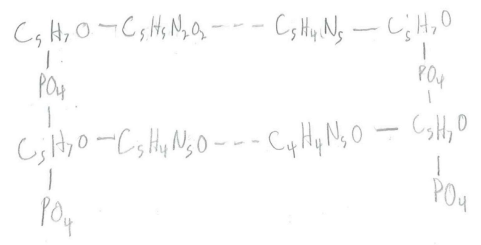
M13 is 25,000 light years away.







2 sets of  
base pairs  
whole of  
human  
genome.

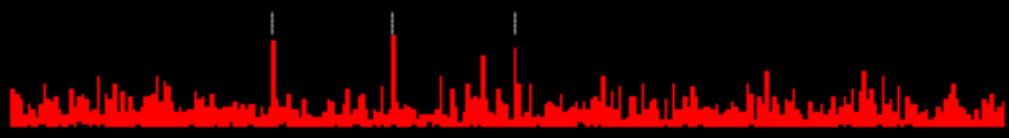






### Data Analysis

Computing Fast Fourier Transform 87%   
Doppler drift rate: -19.4612 Hz/sec Resolution: 0.149 Hz  
Best Triplet: power 9.33, period 0.7275



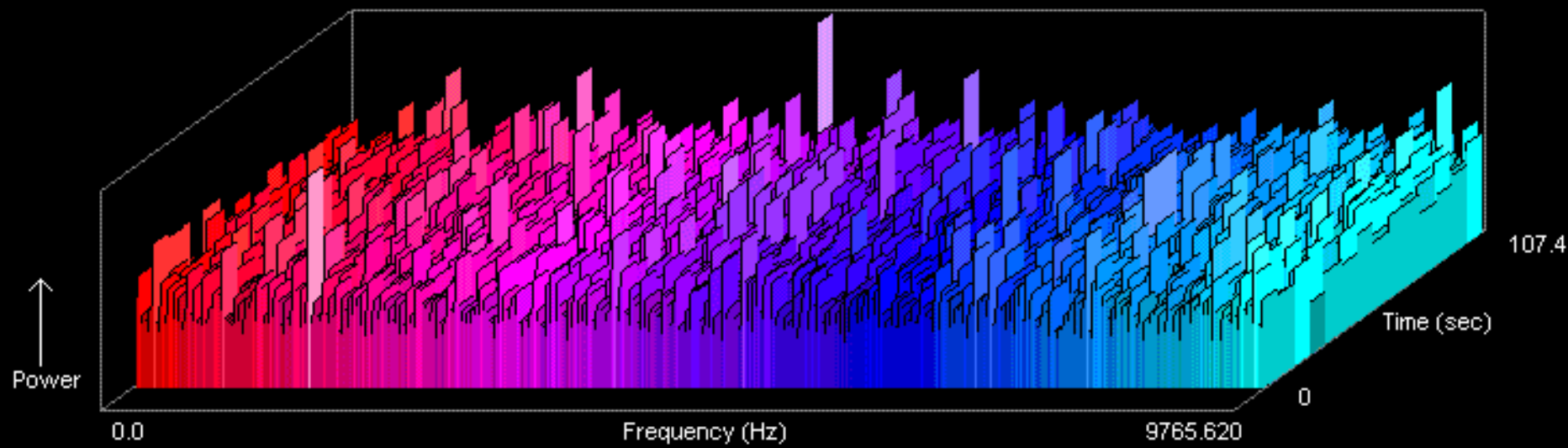
Overall: 93.929% done CPU time: 8 hr 28 min 41.1 sec

### Data Info

From: 18 hr 45' 17" RA, + 13 deg 0' 36" Dec  
Recorded on: Wed Mar 07 12:47:29 2001 GMT  
Source: Arecibo Radio Observatory  
Base Frequency: 1.419707031 GHz

### User Info

Name: Alan M. MacRobert  
Data units completed: 197  
Total computer time: 6327 hr 20 min 01.5 sec







# Kepler Mission: *A search for habitable planets.*



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- News & Schedule
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## Launch of the Kepler Spacecraft

### Videos:

[21 Mb AVI](#)  
(best for PCs)

[2.5 Mb MPEG4](#)  
(best for fast download)

[17 Mb Quicktime](#)  
(best for Mac)

[Launch blog](#)

[Mission Clock](#)

[Launch videos](#)

**SUCCESSFUL LAUNCH:**  
2009 March 6 at 10:49 pm EST.

[Media from Kennedy Space Center \(KSC\)](#)

[Press Conference Media Resources](#)  
Full [Press Kit](#) (3 Mb pdf)

[Mission Manager's Updates](#)

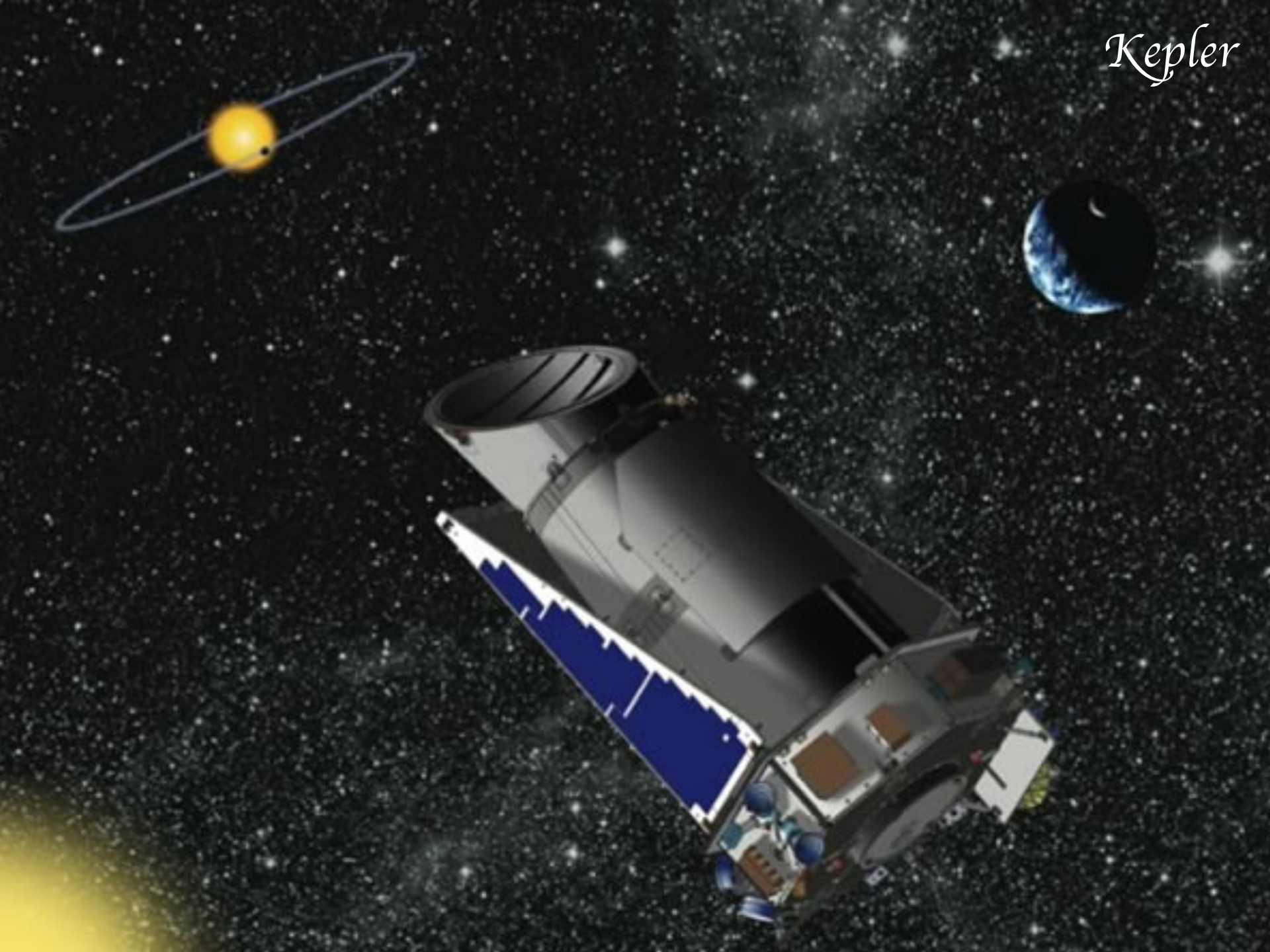
[NASA Kepler webcasts](#)



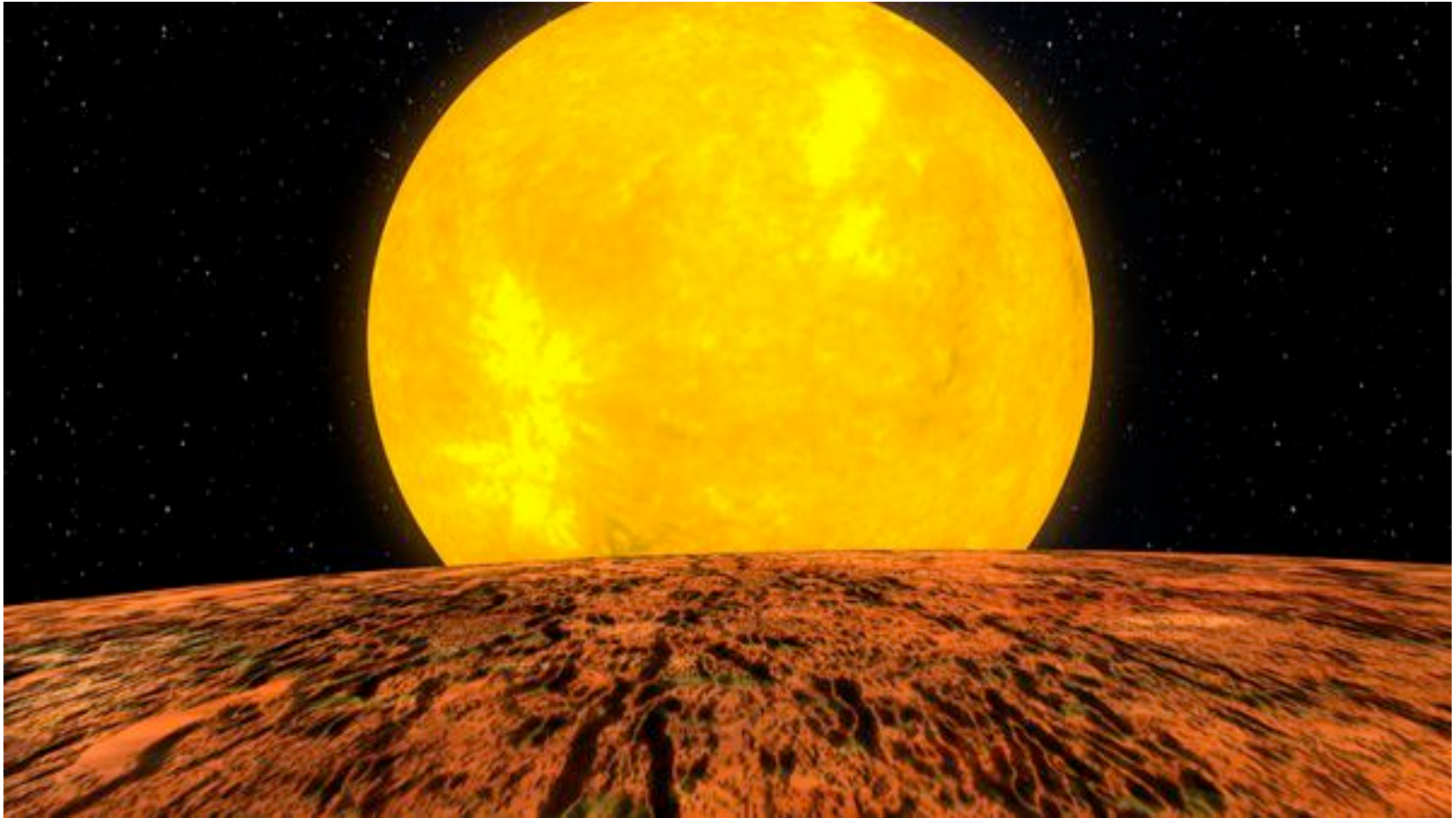
Photo below by Ben Cooper  
<http://www.launchphotography.com>  
originally posted at <http://apod.nasa.gov/apod/ap090309.html>



*Kepler*







Imagined View from Planet Kepler-10b (Artist's Depiction)  
Credit: NASA/Kepler Mission/Dana Berry

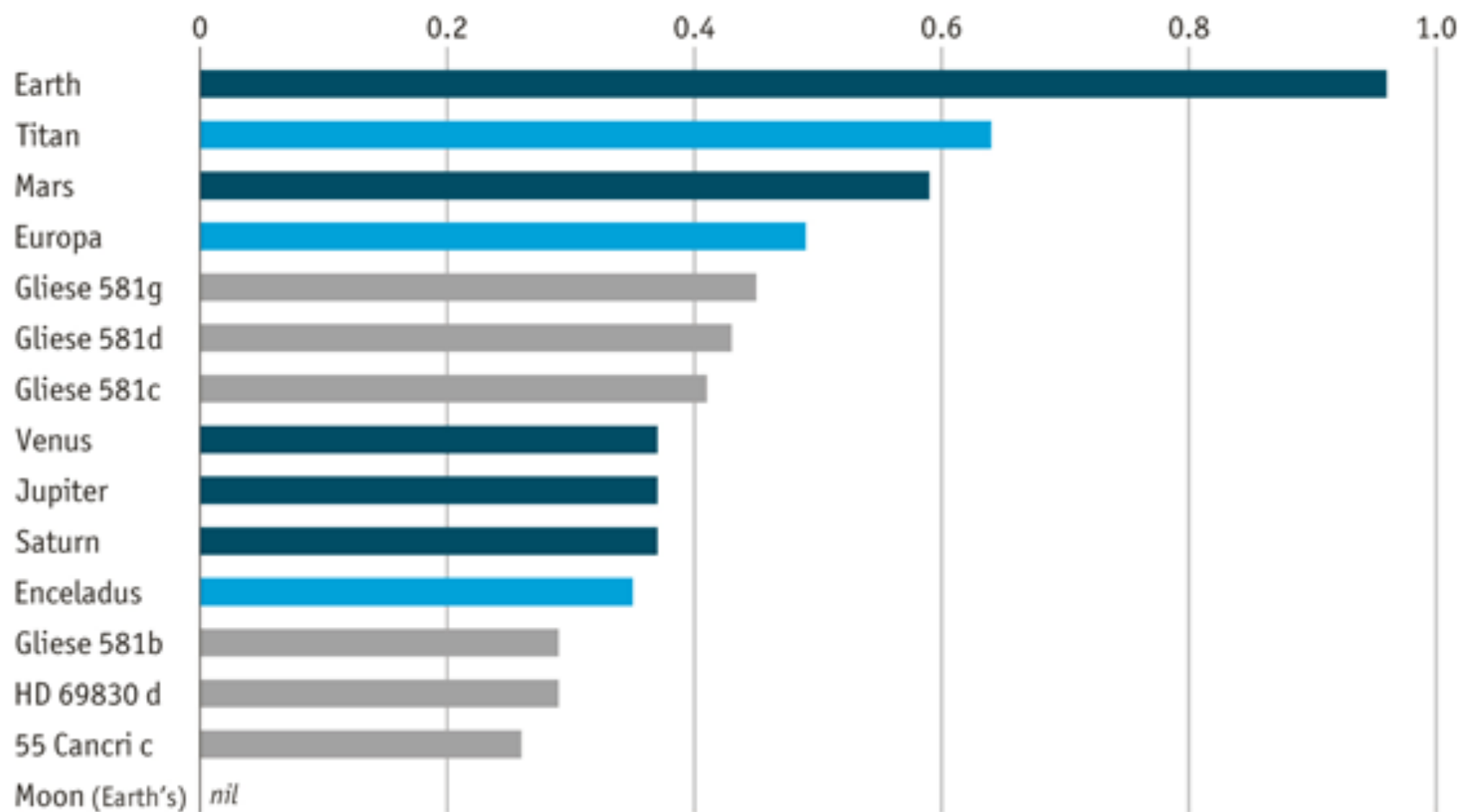
## Planet habitability index

Selected bodies, 2011, 1=maximum

■ Solar-system planet

■ Solar-system moon

■ Exoplanet



Source: *Astrobiology*



## In Disasters, Panic Is Rare; Altruism Dominates

*ScienceDaily* (Aug. 8, 2002) — WASHINGTON, DC -- Group panic and irrational behavior did not occur at the World Trade Center on September 11, 2001. Instead the event created a sense of "we-ness" among those threatened, says Rutgers University sociology professor Lee Clarke. In his article, "Panic: Myth or Reality?", in the fall 2002 edition of *Contexts* magazine, he explains that 50 years of evidence on disasters and extreme situations shows that panic is rare, even when people feel "excessive fear."

### *Rarity of Panic*

Because this combination of conditions is so uncommon in disasters, panic is also quite rare. (6, 7) When panic does occur, it usually involves few persons, is short-lived, and is not contagious. (21) In studies of more than 500 events, the University of Delaware's Disaster Research Center found that panic was of very little practical or operational importance. (21, 22) A number of systematic studies of human behavior in disasters have failed to support news accounts of widespread panic. (5, 8, 23–26)



THE ORIGINAL INVASION!

# THE WAR OF THE WORLDS

