Life on Mars: What to Know Before We Go

David A. Weintraub
**The Principle of Plenitude**

*Extraterrestrial beings must exist because God’s goodness demands that all worlds (Sun, Moon, Mercury, Venus, Mars, Jupiter, Saturn, all stars) should be populated with intelligent, God-worshipping denizens.*

This concept can be traced back to:

- **Plato:** in the ideal universe, all possibilities must exist (4th century B.C.E.)

- **Epicurus:** every possible explanation is true, somewhere in the universe (3rd century B.C.E.)

- **St. Augustine:** better to have a universe full of all kinds of beings, even if some of them suffer or create evil (4th century C.E.)

- **Giordano Bruno:** we live an infinite universe with an infinite number of beings (1580s)

*A predisposition to assume life exists on Mars (and everywhere else) was our cultural inheritance when the telescope arrived (1609)*
Game Changer: 1609

Galileo Gallilei
Pre-telescopic era:
• “seas”
• mountains

With a telescope:
• No atmosphere (Bessell)
• “seas” not water
In the era of ‘modern’ physics:

- Source of heat and light
- Must be scorchingly hot and bright
- Unlivable
Early telescopic era:
• Boring (just a speck) of light
• Too hot

Modern ideas
• No atmosphere
• 801 F at noon
• -297 F at midnight
• too hot
• too cold
• too dry
Early days of telescopes:
- Boring

Modern ideas
- Hellishly hot
- Poisonous atmosphere
- Bone dry

Venus

Visible light

ultraviolet light

Radar map
Early days of telescopes:
• Too far from Sun
• Too cold
• Too small to study

Modern era:
• Too cold
• Mostly H and He
• Gravity too strong
• Intense radiation environment
Early
• even farther from Sun
• even colder
• even harder to study with primitive telescopes

Modern
• Too cold
• Mostly H and He
Discovered in 1781

- Principle of plentitude fading
- Never of interest for life
Discovered in 1846
- Principle of plentitude a relic
- Never of interest for life
Discovered in 1930
• Too small
• Too cold
• Until 2015, just a point of light
• Never of interest for life
Mars
Martian Day = 24 hours

Christiaan Huygens: 1659
Giovanni Cassini: 1666

Martian Day = 24 hours 40 minutes
Giacomo Maraldi: 1704, 1719

- Martian Day = 24 hours 39 minutes
- Dark patches that vary in form and location
- Bright polar patches that change in size
Martian Day =
24 hours 39 minutes 21.67 seconds
(Actual: 24:39:35)

Polar caps
• Wax and wane antisynchronously
• Must be the result of seasons

Atmosphere
• Variations in brightness due to clouds and vapors
• Stars dimmed when close to Mars

William Herschel
1777-1783
Tilt of Mars' rotation axis $\rightarrow$ seasons

Martian tilt = 28.7° (actual = 25.2°)
“The analogy between Mars and Earth is certainly more evident than for any other planets in the Solar System. Their diurnal movement is almost the same; the obliquity of the ecliptic, causing the seasons, is analogous; of all the superior planets, the distance of Mars from the Sun most nearly resembles that of Earth, and as a result the Martian year is not enormously different from ours.”

--- William Herschel, March 11, 1784
--- address to the Bath Philosophical Society, England
EARTH:
- 24 hour day
- 365 earth-day year
- polar caps
- seasons
- thin atmosphere
- clouds

MARS:
- 24 hour, 39 minute day
- 687 earth-day year
- polar caps
- seasons
- thin atmosphere
- clouds

Another Earth?????
1830 - 1839

Wilhelm Wolff Beer
- Banker by trade
- Astronomer by hobby

Johann Heinrich von Mädler
• defined longitude system from ‘a’ (Meridian Bay)

• Identified dark and bright patches

• Claimed reddish color of dark spots as proof that Mars has an atmosphere (wrong!)

• Claimed polar patches “genuinely made of snow” (wrong!)
← light patches: continents

← dark patches: oceans
← light patches: continents (wrong!)

← dark patches: oceans (wrong!)
The polar patches are “genuinely made up of snow, shrinking with the onset of summer.” As the polar ice melts and evaporates, “the surface close to the evaporating snow will become extremely humid,” creating “wet marshy soil. ... It is not going too far to claim that Mars bears a strong resemblance to the Earth, even with regard to physical conditions.” ---- Beer and von Mädler, 1840
1858: “canali”

The Atlantic Canal (Syrtis Major)

This Chart has been wholly formed from Mr. Dawes’s drawings, which far surpass all others I have met with. I have consulted, however, upwards of 200 drawings of Mars, by Hooke, Cassini, Memmel, Sir W. Herschel, Beer and excellent and consistent series of views by Mr. Lockyer in 1862. I have also consulted charts of Mars and Paldnier notes.

From a comparison of a view by Hooke on Mar 9, 1864 (Dec. 1863) and Mr. Dawes on Nov 28, 1864 (in which interval Mars rotated 79740 times, I make 365° 57’ 22.73” with a probable error of 0.02 sec.

Angelo Secchi

(sketch by Richard Proctor, 1880, using 1864-65 drawing by William Dawes)
Suez Canal:
- Planning stage 1854-1858
- Construction: 1859-1869
- Length (original): 102 miles
Secchi, 1862

“the Atlantic Canal, a name given for brevity to this large blue patch which seems to play the role of the Atlantic which, on Earth, separates the Old World from the New.”

“these two canali enclose a reddish continental area. ... The reddish regions, like the bluish ones, seem too permanent for their nature to be doubted; it is probable that the former are solid the latter liquid.”

The variations in the sizes of the polar patches and in the appearances of clouds “proved that liquid water and seas exist on Mars ... the existence of seas and continents, and even the alternations of the seasons and the atmospheric variations, have been today conclusively proved.”
“The atmospheric envelopes which surround it and Earth; the snows which appear periodically over the poles of both planets; the clouds which extend from time to time in their atmospheres; the geographical arrangement of their surfaces in terms of continents and seas; the seasonal variations and the climates common to these two worlds; leads us to believe that both planets are inhabited by beings whose organization is of similar character.”
Map of Mars showing William Dawes’ ‘discovery’ (1865) that Meridian Bay was “distinctly forked ... giving the impression of two wide mouths of a river.”

Dawes: “Nothing appears more certain, than the red tint of Mars is not produced by the atmosphere of the planet.” So why is Mars red? Plant life!
Water everywhere on Mars!!!! Canals, rivers oceans, seas, bays

Red color: evidence of vegetation!!!!!

ALL WE NEED IS PROOF

TIME TO INVENT ASTROPHYSICS
spectroscopy
Absorption Spectrum of Chlorophyll $a$

- Blue absorbed
- Green gets through
- Red absorbed

% Absorption

Wavelength (nm)
Water vapor absorption

Most UV absorbed by Earth’s atmosphere

Most IR absorbed by Earth’s atmosphere
William Huggins (1824 – 1910)
Gold Medal, RAS (1867, 1885)
President, RAS (1876-1878)
Fellow, Royal Society (1865)
President, Royal Society (1900-1905)

William Allen Miller (1817 – 1870)
Chemist, King’s College, London

Jules Janssen (1824-1907)
Co-discovered Helium
Director, Meudon Observatory
Insert cornhill stuff: Huggins as great hero
The Rise of Mars in Popular Culture
Radio Listeners in Panic, Taking War Drama as Fact

Many Flee Homes to Escape 'Gas Raid From Mars'—Phone Calls Swamp Police at Broadcast of Wells Fantasy

A wave of mass hysteria seized thousands of radio listeners throughout the nation between 8:15 and 9:30 o'clock last night when a broadcast of a dramatization of H. G. Wells's fantasy, "The War of the Worlds," led thousands to believe that an interplanetary conflict had started with invading Martians spreading wide death and radio stations here and in other cities of the United States and Canada seeking advice on protective measures against the raids.

The program was produced by Mr. Welles and the Mercury Theatre on the Air over station WABC and the Columbia Broadcasting System's coast-to-coast network, from 8 to 9 o'clock.
John McCoy
*A Prophetic Romance: Mars to Earth*
1896

George du Maurier
*The Martian*
1897

Garret P. Serviss
*Edison’s Conquest of Mars*
1898

Edwin Arnold
*Lieut. Gullivar Jones: His Vacation*
1905

Arnould Galopin
*Doctor Omega*
1906
Barsoom Series by Edgar Rice Burroughs (1912+)
Director: Ashley Miller
1910
The Edison Company
Short (5 min.)

https://www.imdb.com/title/tt1515725/

Director: Wallett Waller
1913
Full length (69 min.)

http://horrornews.net/76688/film-review-a-trip-to-mars-1918/

Director: Holger-Madsen
1918
Full length (80 min.)

https://www.imdb.com/title/tt0316241/
Buck Rogers in the 25th Century:
An Interplanetary Battle with the Tiger Men of Mars (1934)

Flash Gordon’s Trip to Mars (1938)

http://gotomars.free.fr/buck_rogers_1934.htm
https://www.imdb.com/title/tt0030138/
Felix the Cat Flirts With Hate (1926)

Bimbo Up to Mars (1930)

Oswald the Lucky Rabbit: Mars (1930)

Popeye’s Rocket to Mars (1946)
William Wallace Campbell (1862 – 1938)
Director, Lick Observatory (1901-1930)
36-inch refractor: largest telescope on Earth (1888-1897)

1890s: “The spectra of Mars and the Moon ... seem to be identical in every respect.”
Taken through dry air

Claim: ‘a’ only “strong” in Mars spectrum

FIG. 1

Spectrograms of Mars and Moon

Taken through humid air

Claim: ‘a’ “strong” in all three spectra

FIG. 2
HIGH-DISPERSION SPECTRA OF MARS

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ABSTRACT

In July, 1956, a concave-grating spectrograph was set up at the Slope Observatory of the U.S. Weather Bureau, near the summit of Mauna Loa, Hawaii, for the purpose of photographing spectra of Mars with high dispersion. Several sets of spectrograms with spectra of the moon and Mars in juxtaposition were obtained with dispersions of 5 and 2 Å/mm. The shortward shift of the spectrum of Mars, due to the Doppler-Fizeau effect, was sufficient to separate Martian lines of \( \text{O}_2 \) and \( \text{H}_2\text{O} \) in the B and “a” bands from those of terrestrial origin. No such shifted lines were detected. After opposition, our spec-

< 80 micron thick layer of water on Mars
Stratoscope II high-altitude balloon experiment, 1963 (short wavelengths)

Press conference: “it’s pretty certain” we detected water on Mars”

WSJ headline: “Lower Life Forms May be able to Live in Mars Atmosphere, Balloon Findings Show”
Stratoscope II high-altitude balloon experiment, 1963
(long wavelengths)

- Martian CO\(_2\) lines at 4.3, 4.8, 5.2 microns
- Martian H\(_2\)O from 5.5-6.3 microns: solid line is model with 70 microns of water
Dome for 100-inch Hooker Telescope, Mt. Wilson, CA (1917)
Edwin Hubble

- Born 1889, Missouri
- Age 9, moved to Chicago area
- State champion, high jump (set state record)
- Attended U. Chicago
- On Big 10 championship track and basketball teams
- Rhodes scholar; starred in track, water polo, boxing; studied law
AN ANALYSIS OF THE SPECTRUM OF MARS

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ABSTRACT

On a high-dispersion spectrogram of Mars taken at Mount Wilson rotational lines of H₂O near λ 8300 and CO₂ near λ 8700 have been detected. Recent laboratory measurements of line strengths by D. Rank have been used to determine the amounts of H₂O and CO₂ in the atmosphere of Mars: 14 ± 7 µ precipitable water and 55 ± 20 m atm CO₂. From the absence of O₂ in the Martian spectra, we set an upper limit of 70 cm atm for the O₂ content.

By suitably combining the CO₂ amount with observations by Kuiper and Sinton of the strongly saturated bands in the 2-µ region, a surface pressure of 25 ± 15 mb has been derived.

The implications of the results on the composition of the Martian atmosphere are discussed.
1971: “Water exists on Mars. The water vapor varies with location on the planet, the season on Mars, and from year to year. The water appears to cycle through the polar caps, which are partly H$_2$O. The total amount of water in the atmosphere of Mars is at most a few cubic kilometers.”

[would yield a global layer $\sim$25 microns deep; compare to width of human hair --- 17 to 180 microns]

1992: the work of Huggins and Janssen “are no longer believed”