

Water in the Universe

Big Bang

Life cycle of a star – stellar processes

Elemental solar abundance

Fusion vs Fission

Birth of the Solar System

Water on planets and moons

Comets



Ban dihydrogen monoxide

from [mercury news](#)

SoCal city falls victim to Internet hoax, considers banning items made with water

Associated Press

ALISO VIEJO, Calif. - City officials were so concerned about the potentially dangerous properties of dihydrogen monoxide that they considered banning foam cups after they learned the chemical was used in their production.

Then they learned that dihydrogen monoxide - H2O for short - is the scientific term for water.

"It's embarrassing," said City Manager David J. Norman. "We had a paralegal who did bad research."

The paralegal apparently fell victim to one of the many official looking Web sites that have been put up by pranksters to describe dihydrogen monoxide as "an odorless, tasteless chemical" that can be deadly if accidentally inhaled.

As a result, the City Council of this Orange County suburb had been scheduled to vote next week on a proposed law that would have banned the use of foam containers at city-sponsored events. Among the reasons given for the ban were that they were made with a substance that could "threaten human health and safety."

The measure has been pulled from the agenda, although Norman said the city may still eventually ban foam cups.

"Our main concern is with the Aliso Creek watershed," Norman said. "If you get Styrofoam into the water and it breaks apart, it's virtually impossible to clean up."

See More About: [jokes and humor](#) [parodies](#) [safety warnings](#)

Safety Warning: Dihydrogen Monoxide (DHMO)

Forwarded email warns of serious health hazards associated with the chemical substance dihydrogen monoxide, also known as DHMO.

Description: Email joke / Hoax

Circulating since: 1990

Status: True (nudge, wink... not really!)

Email example contributed by S. Keeton, Apr. 16, 2001:

BAN DIHYDROGEN MONOXIDE!

Dihydrogen monoxide is colorless, odorless, tasteless, and kills uncounted thousands of people every year. Most of these deaths are caused by accidental inhalation of DHMO, but the dangers of dihydrogen monoxide do not end there.

Prolonged exposure to its solid form causes severe tissue damage. Symptoms of DHMO ingestion can include excessive sweating and urination, and possibly a bloated feeling, nausea, vomiting and body electrolyte imbalance. For those who have become dependent, DHMO withdrawal means certain death.

Dihydrogen monoxide:

- is also known as hydroxyl acid, and is the major component of acid rain.
- contributes to the "greenhouse effect."
- may cause severe burns.
- contributes to the erosion of our natural landscape.
- accelerates corrosion and rusting of many metals.

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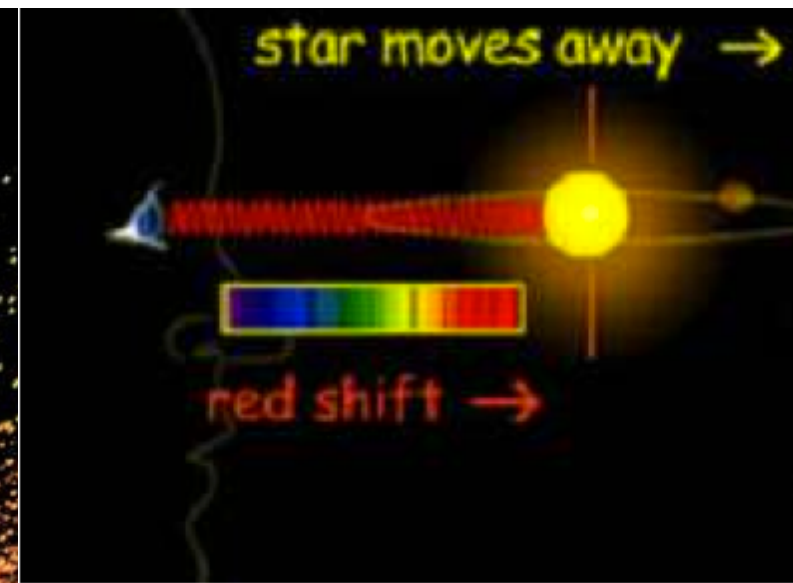
more people go with Visa. | **VISA**

Utility Company PG&E Plans Bankruptcy Filing Over California Wildfires



Pacific Gas and Electric crews restoring power lines in Paradise, Calif., in November. The utility company said it faced an estimated \$30 billion liability for damages from the 2017 and 2018 wildfires in Northern California. Rich Pedroncelli/Associated Press

Big Bang



Red Shift Diagram nasa.gov

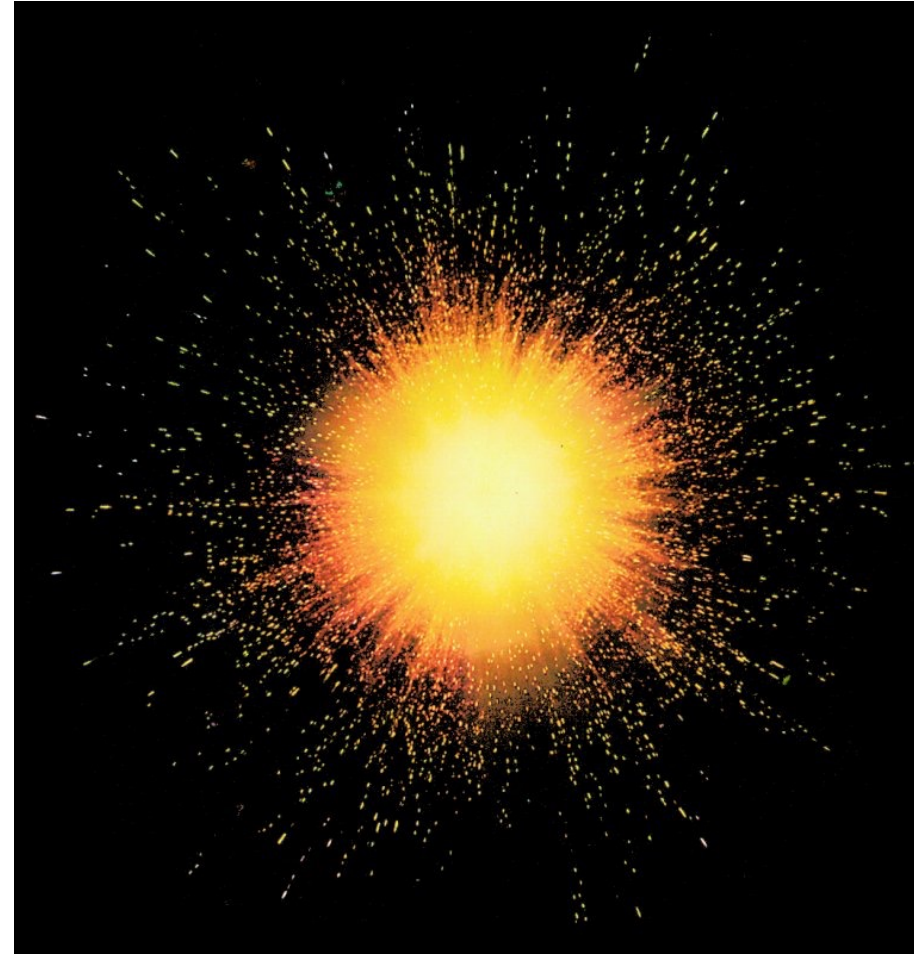
In 1927, the Belgian priest Georges Lemaître was the first to propose that the universe began with the explosion of a primeval atom.

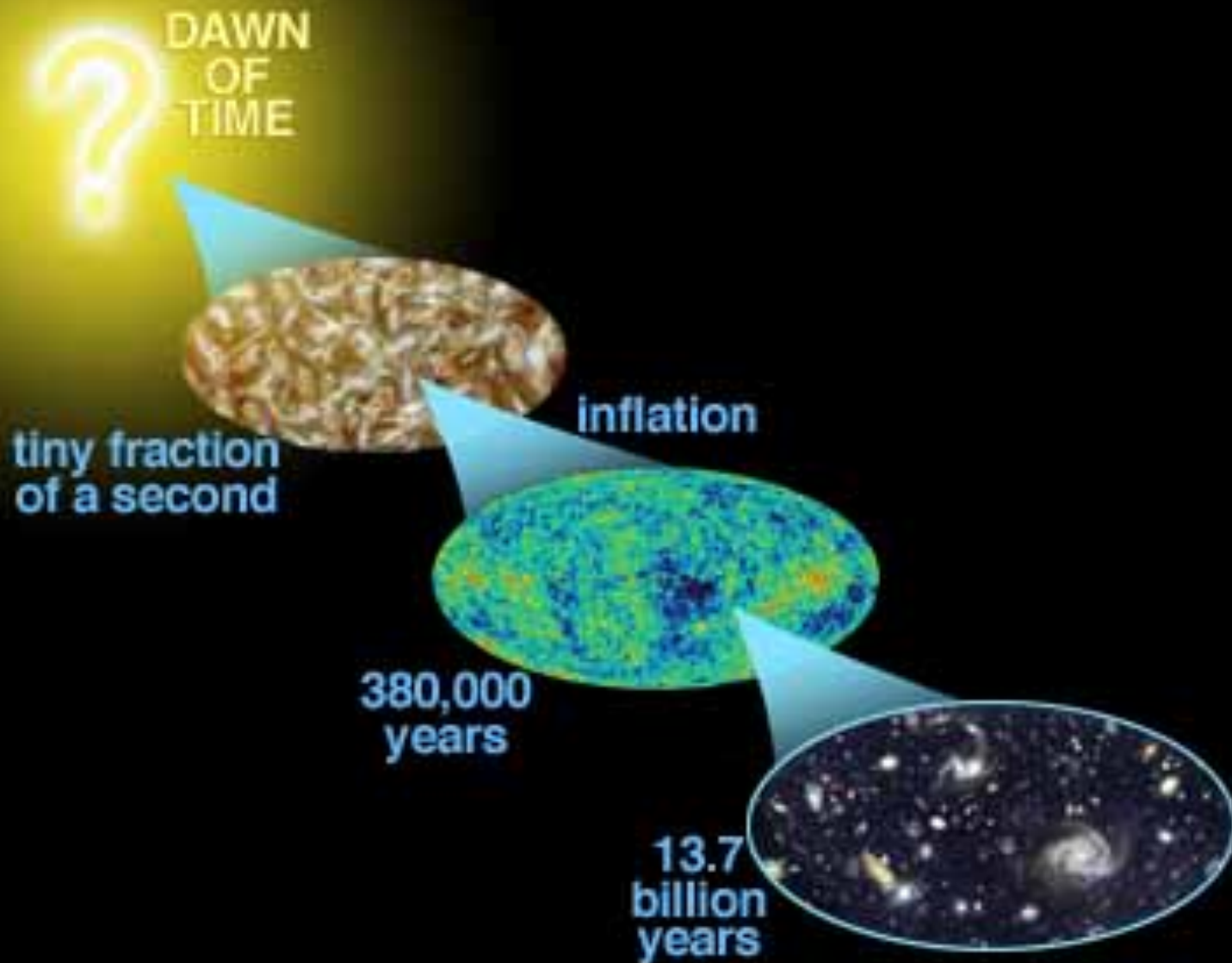
To make an apple pie from scratch, you
must first invent the universe.

Carl Sagan

What is the Big Bang Theory?

- The expansion of the universe began in a state of enormous density, pressure and temperature.
- A violent release of energy in which all matter expands outward from a single point
- “Big Bang” is a highly successful family of theories with no obvious competitor.
- Explains what we see, and has made several successful predictions.





1964 by Arno Penzias and Robert Wilson- background radiation

Two conflicting theories

In the 1950s, there were two theories to the origin of the universe. The first was called the Steady State Theory. It had been put forward by Hermann Bondi, Thomas Gold and Fred Hoyle and held that the universe was homogeneous in space and time and had remained like that forever -- essentially, that the universe existed in "a steady state."

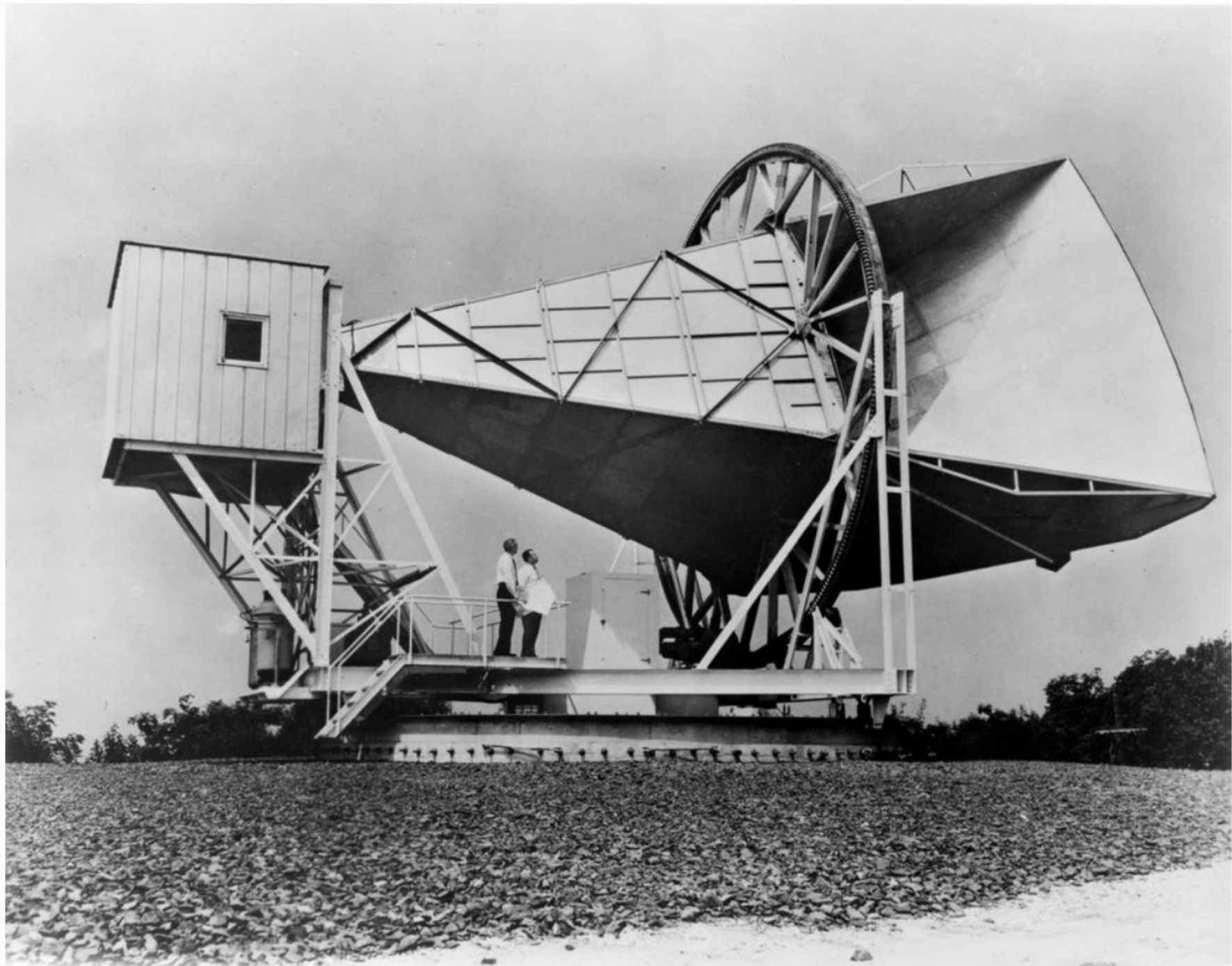
The rival, more controversial theory sought to incorporate the expansion of the universe into its framework. Edwin Hubble had shown in 1929 that galaxies are moving away from one another at remarkable speeds, implying that the space between galaxies is constantly expanding. A few physicists led by George Gamow had taken this notion and argued that the separation between galaxies must have been smaller in the past.

If one stretched the idea to the limit, it meant that the universe had been infinitely dense at one point sufficiently back in time. Using the laws of physics, Gamow and his colleagues were able to show that the point -- which was also infinitely hot -- corresponded to the moment of creation. Everything in the universe had emerged from this incredibly dense and hot state in a cataclysmic event astronomers call "the Big Bang."

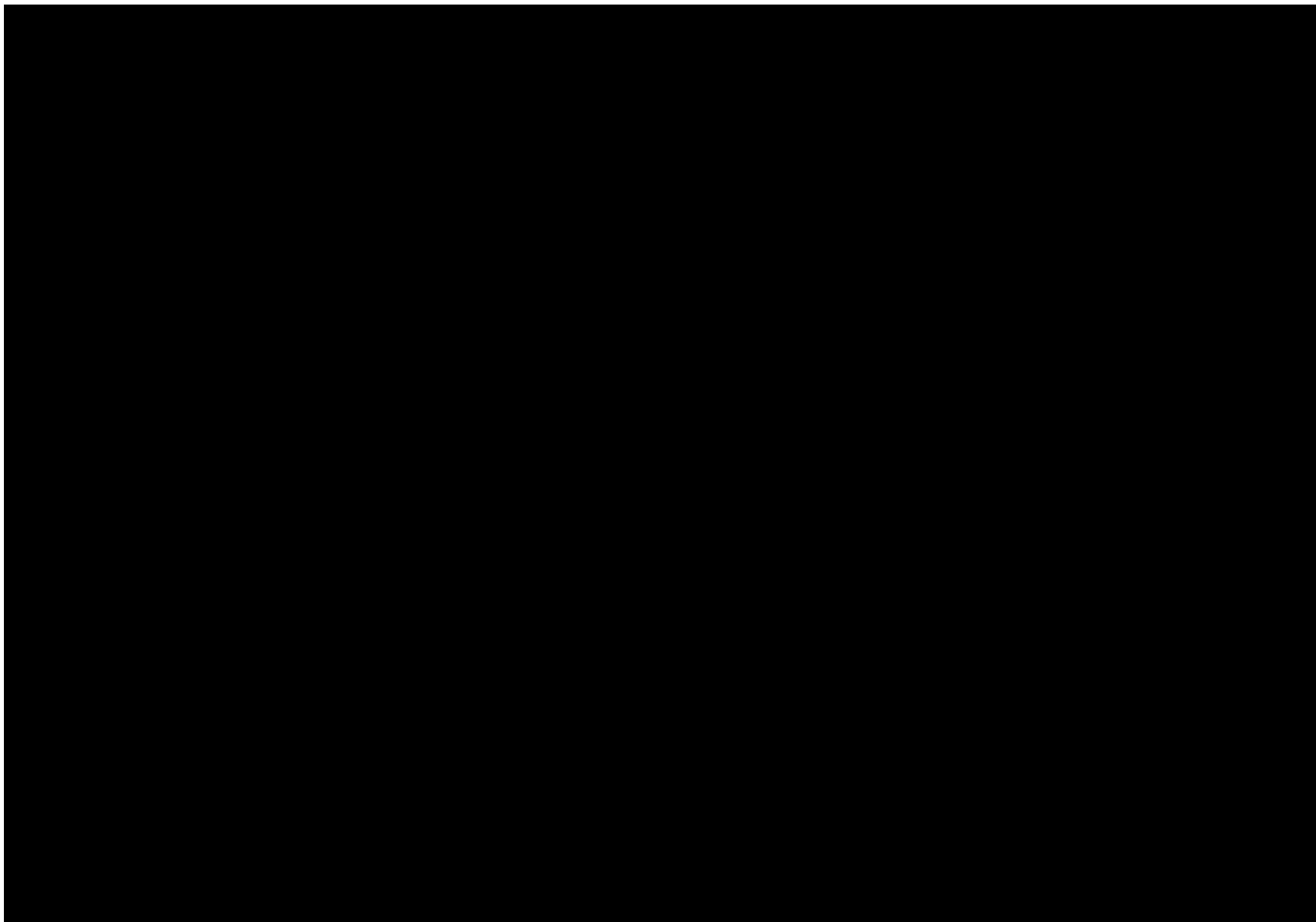
Bell labs wanted to remove hiss from overseas communications



Hired two physicists – Penzias and Wilson



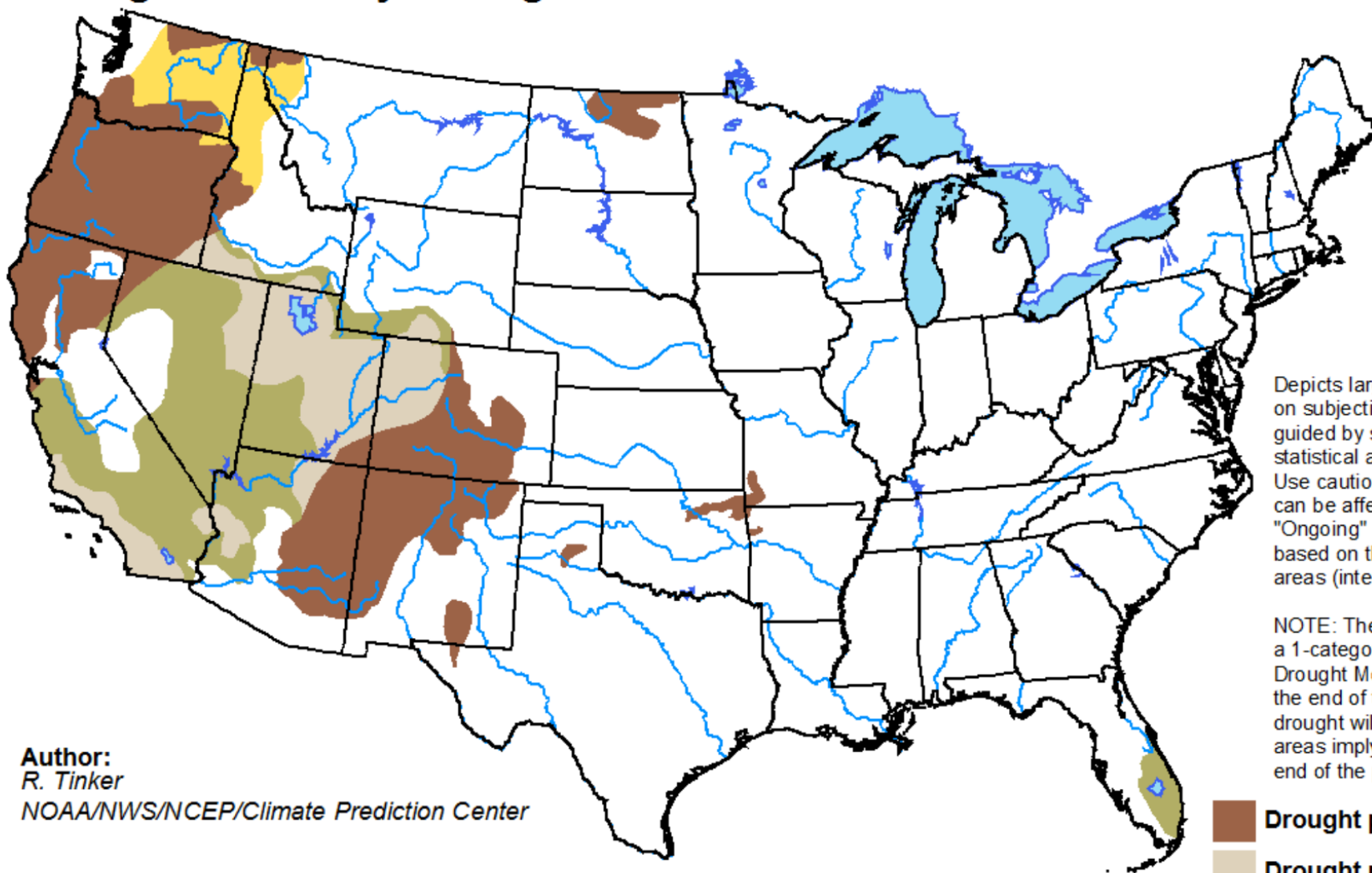
Penzias and Wilson at the 15 m Holmdel Horn Antenna, which first detected the CMB. Although many sources can produce low-energy radiation backgrounds, the properties of the CMB confirm its cosmic origin. NASA



U.S. Seasonal Drought Outlook

Drought Tendency During the Valid Period

Valid for December 20, 2018 - March 31, 2019
Released December 20, 2018

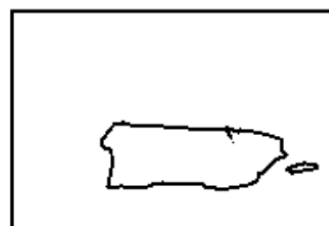


Author:
R. Tinker
NOAA/NWS/NCEP/Climate Prediction Center

Depicts large-scale trends based on subjectively derived probabilities guided by short- and long-range statistical and dynamical forecasts. Use caution for applications that can be affected by short lived events. "Ongoing" drought areas are based on the U.S. Drought Monitor areas (intensities of D1 to D4).

NOTE: The tan areas imply at least a 1-category improvement in the Drought Monitor intensity levels by the end of the period, although drought will remain. The green areas imply drought removal by the end of the period (D0 or none).

-  Drought persists
-  Drought remains but improves
-  Drought removal likely
-  Drought development likely

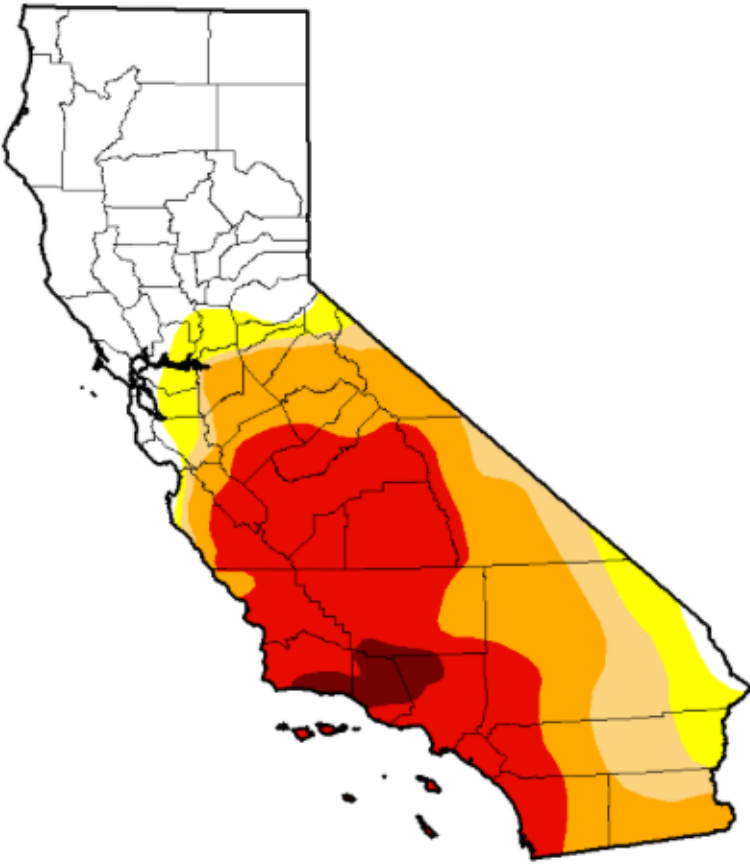


U.S. Drought Monitor

California

January 10, 2017
(Released Thursday January 12, 2017)
Valid 7 a.m. EST

Statistics type: Traditional Percent Area Export table: PNG CSV XLS



Week	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current 2017-01-10	34.62	65.38	58.22	49.22	27.80	2.13
Last Week 2017-01-03	18.07	81.93	67.61	54.02	38.17	18.31
3 Months Ago 2016-10-11	0.00	100.00	83.59	62.27	42.80	21.04
Start of Calendar Year 2016-12-27	17.47	82.53	68.87	57.79	40.60	18.31
Start of Water Year 2016-09-27	0.00	100.00	83.59	62.27	42.80	21.04
One Year Ago 2016-01-12	0.00	100.00	97.33	87.55	69.07	42.66

Estimated Population in Drought Areas: 26,085,979 View More Statistics

Intensity:

D0 (Abnormally Dry)

D2 (Severe Drought)

D4 (Exceptional Drought)

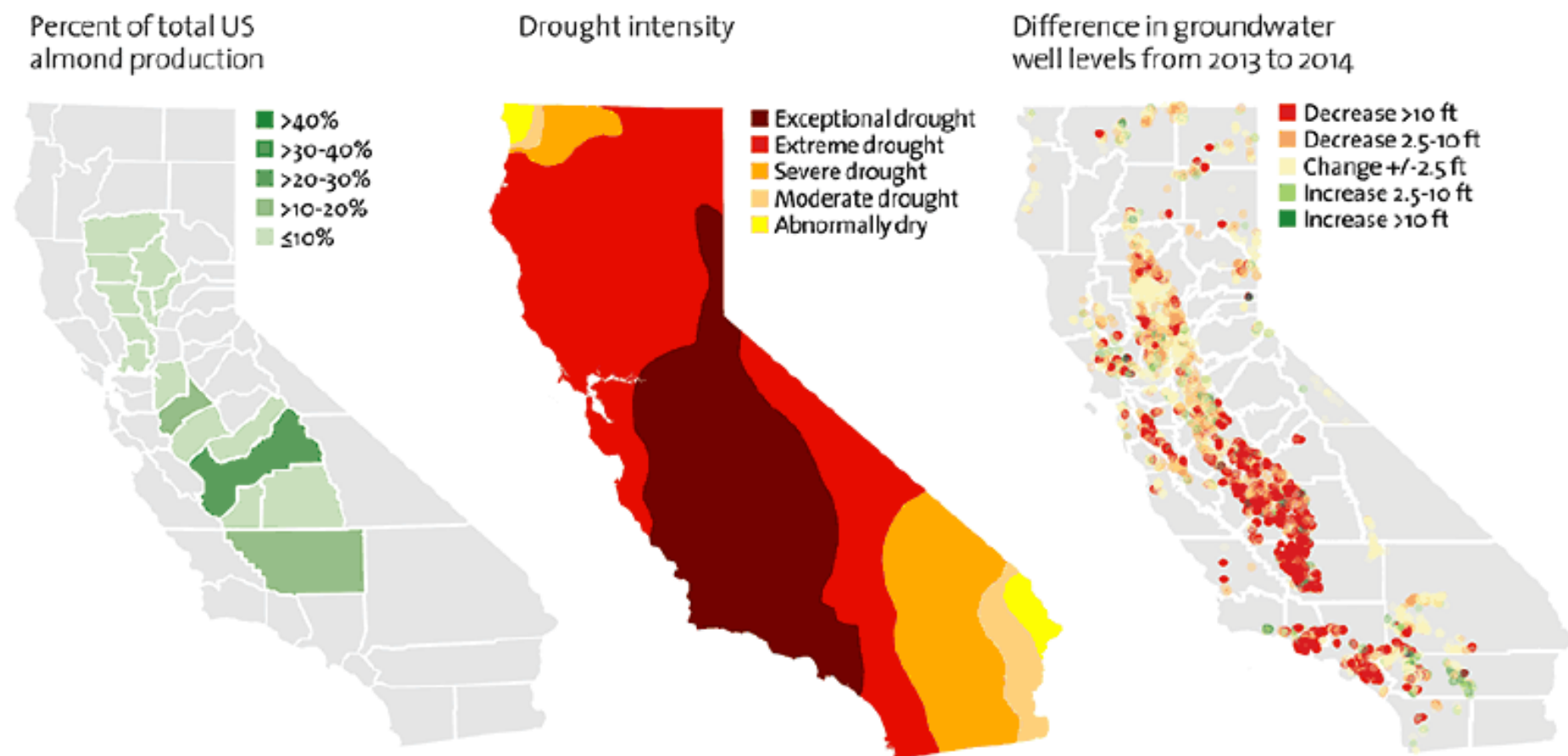
D1 (Moderate Drought)

D3 (Extreme Drought)

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying [text summary](#) for forecast statements.

Author(s):
David Miskus, NOAA/NWS/NCEP/CPC

California's Almond Counties Are Its Driest—and Most Overpumped

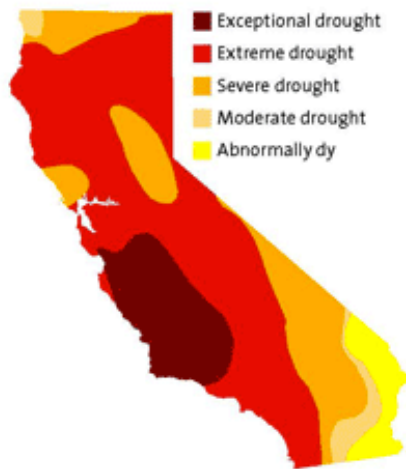


Note: The drought map represents the intensity of the drought as of January 6, 2015. The groundwater map shows data currently available from the California Department of Water Resources. Not all wells in California are part of the database.

Sources: US Drought Monitor (drought map); California Department of Water Resources (groundwater levels); California County Agricultural Commissioners (crop maps).



His logic is unassailable. Almond products—snack mixes, butters, milk—are flying off supermarket shelves. The value of the California almond market hit \$4.8 billion in 2012 (<http://www.motherjones.com/documents/1310072-2012-nass>)—that's



■ Exceptional drought
■ Extreme drought
■ Severe drought
■ Moderate drought
■ Abnormally dry



99% of all US
almonds



99% all US
walnuts



98% of all US
pistachios



95% of all US
broccoli



92% of all US
strawberries



91% of all US
grapes



90% of all US
tomatoes



74% of all US
lettuce

How Thirsty Is Your Food?



One head of broccoli



5.4 gallons of water



One walnut



4.9 gallons of water



One head of lettuce



3.5 gallons of water



One tomato



3.3 gallons of water



One almond



1.1 gallons of water

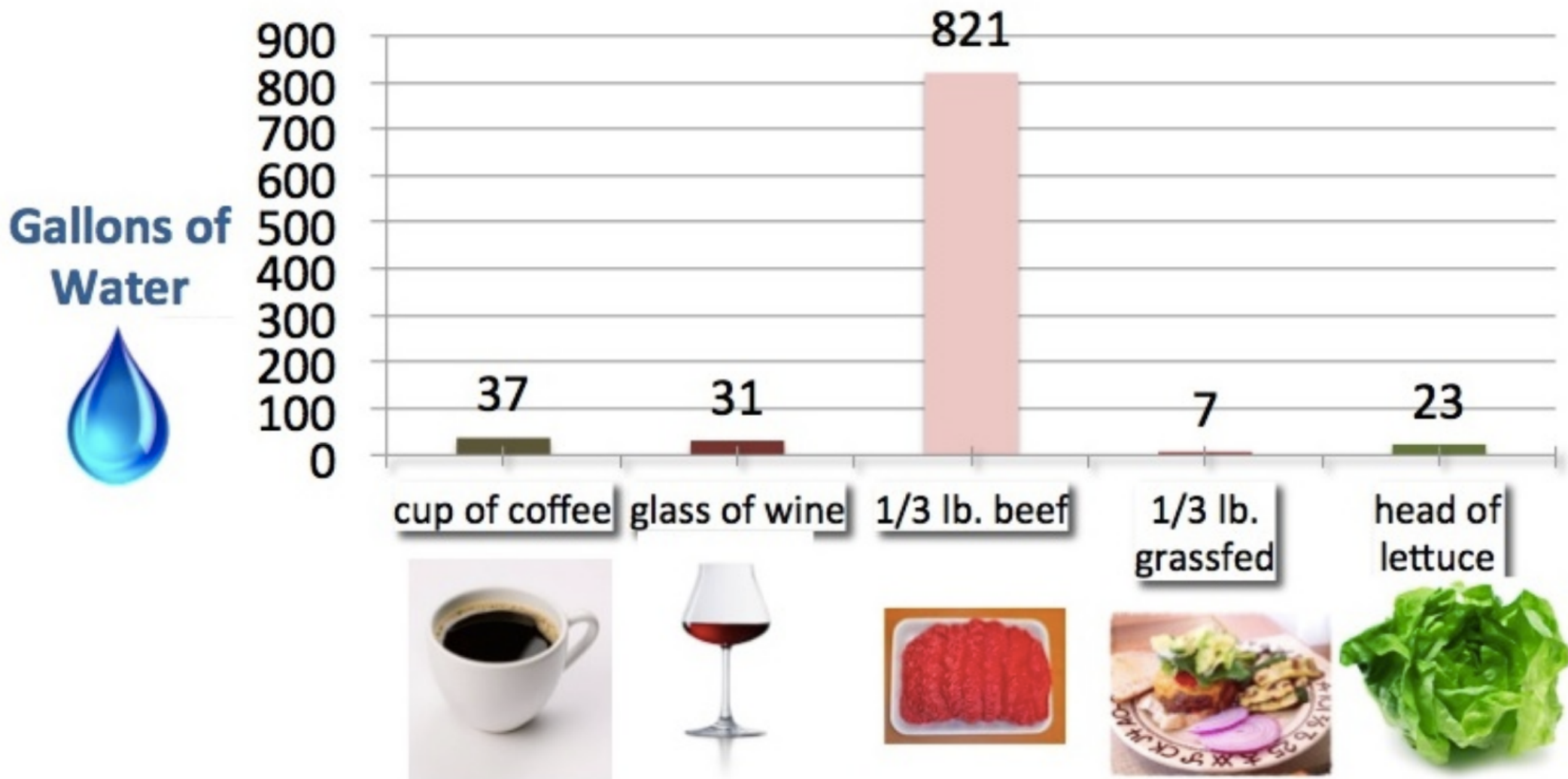


One pistachio



0.75 gallons of water

Favorite foods water footprint



Sources: <http://ga2.er.usgs.gov/edu/activity-water-content.cfm> ; <http://www.vegsource.com/articles/factoids.htm>

Water footprints of everyday products



76 litres of water to
produce a 250ml glass of beer

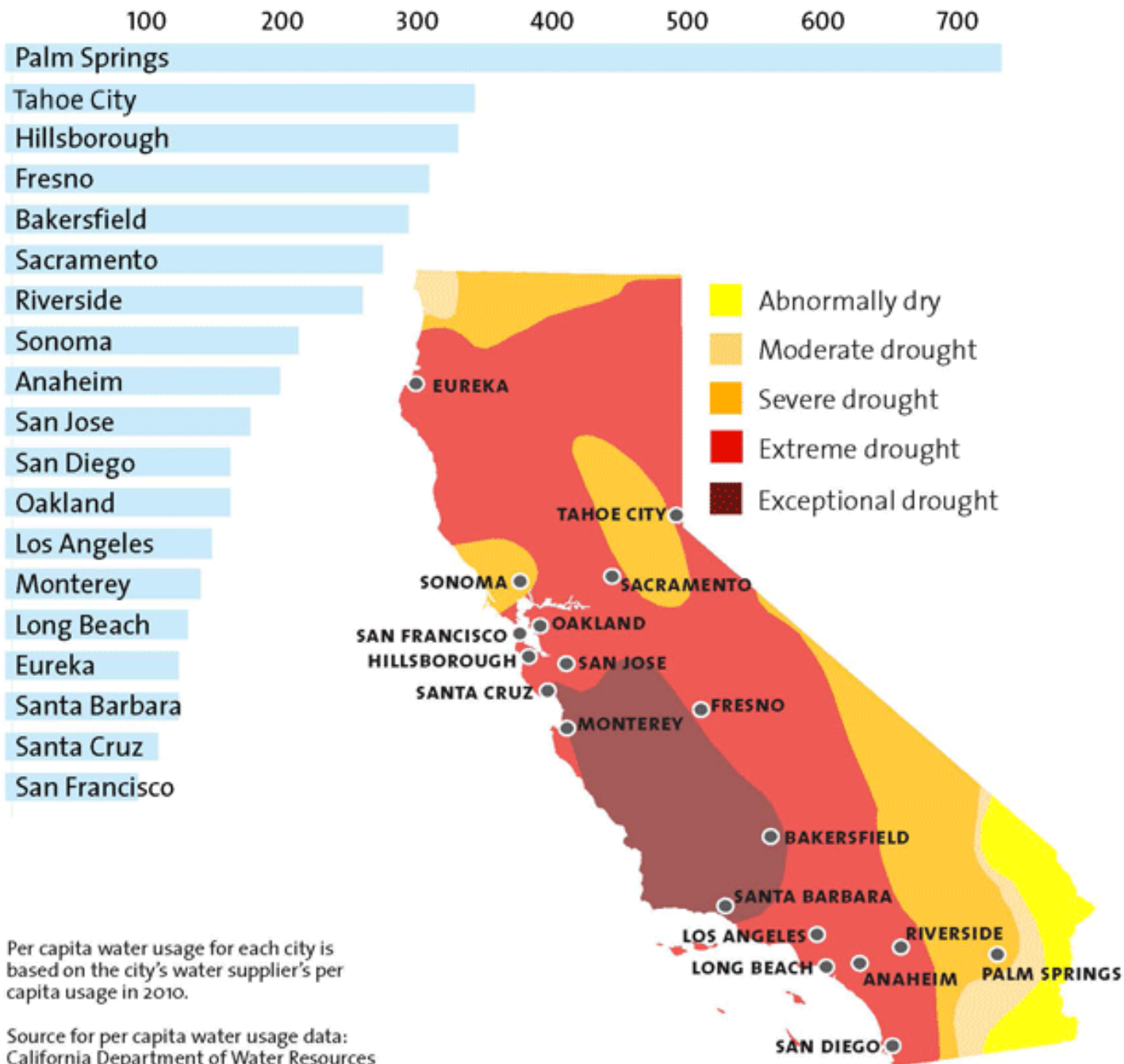


109 litres of water
to produce a 250ml glass of beer

– Mekonnen, M.M. and Hoekstra, A.Y. (2011)

How Much Water Are California Cities Using?

Gallons of water used per person per day, not including water used for agriculture



Per capita water usage for each city is based on the city's water supplier's per capita usage in 2010.

Source for per capita water usage data: California Department of Water Resources Urban Management Plan, 2010; source for drought map: US Drought Monitor, author: David Miskus.

Penzias and Wilson's Discovery is One of the Century's Key Advances

Murray Hill, N.J. -- When the intellectual history of the 20th century is written, a few achievements will tower over all. Einstein's theory of general relativity will be one; the laws of quantum mechanics will be another. The so-called Big Bang Theory of the origin of the universe will be a third.

The discovery in 1963 by Arno Penzias and Robert Wilson of the cosmic microwave background of the Big Bang set the seal of approval on the theory, and brought cosmology to the forefront as a scientific discipline. It was proof that the universe was born at a definite moment, some 15 billion years ago.

Wilson and Penzias with their historic horned antenna at Crawford Hill, N.J.

Dan Stanzione, then Bell Labs president and Lucent's chief operating officer when Penzias retired, said Penzias "embodies the creativity and technical excellence that are the hallmarks of Bell Labs." He called him a Renaissance figure who "extended our fragile understanding of creation, and advanced the frontiers of science in many important areas."



Scientists acknowledge that the discovery that Penzias and Wilson made was one of the century's key scientific advances.

Said Michael Turner, a well-known cosmologist at the University of Chicago who recently gave a talk here, "The discovery of the cosmic microwave background by Penzias and Wilson transformed cosmology from being the realm of a handful of astronomers to a 'respectable' branch of physics almost overnight."

Penzias and Wilson began looking for theoretical explanations. Around the same time, Robert Dicke (1916-1997) at nearby Princeton University had been pursuing theories about the big bang. He had elaborated on existing theory to suggest that if there had been a big bang, the residue of the explosion should by now take the form of a low-level background radiation throughout the universe. Dicke was looking for evidence of this theory when Penzias and Wilson got in touch with his lab. He shared his theoretical work with them, even as he resignedly said to his fellow-researchers, "We've been scooped."



The Nobel Prize in Physics 1978

"for his basic inventions and discoveries in the area of low-temperature physics"

"for their discovery of cosmic microwave background radiation"



Pyotr Leonidovich Kapitsa

🕒 1/2 of the prize

USSR



Arno Allan Penzias

🕒 1/4 of the prize

USA



Robert Woodrow Wilson

🕒 1/4 of the prize

USA

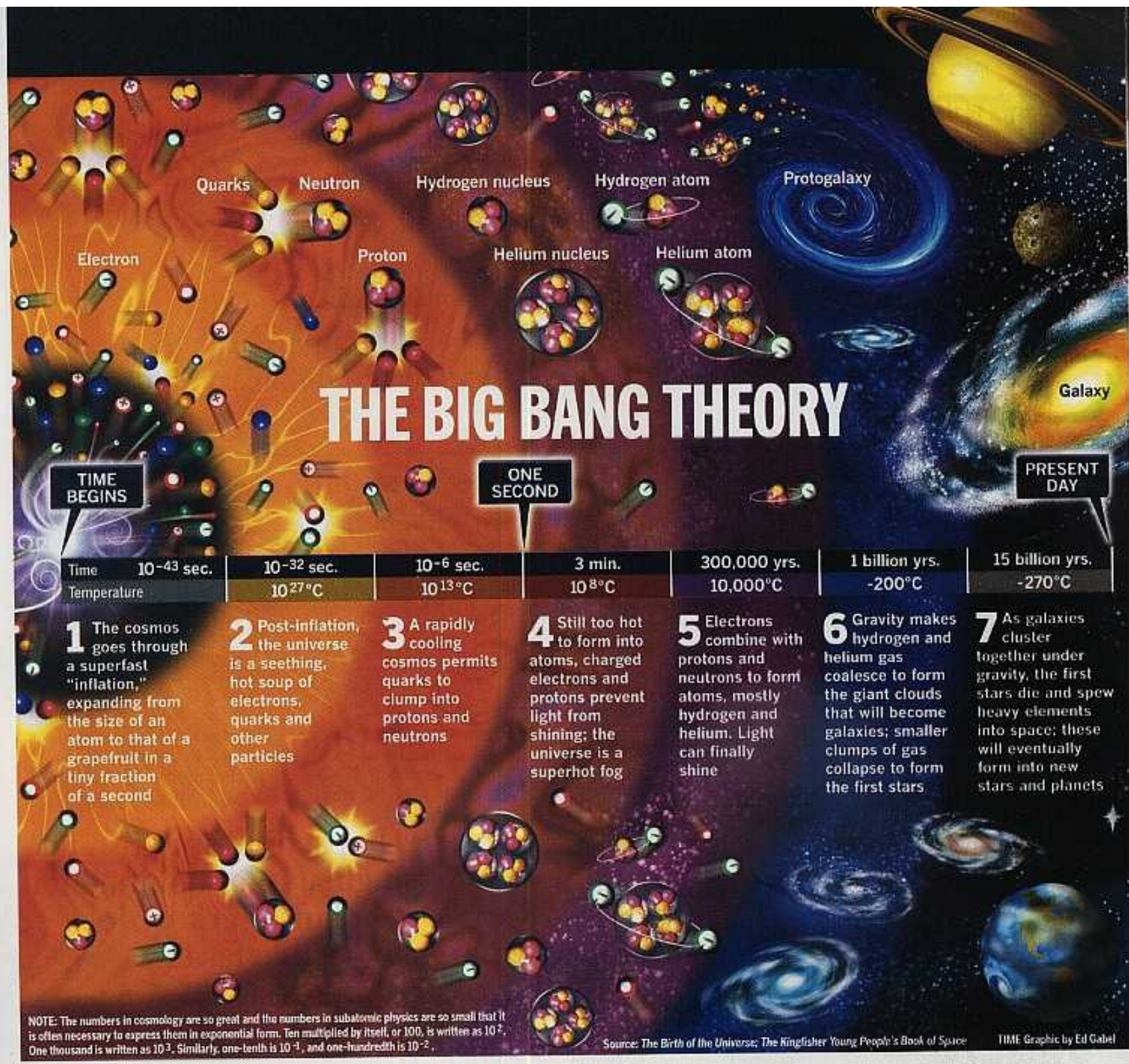
Alpher (Gamow's grad student) told Joseph D'Agnesse in his interview for Discover Magazine, *There are two reasons you do science. One is the altruistic feeling that maybe you can contribute to mankind's store of knowledge about the world. The other and more personal thing is you want the approbation of your peers. Pure and simple.*^[12]

However, Ralph Alpher told his son Victor (1980) when he was considering advanced education, that "approbation" of anyone was NOT the reason to pursue graduate study or a career requiring advanced intensive study. Rather, he said to Victor, "you must enjoy and find satisfaction in the work you do every day, because you will not receive frequent rewards or pats on the back." Up to that time, he had received only three awards for his work in cosmology, from the American Philosophical Society, the Belgian Academy of Science, and the Franklin Institute—all occurring after he turned 50 (personal communication to Victor S. Alpher added July 7, 2011).

Alpher received the National Medal of Science in 2005 for his discoveries in Cosmology as a graduate student.

The medal was presented to Alpher's son as he was too ill to travel.

Alpher died in 2007



Quarks

Neutron

Hydrogen nucleus

Hydrogen atom

Protogalaxy

Electron

Proton

Helium nucleus

Helium atom

Galaxy

THE BIG BANG THEORY

TIME
BEGINS

ONE
SECOND

PRESENT
DAY

Time 10^{-43} sec.
Temperature

10^{-32} sec.
 10^{27}°C

10^{-6} sec.
 10^{13}°C

3 min.
 10^8°C

300,000 yrs.
 $10,000^{\circ}\text{C}$

1 billion yrs.
 -200°C

15 billion yrs.
 -270°C

1 The cosmos goes through a superfast "inflation," expanding from the size of an atom to that of a grapefruit in a tiny fraction of a second

2 Post-inflation, the universe is a seething, hot soup of electrons, quarks and other particles

3 A rapidly cooling cosmos permits quarks to clump into protons and neutrons

4 Still too hot to form into atoms, charged electrons and protons prevent light from shining; the universe is a superhot fog

5 Electrons combine with protons and neutrons to form atoms, mostly hydrogen and helium. Light can finally shine

6 Gravity makes hydrogen and helium gas coalesce to form the giant clouds that will become galaxies; smaller clumps of gas collapse to form the first stars

7 As galaxies cluster together under gravity, the first stars die and spew heavy elements into space; these will eventually form into new stars and planets

NOTE: The numbers in cosmology are so great and the numbers in subatomic physics are so small that it is often necessary to express them in exponential form. Ten multiplied by itself, or 100, is written as 10^2 . One thousand is written as 10^3 . Similarly, one-tenth is 10^{-1} , and one-hundredth is 10^{-2} .

Source: *The Birth of the Universe*; *The Kingfisher Young People's Book of Space*

TIME Graphic by Ed Gabel



<http://www.youtube.com/watch?v=U0kXkWSXRA>



Book of the Month
MOUNTAIN WITNESS

A Natural History of Nature Writing

RIVER TEETH
DAVID JAMES PROCTOR

Car The Windward Road

Conducts The Practice of Home

Adam Sedgwick Writing the High Ridge

REFUGE

THE NEW NATURE

AFRICANA

THE NEW NATURE

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FRANK LLOYD WRIGHT

A Concise History of Western Architecture

THE NEW NATURE

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CATCH-22 JOSEPH

CRIME AND PUNISHMENT

CRIME AND PUNISHMENT

CRIME AND PUNISHMENT

CRIME AND PUNISHMENT

CRIME AND PUNISHMENT

Agatha Christie

Agatha Christie

Agatha Christie

Agatha Christie

Agatha Christie



This new Hubble image shows a cosmic creepy-crawly known as the Tarantula Nebula in infrared light. This region is full of star clusters, glowing gas, and thick dark dust. Image released Jan. 9, 2014.

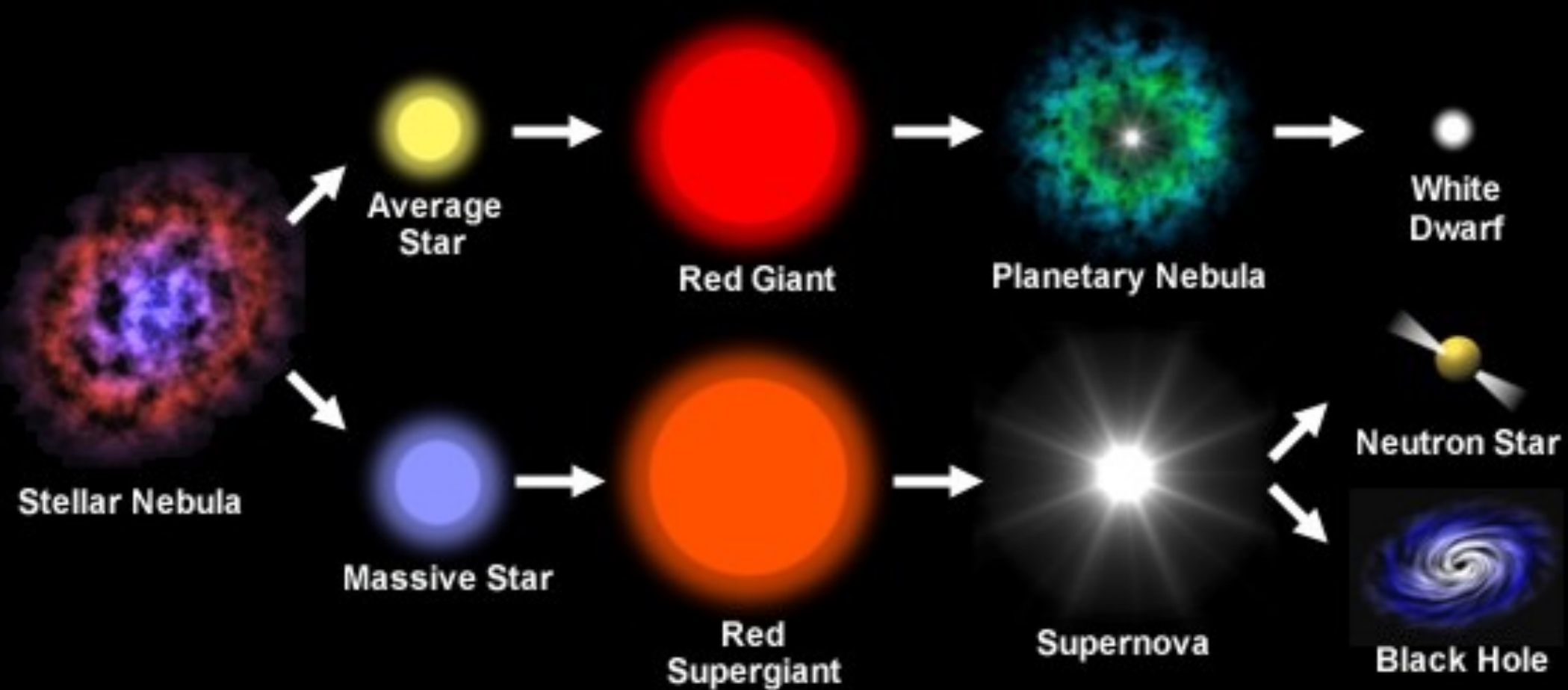
"The image is dominated by gas and dust, but I can assure you that there are more than 800,000 stars living in this region," Elena Sabbi, of the Space Telescope Science Institute, said as she unveiled the new image here at the 223rd meeting of the American Astronomical Society. "To see them, you have to strip away the veil the dust is causing and then you can admire the stars in this region. This is a very efficient way to identify where stars are forming nowadays in the Tarantula Nebula."

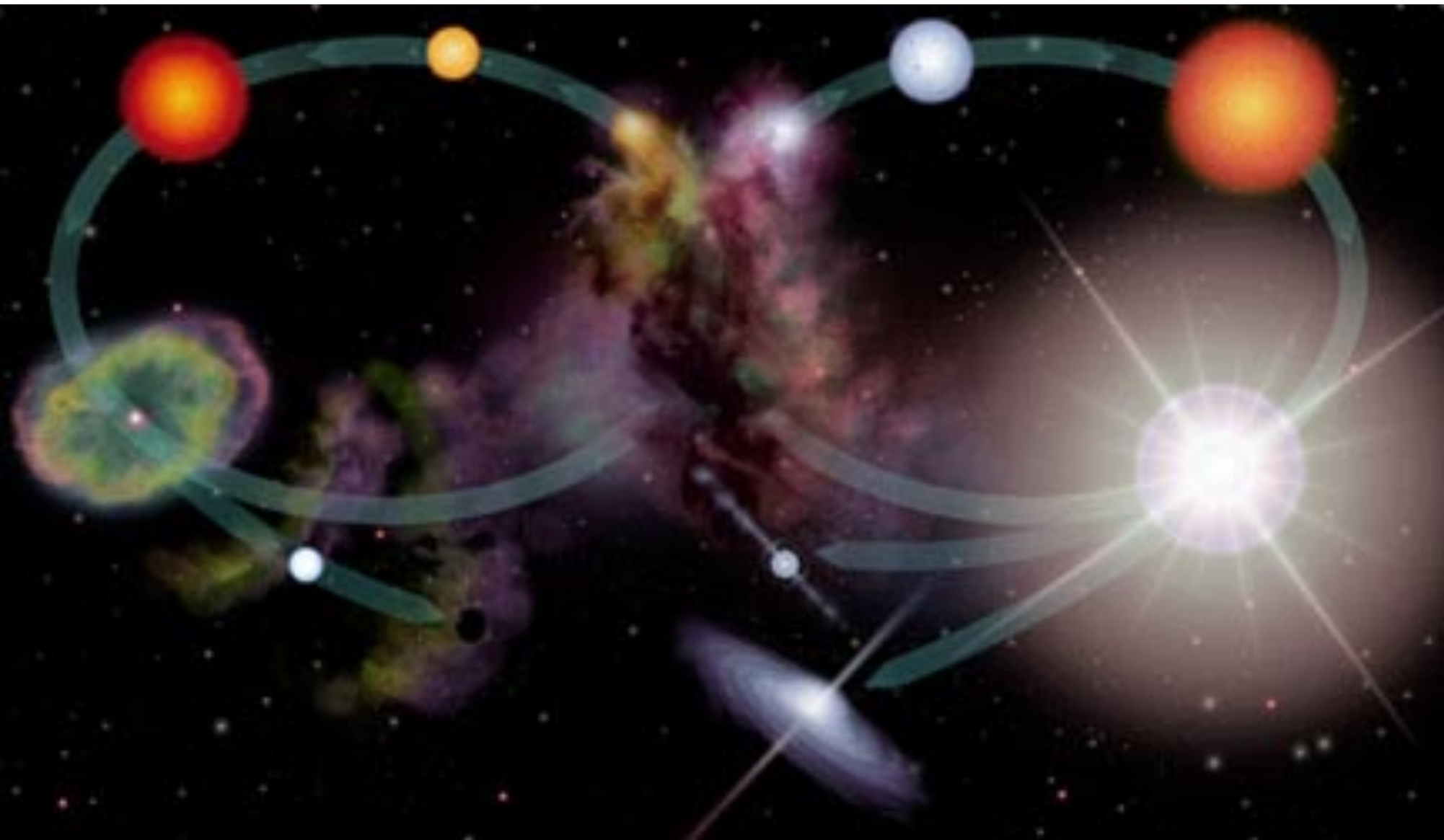


NASA, ESA, E. Sabbi/STScI

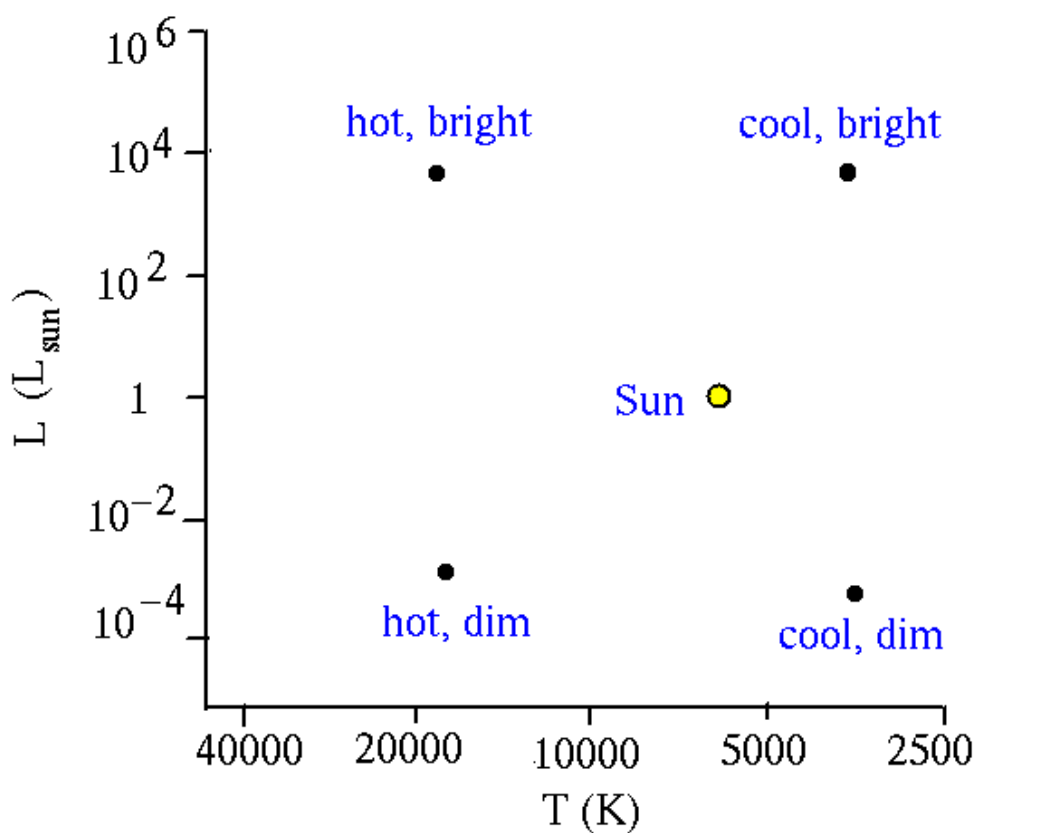
Created using observations taken as part of the Hubble Tarantula Treasury Project (HTTP), these images were snapped using Hubble's Wide Field Camera 3 (WFC3) and Advanced Camera for Surveys (ACS). Image released Jan. 9, 2014.

Life Cycle of a Star

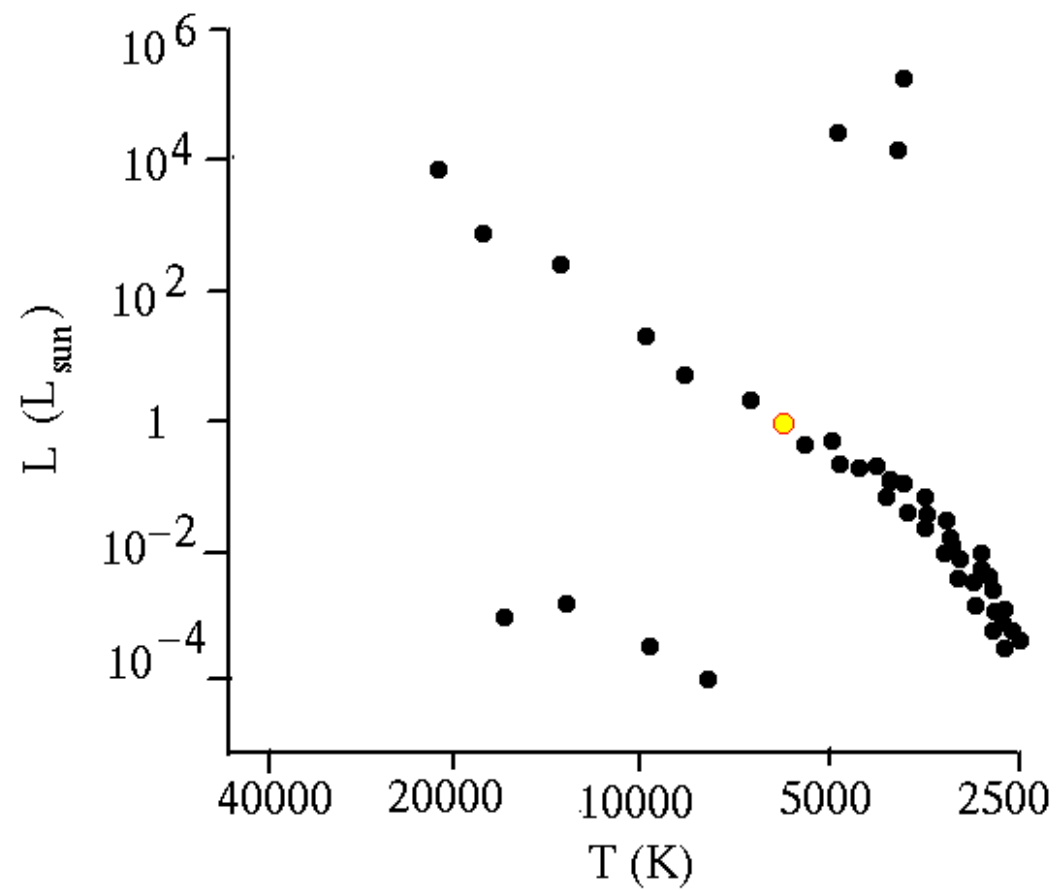
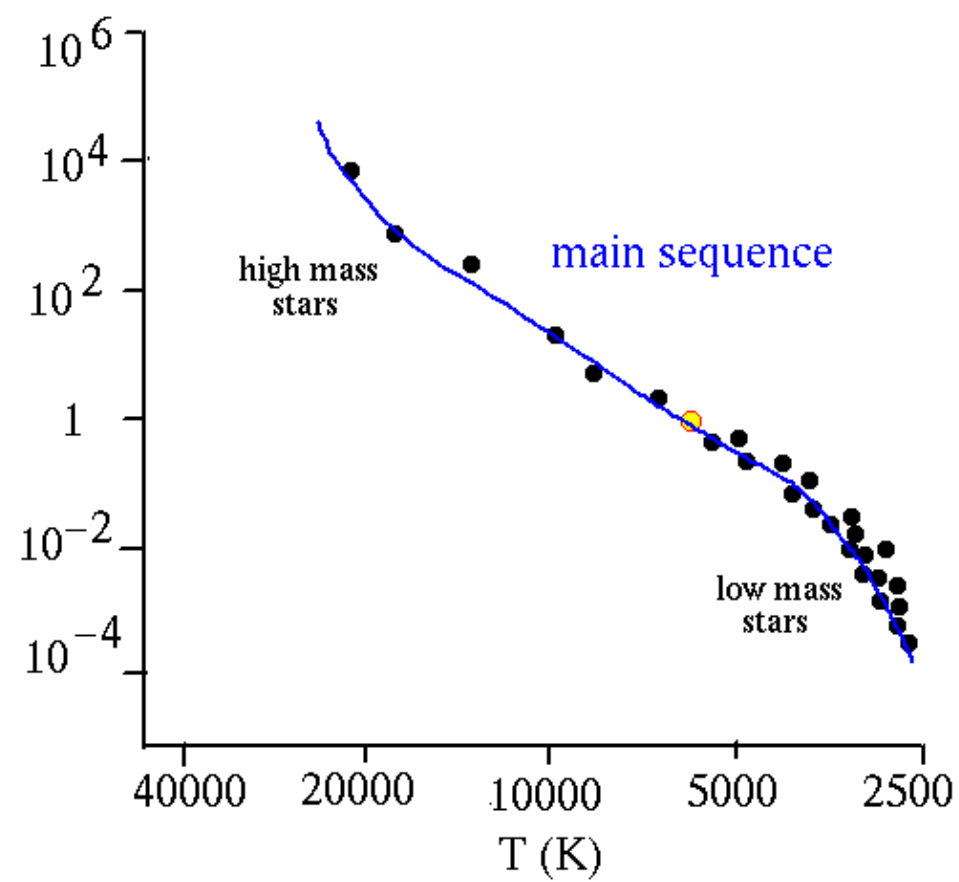


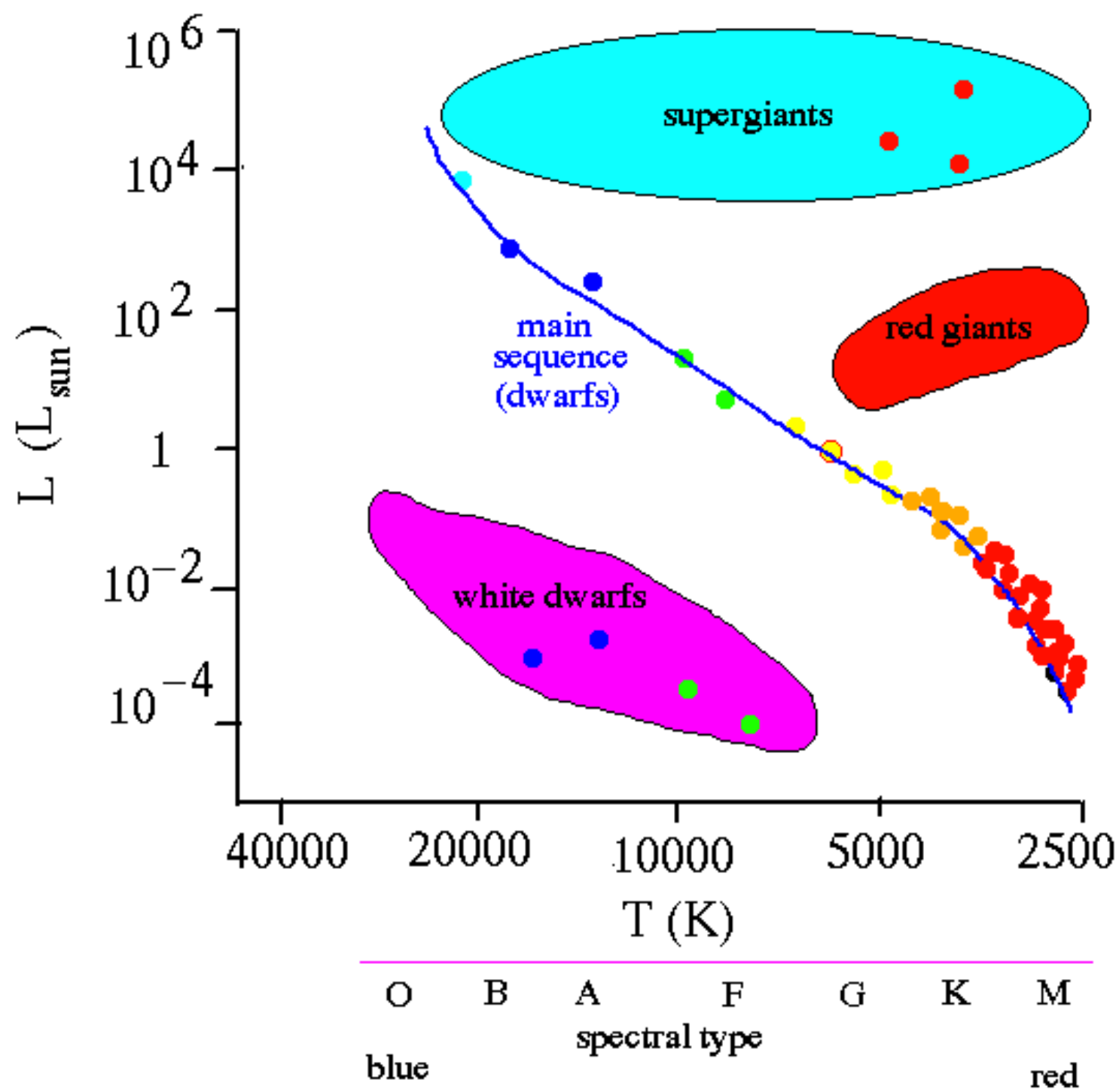


These diagrams, called the Hertzsprung-Russell or HR diagrams, plot luminosity in solar units on the Y axis and stellar temperature on the X axis, as shown below.



A plot of the nearest stars on the HR diagram is shown below:





**Low to Average
Mass Star
(Our Sun)**



**White
Dwarf**

**Large Mass
Star**



**Neutron
Star**

**Very Large
Mass Star**



**Black
Hole**

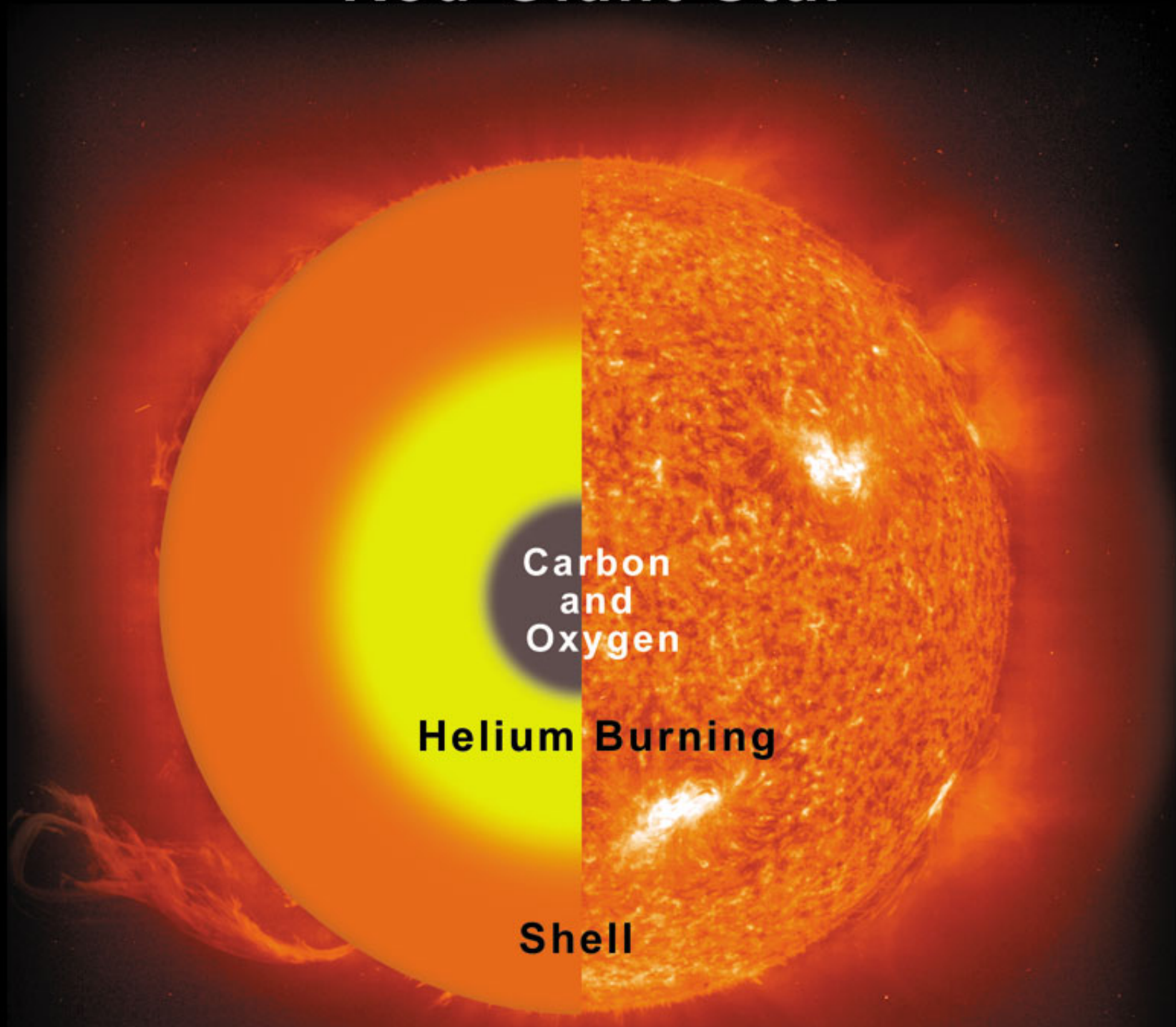
**The Fate of a Star Depends on Its Mass.
The More Mass, the Shorter Its Life Cycle
and the More Dramatic Its Death!**

Stellar Nebulae

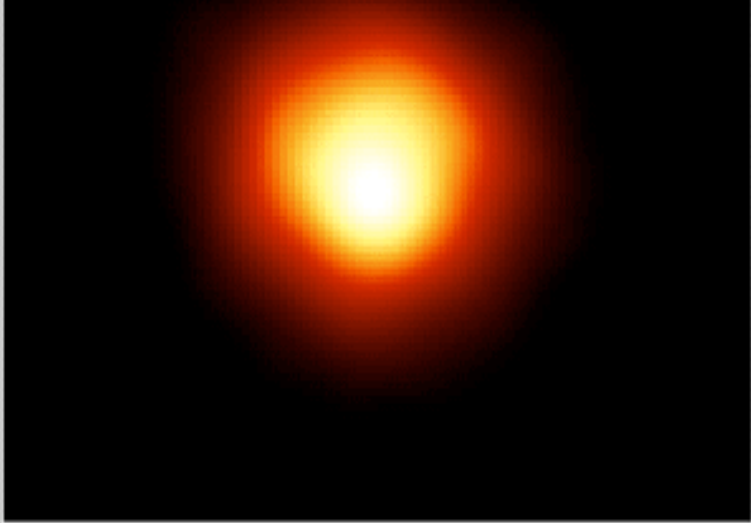




Red Giant Star



Betelgeuse, also known by its Bayer designation Alpha Orionis, is the ninth-brightest star in the night sky and second brightest in the constellation of Orion.



Size of Star



Size of Earth's Orbit



Size of Jupiter's Orbit



Atmosphere of Betelgeuse

HST • FOC

PRC96-04 • ST Scl OPO • January 15, 1995 • A. Dupree (CfA), NASA

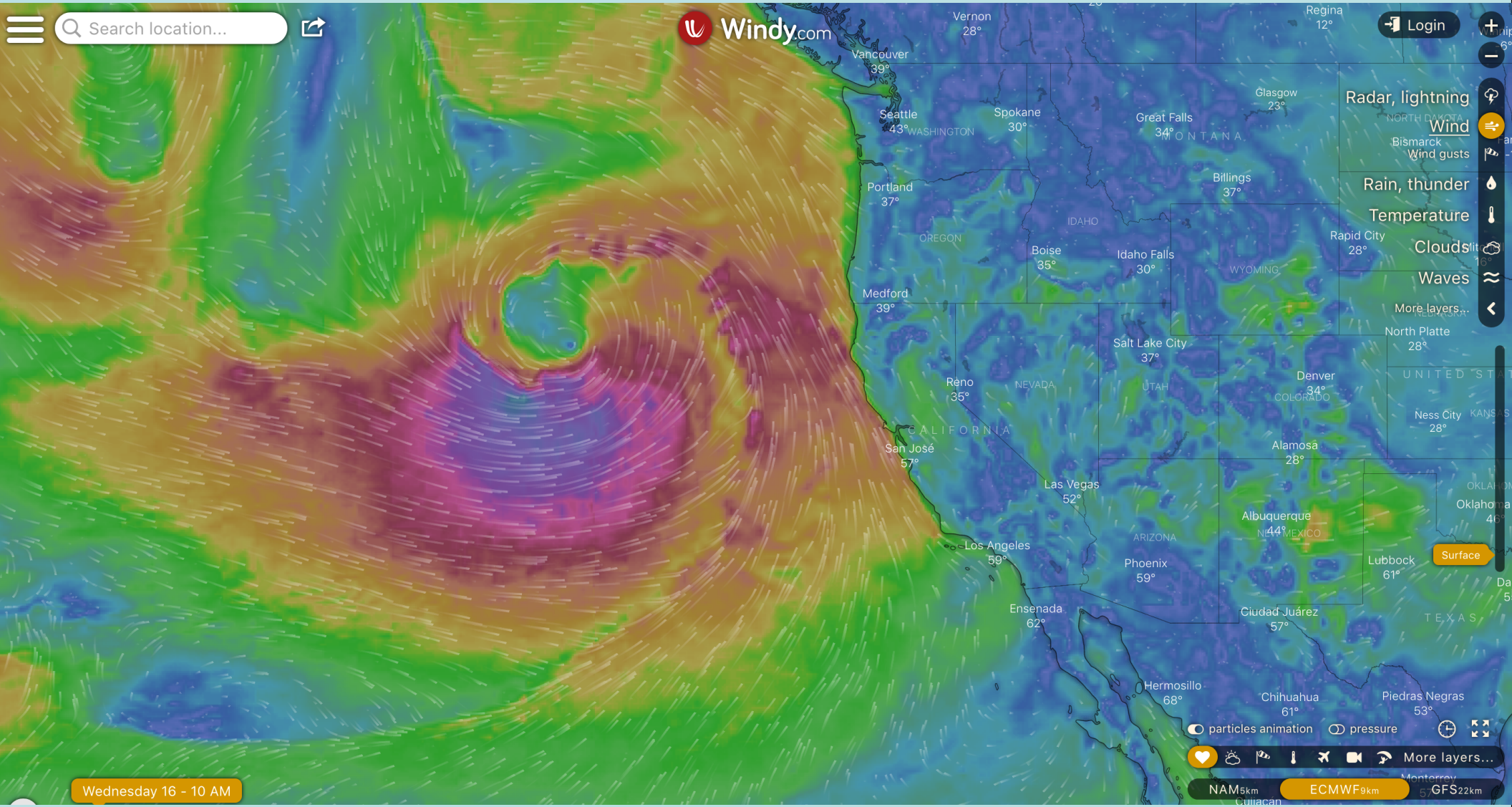


Search location...



Windy.com

Login



Radar, lightning

Wind

Bismarck
Wind gusts

Rain, thunder

Temperature

Clouds

Waves

More layers...

North Platte
28°

UNITED STATES

Ness City
28°

KANSAS

Oklahoma
46°

OKLAHOMA

Albuquerque
44°

MEXICO

Lubbock
61°

TEXAS

Chihuahua
61°

Piedras Negras
53°

Monterrey
57°

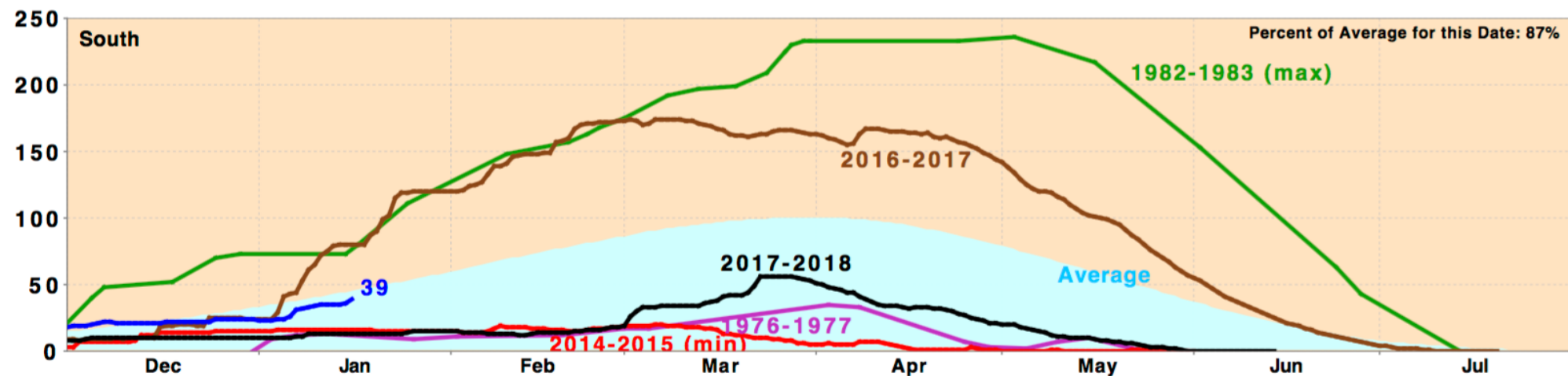
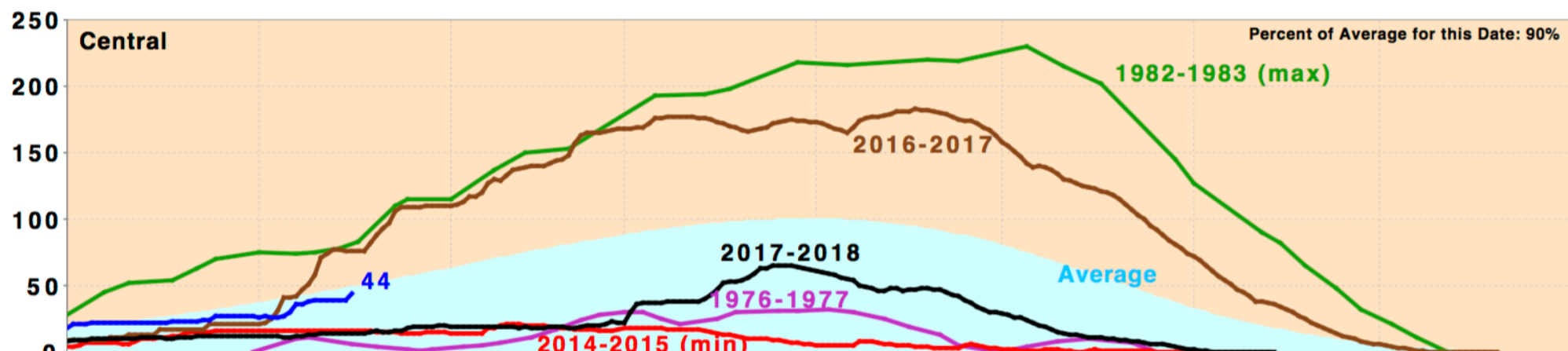
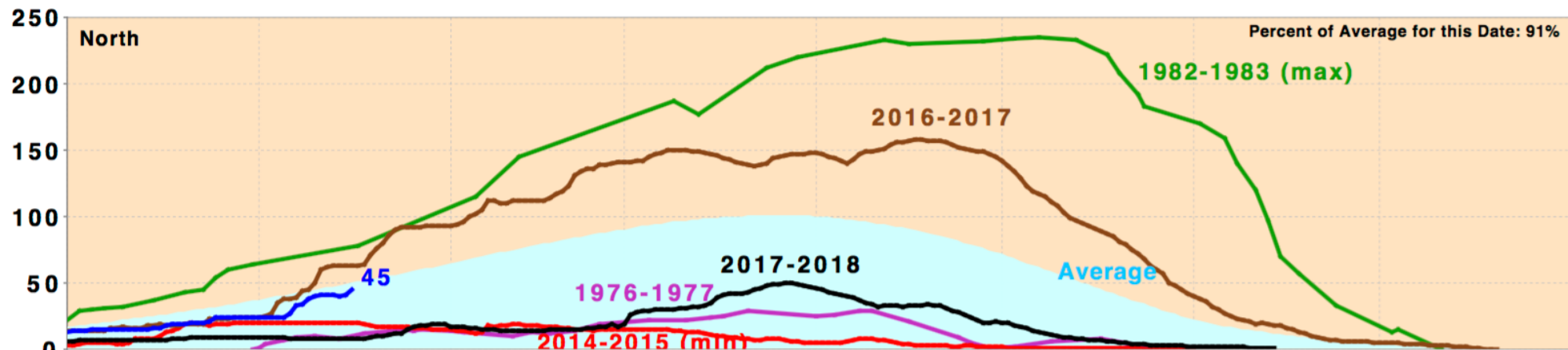
More layers...

particles animation pressure

NAM5km ECMWF9km GFS22km

Wednesday 16 - 10 AM

California Snow Water Content, January 16, 2019, Percent of April 1 Average

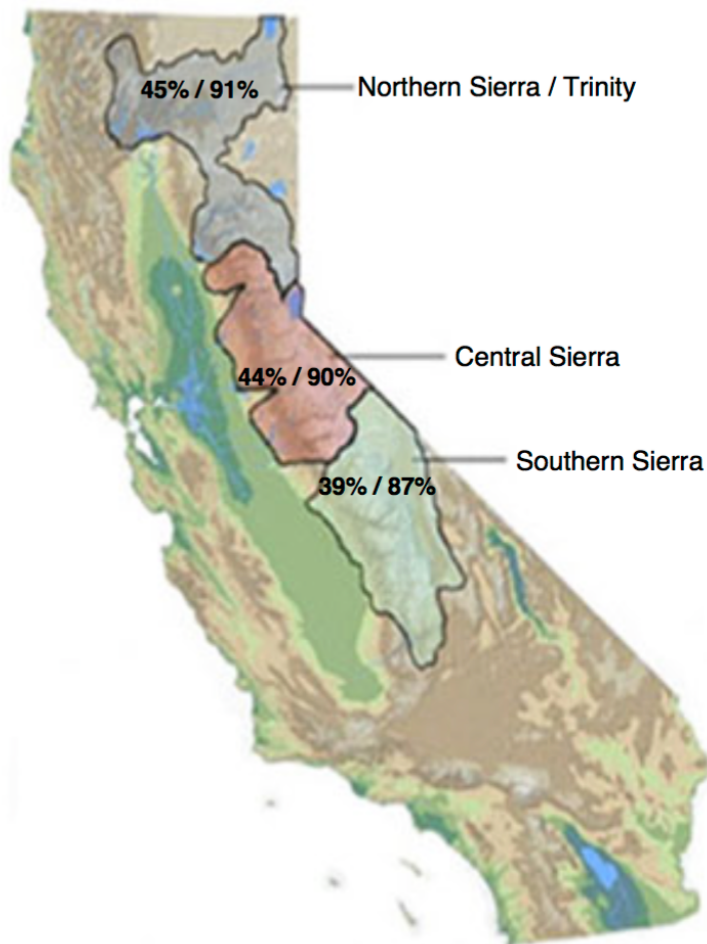


Statewide Percent of April 1: 43%

Statewide Percent of Average for Date: 90%

Current Regional Snowpack from Automated Snow Sensors

% of April 1 Average / % of Normal for This Date



Statewide Average: 43% / 90%

NORTH	
Data as of January 16, 2019	
Number of Stations Reporting	32
Average snow water equivalent (Inches)	13.0
Percent of April 1 Average (%)	45
Percent of normal for this date (%)	91

CENTRAL	
Data as of January 16, 2019	
Number of Stations Reporting	45
Average snow water equivalent (Inches)	13.3
Percent of April 1 Average (%)	44
Percent of normal for this date (%)	90

SOUTH	
Data as of January 16, 2019	
Number of Stations Reporting	29
Average snow water equivalent (Inches)	9.9
Percent of April 1 Average (%)	39
Percent of normal for this date (%)	87

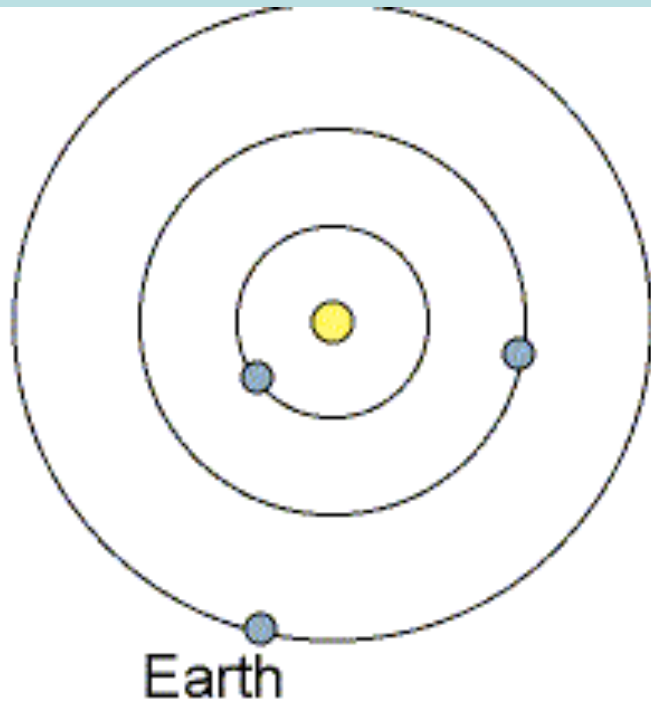
STATE	
Data as of January 16, 2019	
Number of Stations Reporting	106
Average snow water equivalent (Inches)	12.3
Percent of April 1 Average (%)	43
Percent of normal for this date (%)	90

Data as of January 16, 2019

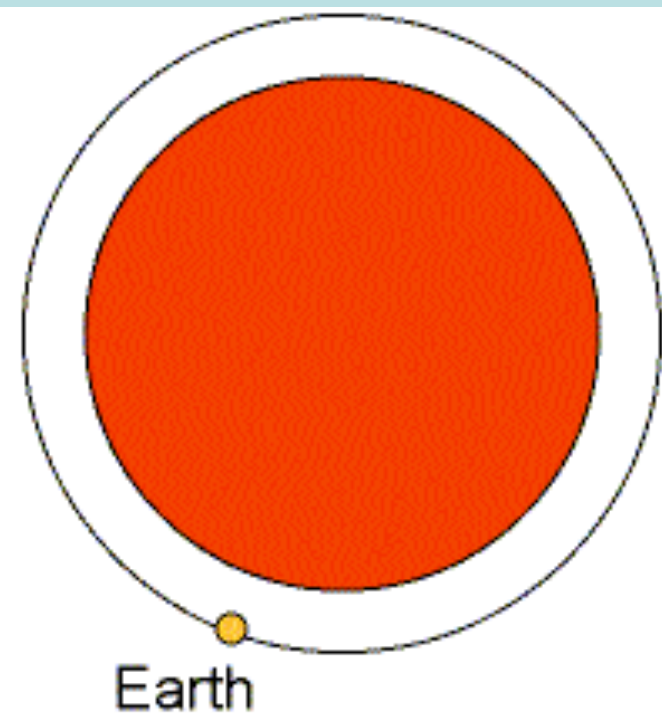
RAIN AND SNOW FORECAST

THROUGH THURSDAY



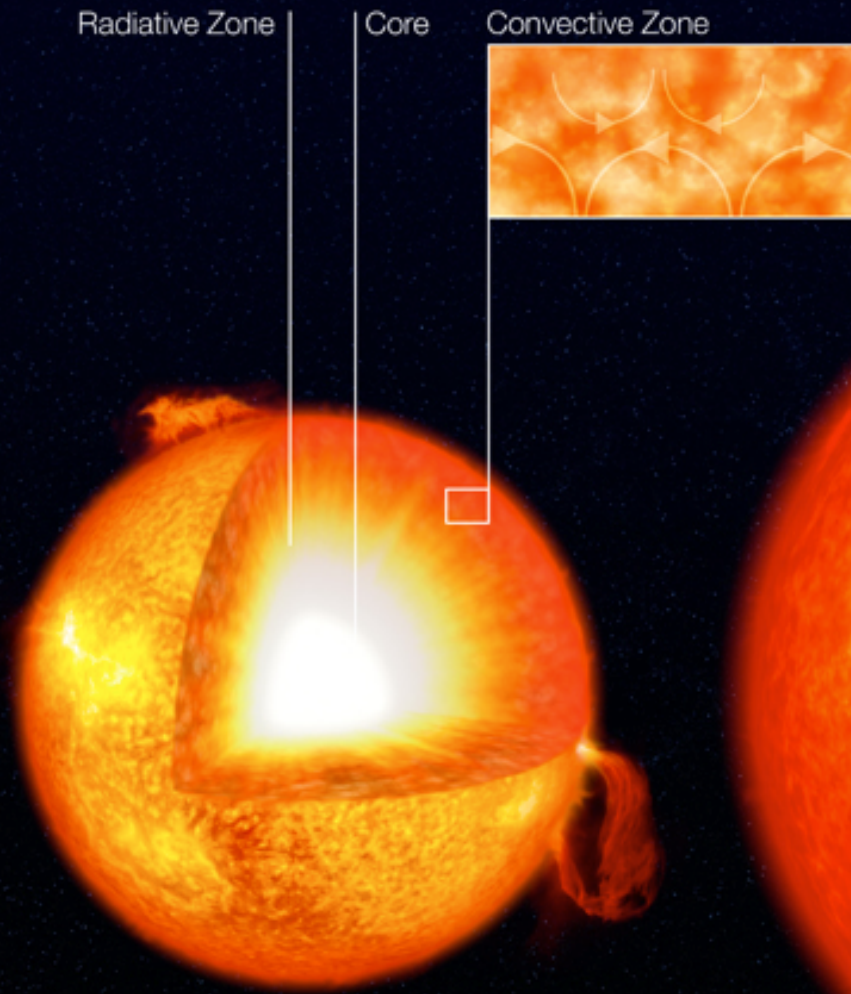


Now: hot core + warm surface; small size.

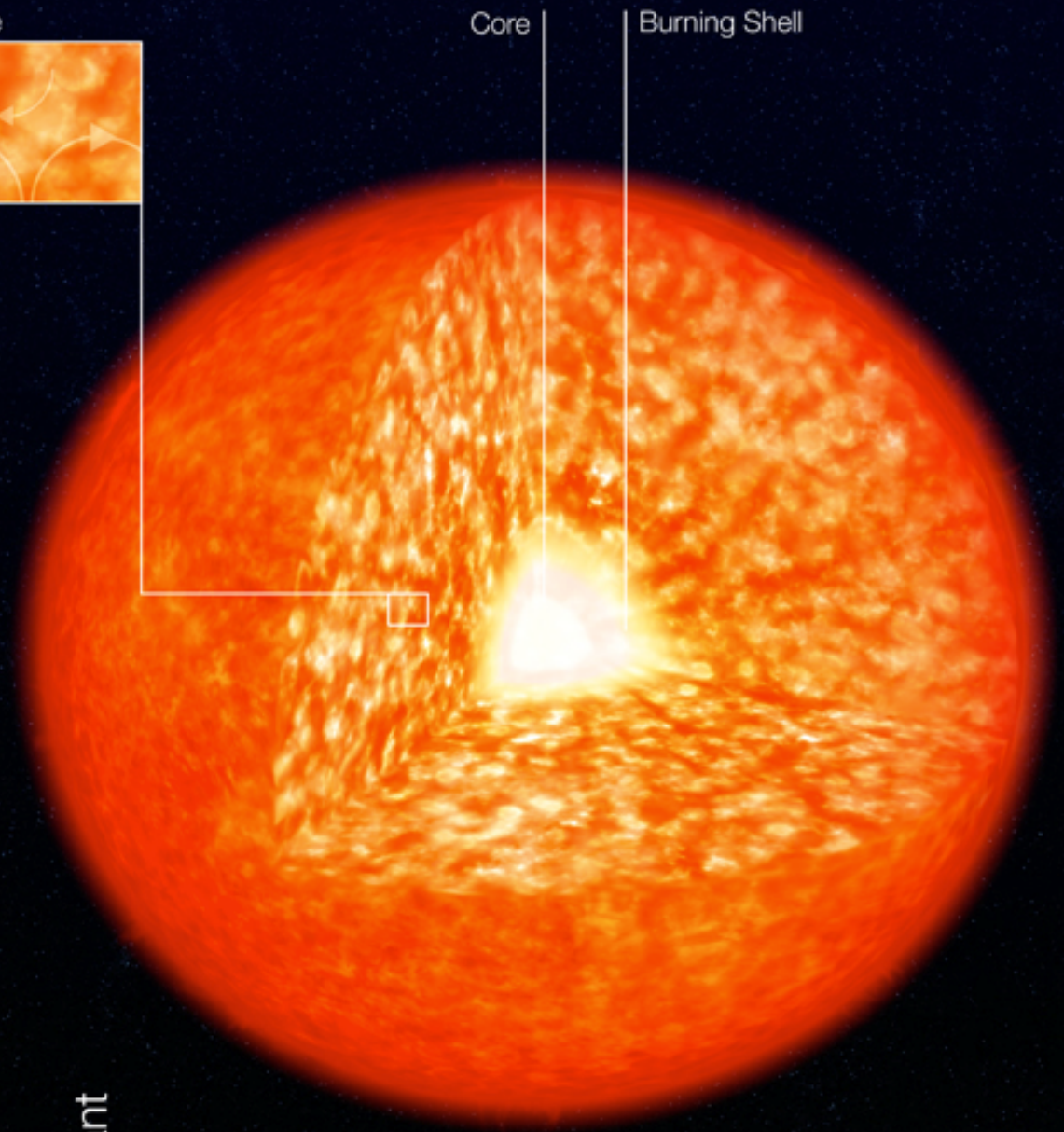


Future: very hot core + cool surface. Large size but less mass; very bright.

Solar Type

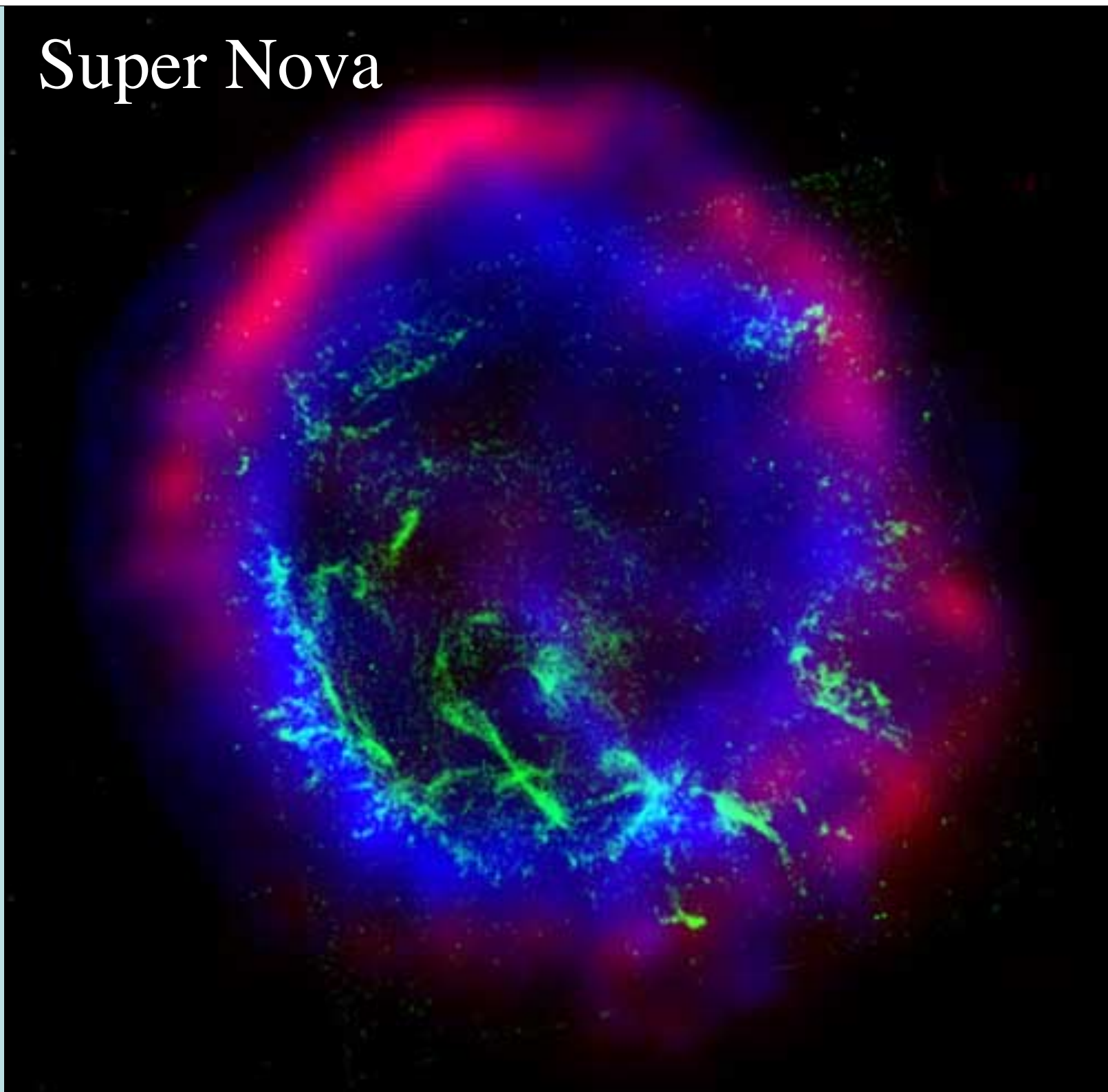


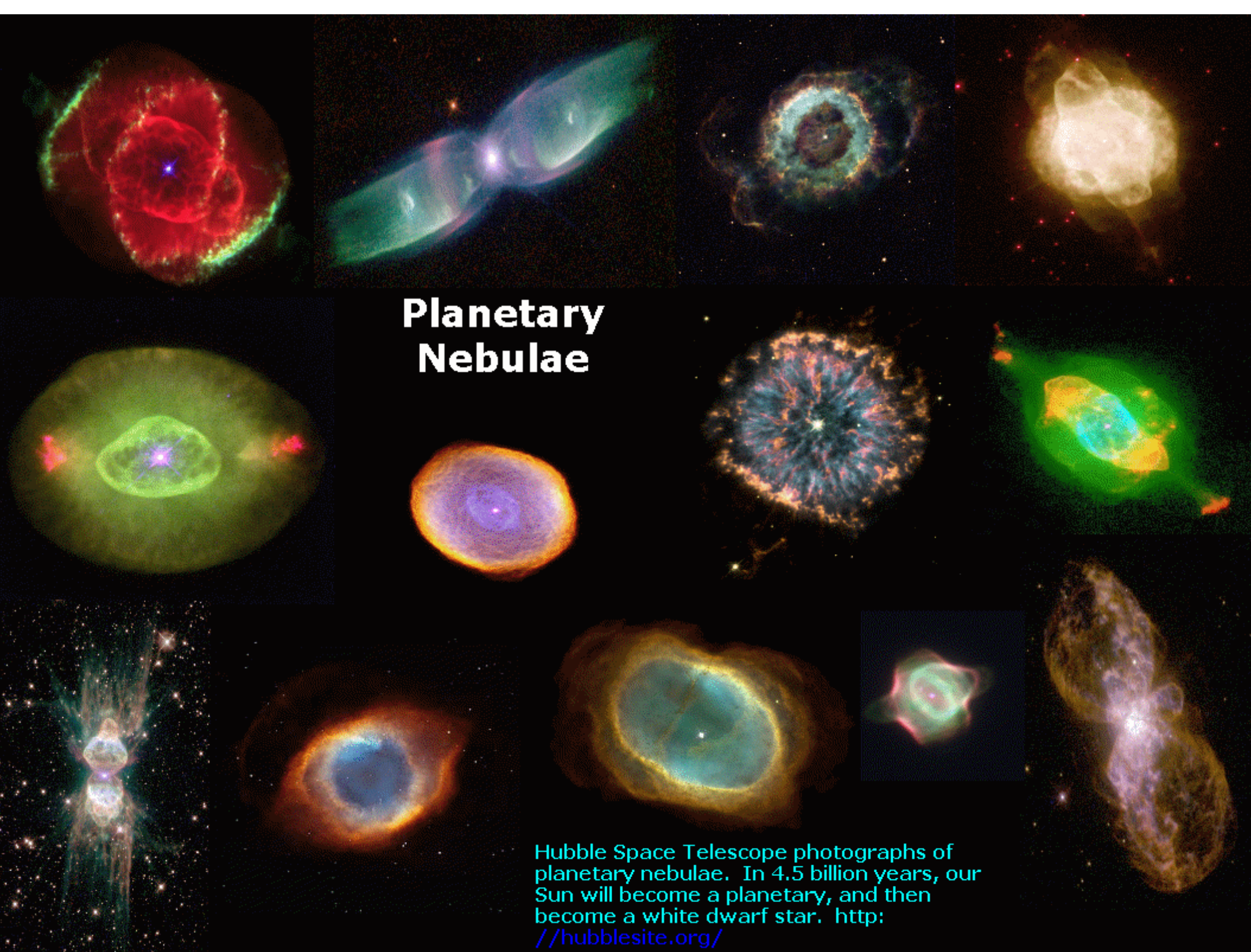
Red Giant



Scale $\rightarrow$ 200 Earth Radii

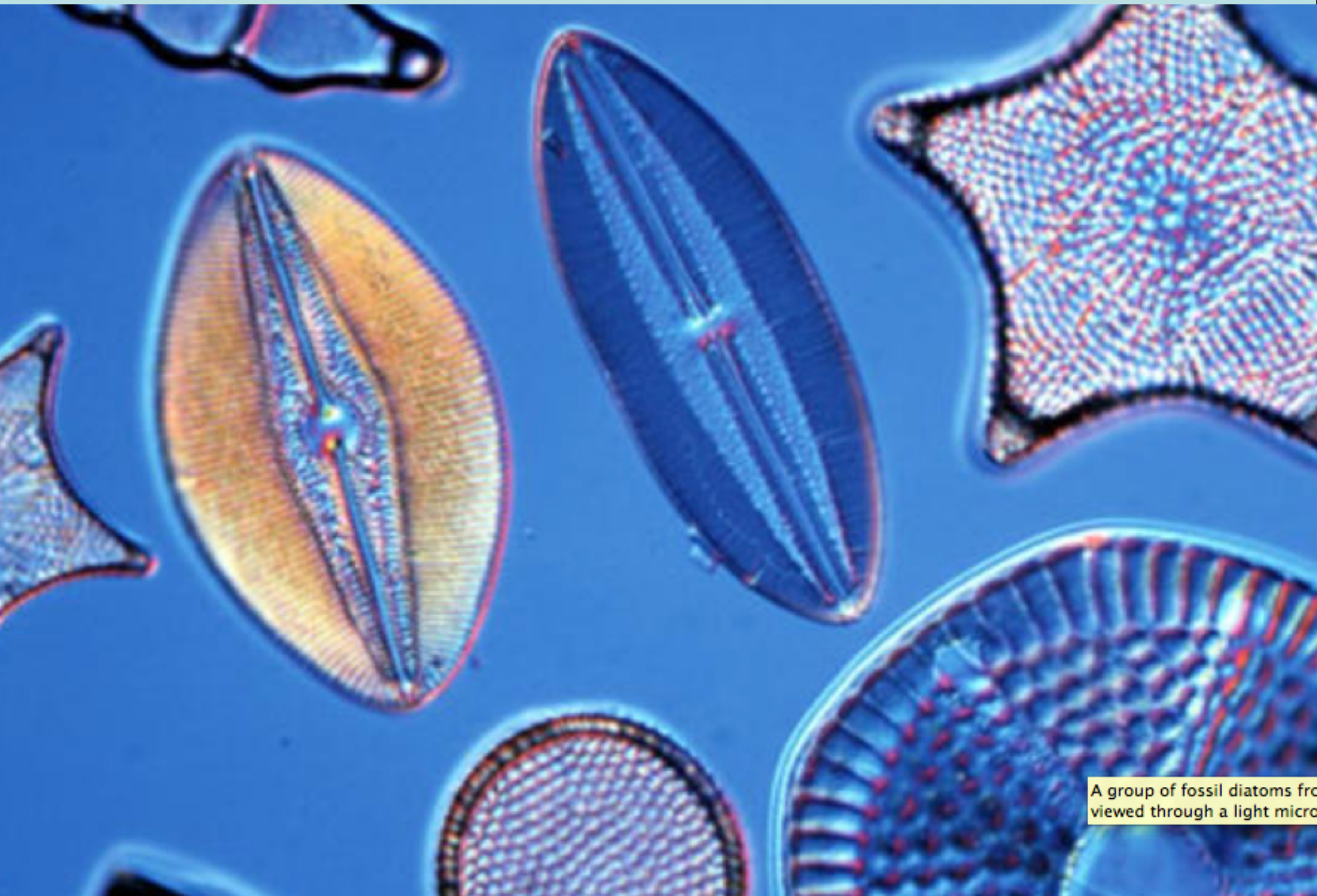
Super Nova





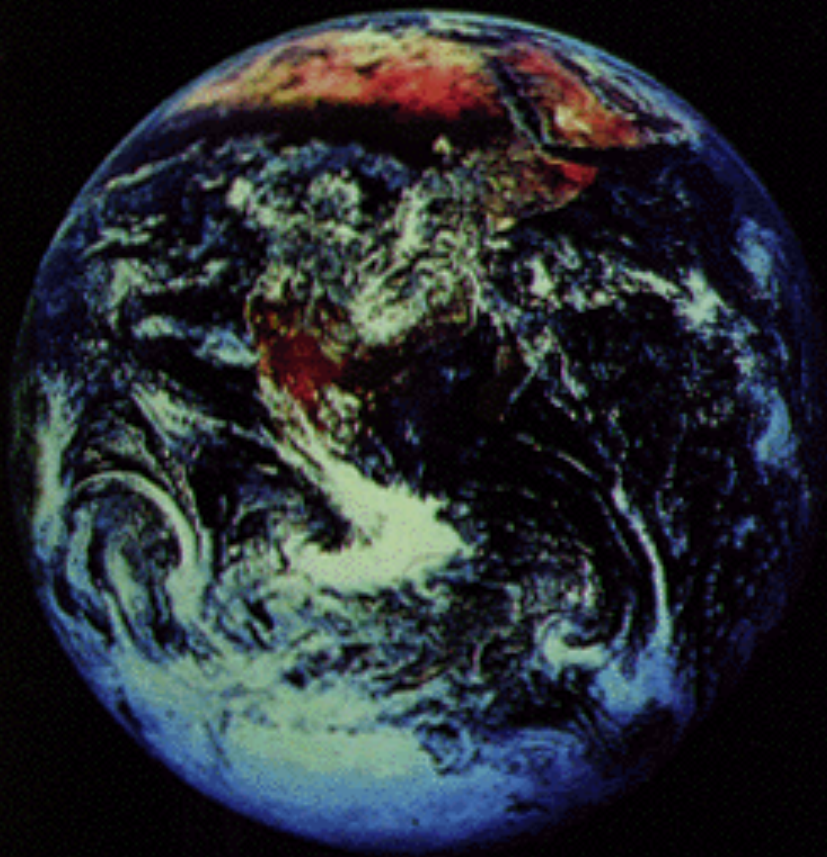
Planetary Nebulae

Hubble Space Telescope photographs of planetary nebulae. In 4.5 billion years, our Sun will become a planetary, and then become a white dwarf star. <http://hubblesite.org/>

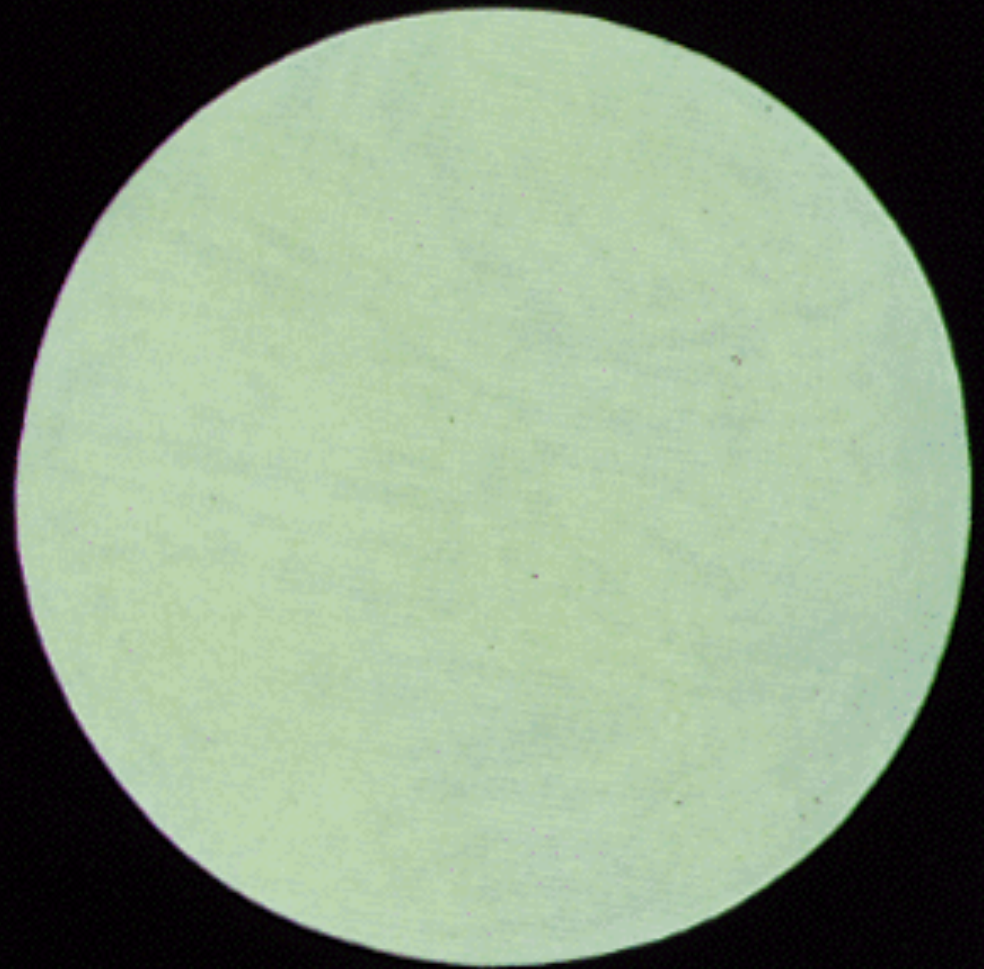


A group of fossil diatoms from
viewed through a light micro

EARTH



WHITE DWARF

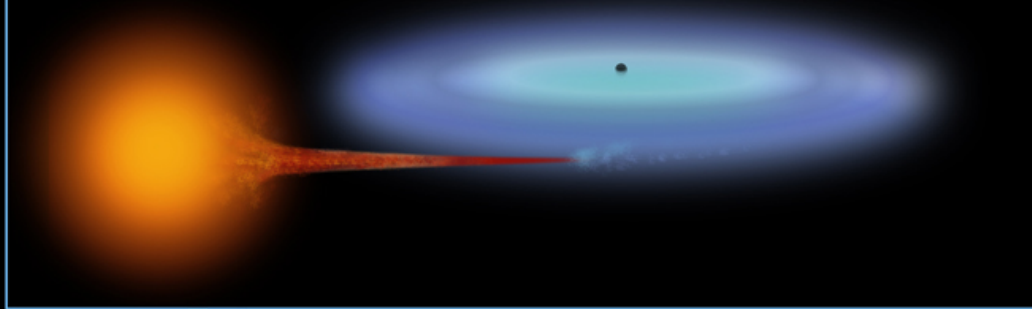


NEUTRON STAR

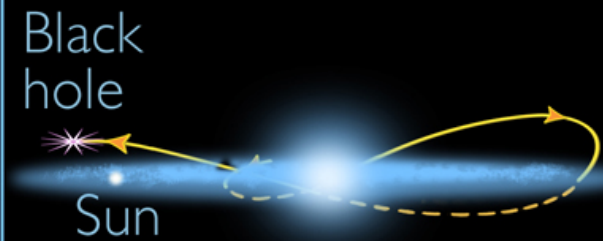


Black hole's wild ride through the Milky Way

The black hole, liberated from a globular cluster some 7 billion years ago, has been cannibalizing its companion star ever since.



Edge-on view of orbit



Our
Sun

Black
hole's
orbit

Artist's conception of the Milky Way

Solar Elemental Abundances

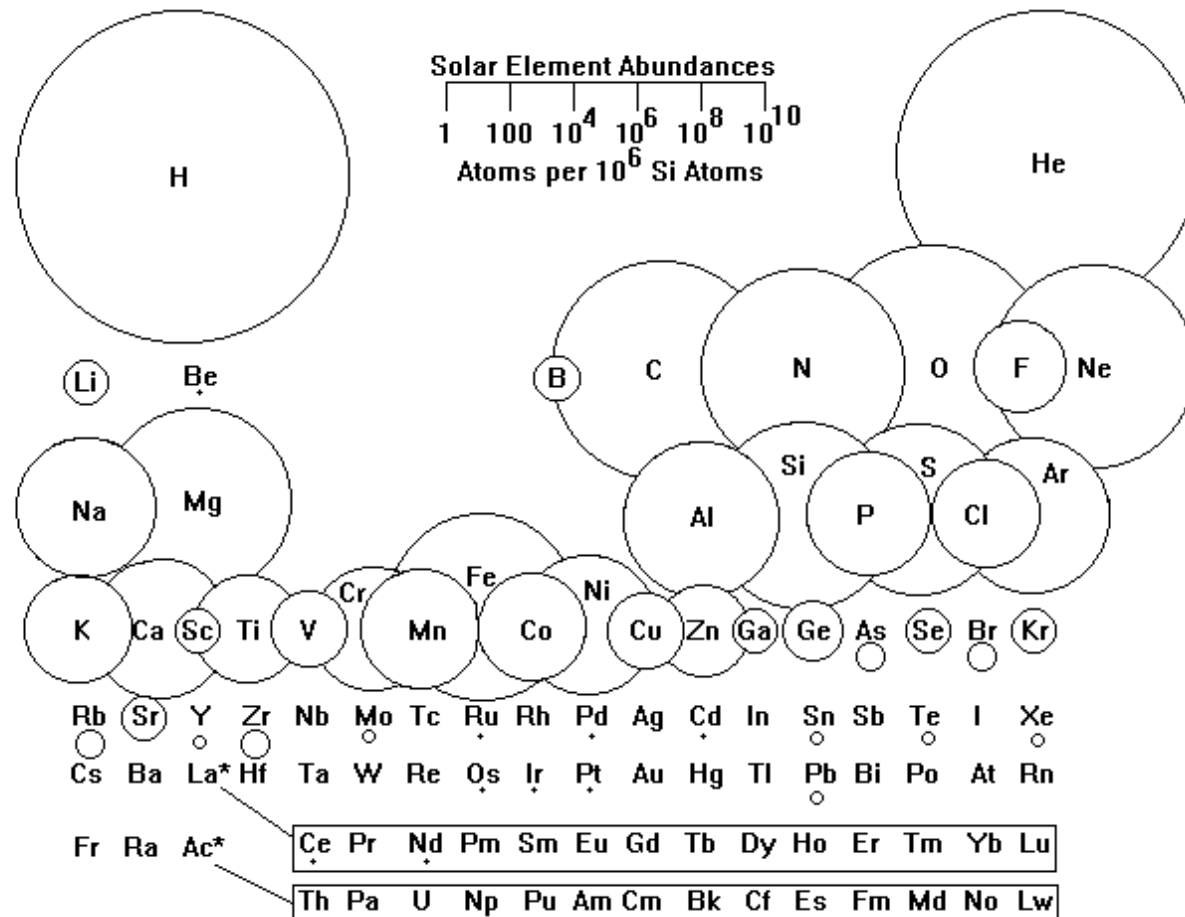
Element	Number %	Mass %
Hydrogen	92.0	73.4
Helium	7.8	25.0
Carbon	0.02	0.20
Nitrogen	0.008	0.09
Oxygen	0.06	0.8
Neon	0.01	0.16
Magnesium	0.003	0.06
Silicon	0.004	0.09
Sulfur	0.002	0.05
Iron	0.003	0.14

absorption lines in its spectrum (*the Fraunhofer lines*)

The Sun and Stars

The Sun is a pretty typical star whose composition is known from spectroscopy. The composition of the Sun in atomic abundance is shown below. Silicon is used as a basis for comparison because it allows convenient comparison of solar and planetary element abundances.

Note that the abundance scale is *logarithmic*

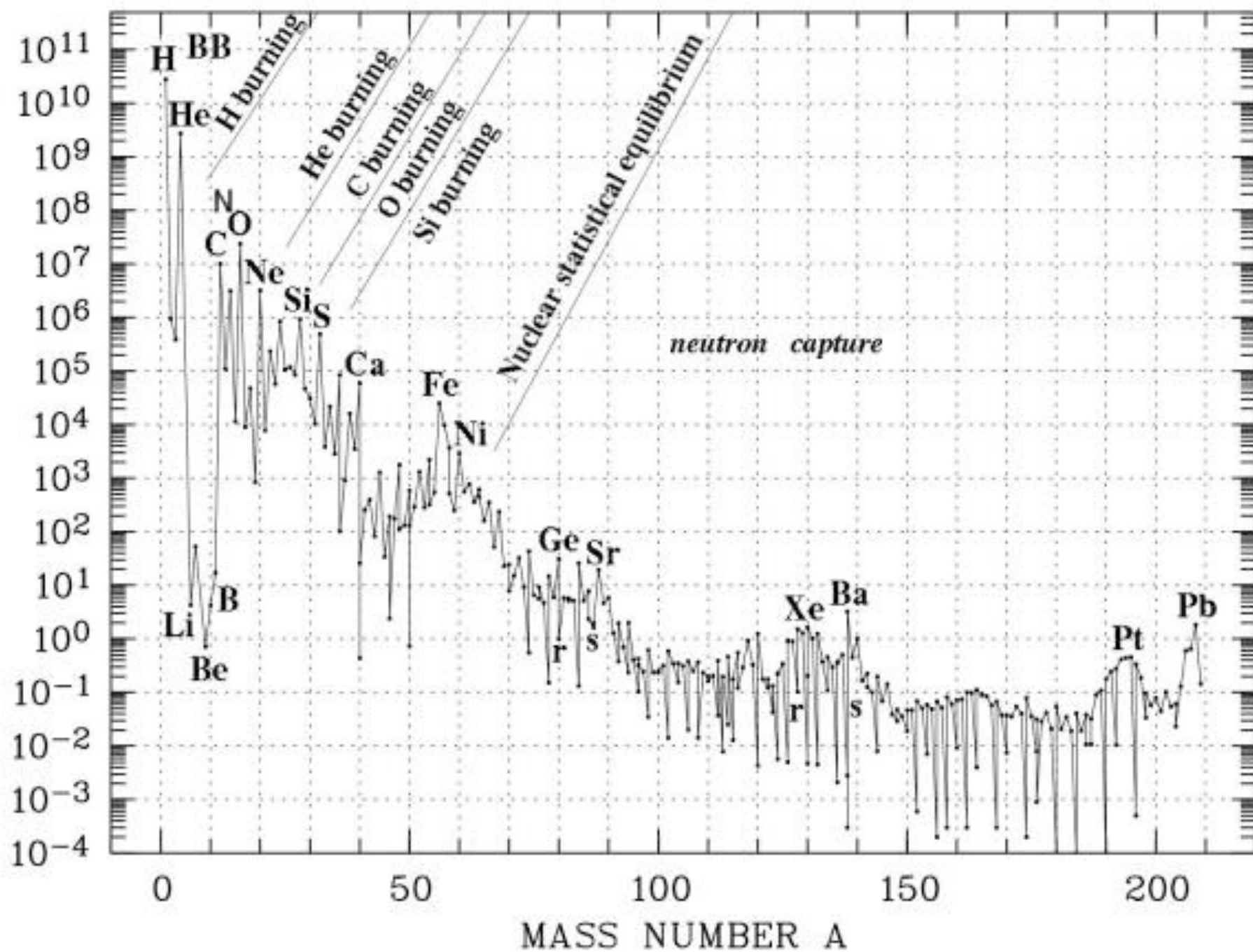


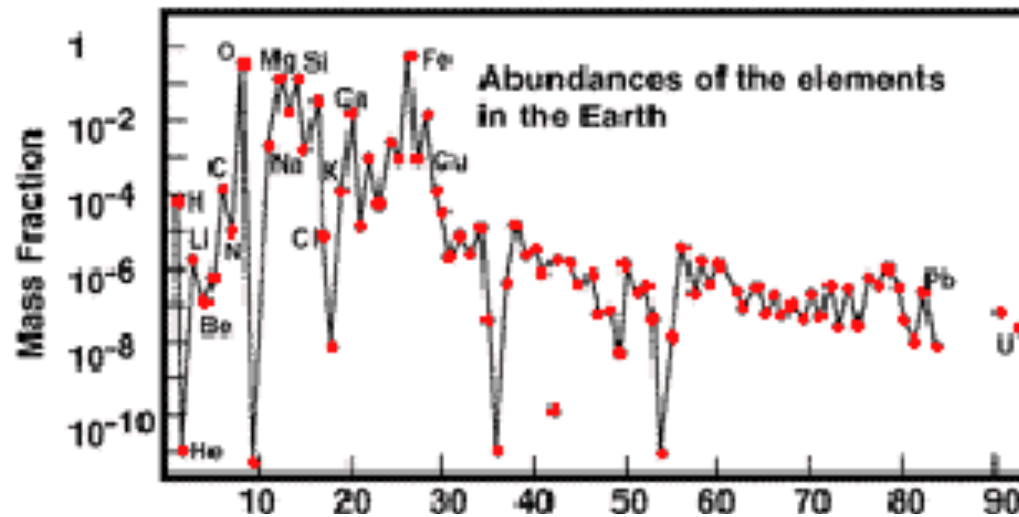
From the figure above, we see four patterns:

- An overwhelming abundance of light elements
- A strong preference for even-numbered elements
- A peak in abundance at iron, followed by a steady decrease.
- Elements 3-5, Lithium, Beryllium and Boron, are very low in abundance.

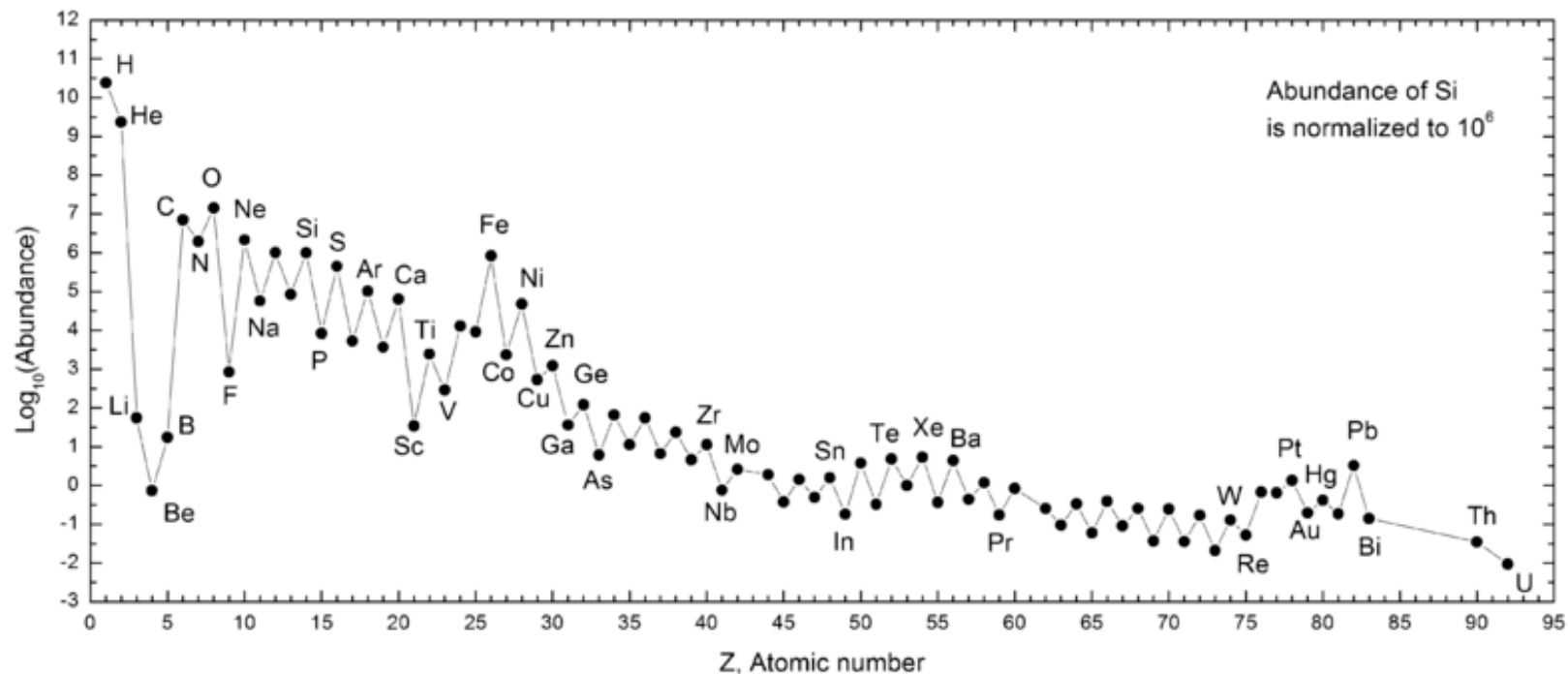
These patterns have to do with nucleosynthesis (element formation) in the stars

ABUNDANCE RELATIVE TO SILICON = 10^6





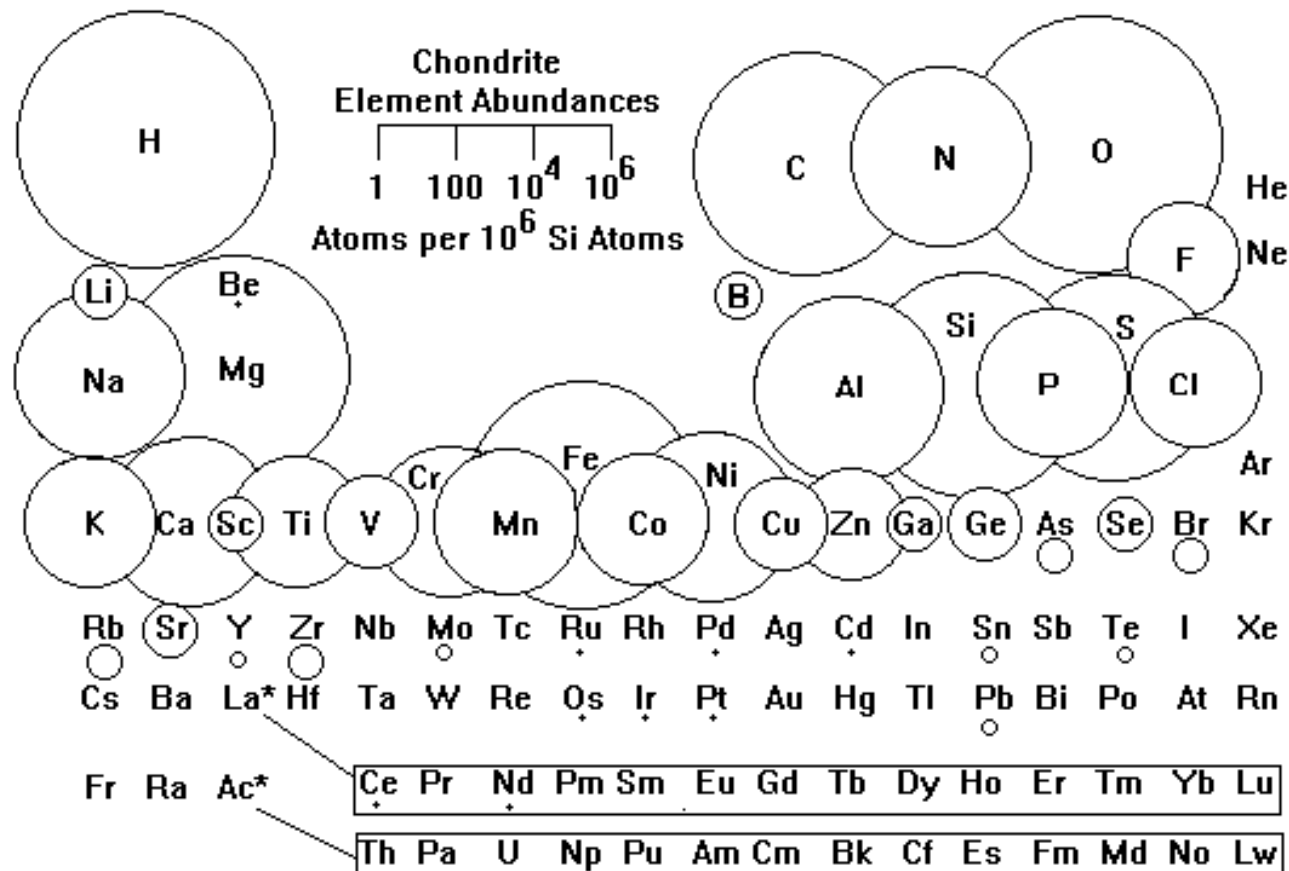
What controls the abundance of Elements in the Earth?



What controls the abundance of Elements in the Solar System?

The Planets

After any large construction job, there are always scraps of building material lying about. If the Sun and Solar System formed from the same material, we would expect the raw material of the planets to match the composition of the Sun, minus those elements that would remain as gases. We find such a composition in a class of meteorites called *chondrites*, which are thought to be the most primitive remaining solar system material. Chondrites are considered the raw material of the inner Solar System and probably reflect the bulk composition of the Earth.

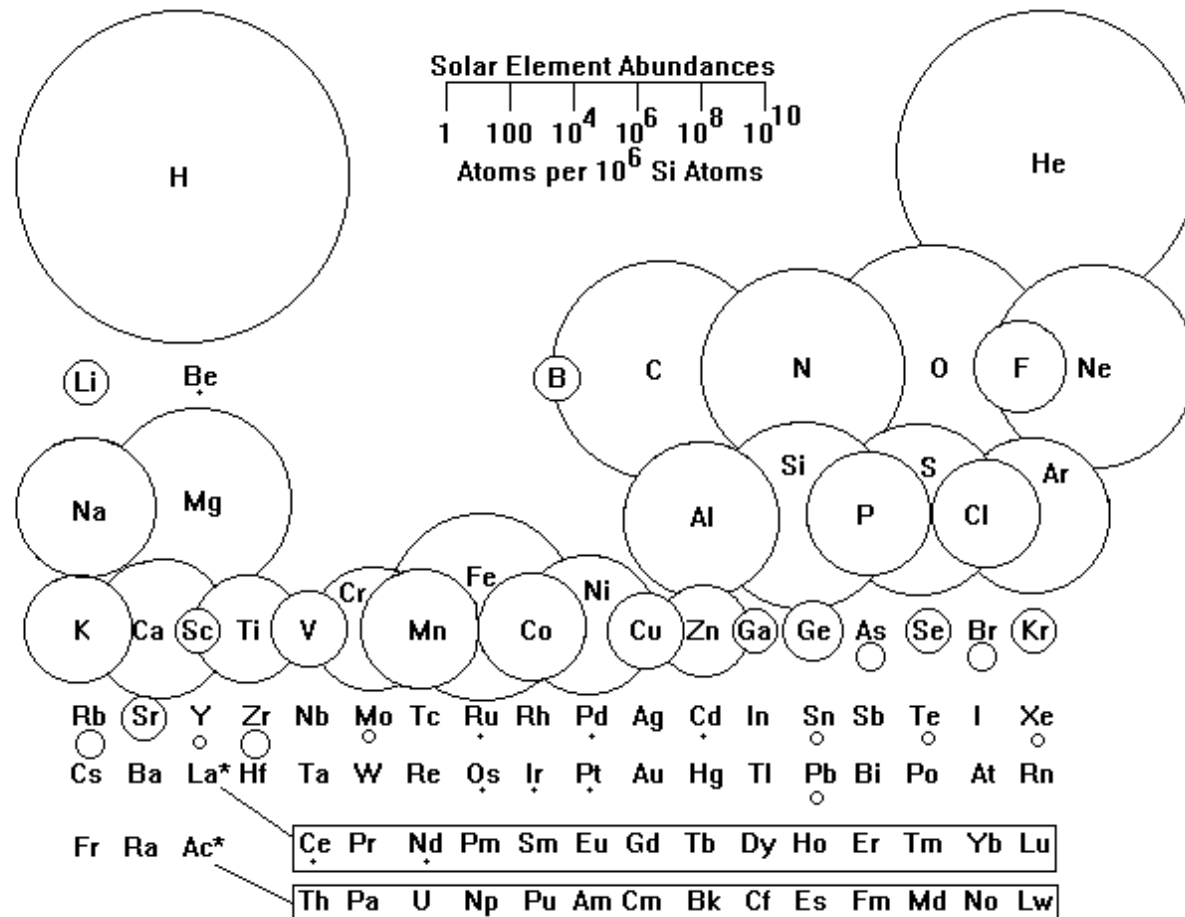


About halfway between Mars and Jupiter, it is cold enough for ice to persist even in a vacuum, so the moons of the outer planets are made of both rock and ice. On the outermost planets, methane, ammonia and finally nitrogen also condensed as solids. Comets are probably leftover raw material from the cold outermost Solar System, which is one reason they are so intensively studied.

The Sun and Stars

The Sun is a pretty typical star whose composition is known from spectroscopy. The composition of the Sun in atomic abundance is shown below. Silicon is used as a basis for comparison because it allows convenient comparison of solar and planetary element abundances.

Note that the abundance scale is *logarithmic*



From the figure above, we see four patterns:

- An overwhelming abundance of light elements
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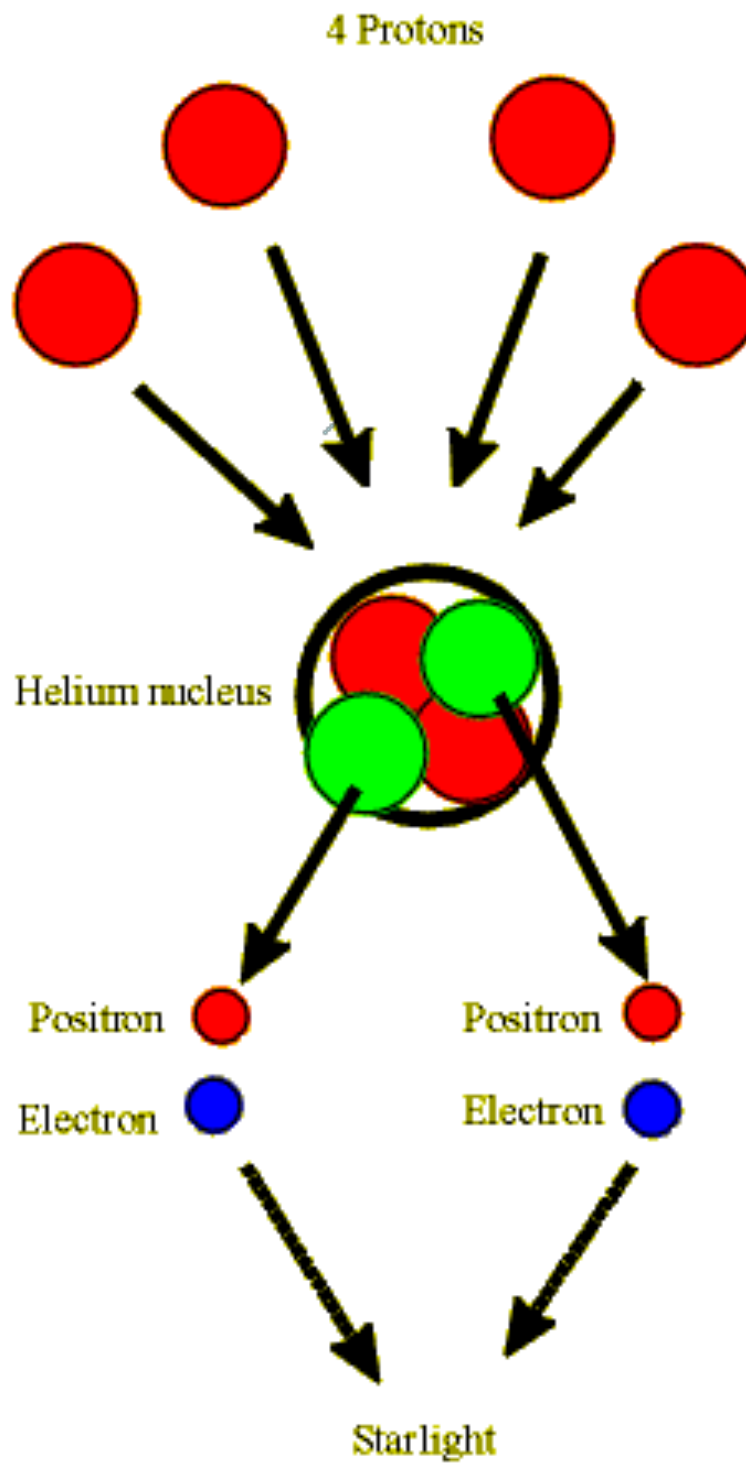
These patterns have to do with nucleosynthesis (element formation) in the stars

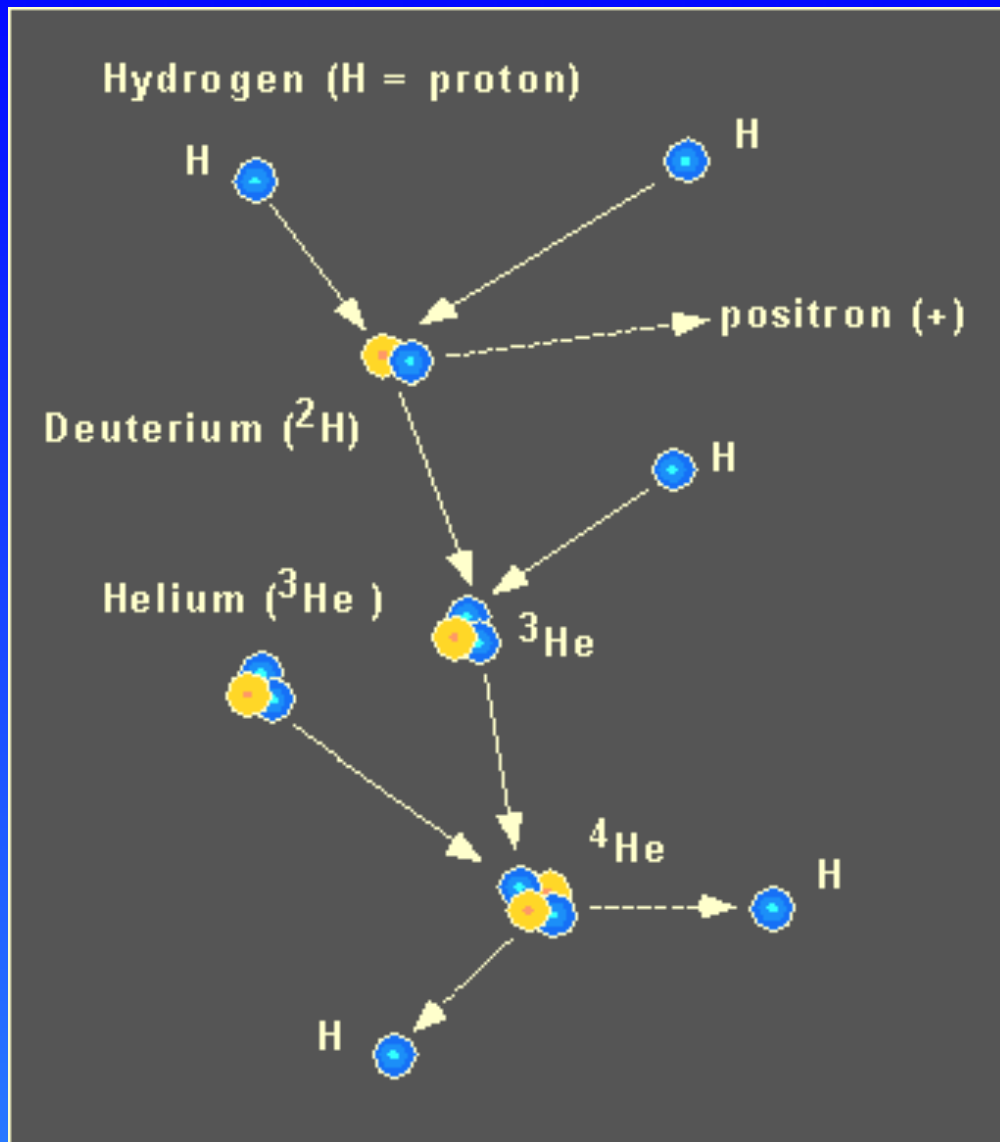
Periodic Table of the Elements

1 IA New Original Alkali metals Alkaline earth metals Transition metals Lanthanide series Actinide series Poor metals Nonmetals Noble gases C Solid Br Liquid H Gas Tc Synthetic																												18 VIIIA	
1 H Hydrogen 1.00794		2 He Helium 4.002602																											
3 Li Lithium 6.941		4 Be Beryllium 9.012182																											
11 Na Sodium 22.989770		12 Mg Magnesium 24.3050																											
19 K Potassium 39.0983		20 Ca Calcium 40.078																											
37 Rb Rubidium 85.4678		38 Sr Strontium 87.62																											
55 Cs Cesium 132.90545		56 Ba Barium 137.327																											
87 Fr Francium (223)		88 Ra Radium (226)																											
Atomic masses in parentheses are those of the most stable or common isotope.																													
Design Copyright © 1997 Michael Dayan (michael@dayan.com). http://www.dayan.com/periodic/																													
57 La Lanthanum 138.9055 58 Ce Cerium 140.116 59 Pr Praseodymium 140.90765 60 Nd Neodymium 144.24 61 Pm Promethium (145) 62 Sm Samarium 150.36 63 Eu Europium 151.964 64 Gd Gadolinium 157.25 65 Tb Terbium 158.92534 66 Dy Dysprosium 162.500 67 Ho Holmium 164.93032 68 Er Erbium 167.259 69 Tm Thulium 168.93421 70 Yb Ytterbium 173.04 71 Lu Lutetium 174.967 89 Ac Actinium (227) 90 Th Thorium 232.0381 91 Pa Protactinium 231.03589 92 U Uranium 238.02891 93 Np Neptunium (237) 94 Pu Plutonium (244) 95 Am Americium (243) 96 Cm Curium (247) 97 Bk Berkelium (247) 98 Cf Californium (251) 99 Es Einsteinium (252) 100 Fm Fermium (257) 101 Md Mendelevium (258) 102 No Nobelium (259) 103 Lr Lawrencium (262)																													

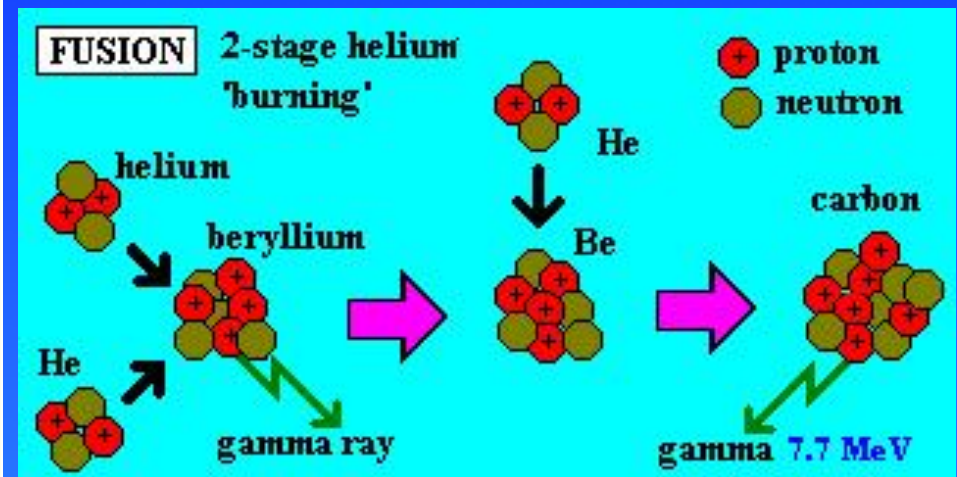
Note: The subgroup numbers 1-18 were adopted in 1984 by the International Union of Pure and Applied Chemistry. The names of elements 112-118 are the Latin equivalents of those numbers.

Fusion

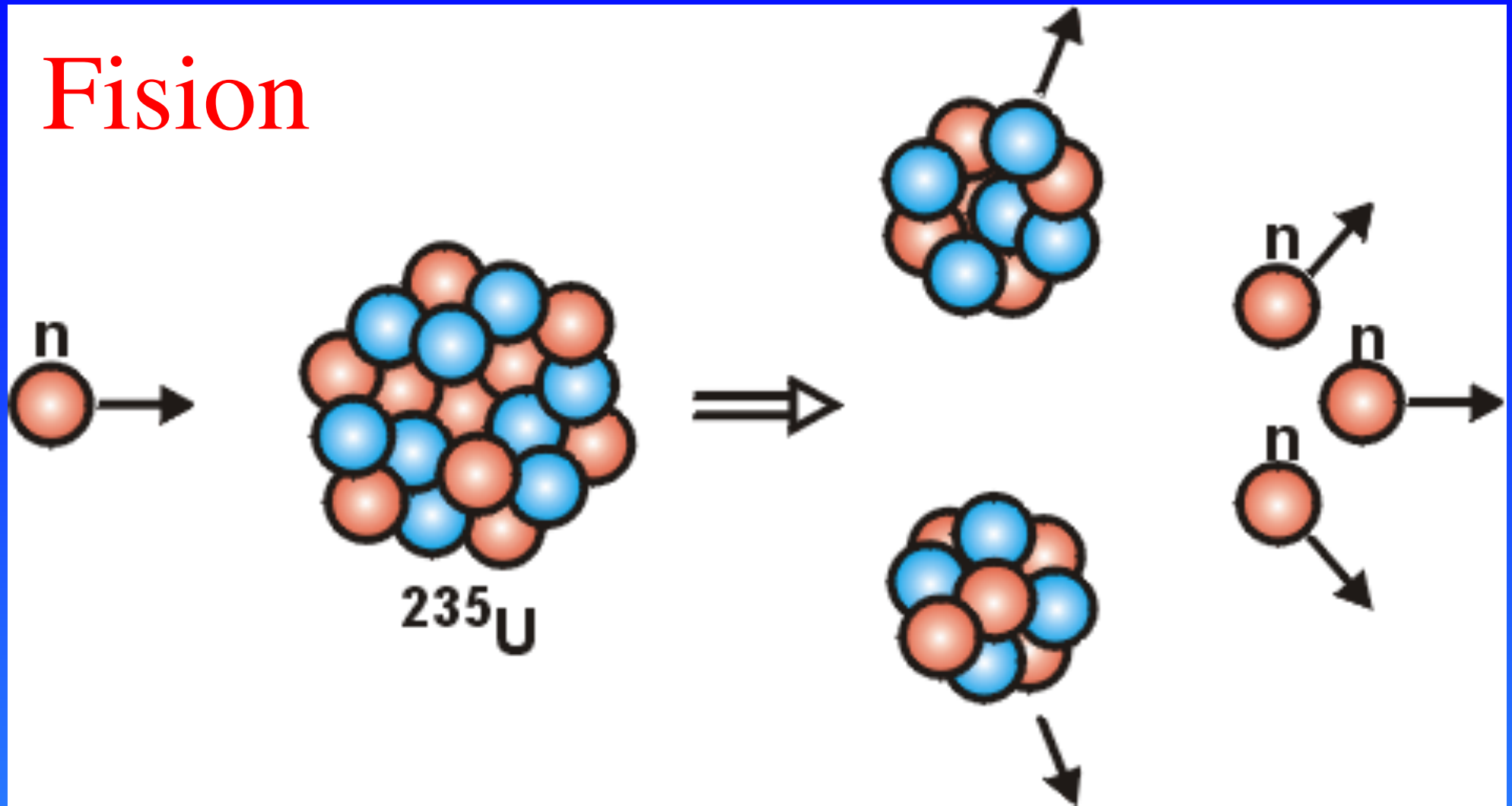




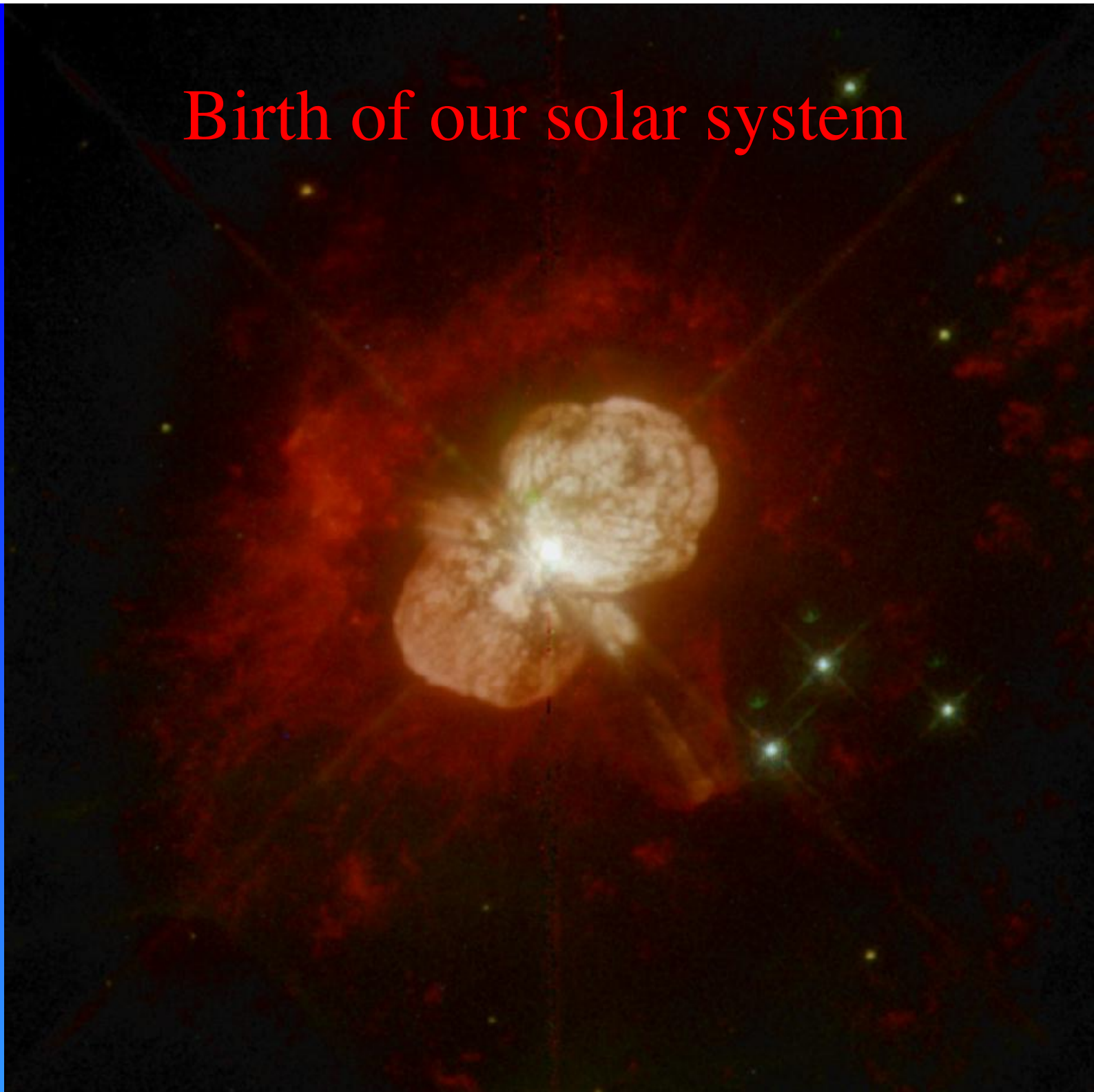
Fusion continues for heavy elements just at a faster rate



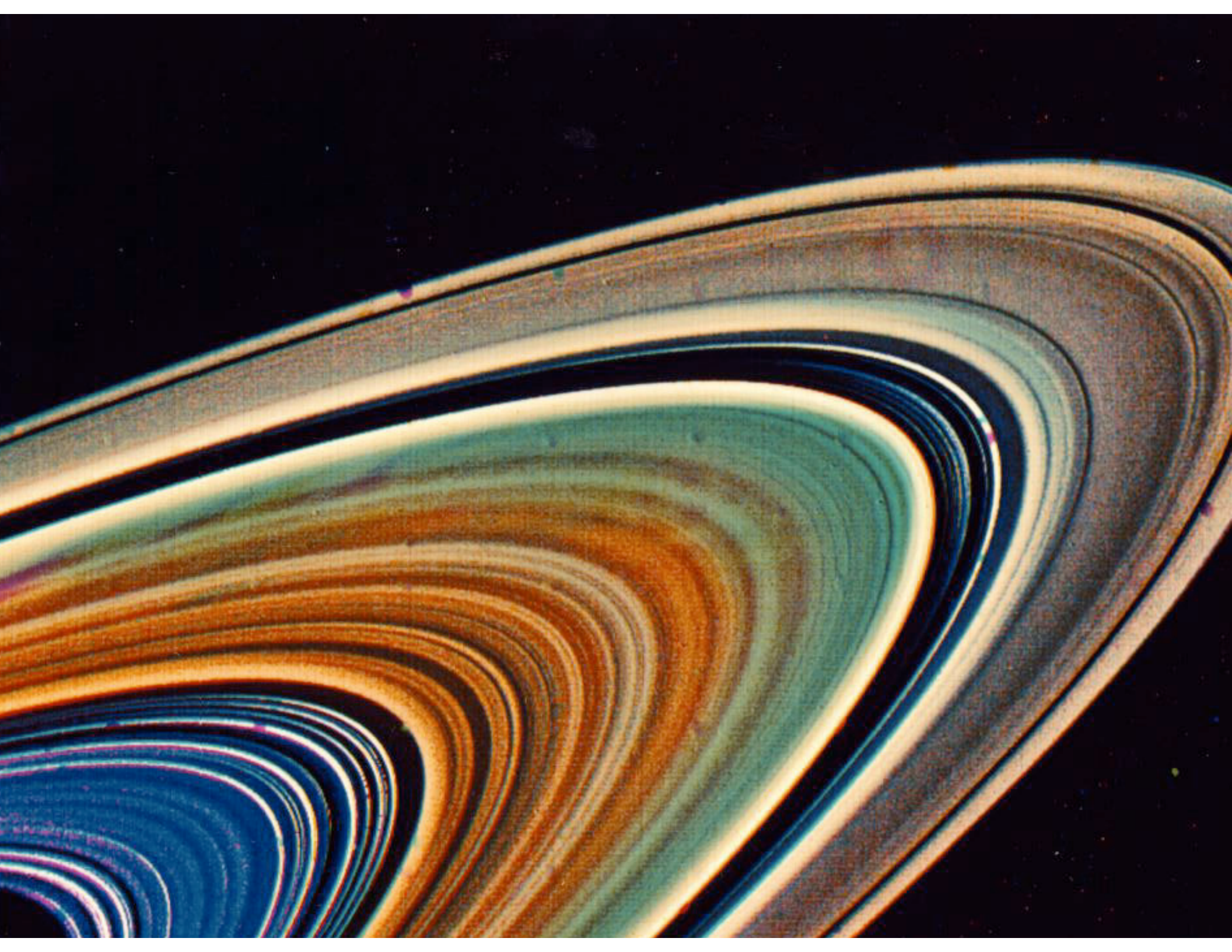
Fission

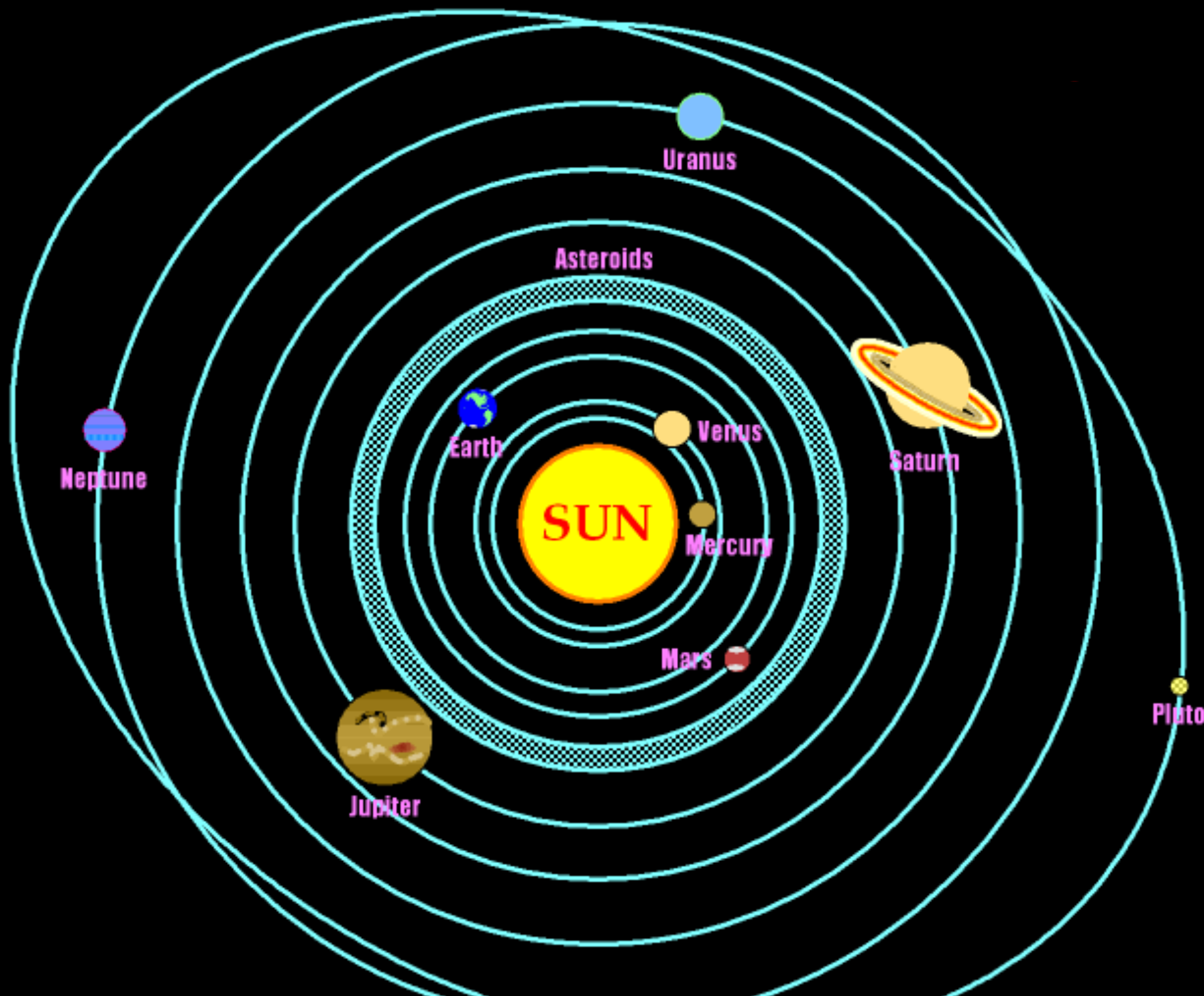


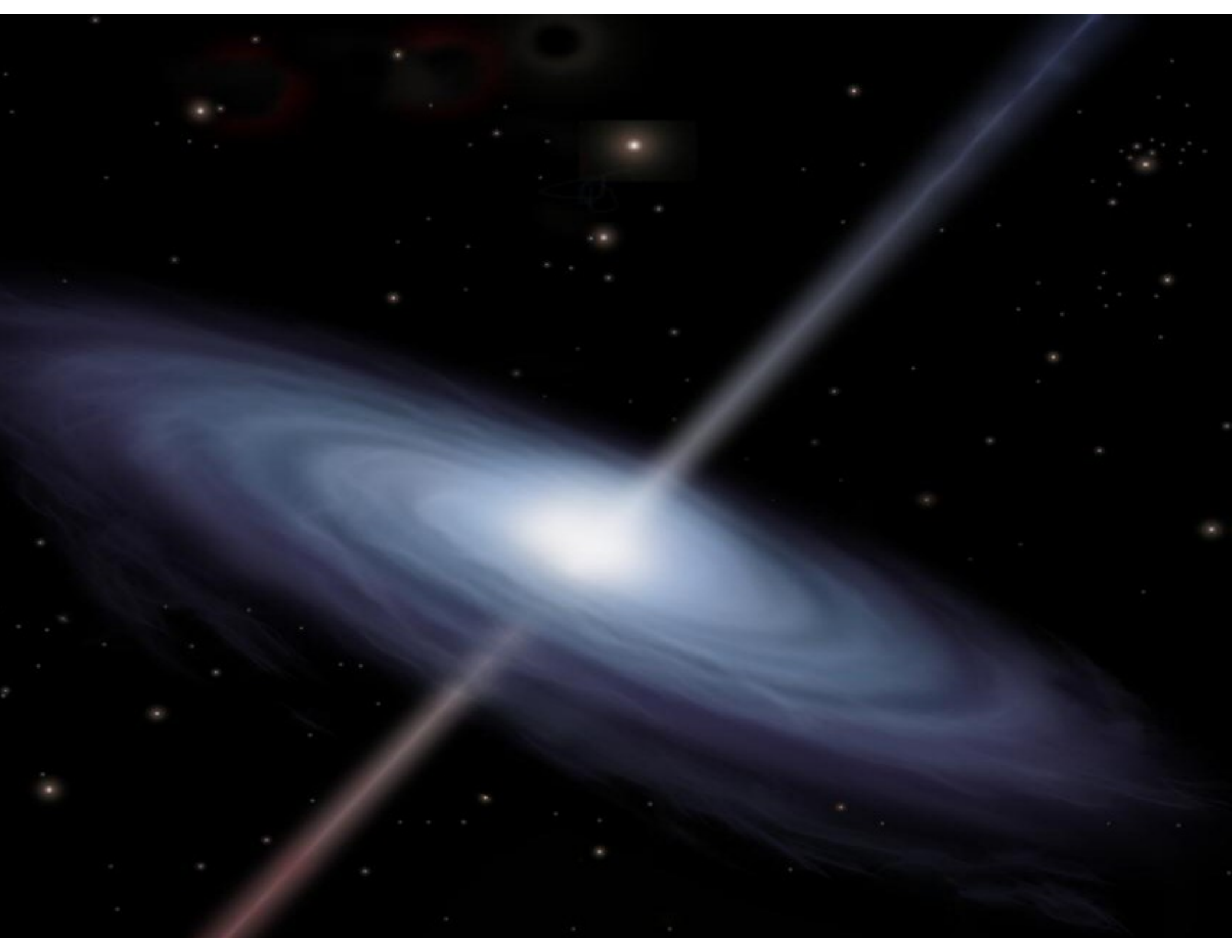
Birth of our solar system



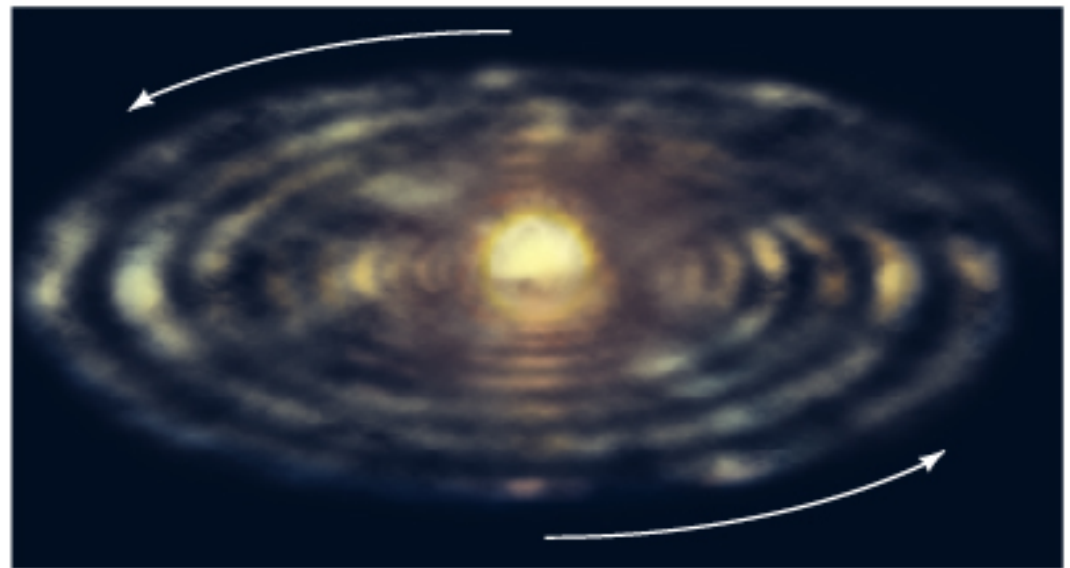
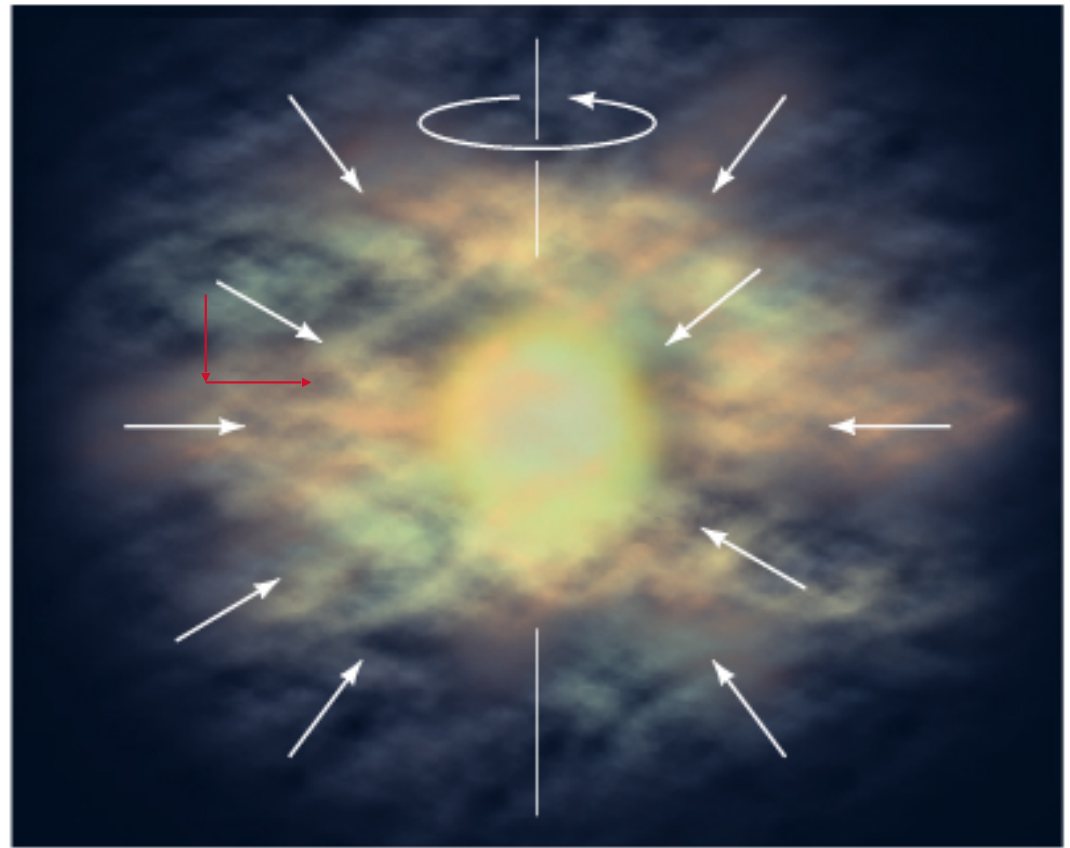








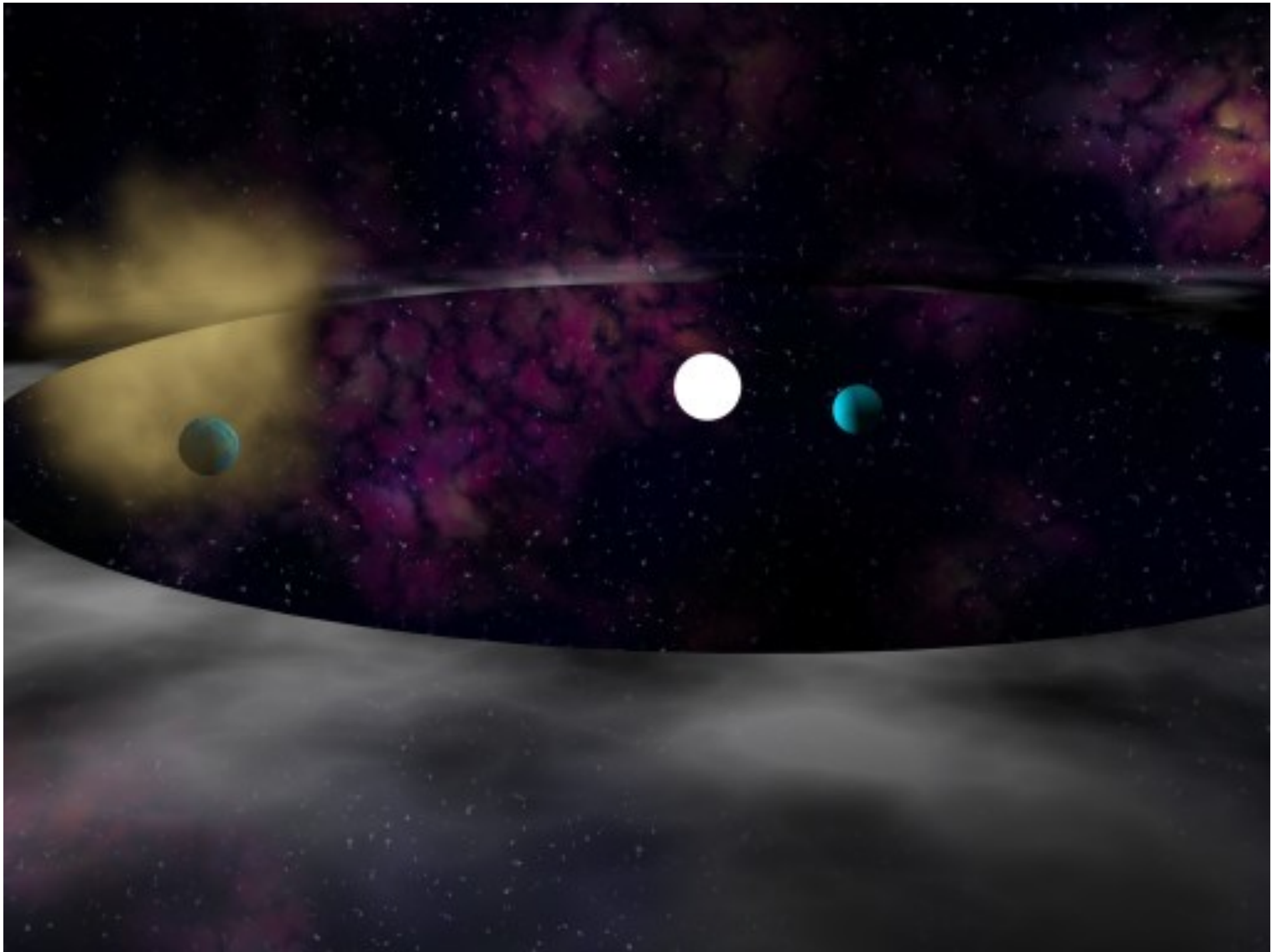
Because the collapsing cloud is rotating, the collapse is inhibited in the plane of rotation. The gravitational collapse is uninhibited along the axis of rotation. The result of this asymmetric collapse is a flattened disk that is rotating around the central protostar.

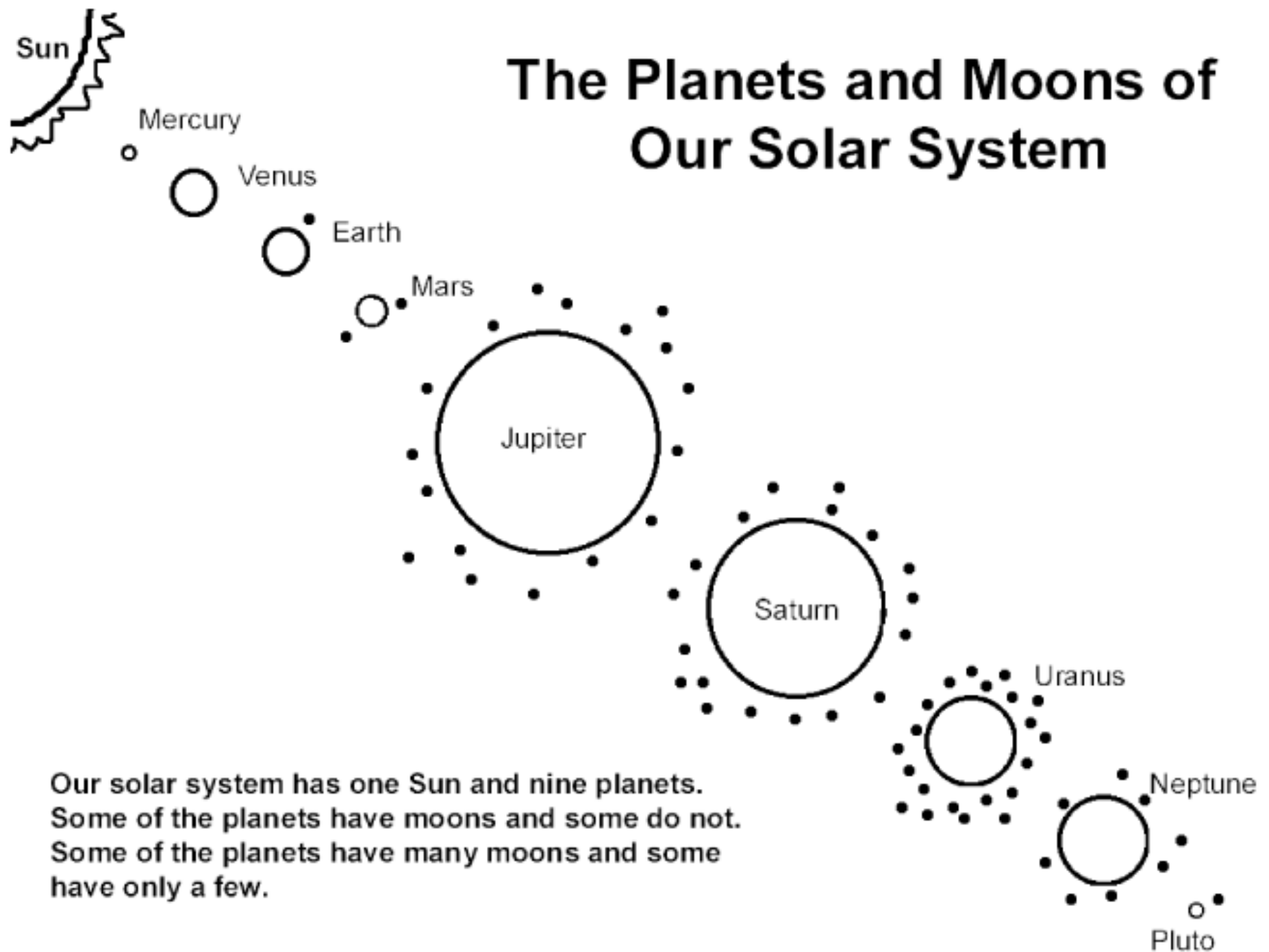




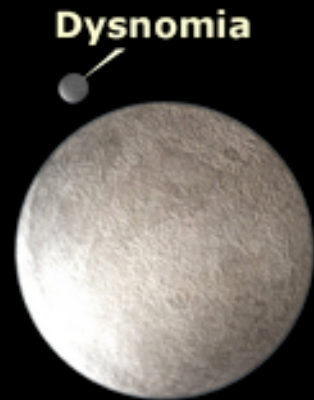
Formation of the planets- Nebular hypothesis

- **~4.6-4.7 Ga, As the nebula collapsed towards center of mass**
- **Rotating disk shape to conserve angular momentum**
- **Irregular patches or eddies coalesce into km-size (and less) planetesimals.**
- **Planetesimals attracted each other and grew by accretion into protoplanets**
- **Protoplanets continued to grow by collision of other protoplanets and planetesimals**





Largest known trans-Neptunian objects (TNOs)



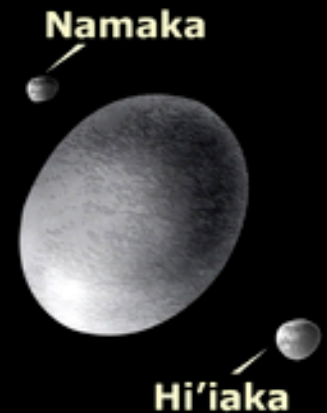
Eris



Pluto



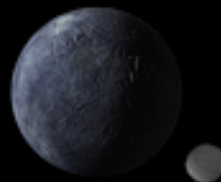
Makemake



Haumea



Sedna



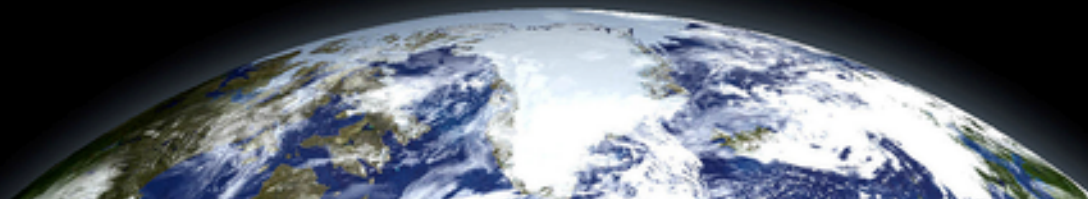
Orcus



2007 OR₁₀



Quaoar



In 2006, the International Astronomical Union (IAU) finally reached a decision. [They issued an official definition](#) of a planet:

"A Celestial body that (a) is in orbit around the Sun, (b) has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape, and (c) has cleared the neighbourhood around its orbit."

... and an official definition of a dwarf planet:

"A celestial body that (a) is in orbit around the Sun, (b) has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape, (c) has not cleared the neighbourhood around its orbit, and (d) is not a satellite."

Pluto is not a satellite, meaning it doesn't orbit another planet. It orbits around the sun, like other planets, and it is round.

Part (c) is where Pluto fails to make the cut. IAU's definition put the issue to rest: Eris is in the "neighbourhood around Pluto's orbit," and vice versa.

Pluto is a dwarf planet, Eris is a dwarf planet, we have eight planets in our solar system, case closed.



[WATCH HERE](#)
Iowa Forum
Sanders ab
to you

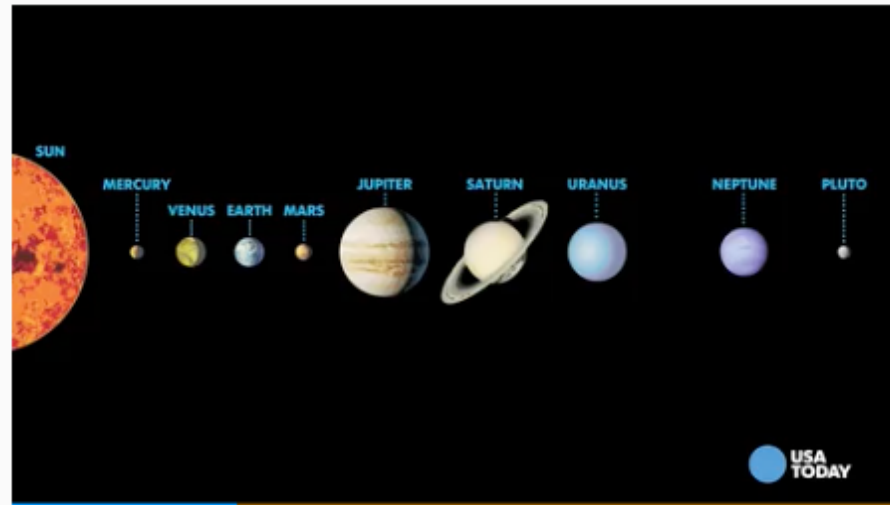


[CITIZEN JOU](#)
YouTube's

Wait, what? Pluto a planet again?

Doyle Rice, USA TODAY

Published 10:02 a.m. ET Oct. 2, 2014 | Updated 6:07 p.m. ET Oct. 2, 2014



There's been a lot of talk about Pluto's planet status, eight years since the celestial body was officially labeled a "dwarf planet." Carly Mallenbaum talks about what all of the fuss is about and why some people are really excited for Pluto. (USA TODAY, USA NOW)



(Photo: Ron Miller via NASA)

Here we go again.

Pluto, a celestial snowball with a surface of methane ice 3.6 billion miles from the sun, might be making its way back into the solar system fraternity.

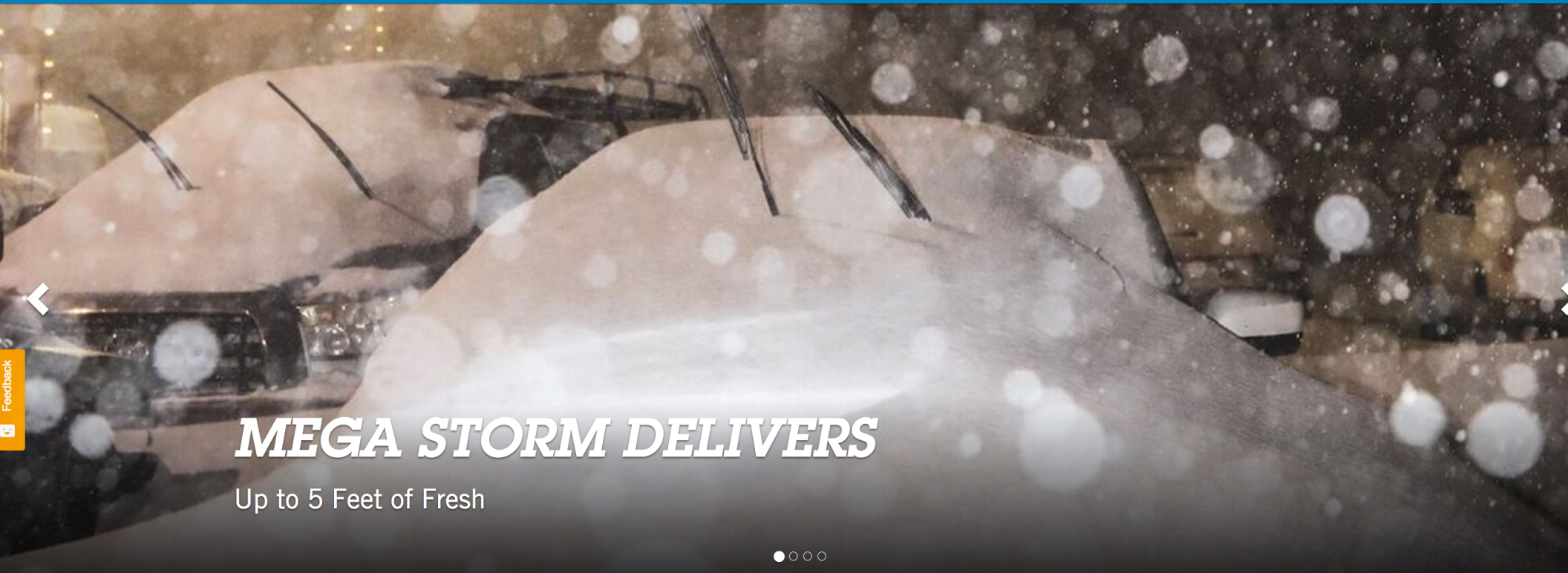
First discovered and classified as planet in 1930, Pluto was relegated to "dwarf-planet" status by the International Astronomical Union in 2006. They

booted it out because there appeared to be a bunch of other big rocks just like Pluto out beyond the eighth planet (Neptune), all considered too puny to be called a planet.

Now, some scientists say that Pluto should be back.

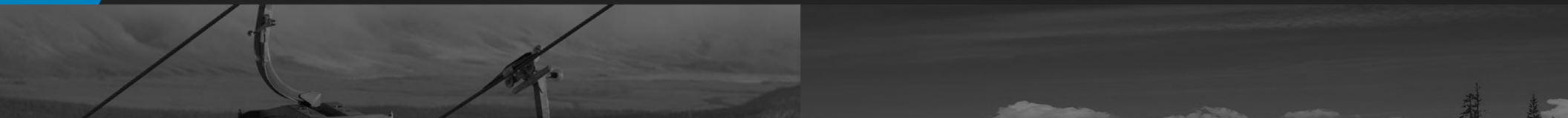
Harvard science historian Owen Gingerich, who chairs the IAU planet definition committee, argued at a forum last month that "a planet is a culturally defined word that changes over time," and that Pluto is a planet.

Another expert, Gareth Williams, associate director of the IAU's Minor Planet Center, said that Pluto is not a planet, citing the official definition, which states that a planet is a celestial body that:

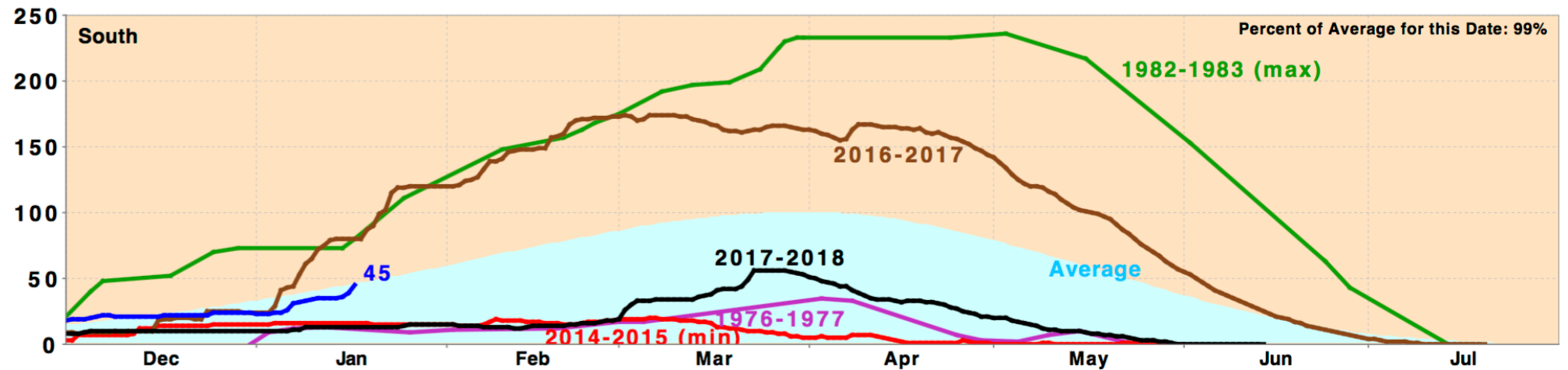
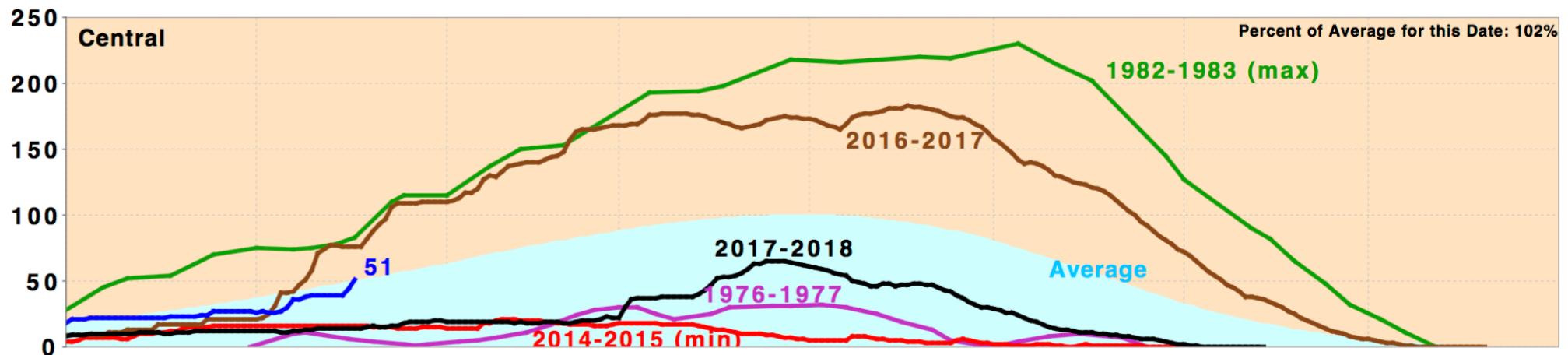
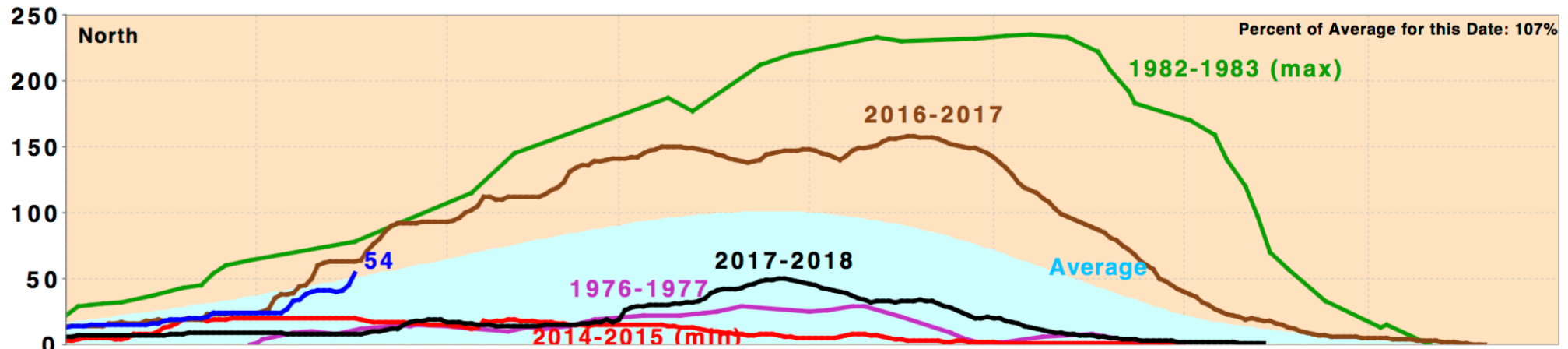


MEGA STORM DELIVERS

Up to 5 Feet of Fresh



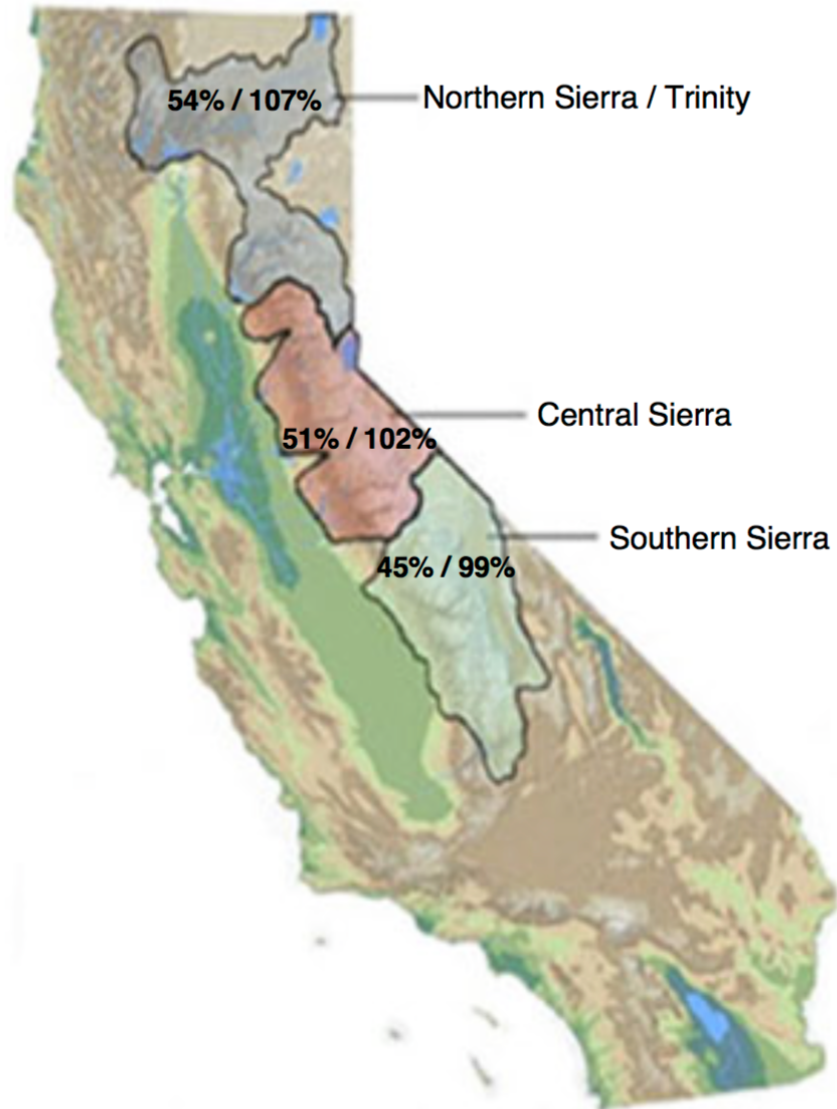
California Snow Water Content, January 17, 2019, Percent of April 1 Average



Statewide Percent of April 1: 50%

Statewide Percent of Average for Date: 103%

% of April 1 Average / % of Normal for This Date



Statewide Average: 50% / 103%

NORTH	
Data as of January 17, 2019	
Number of Stations Reporting	32
Average snow water equivalent (Inches)	15.6
Percent of April 1 Average (%)	54
Percent of normal for this date (%)	107

CENTRAL	
Data as of January 17, 2019	
Number of Stations Reporting	45
Average snow water equivalent (Inches)	15.3
Percent of April 1 Average (%)	51
Percent of normal for this date (%)	102

SOUTH	
Data as of January 17, 2019	
Number of Stations Reporting	29
Average snow water equivalent (Inches)	11.5
Percent of April 1 Average (%)	45
Percent of normal for this date (%)	99

STATE	
Data as of January 17, 2019	
Number of Stations Reporting	106
Average snow water equivalent (Inches)	14.3
Percent of April 1 Average (%)	50
Percent of normal for this date (%)	103

Data as of January 17, 2019



12 hours ago



Mud flows damaged property in Hollywood Hills on Thursday.

Frederic J. Brown/Agence France-Presse — Getty Images

- **Rain caused chaos across the state.** The storm triggered a 19-car pileup in the Cajon Pass and sent rocks sliding in Malibu. A falling tree killed a man in Oakland.

Surf and Marine Hazards

thru Friday Night

Harbor Entrance Waves At Ventura and Morro Bay Harbors



Deadly Rip Currents Dangerous Jetty Waves



Large Damaging Surf on west facing beaches



Coastal Flooding of vulnerable west facing shores

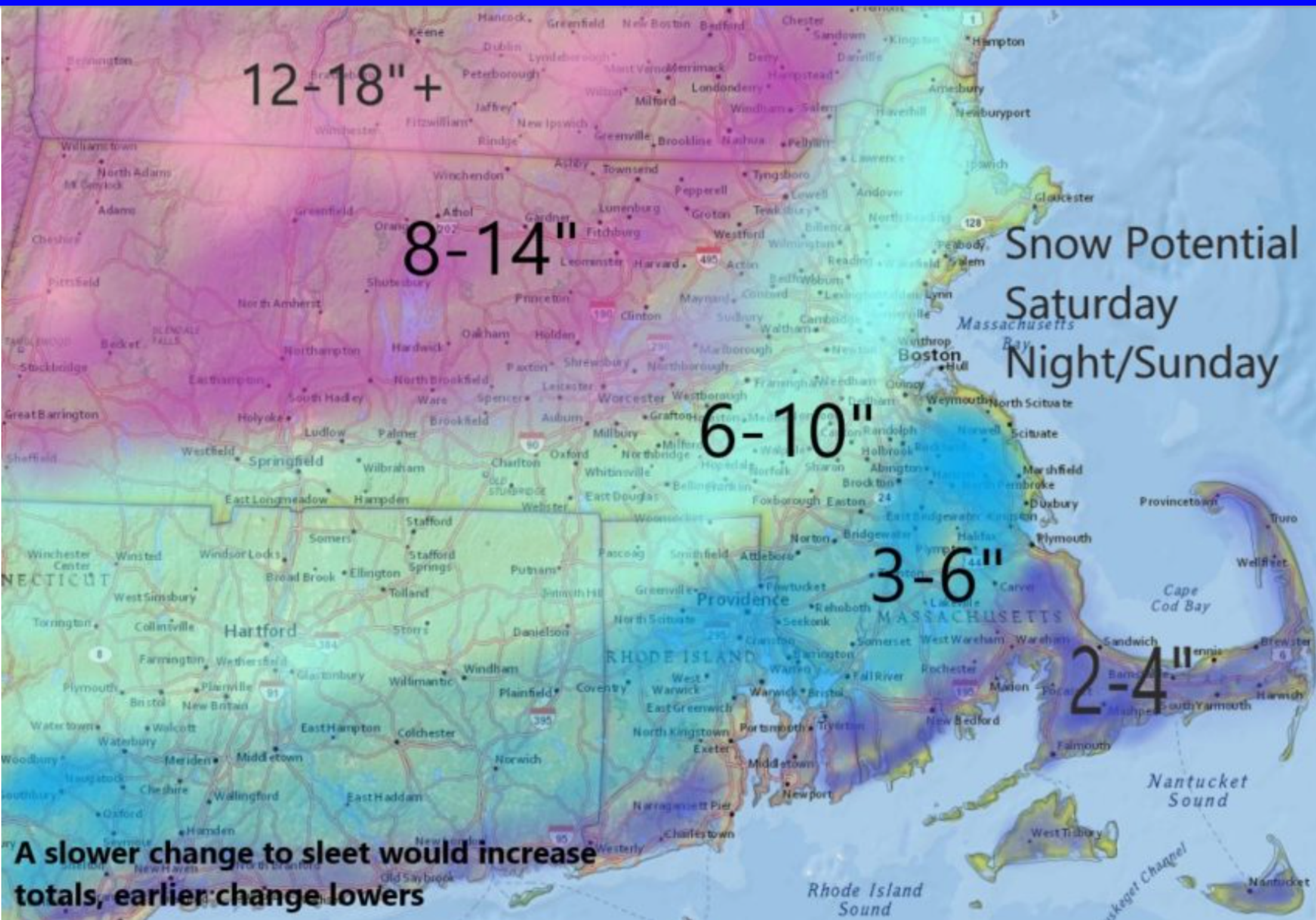


Weather Forecast Office
Los Angeles/Oxnard, CA

Updated January 17, 2018 at 2pm

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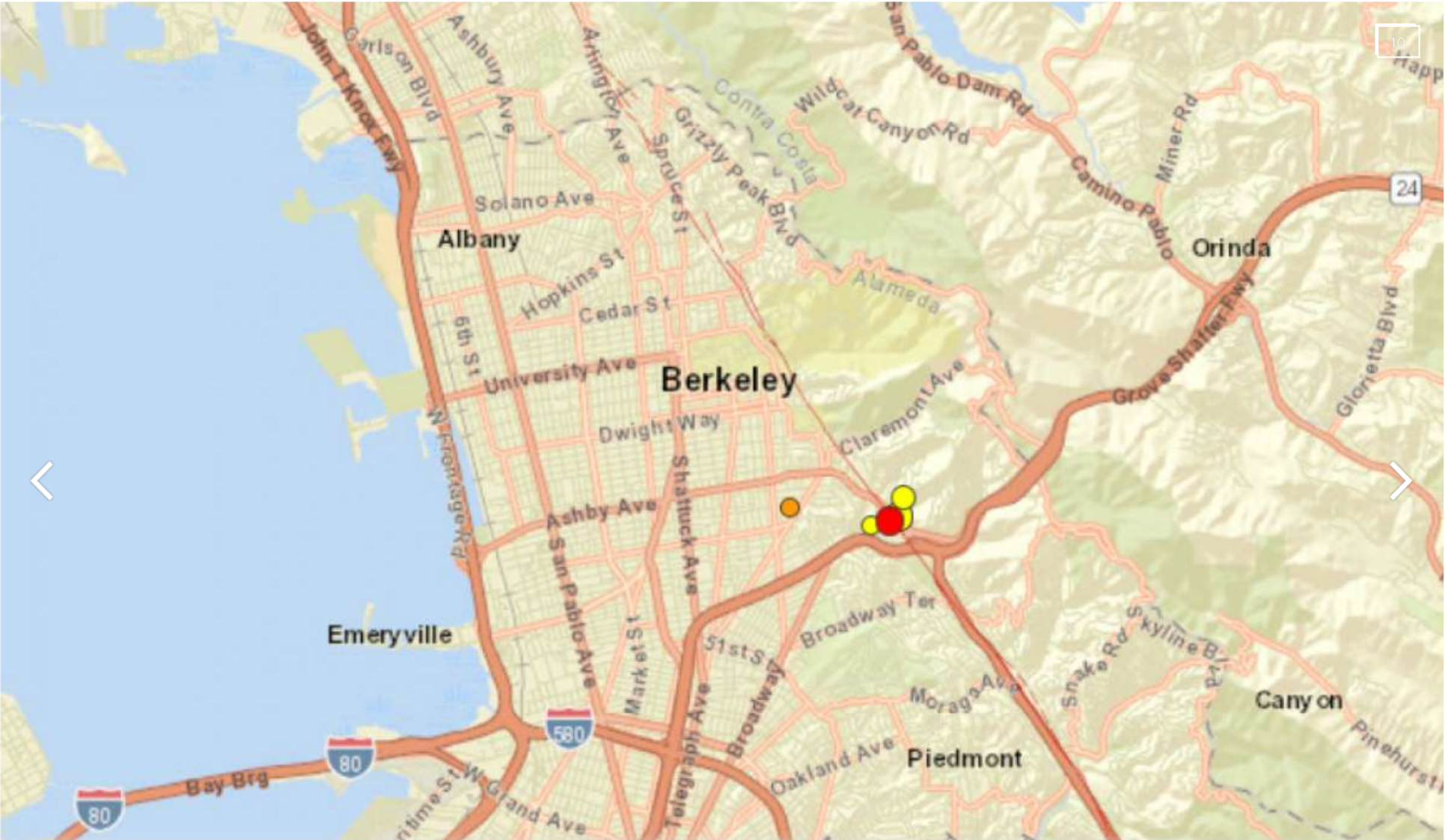
weather.gov/LosAngeles



Early morning earthquake strikes East Bay for second day in a row

 **Alix Martichoux** , SFGATE | Jan. 17, 2019 | Updated: Jan. 17, 2019 8:20 a.m.

[f](#) [t](#) [e](#) [...](#) [m](#) [p](#)





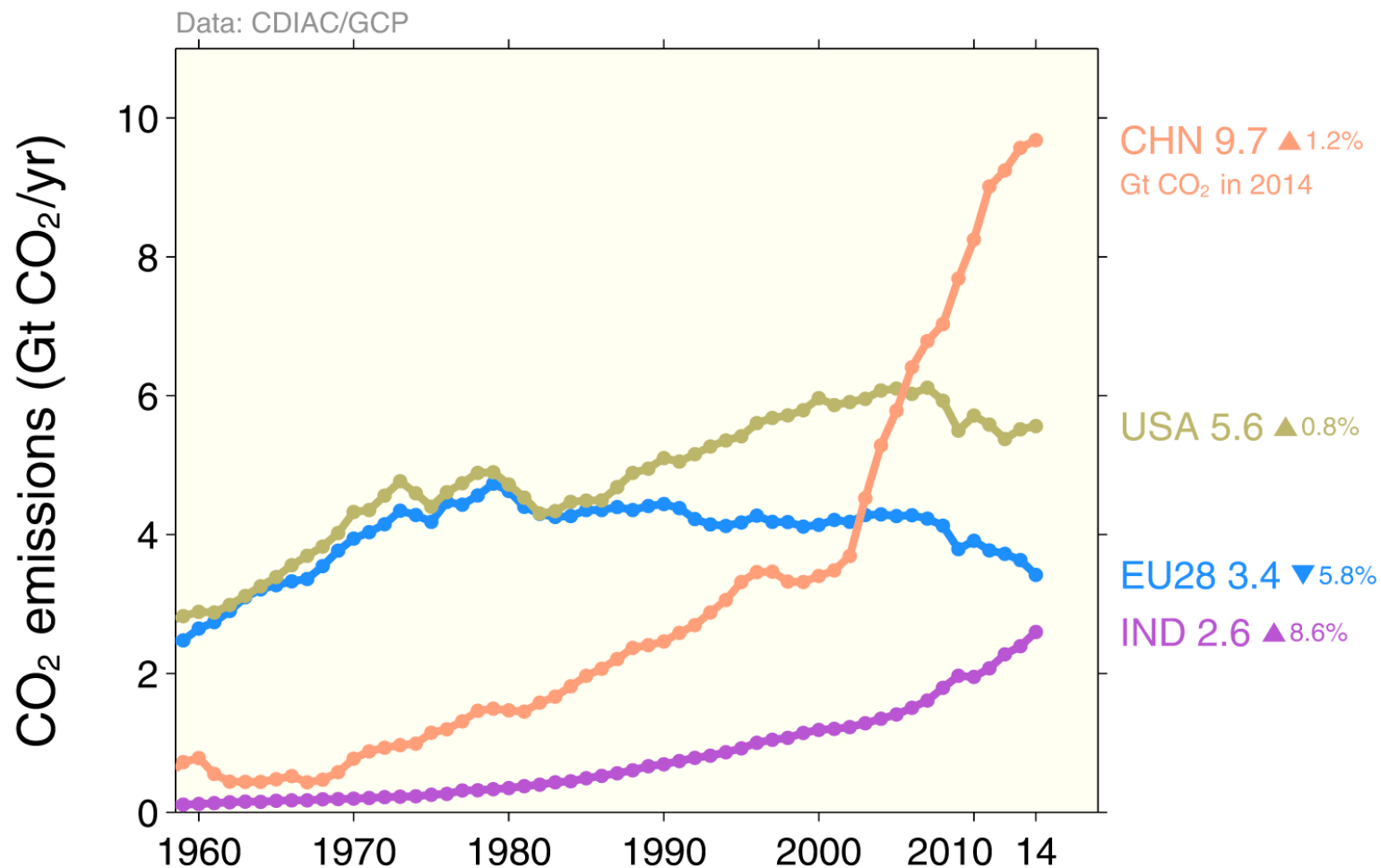
“Wicked Stoopid”



REUTERS

Top fossil fuel emitters

The top four emitters in 2014 covered 59% of global emissions
China (27%), United States (15%), EU28 (10%), India (7%)



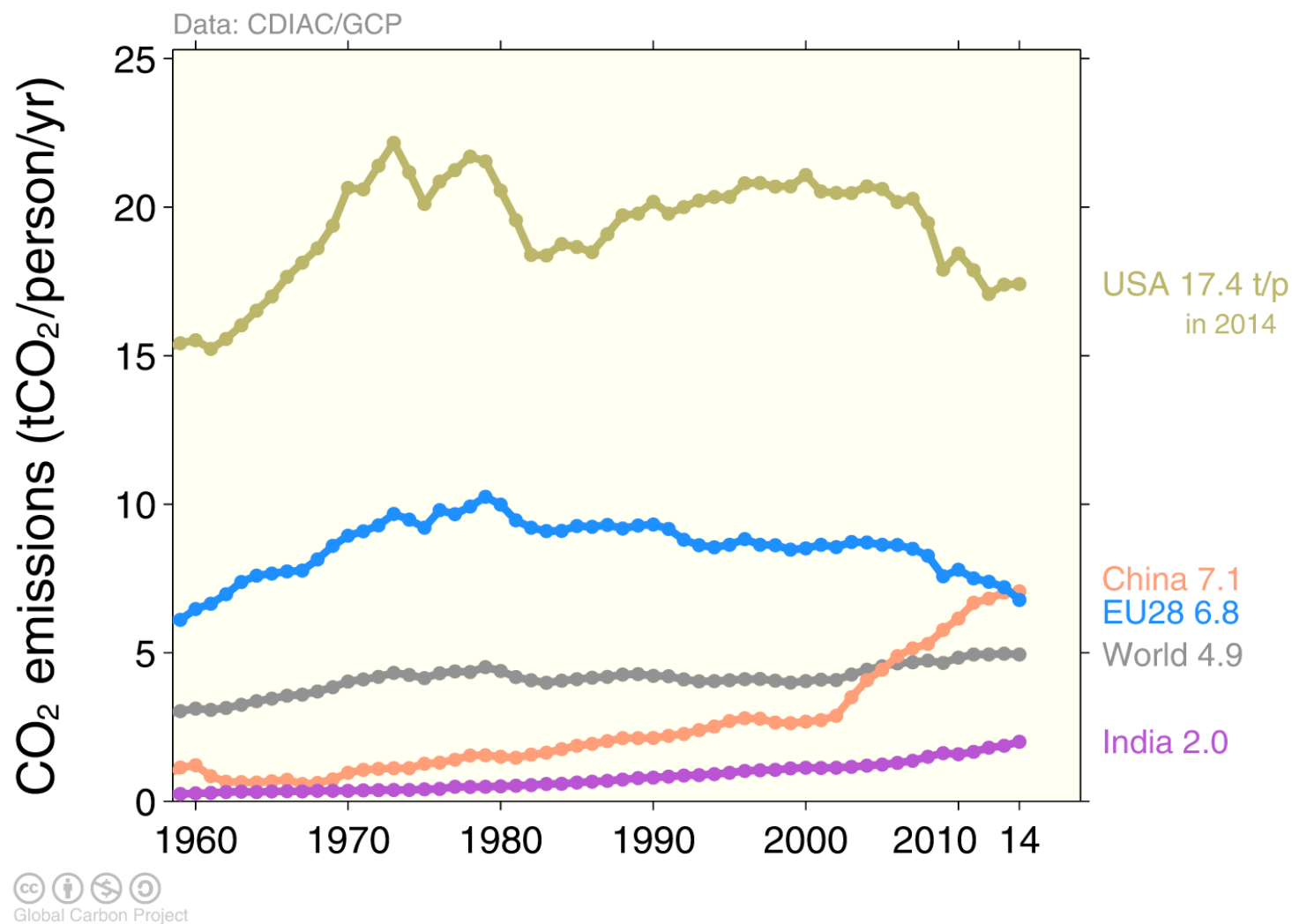
Bunker fuels are used for international transport is 3.0% of global emissions

Statistical differences are between the global estimates and sum of national totals is 1.1% of global emissions

Source: [CDIAC](#); [Le Quéré et al 2015](#); [Global Carbon Budget 2015](#)

Top fossil fuel emitters (per capita)

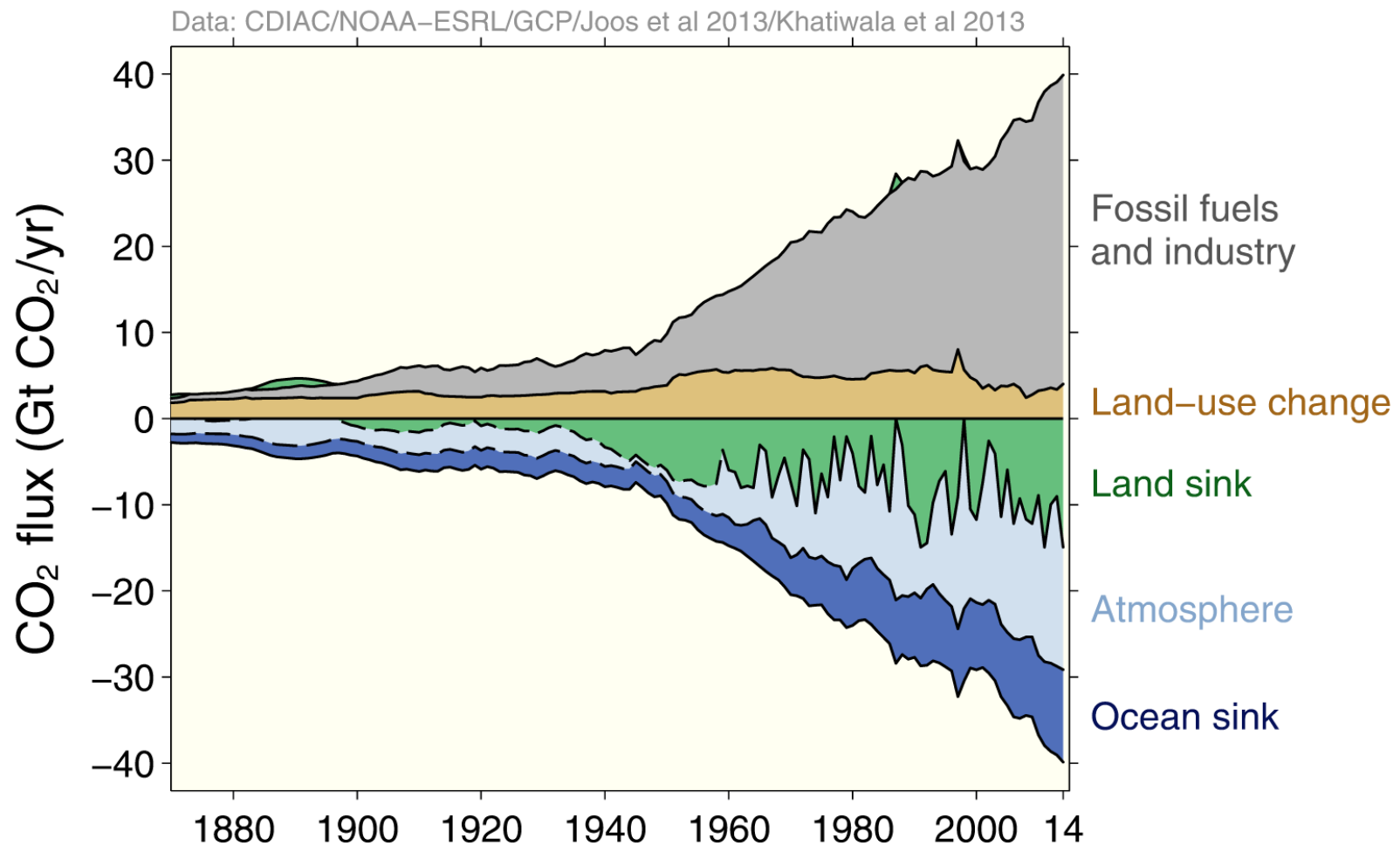
Countries have a broad range of per capita emissions reflecting their national circumstances
China's per capita emissions have passed the EU28 and are 43% above the global average



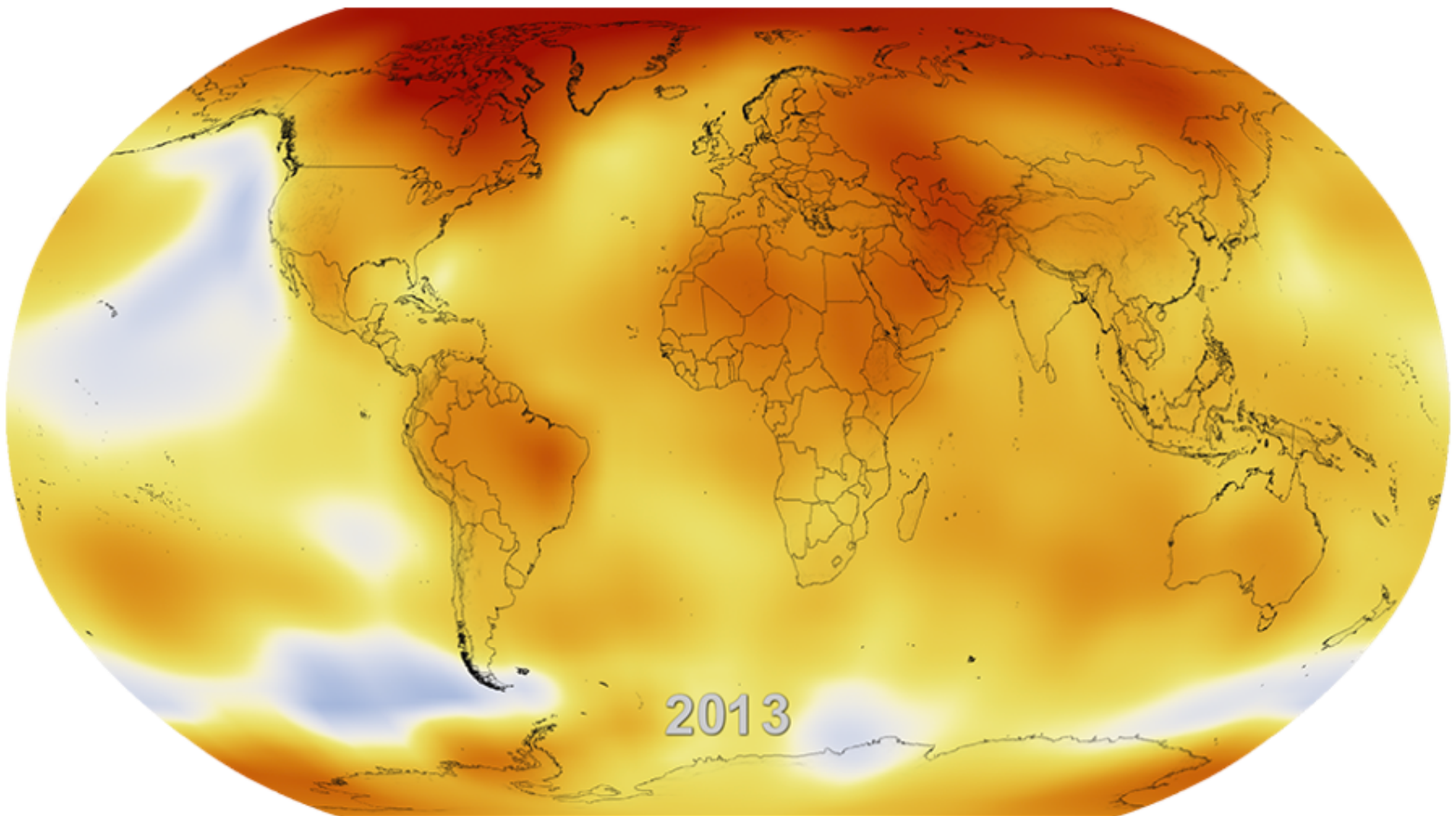
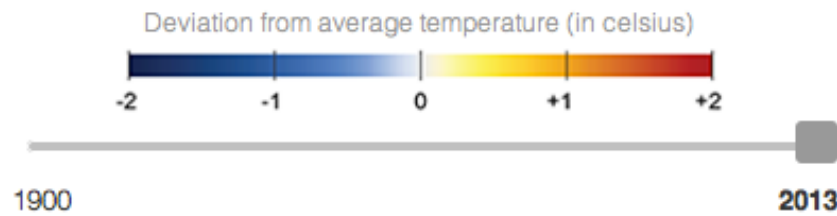
Source: [CDIAC](#); [Le Quéré et al 2015](#); [Global Carbon Budget 2015](#)

Global carbon budget

The carbon sources from fossil fuels, industry, and land use change emissions are balanced by the atmosphere and carbon sinks on land and in the ocean

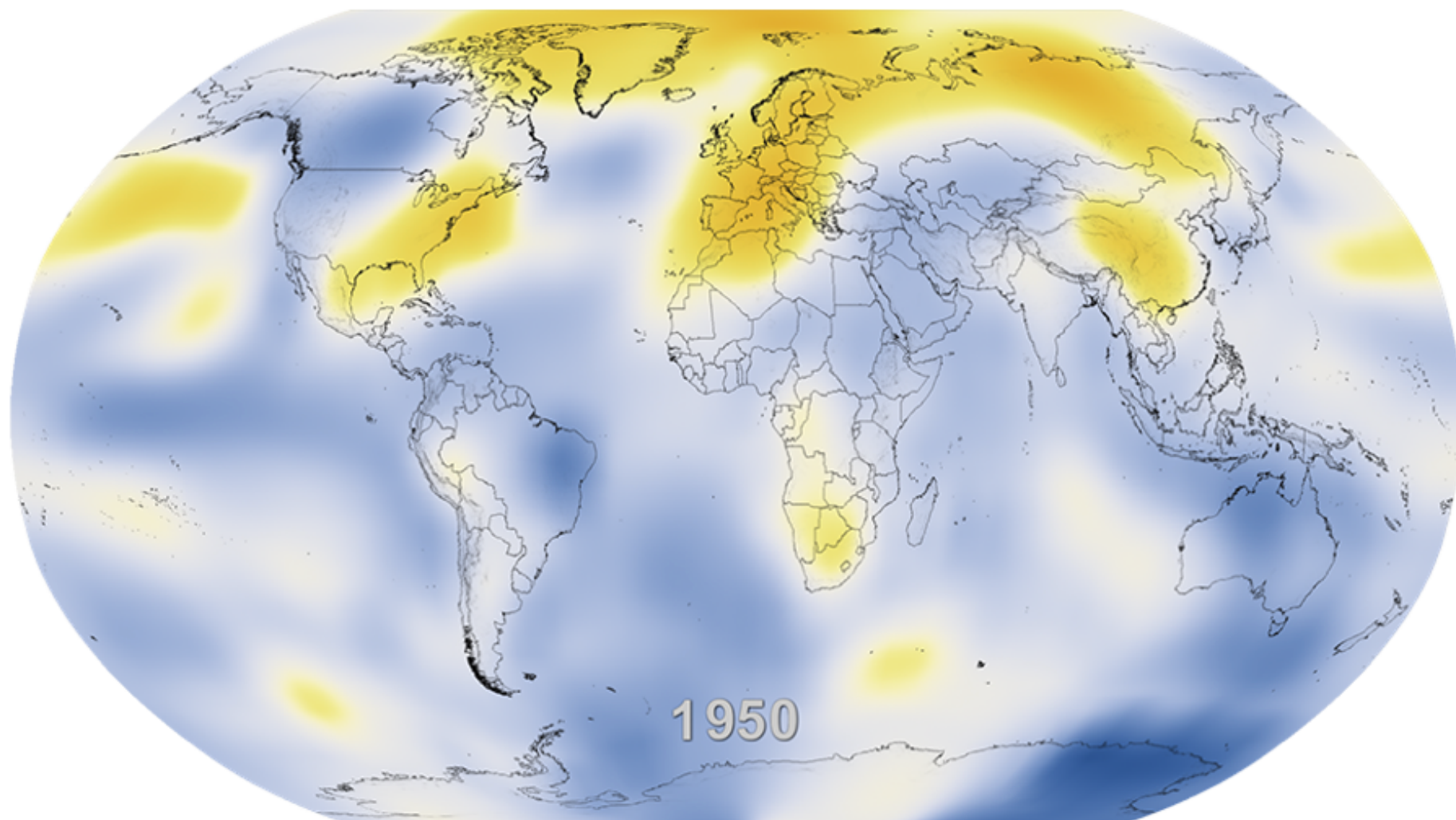
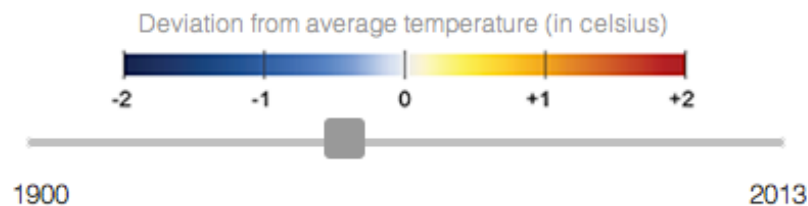


This time-series visualization shows five-year average variation of global surface temperatures. Blue reflects cooler-than-average temperatures and red warmer-than-average.



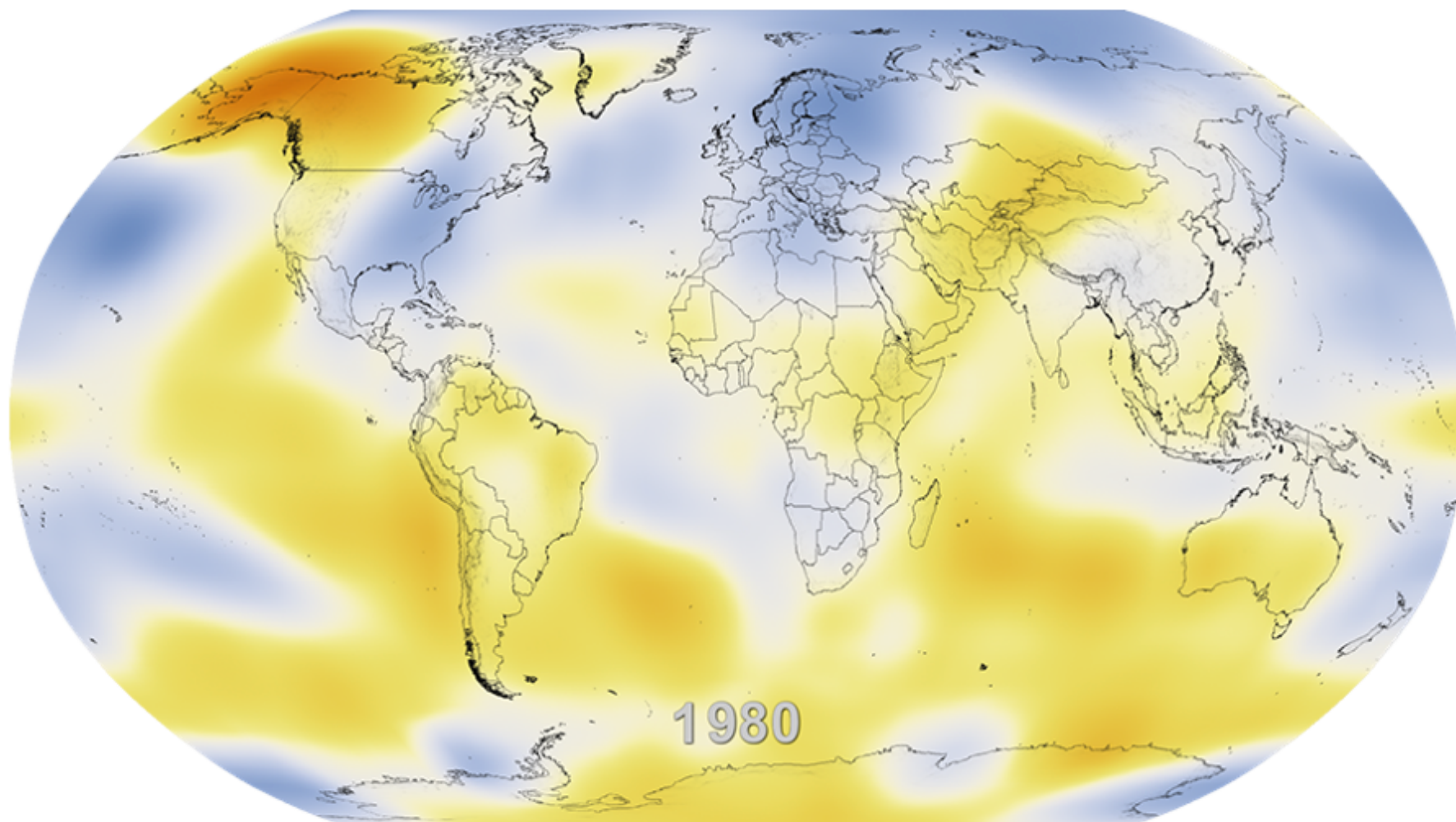
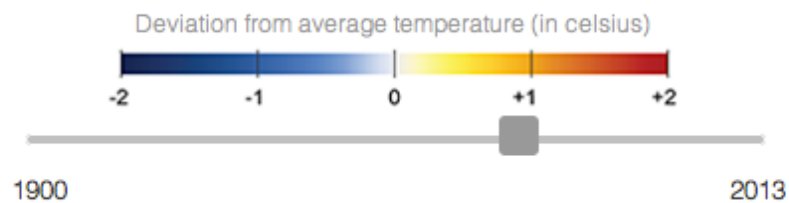
SOURCE: NASA/Goddard Scientific Visualization Studio

This time-series visualization shows five-year average variation of global surface temperatures. Blue reflects cooler-than-average temperatures and red warmer-than-average.



SOURCE: NASA/Goddard Scientific Visualization Studio

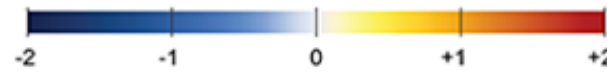
This time-series visualization shows five-year average variation of global surface temperatures. Blue reflects cooler-than-average temperatures and red warmer-than-average.



SOURCE: NASA/Goddard Scientific Visualization Studio

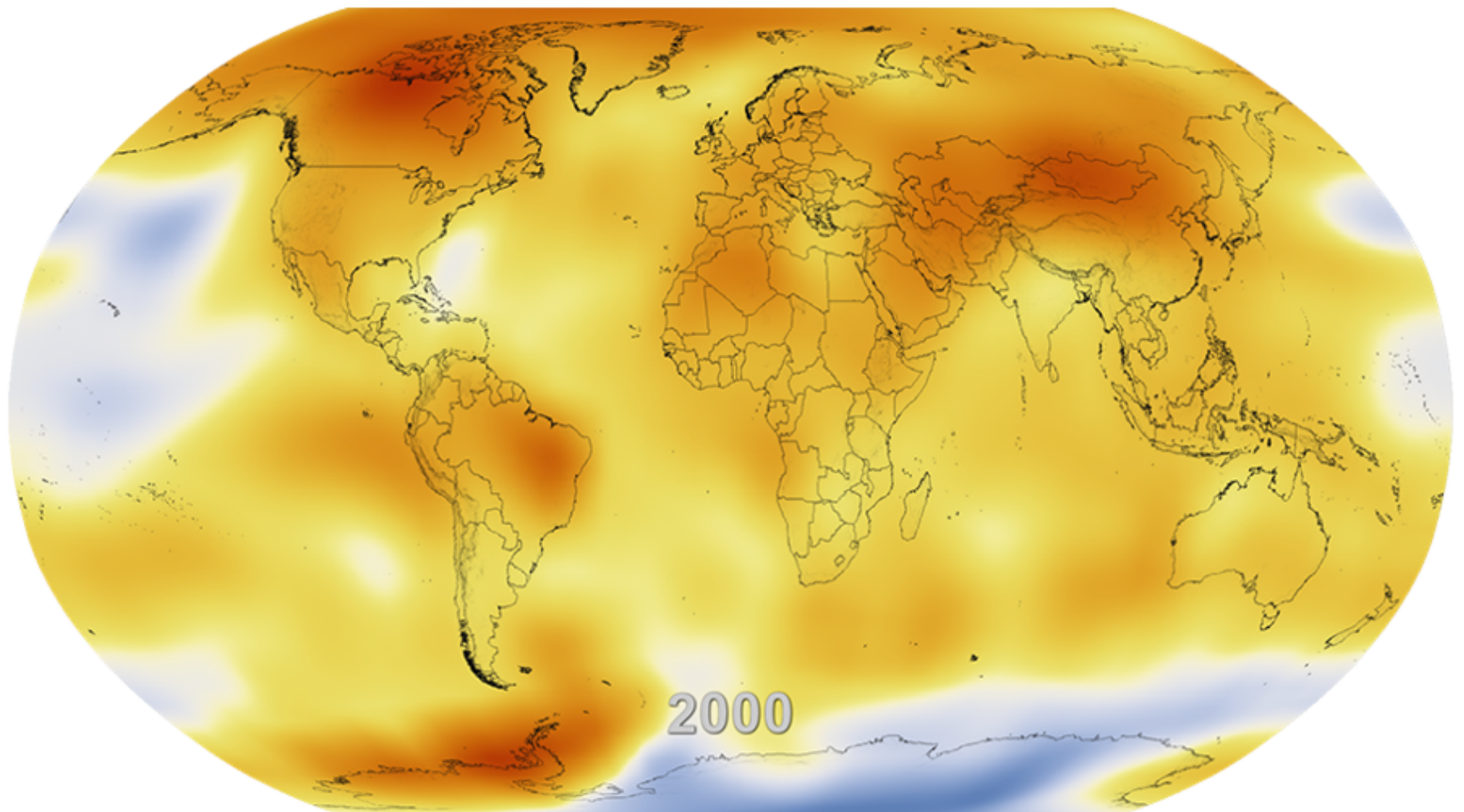
This time-series visualization shows five-year average variation of global surface temperatures. Blue reflects cooler-than-average temperatures and red warmer-than-average.

Deviation from average temperature (in celsius)



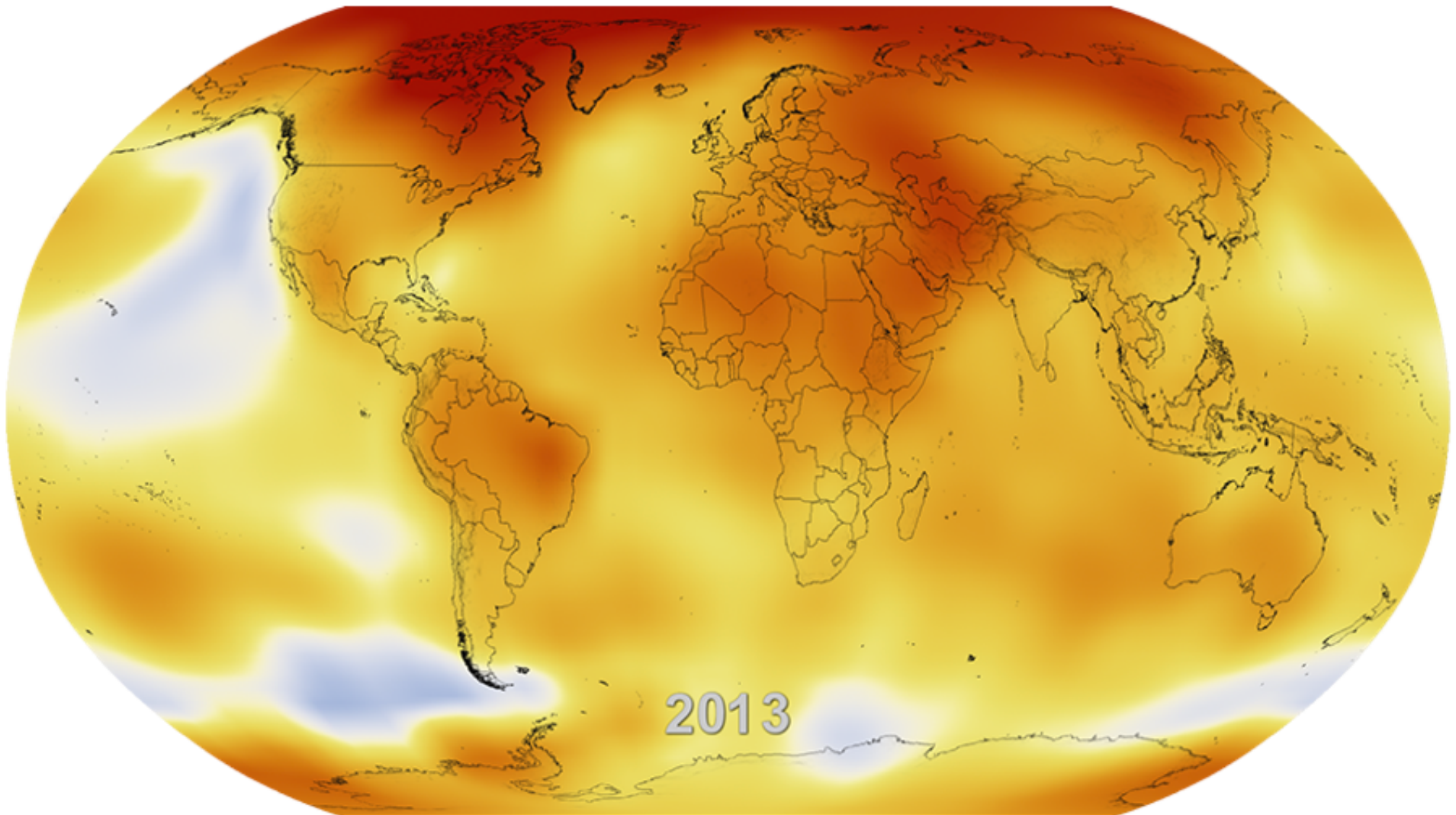
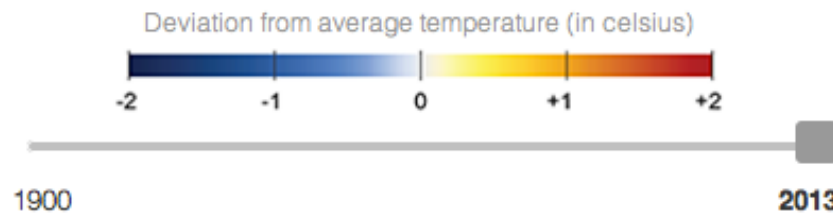
1900

2013



SOURCE: NASA/Goddard Scientific Visualization Studio

This time-series visualization shows five-year average variation of global surface temperatures. Blue reflects cooler-than-average temperatures and red warmer-than-average.



SOURCE: NASA/Goddard Scientific Visualization Studio

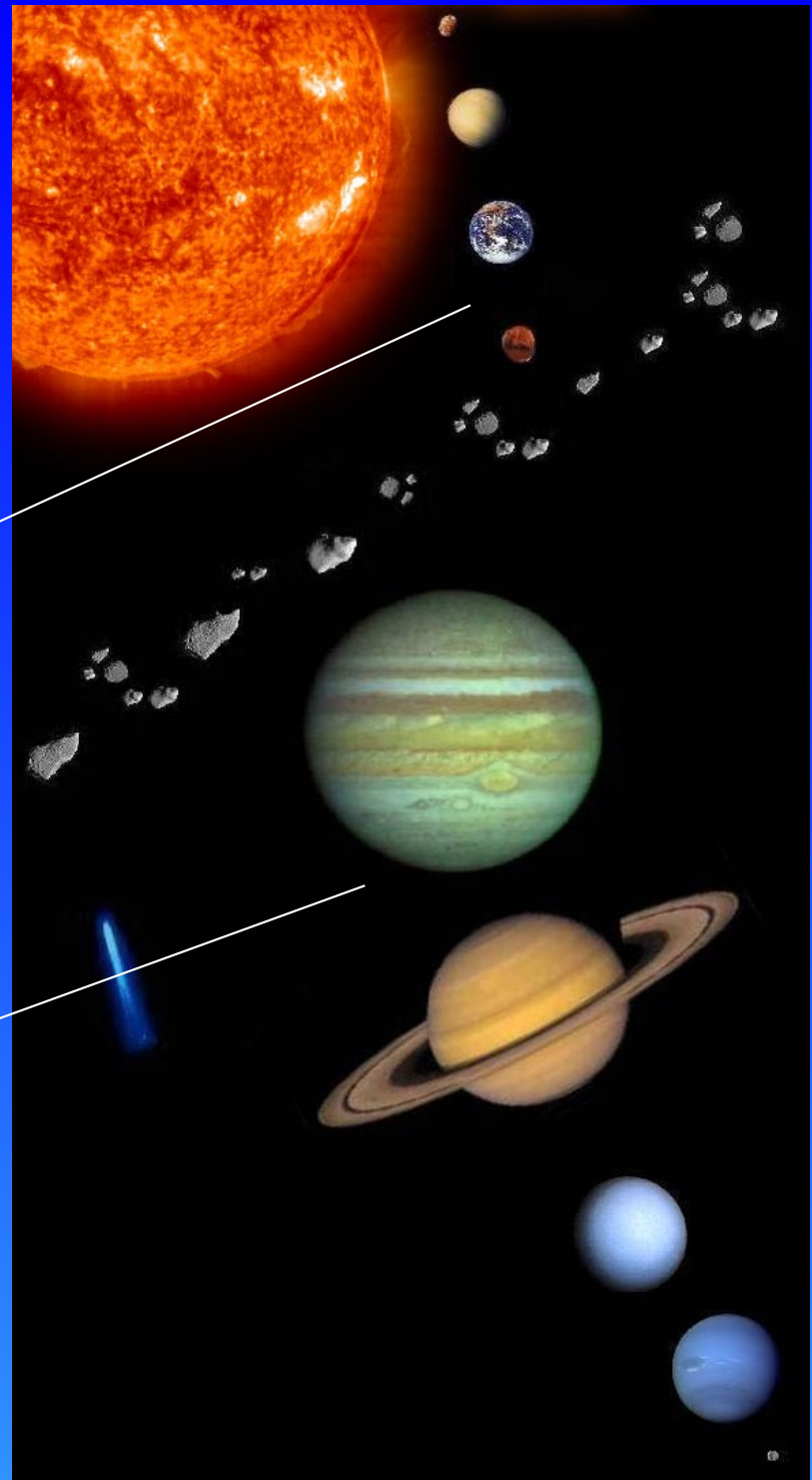
Planetary composition: ~~The Nine~~ Eight Planets

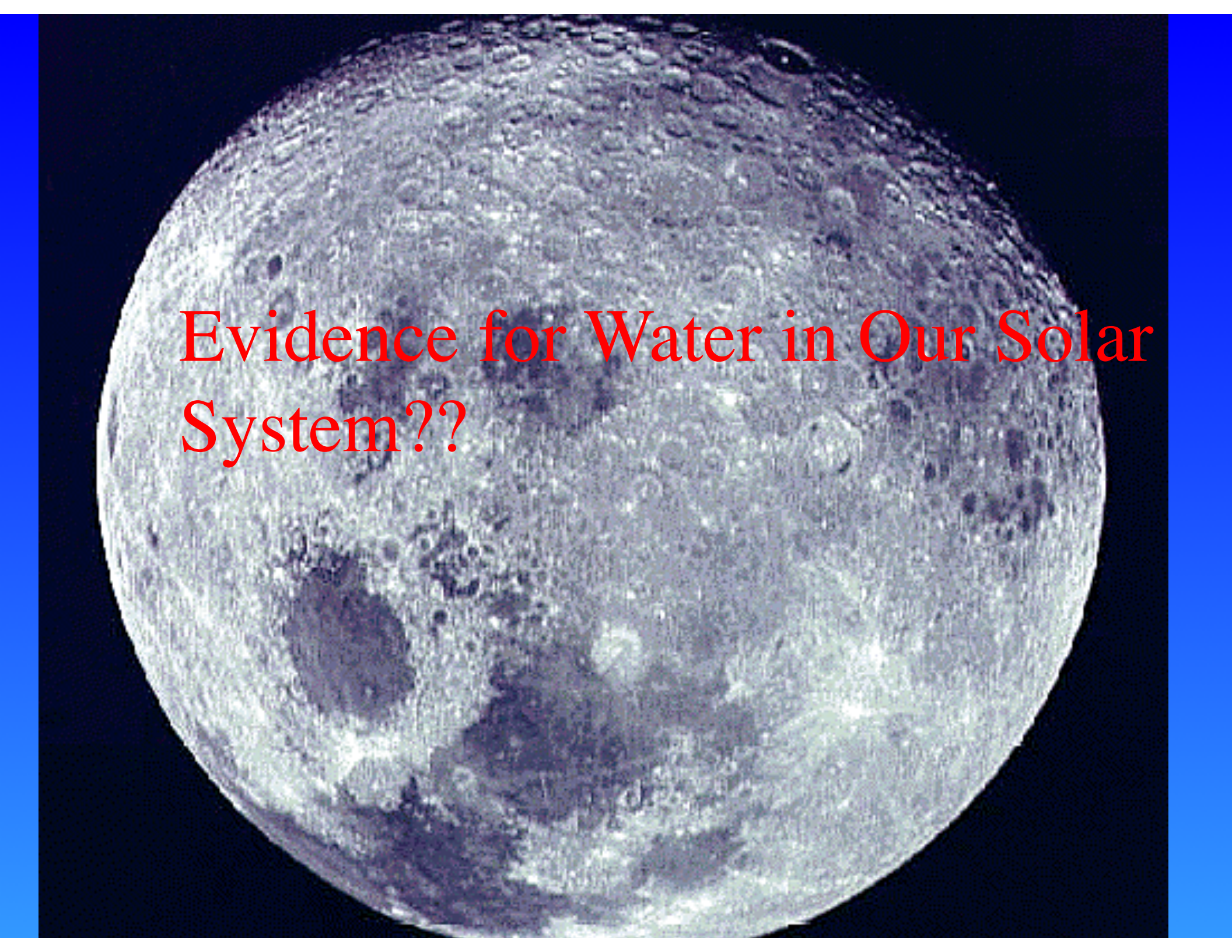
- **Inner terrestrial (Earth-like) planets**
- **Compositional distribution akin to a distillation-condensation sequence Iron (Fe), Magnesium (Mg), Silicon (Si), & Oxygen (O) dominant**
- **Mercury, Venus, Earth, Mars**
- **Outer Jovian Planets (gas giants)**
- **Hydrogen, helium, water (plus small iron cores)**
- **Saturn, Jupiter, Neptune, Uranus**

Evidence for Water

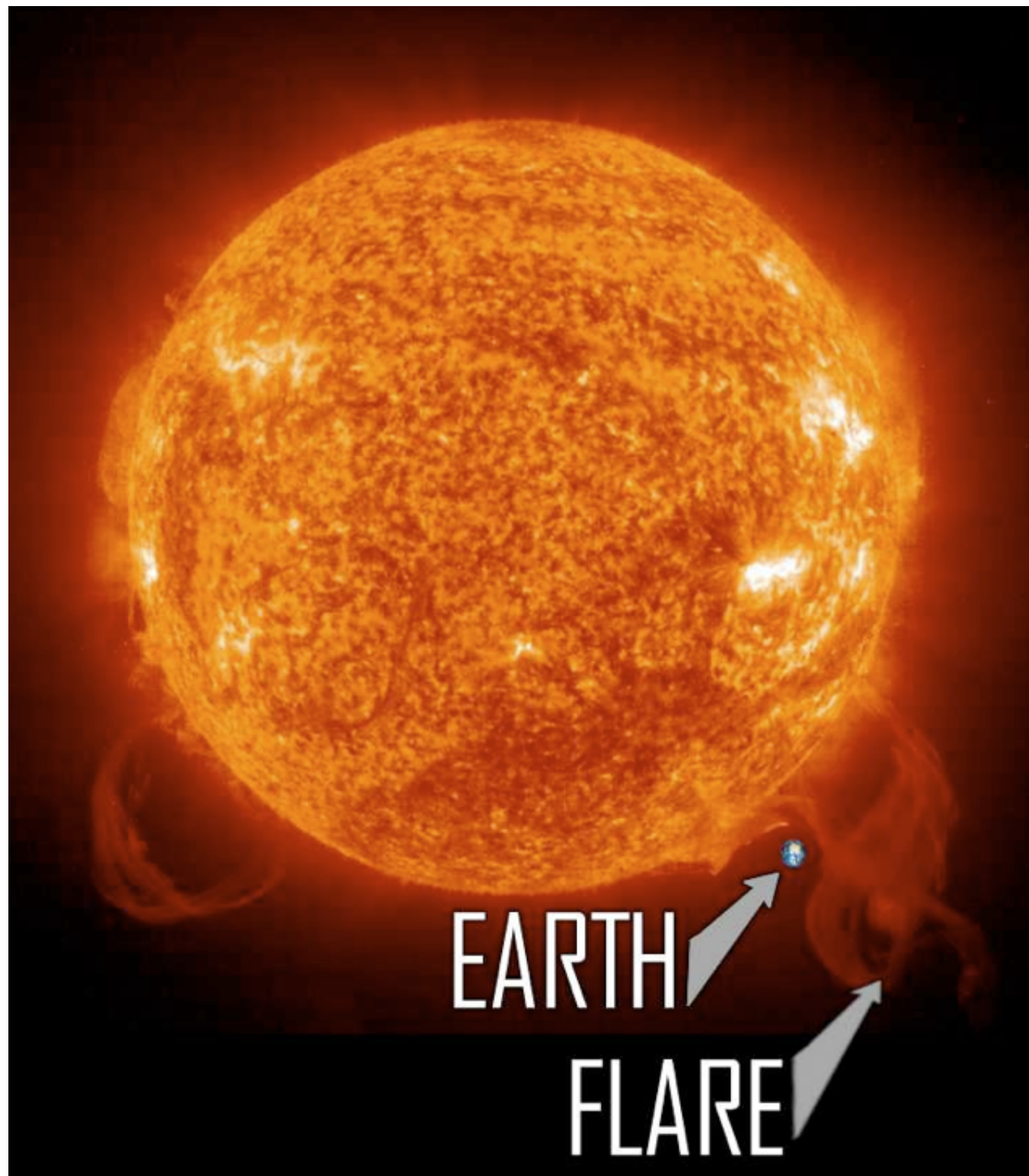
Stony Planets

Gassy Planets



A large, cratered celestial body, likely a moon or planet, is shown against a black background. The surface is covered in numerous craters of various sizes. The image is framed by a blue border.

Evidence for Water in Our Solar System??



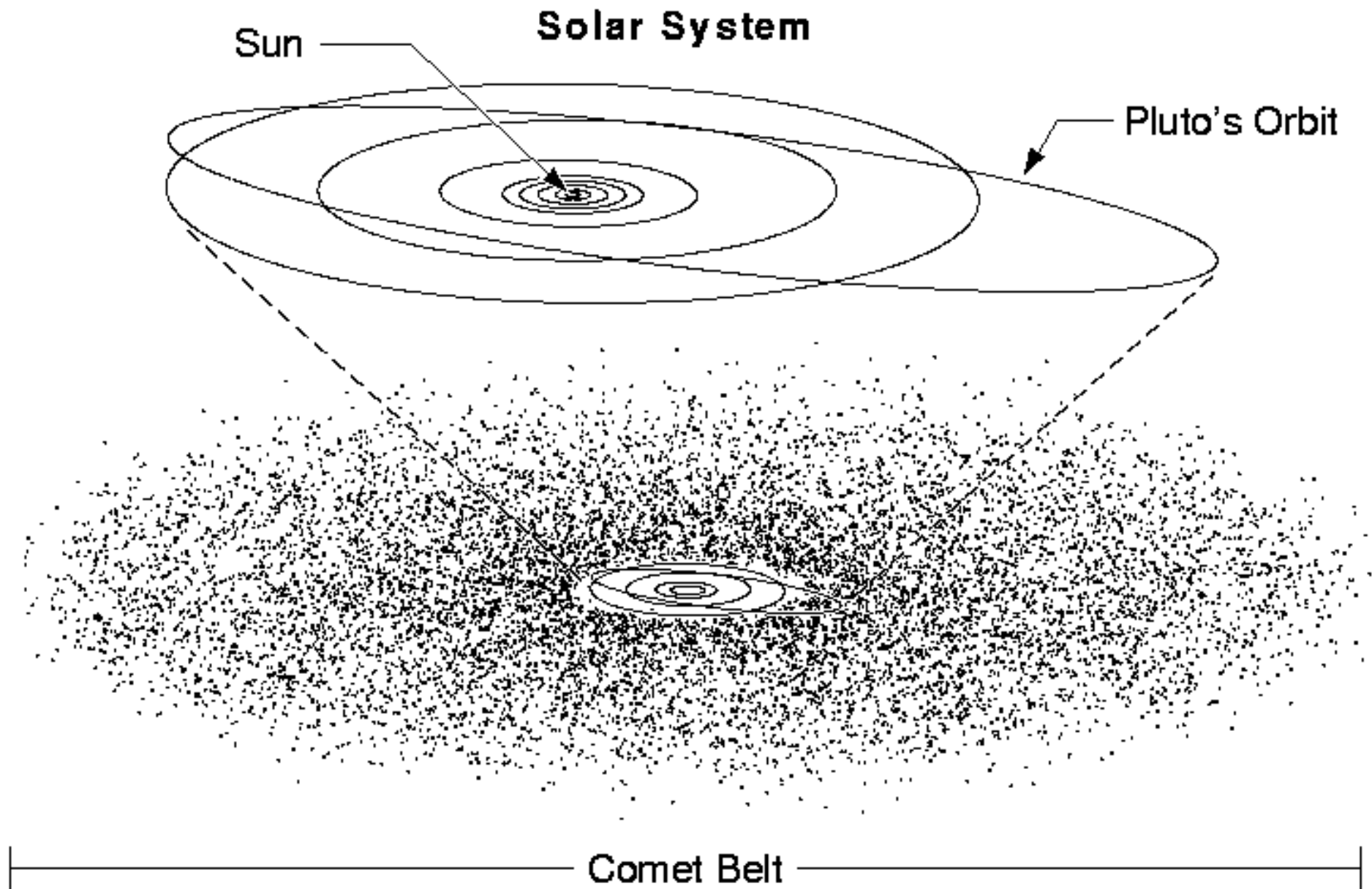
EARTH

FLARE

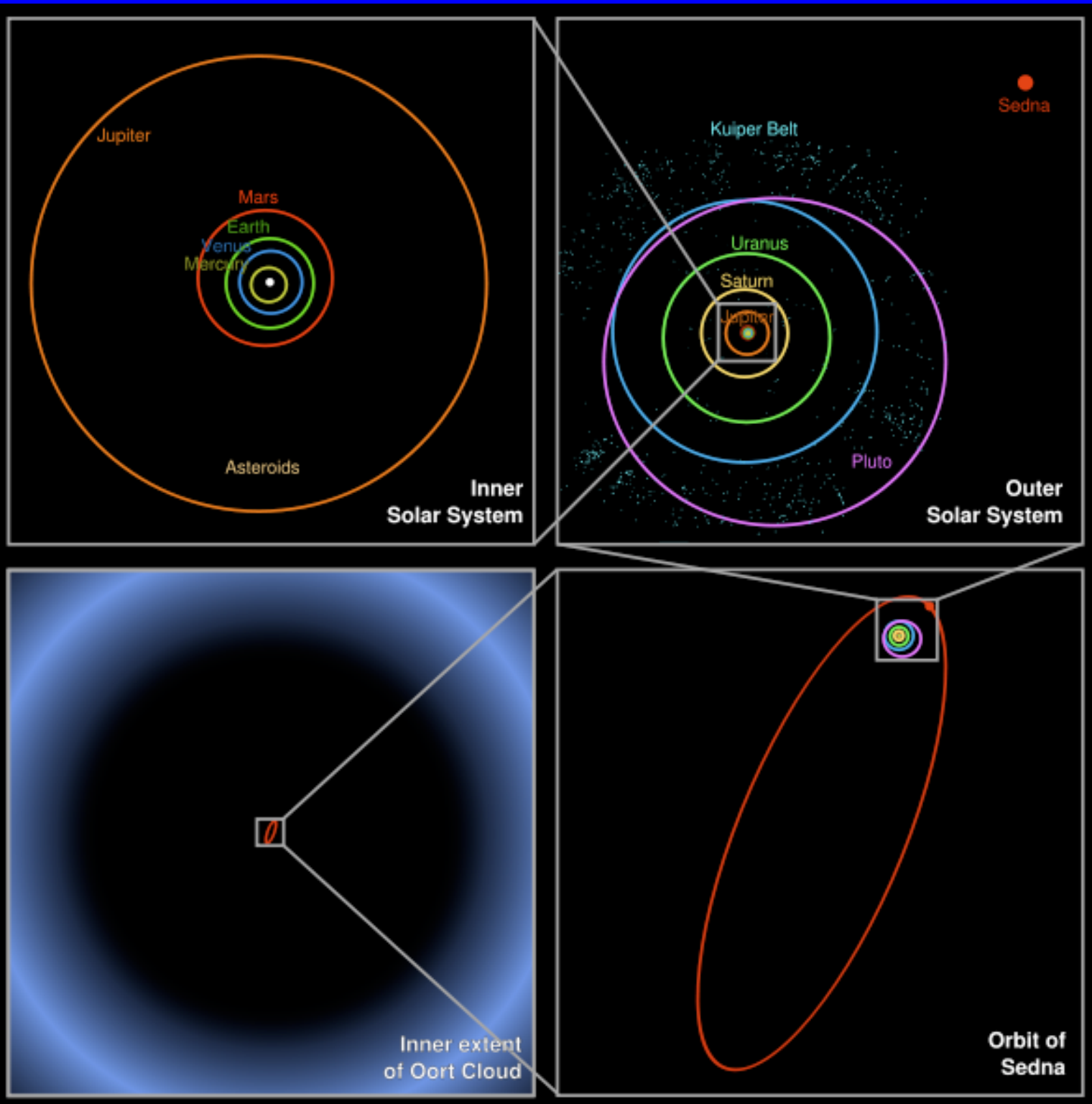


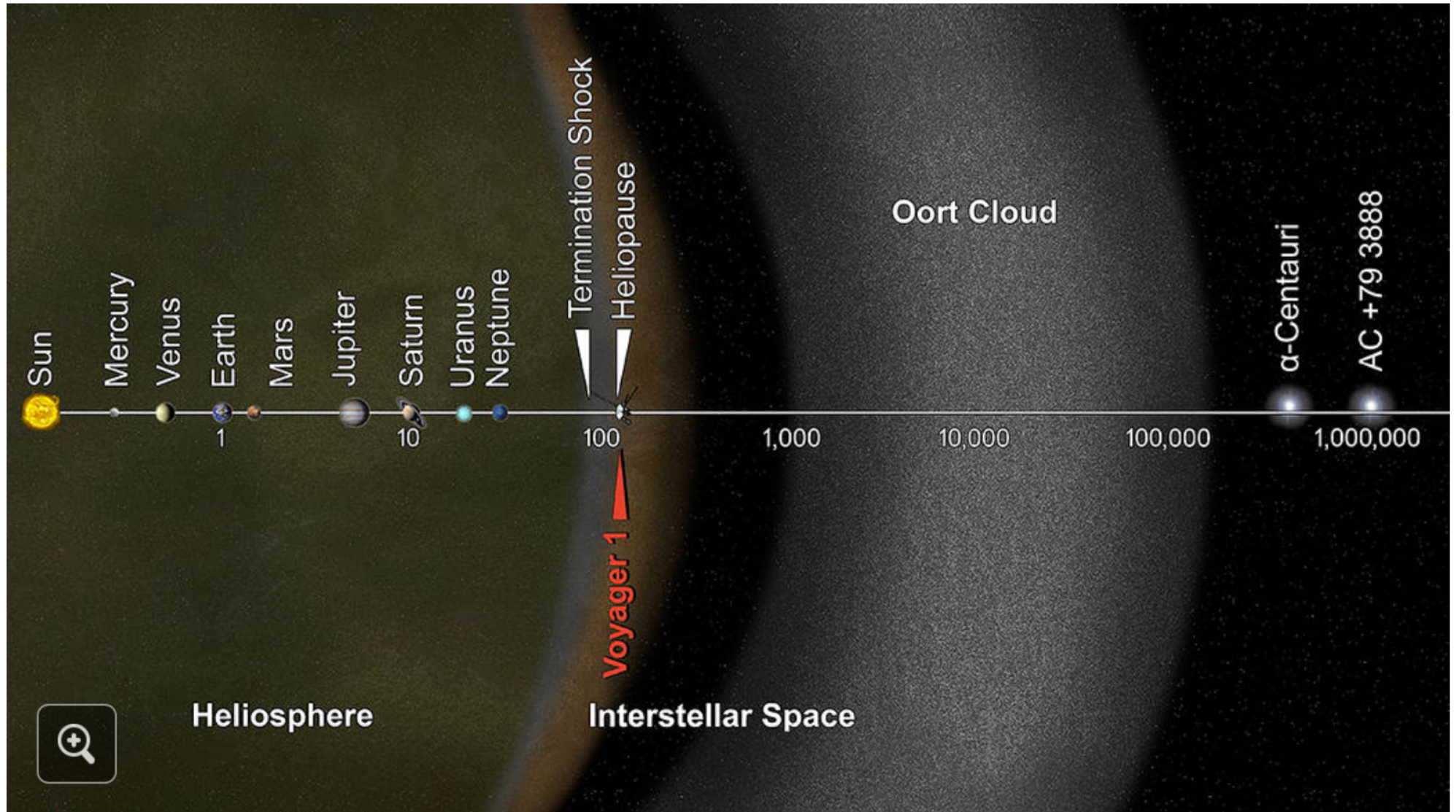
Comets are found in two main regions of the solar system: the Kuiper Belt and the Oort Cloud. There are two types of comets: short-period comets and long-period comets.

Location of the Kuiper Belt of Comets



Estimated Population: 200 Million Comets





This artist's concept puts solar system distances in perspective. The scale bar is in astronomical units, with each set distance beyond 1 AU representing 10 times the previous distance. One AU is the distance from the Sun to the Earth, which is about 93 million miles or 150 million kilometers. Neptune, the most distant planet from the Sun, is about 30 AU. Image Credit: NASA/JPL-Caltech

ShoemakerLevy9 comet



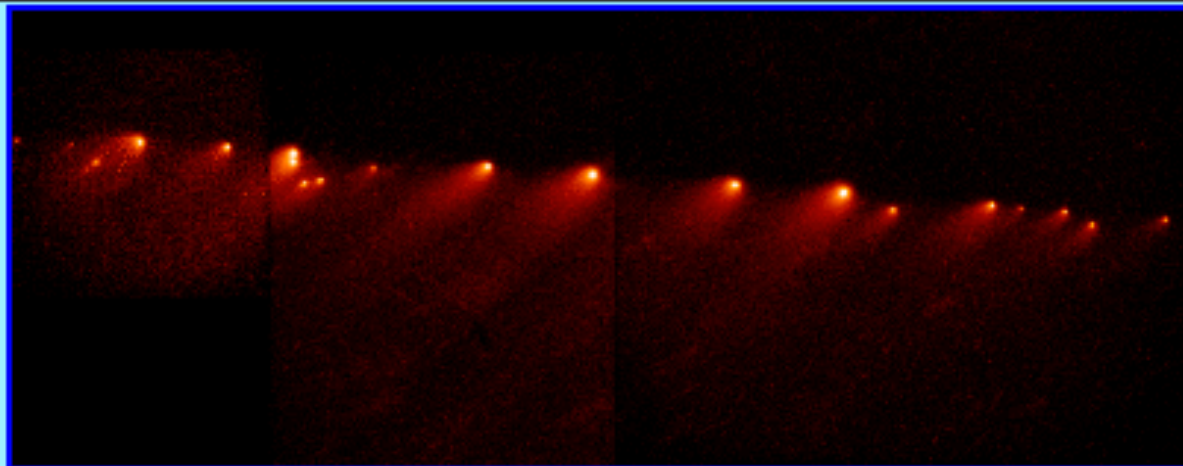
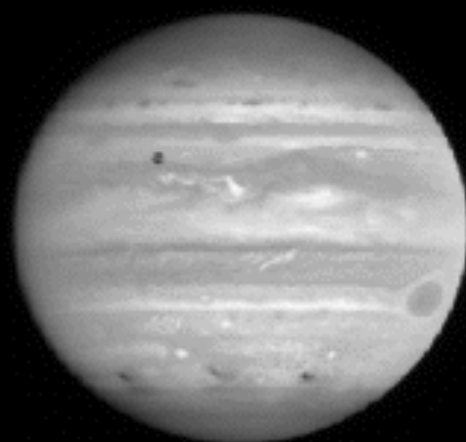
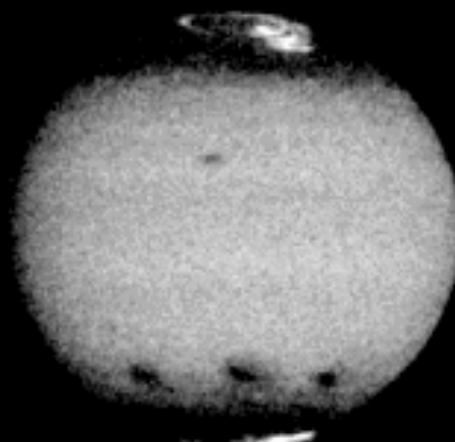


Figure 1. HST view of SL9 taken 24-27 January 1994.

Jupiter July 17, 1994 1900 UT



Violet (3360 Å)



Ultraviolet (1600 Å)

Hubble Space Telescope
Wide Field Planetary Camera 2

Figure 2. HST view of impact sites C, A and E in violet light (left) and ultraviolet light (right)

Halley's comet



Mars



There are polar ice caps on Mars that get larger during the Martian winter and smaller in the summer. The ice caps are largely composed of frozen carbon dioxide, but small amounts of water-ice have also been detected.

Vallis Marinaris



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292



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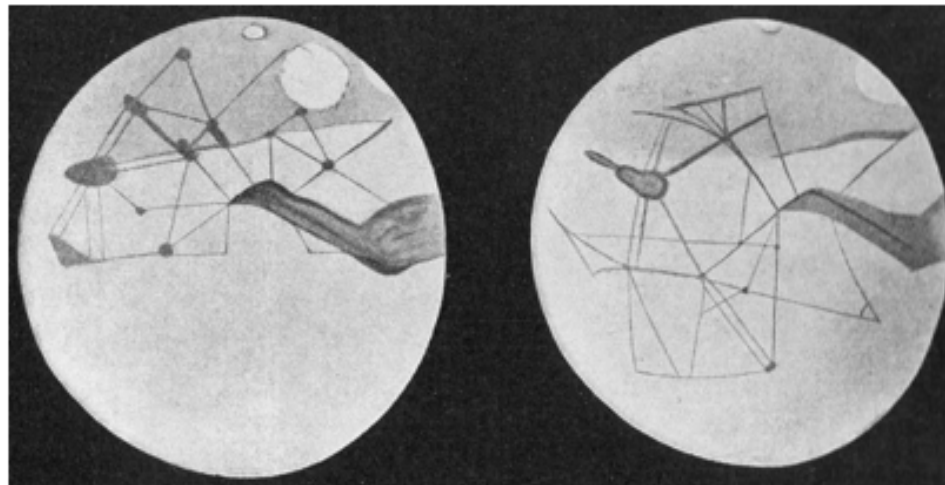


COMMENT
26



EMAIL

FANTASTICALLY WRONG: ONE ASTRONOMER'S QUEST TO EXPOSE THE ALIEN-BUILT CANALS OF MARS



Percival Lowell's sketches of supposed canals on Mars. Or, at left, a giant daddy longlegs that got a bit tangled up in itself; at right, a guitar whose strings have exploded from someone shredding too hard. Image: [Wikimedia](#)



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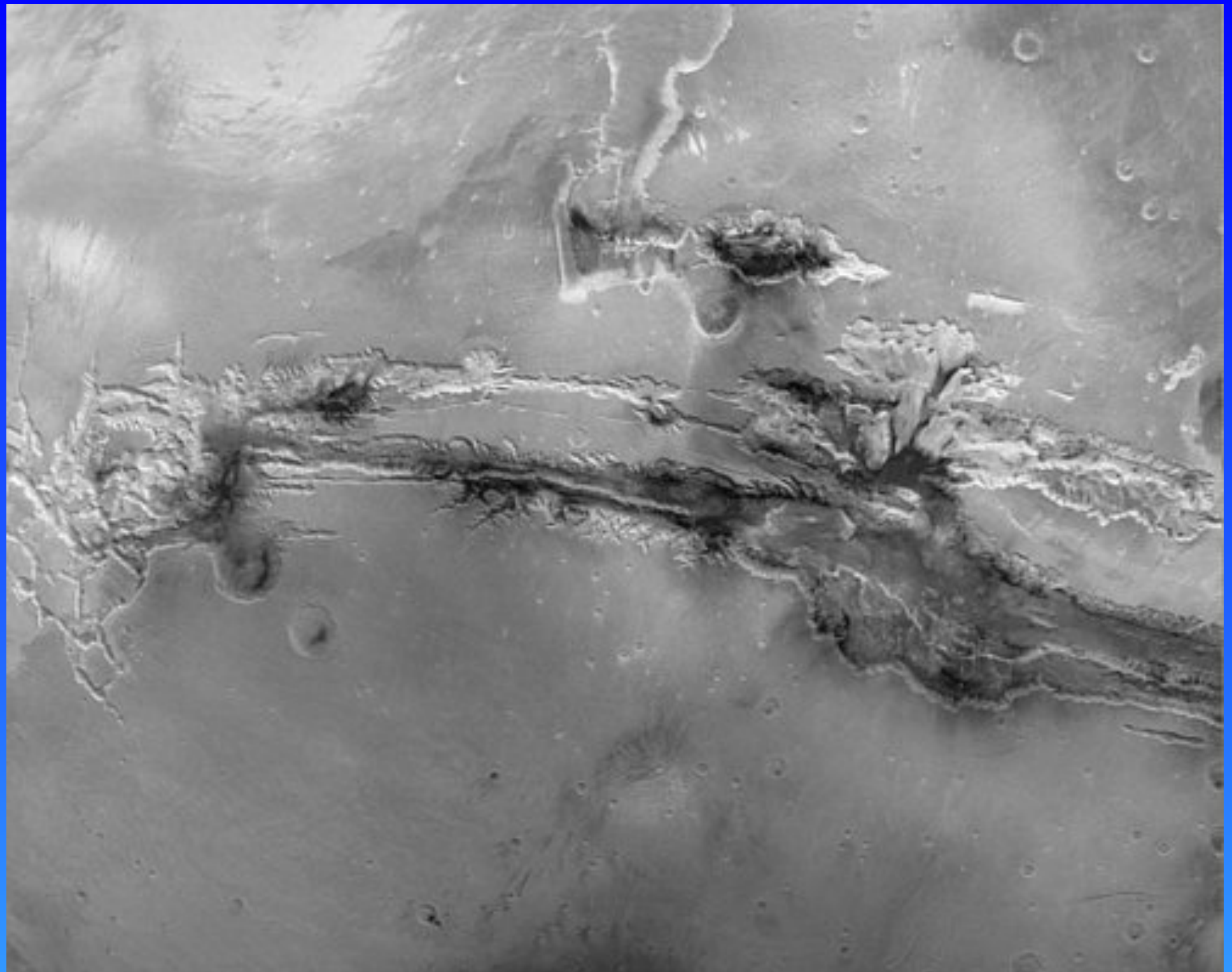


MARGARET RHODES

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36 MINS

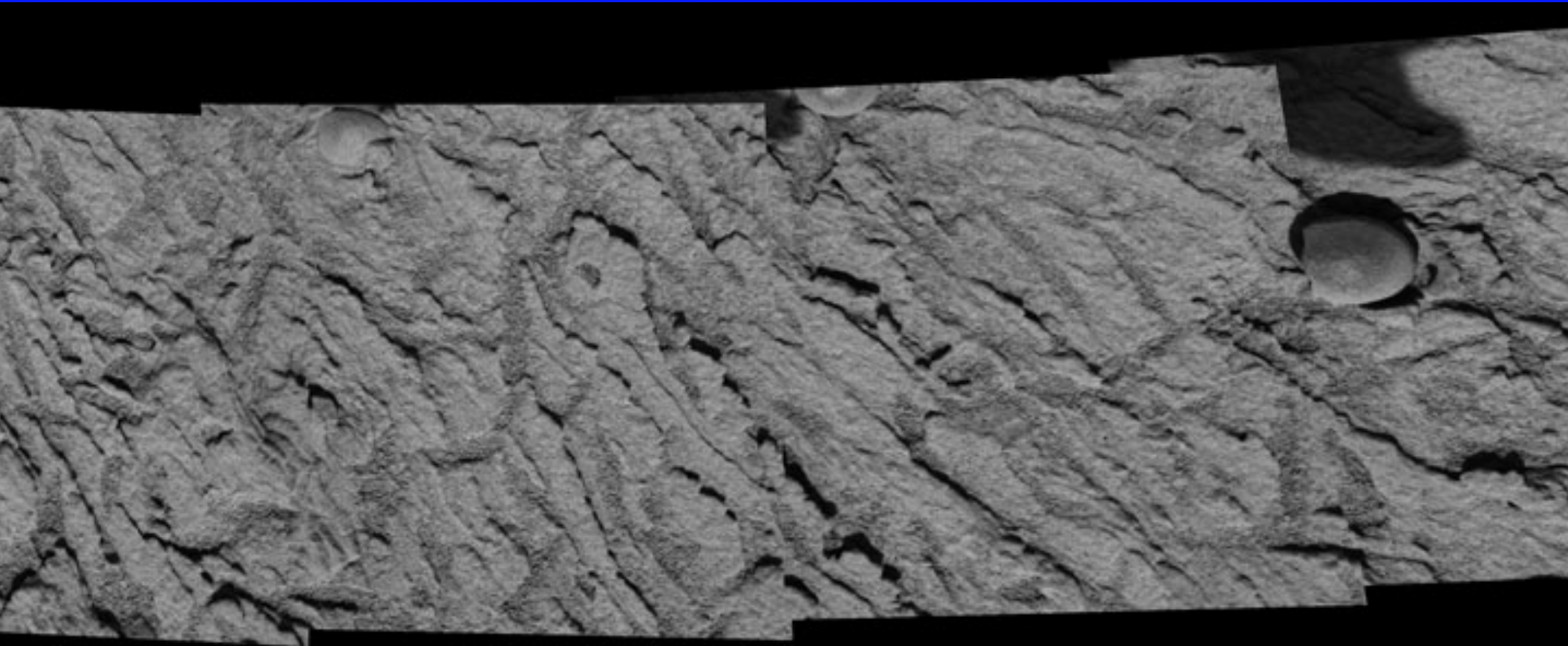




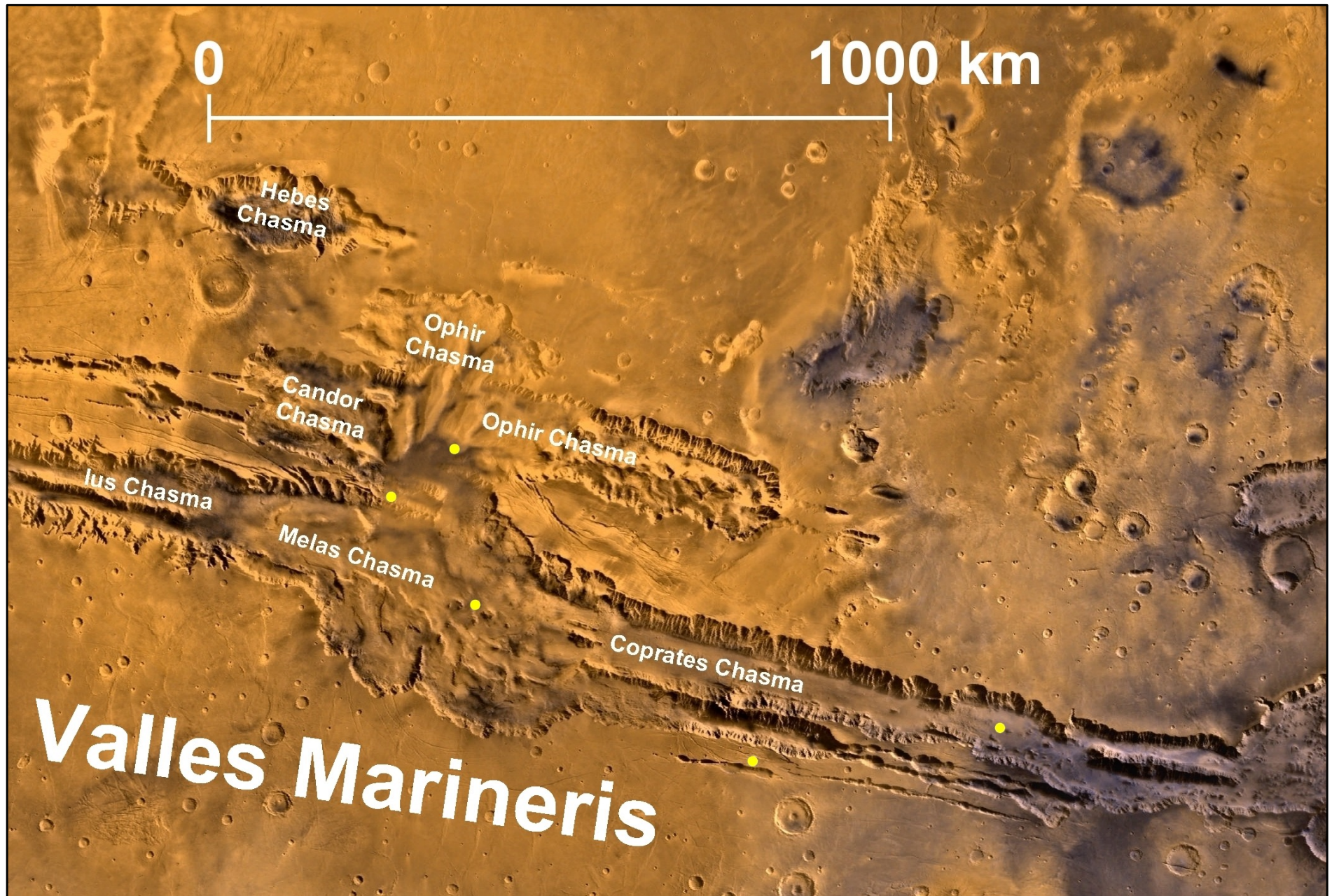
- bedforms - ripples
- evaporites - salt deposits



Water Ripples on Mars??

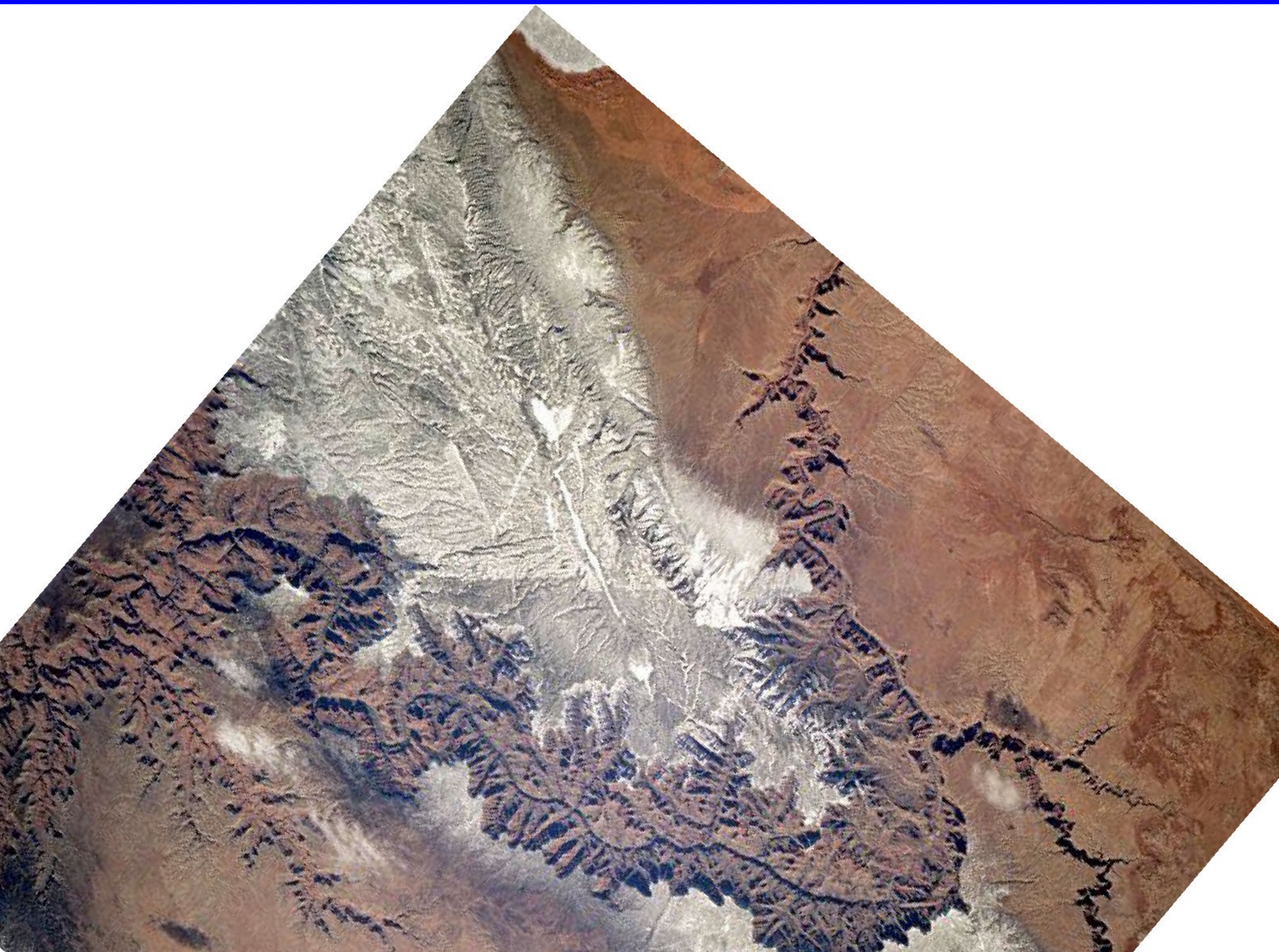


Area of Exploration: What Can We See?



Area of Exploration: Ius Chasma



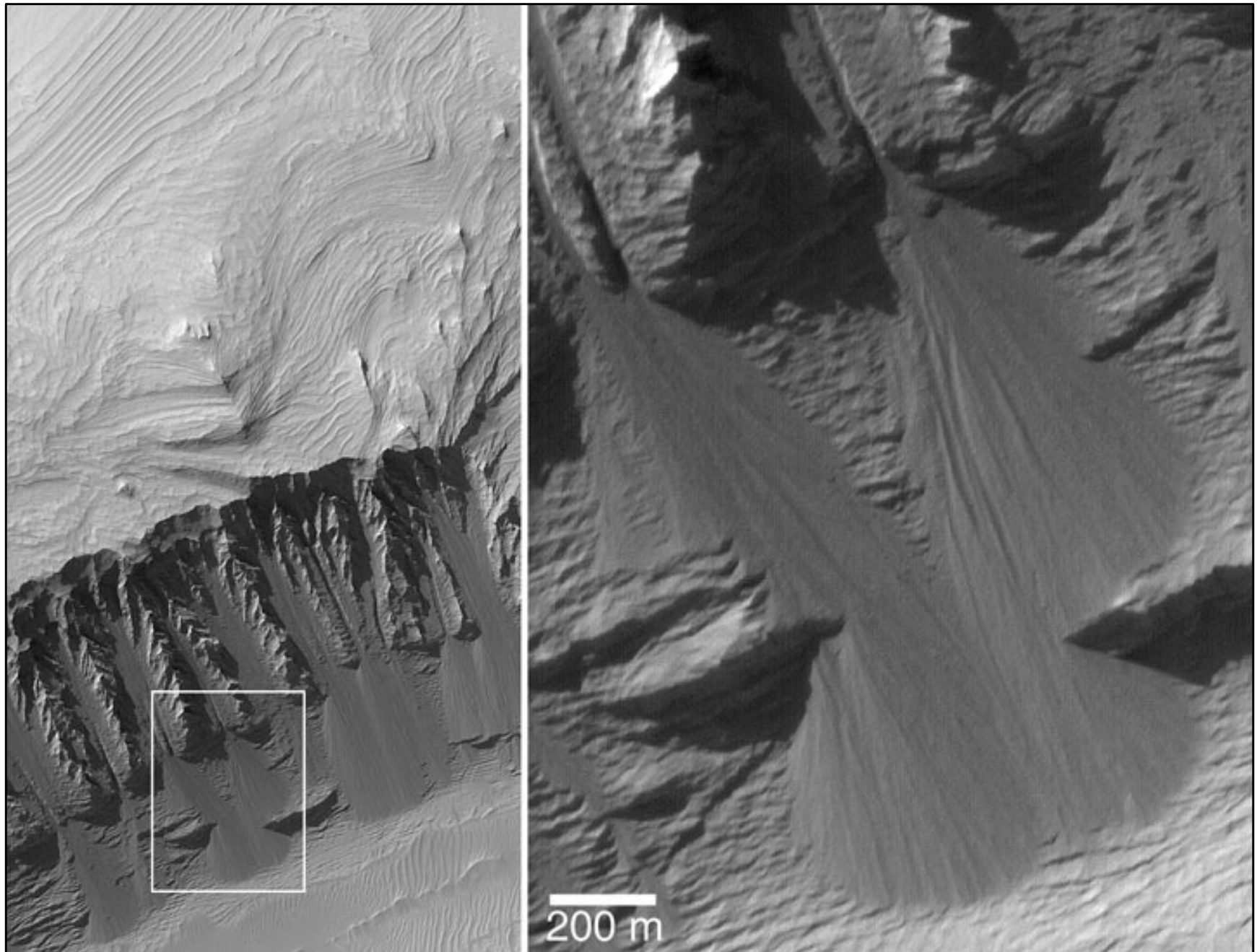




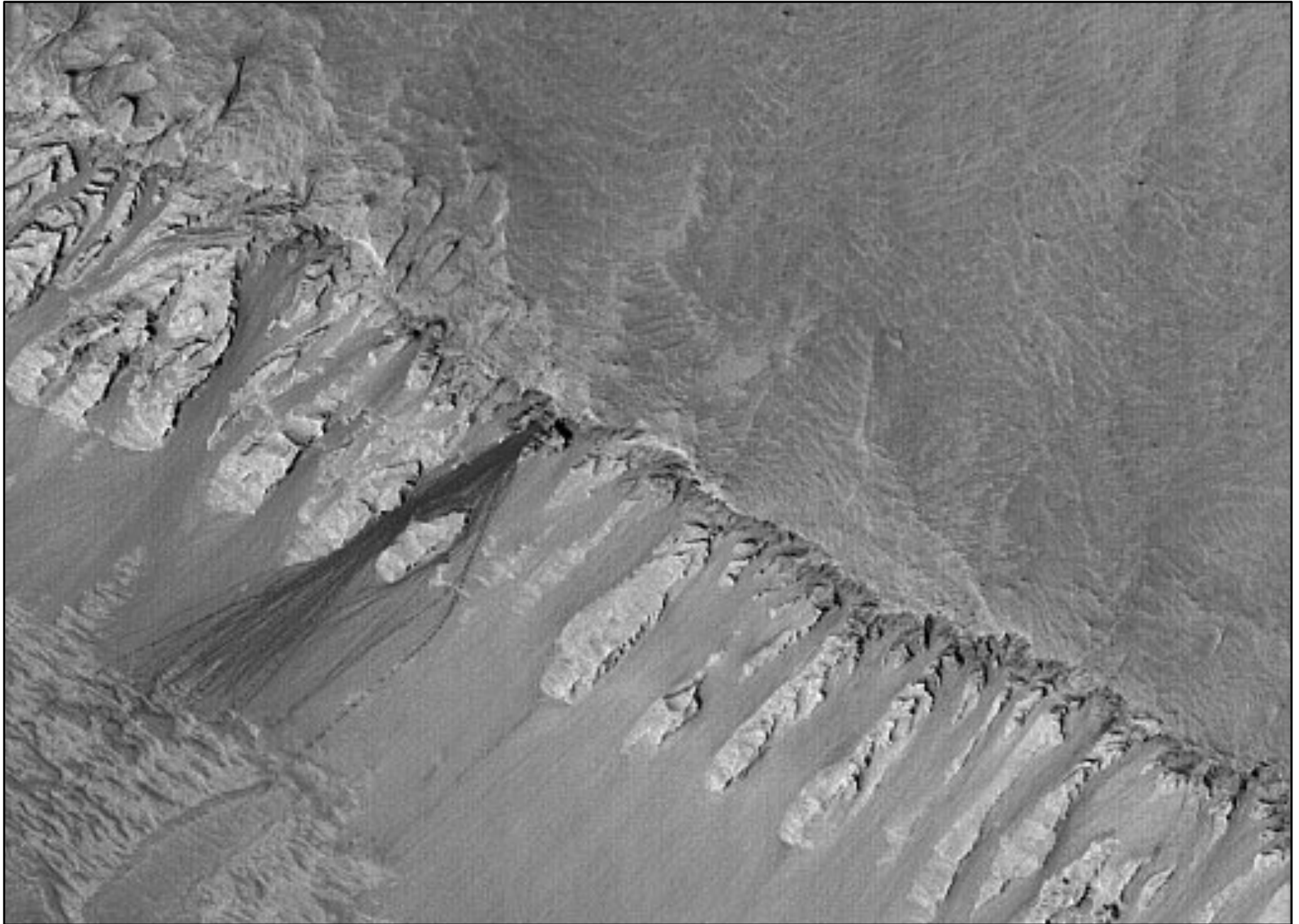
Area of Exploration: Melas Chasma



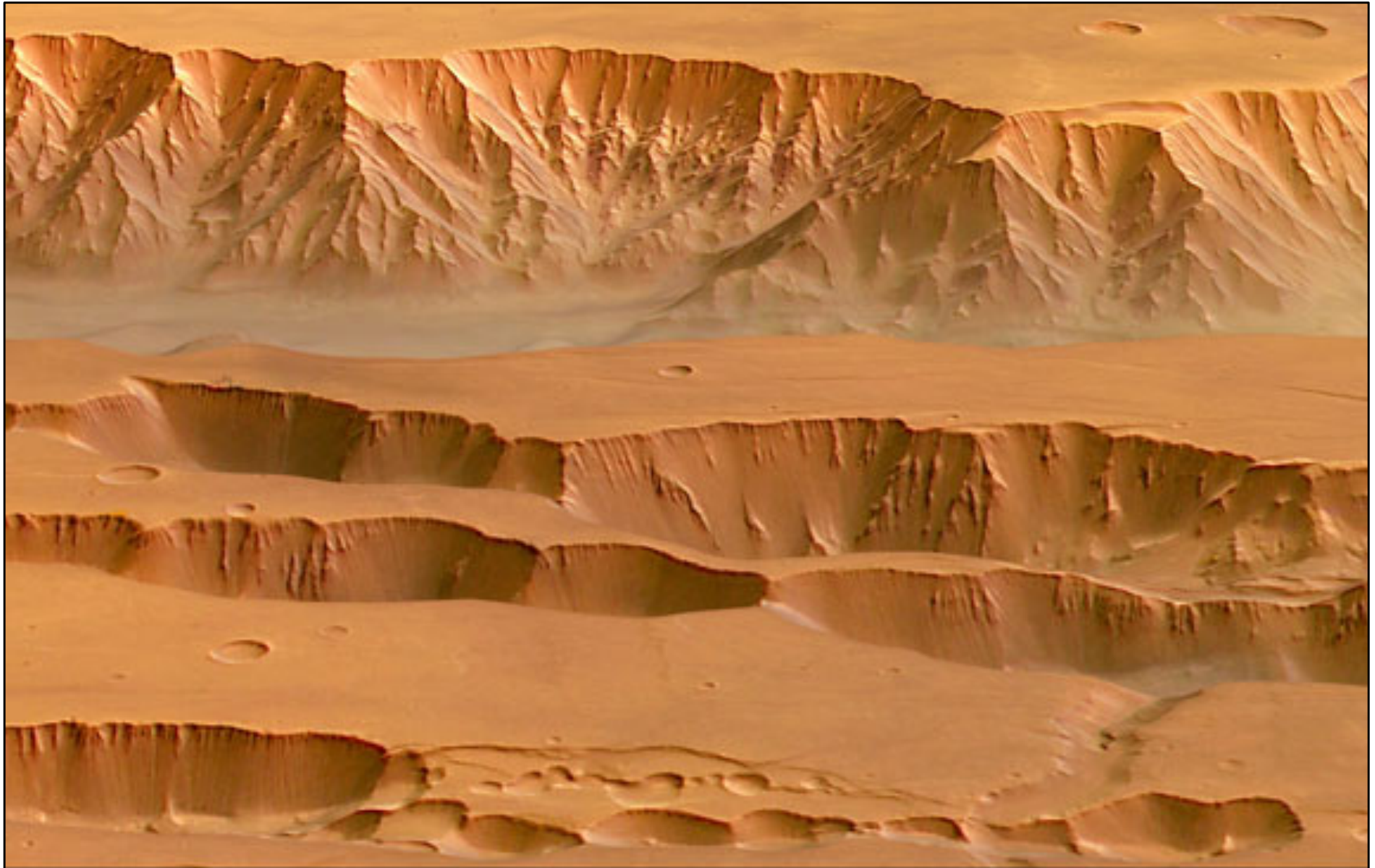
Area of Exploration: Candor Chasma



Area of Exploration: Ophir Chasma



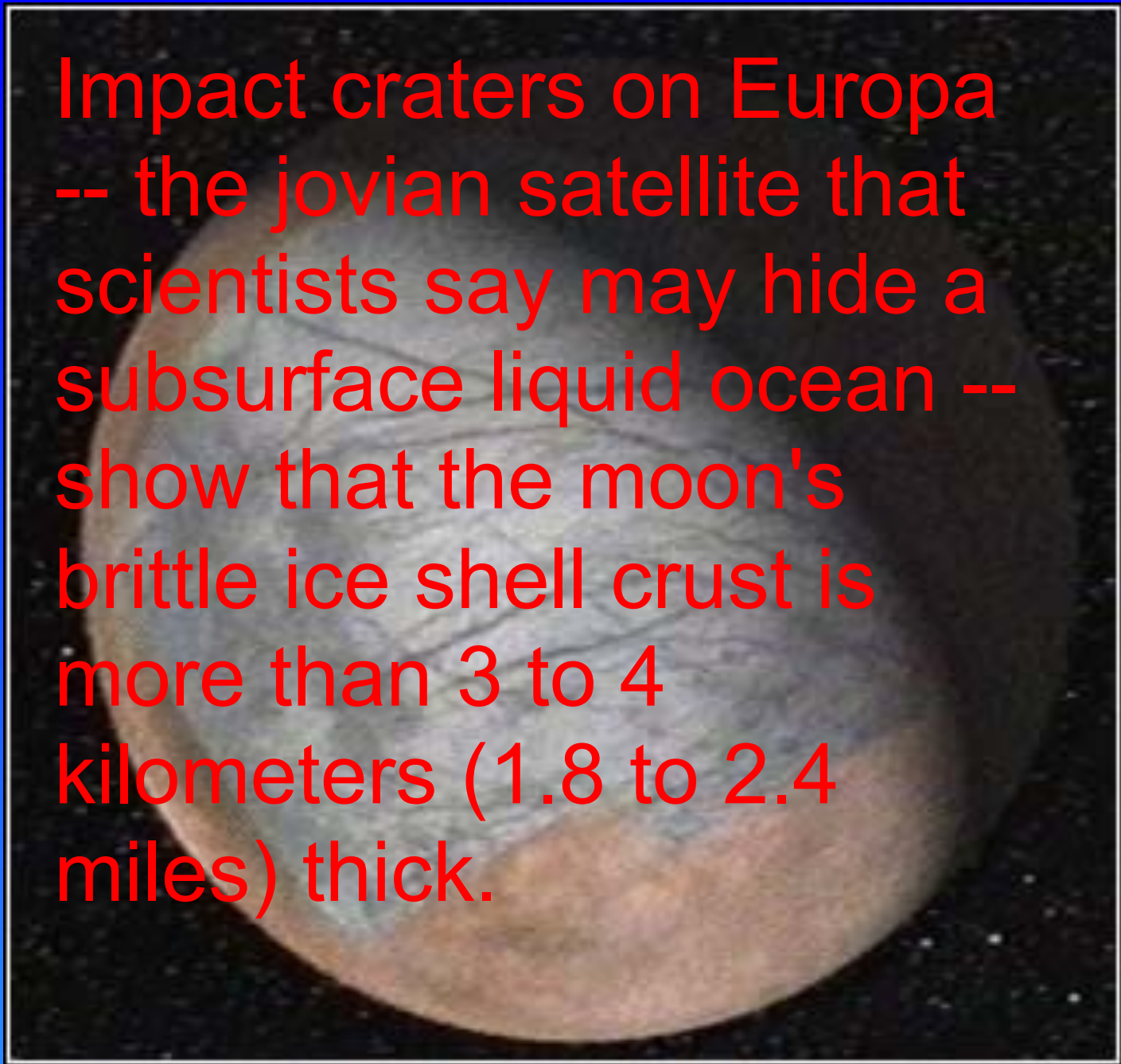
Area of Exploration: Coprates Chasma



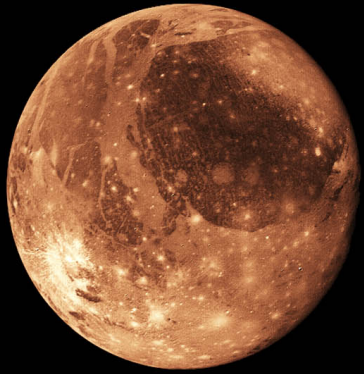
copyright : ESA/DLR/FU Berlin (G. Neukum)

Europa

Impact craters on Europa
-- the jovian satellite that
scientists say may hide a
subsurface liquid ocean --
show that the moon's
brittle ice shell crust is
more than 3 to 4
kilometers (1.8 to 2.4
miles) thick.



(NASA)



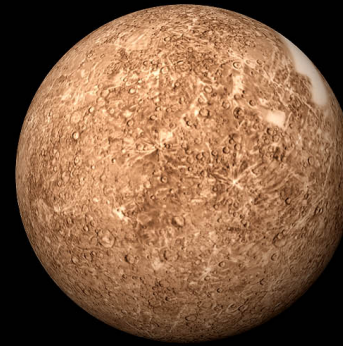
Ganymede

5262 km



Titan

5150 km



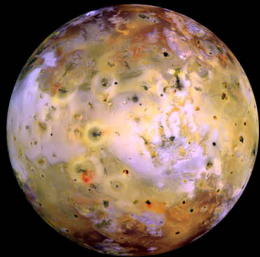
Mercury

4880 km



Callisto

4806 km



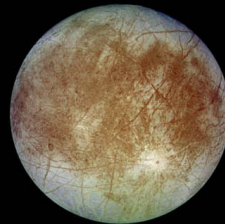
Io

3642 km



Moon

3476 km



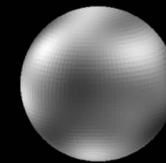
Europa

3138 km



Triton

2706 km



Pluto

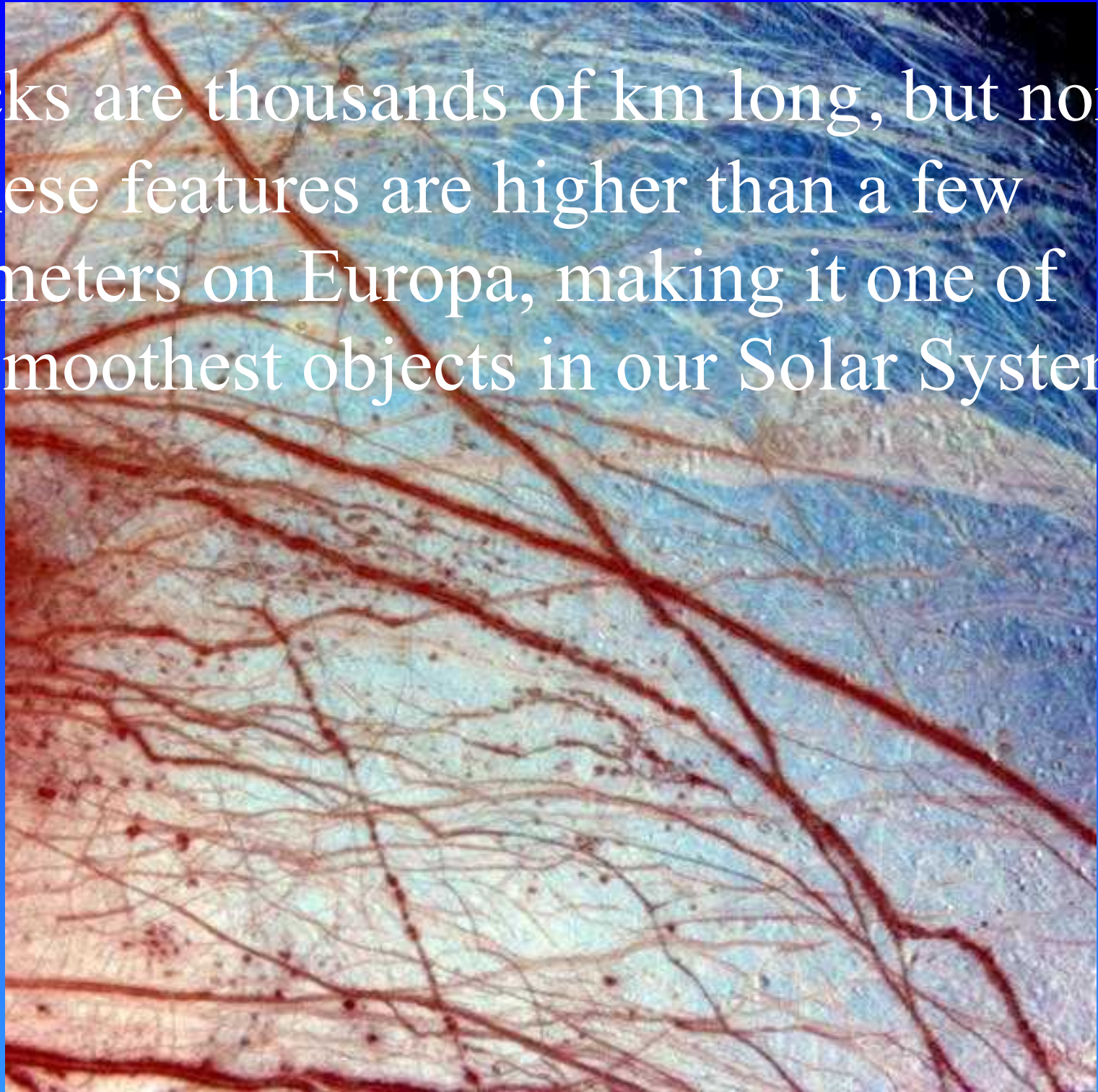
2300 km

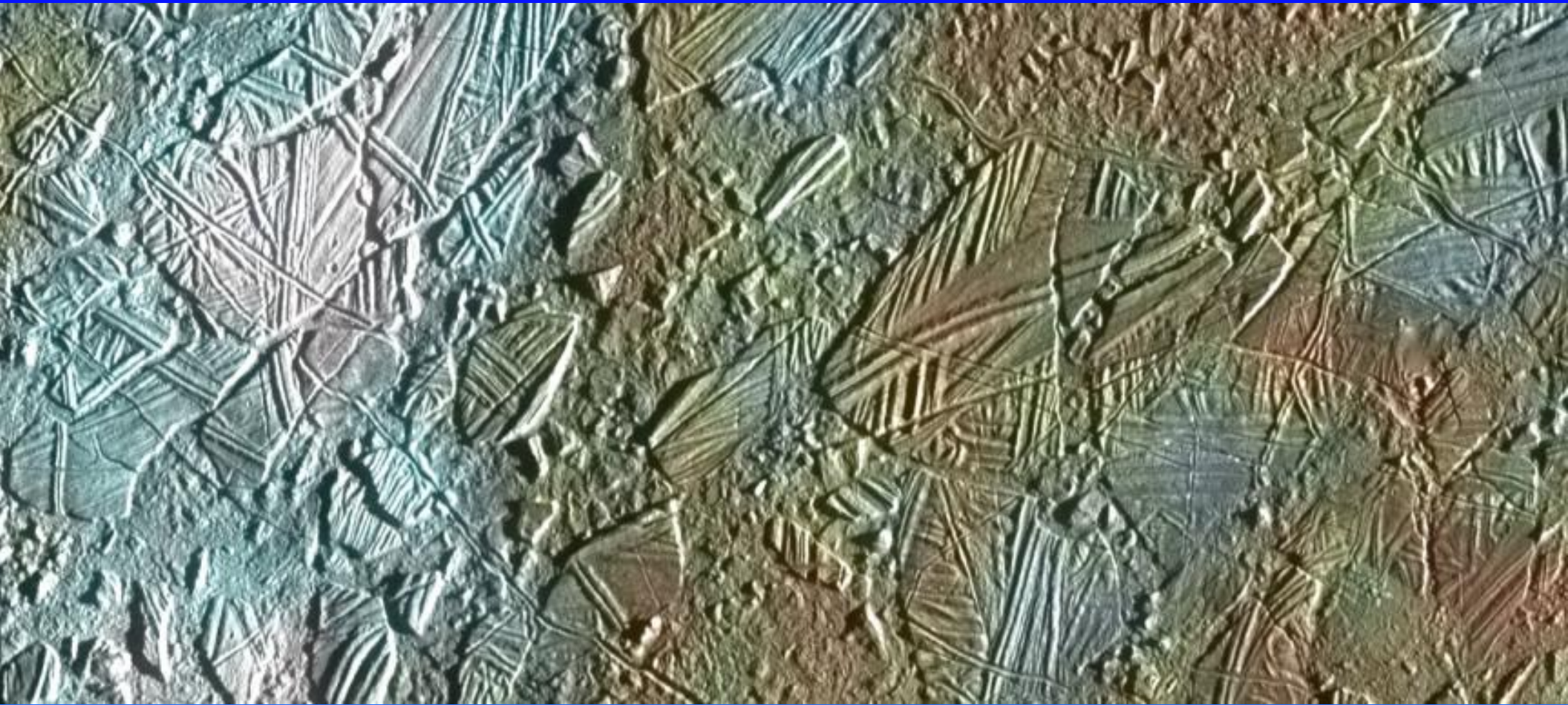


Titania

1580 km

Cracks are thousands of km long, but none of these features are higher than a few kilometers on Europa, making it one of the smoothest objects in our Solar System.





What causes cracks and blocks?