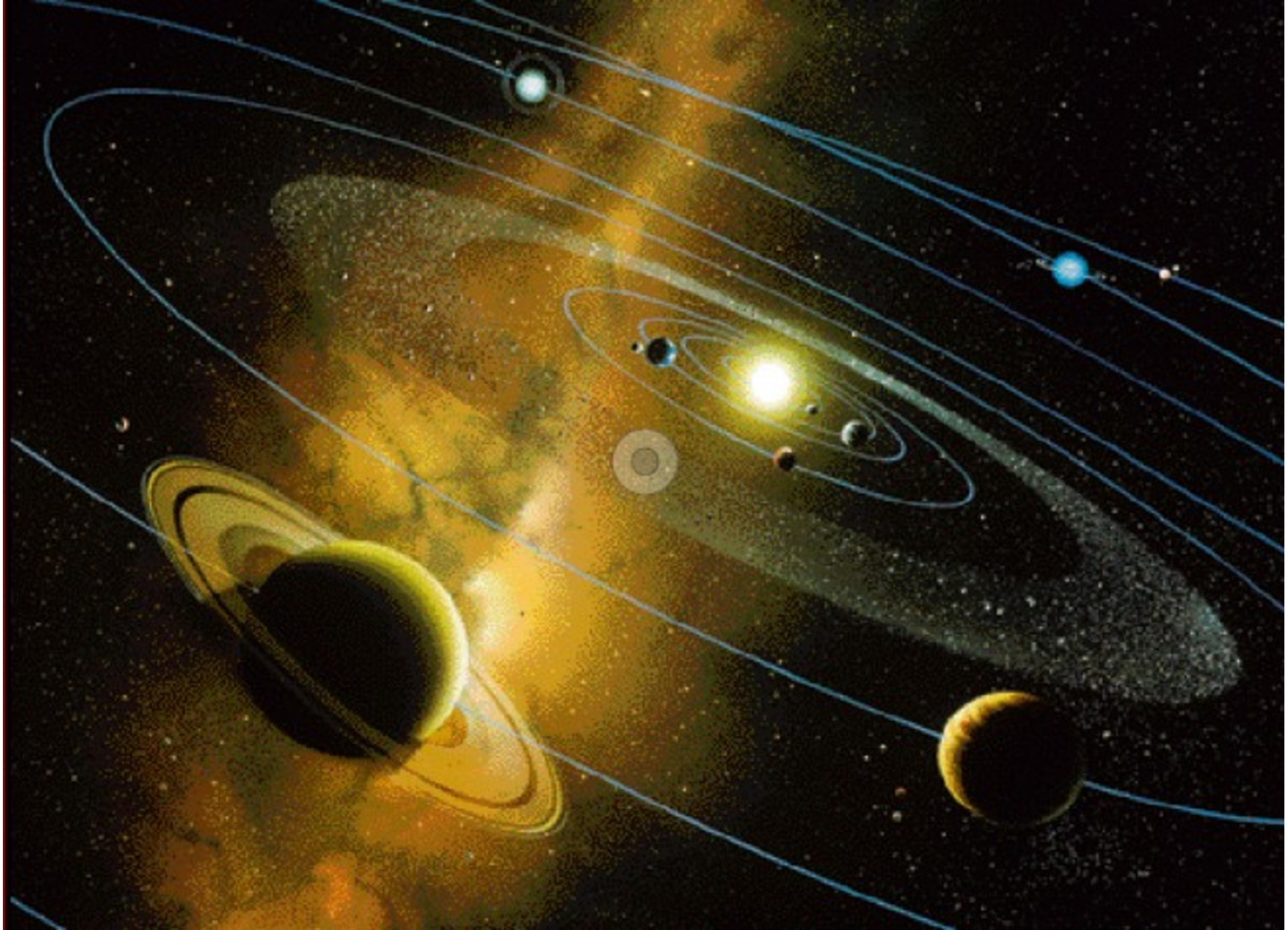
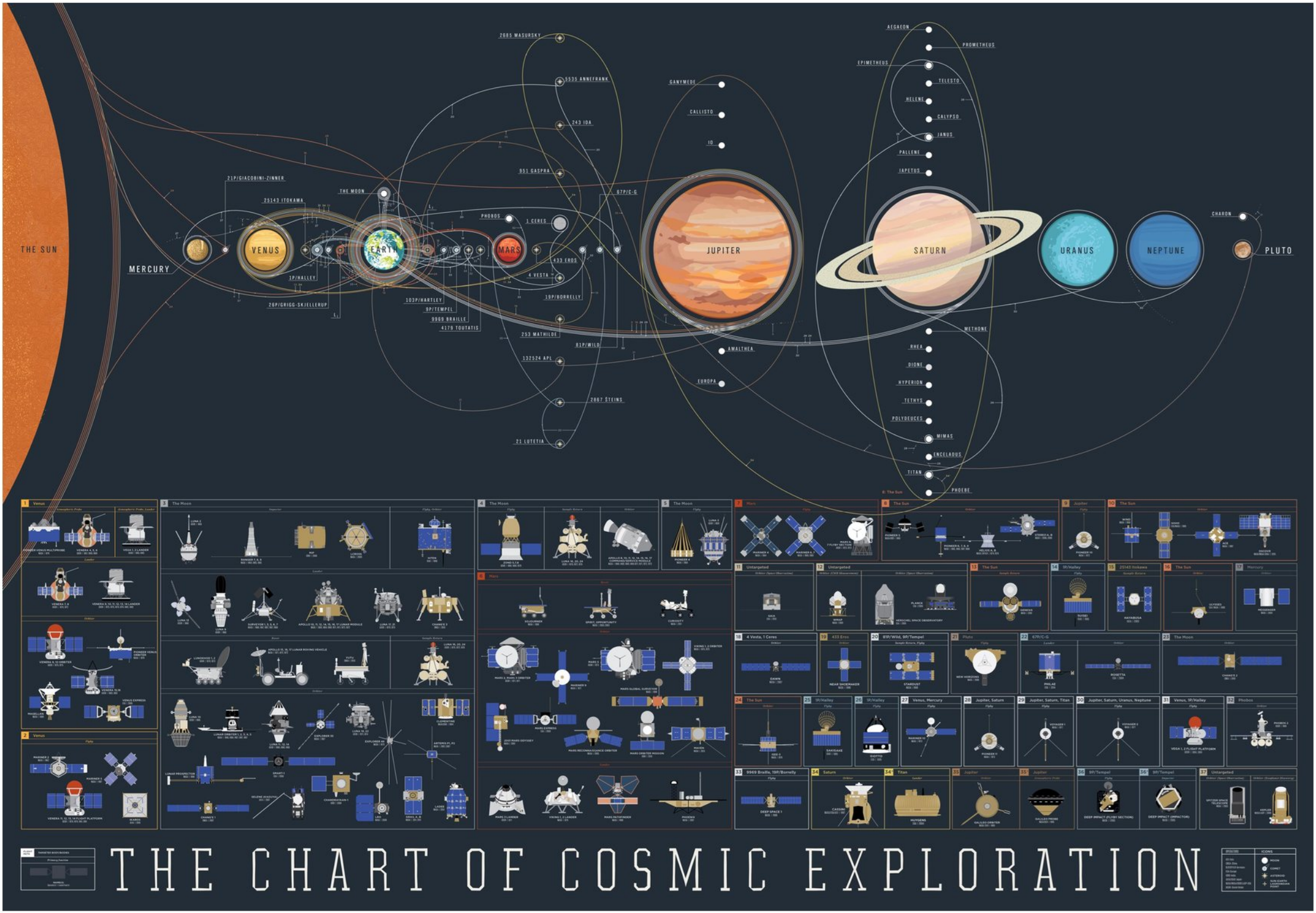
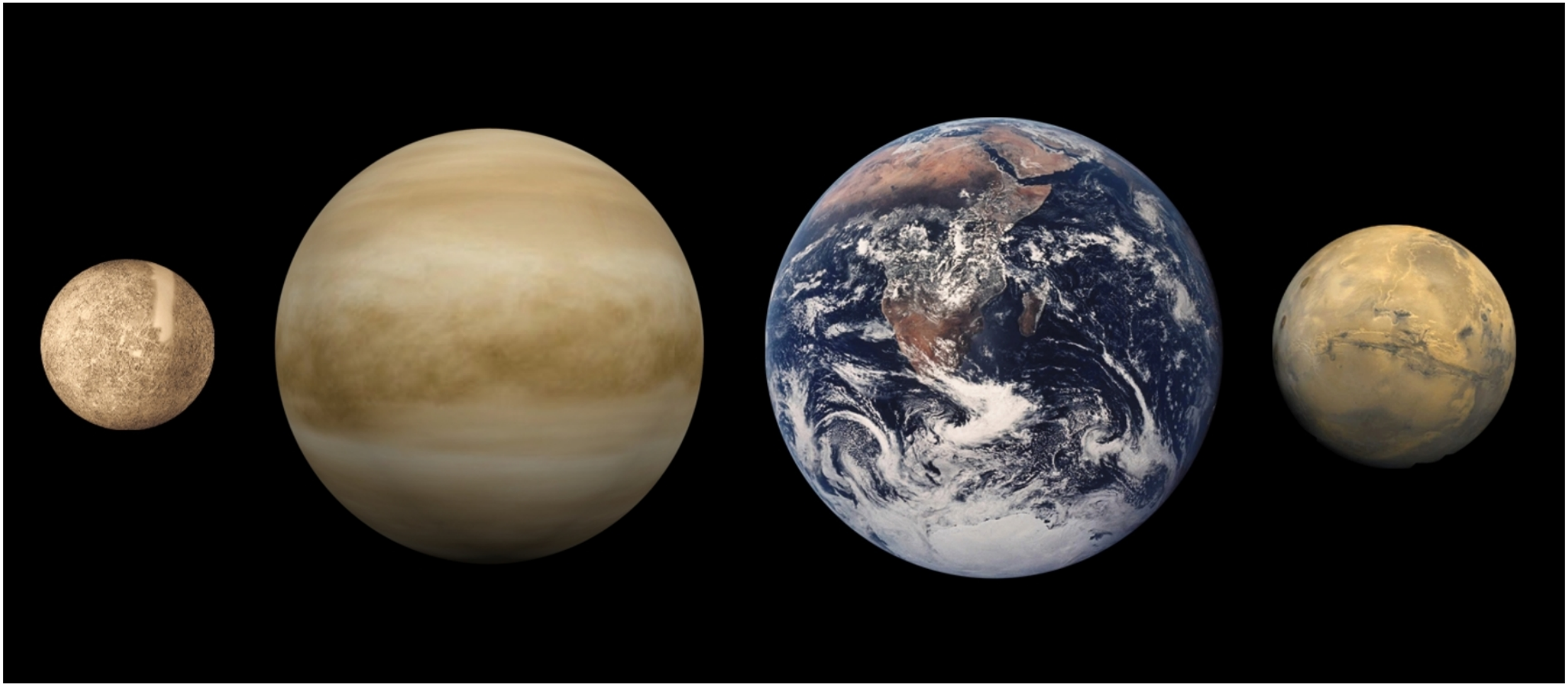


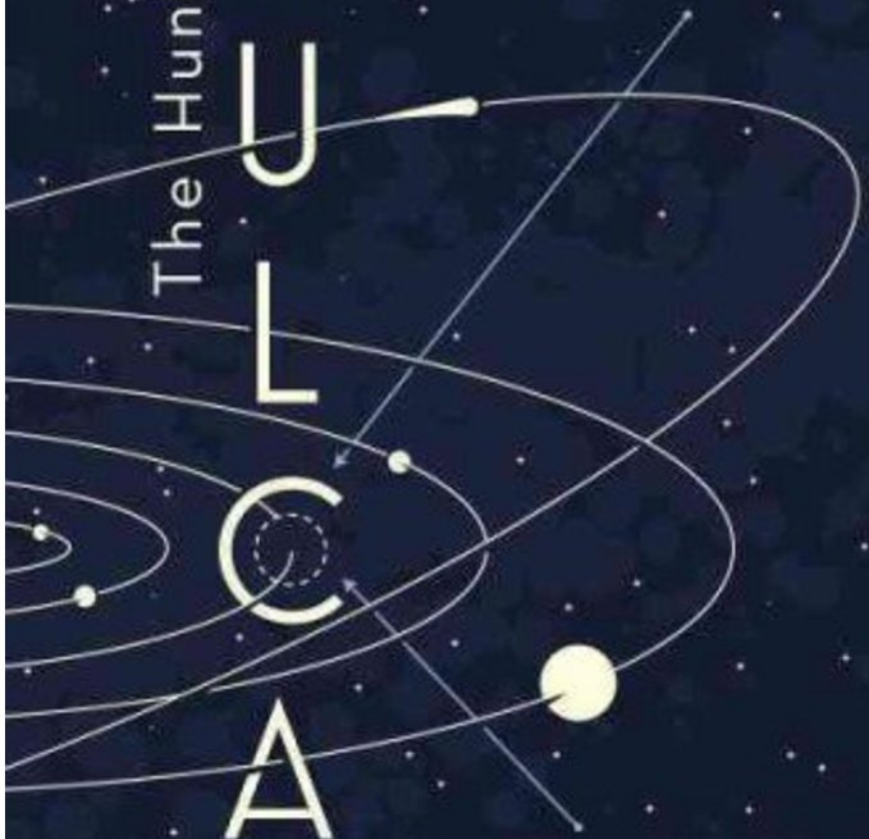

THE CHART OF COSMIC EXPLORATION
THE SUN
MERCURY
VENUS
EARTH
MARS
JUPITER
SATURN
URANUS
NEPTUNE
PLUTO
THE MOON
PHOBOS
1 CERES
433 EROS
4 VESTA
2685 MASURSKY
5535 ANNEFRANK
243 IDA
951 GASPRA
67P/C-G
21P/GIACOBINI-ZINNER
25143 ITOKAWA
1P/HALLEY
26P/GRIGG-SKJELLERUP
103P/HARTLEY
9P/TEMPEL
9969 BRAILLE
4179 TOUTATIS
253 MATHILDE
81P/WILD
132524 APL
2867 ŠTEINS
21 LUTETIA
19P/BORRELLY
GANYMEDE
CALLISTO
IO
AMALTHEA
EUROPA
AEGAEON
PROMETHEUS
EPIMETHEUS
TELESTO
HELENE
CALYPSO
JANUS
PALLENE
IAPETUS
METHONE
RHEA
DIONE
HYPERION
TETHYS
POLYDEUCES
MIMAS
ENCELADUS
TITAN
PHOEBE
CHARON
1 Venus
2 Venus
3 The Moon
4 The Moon
5 The Moon
6 The Sun
7 Mars
8 Mars
9 Jupiter
10 The Sun
11 Untargeted
12 Untargeted
13 The Sun
14 1P/Halley
15 25143 Itokawa
16 The Sun
17 Mercury
18 4 Vesta, 1 Ceres
19 433 Eros
20 81P/Wild, 9P/Tempel
21 Pluto
22 67P/C-G
23 The Moon
24 The Sun
25 1P/Halley
26 1P/Halley
27 Venus, Mercury
28 Jupiter, Saturn
29 Jupiter, Saturn, Titan
30 Jupiter, Saturn, Uranus, Neptune
31 Venus, 1P/Halley
32 Phobos
33 9969 Braille, 19P/Borrelly
34 Saturn
34 Titan
35 Jupiter
35 Jupiter
36 9P/Tempel
36 1 9P/Tempel
37 Untargeted



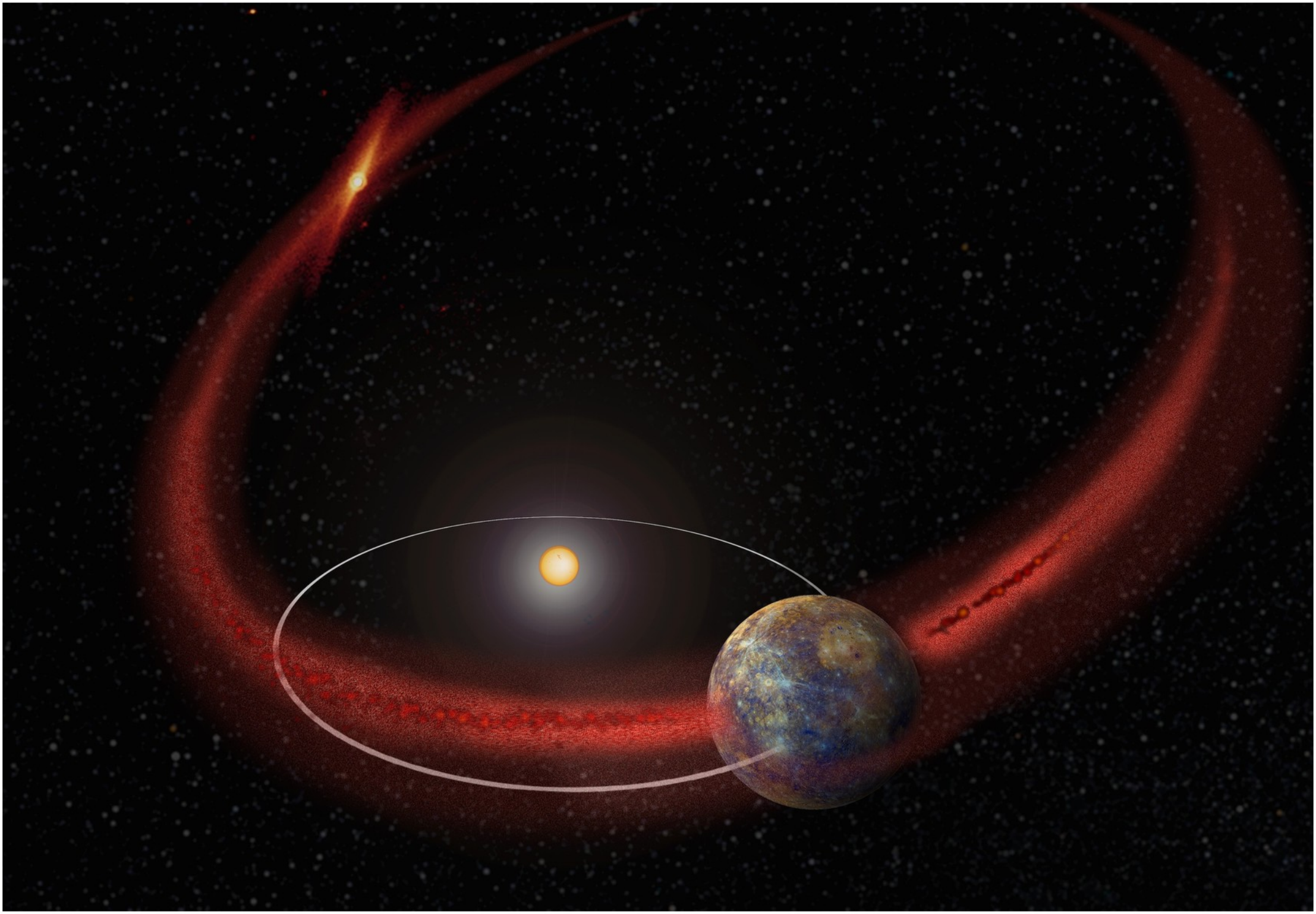
"An inspiring tale about the quest for discovery." —WALTER ISAACSON

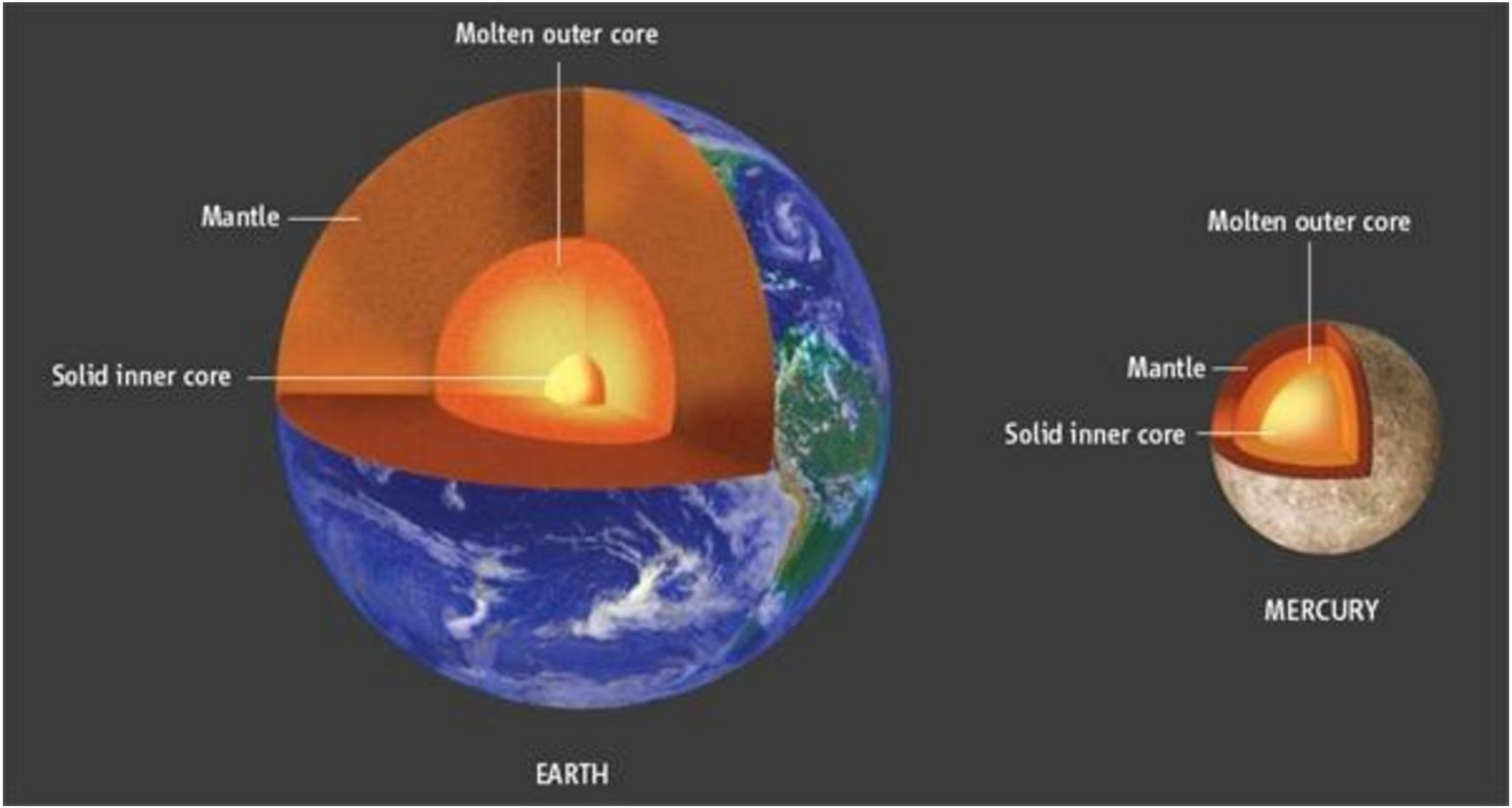
The Hunt for VULCAN

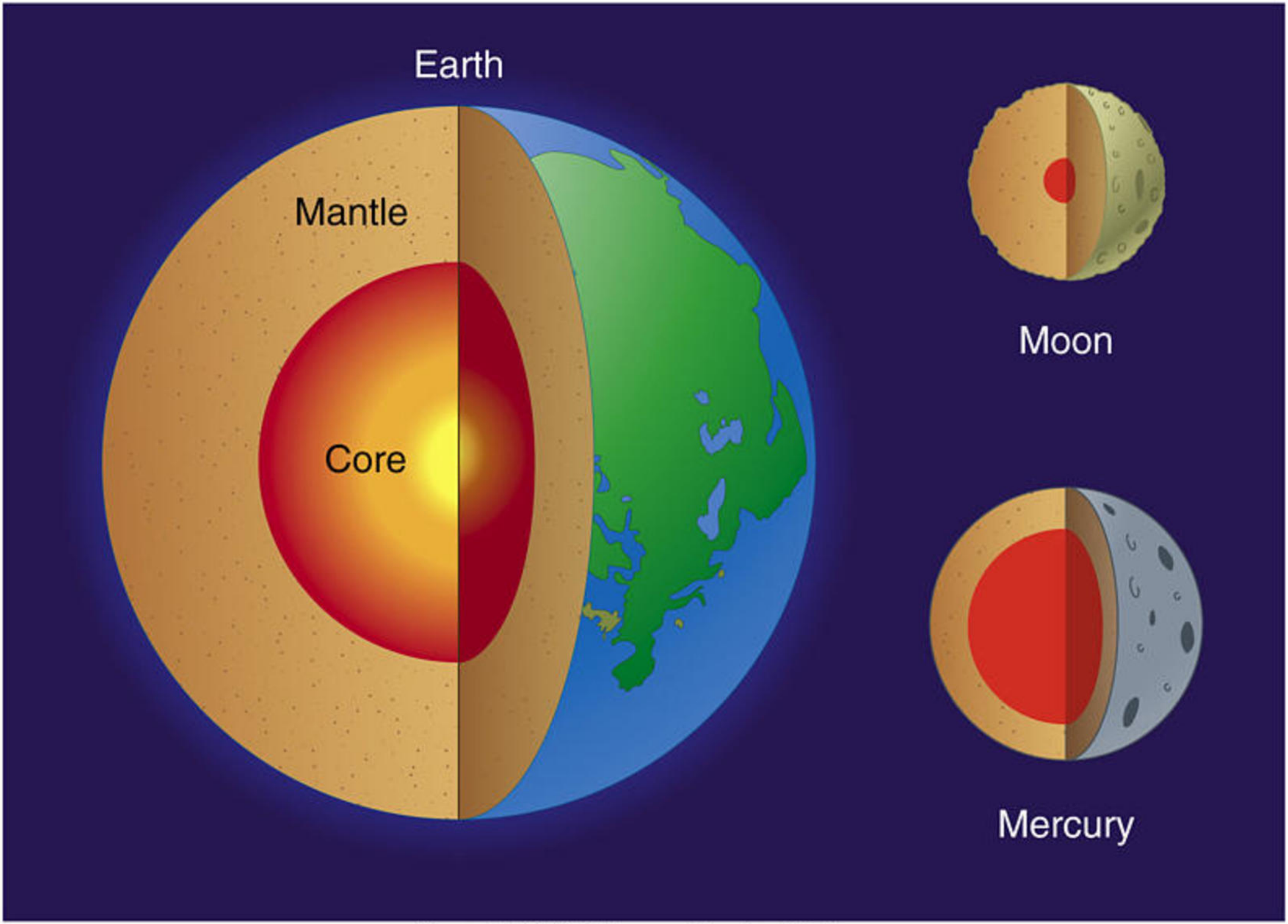
THOMAS LEVENSON

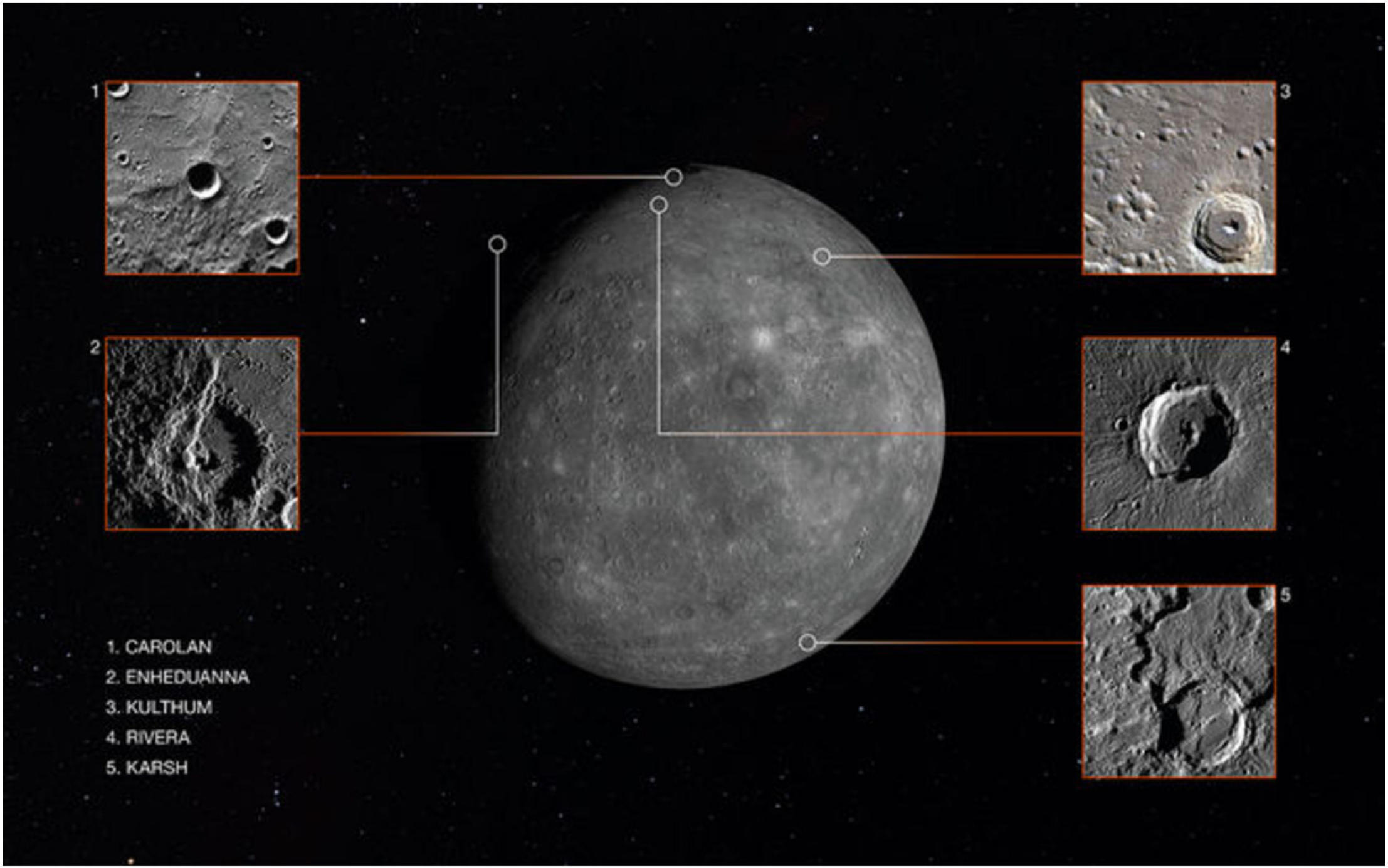


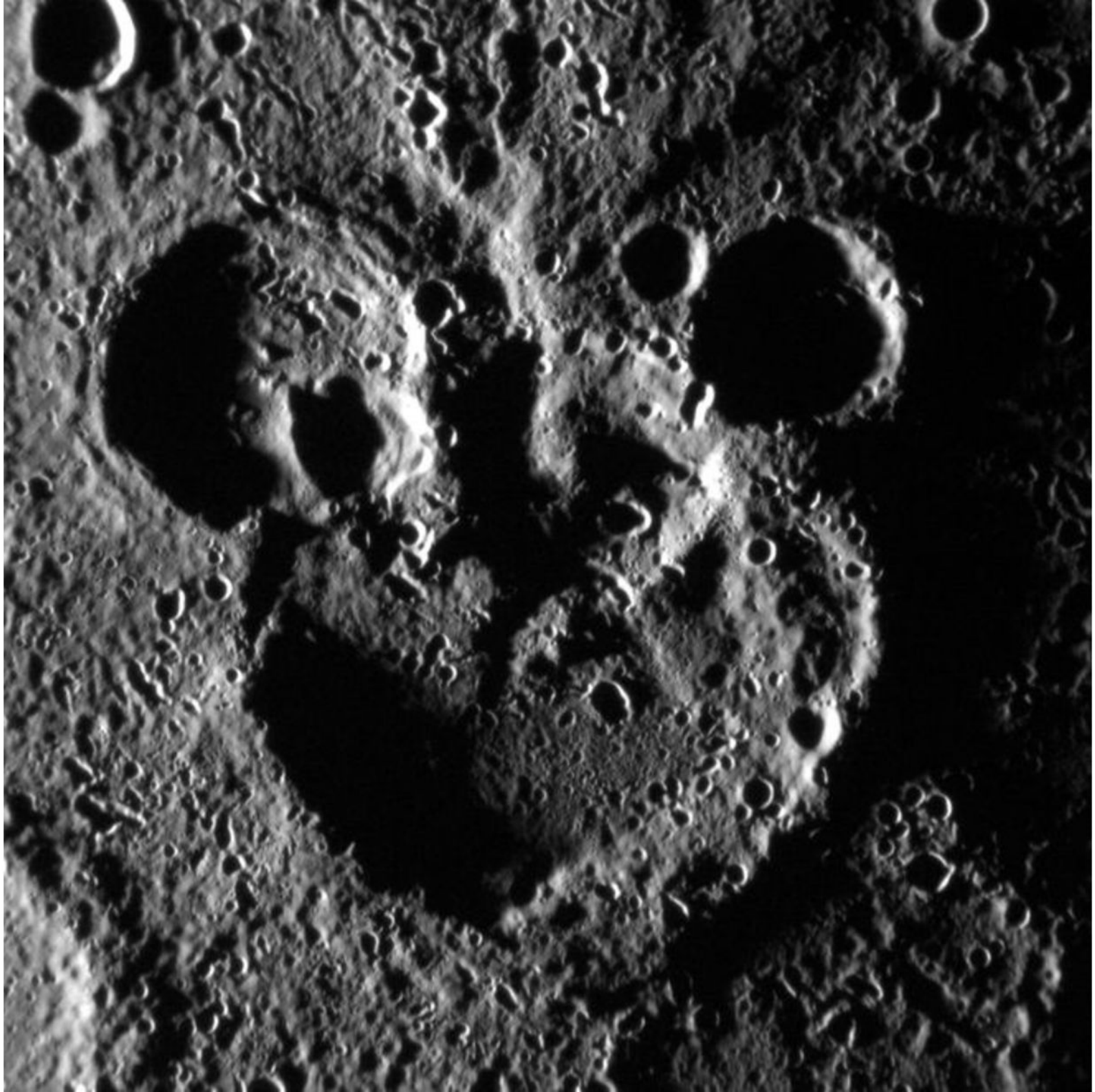
. . . And How Albert Einstein Destroyed a Planet, Discovered Relativity, and Deciphered the Universe

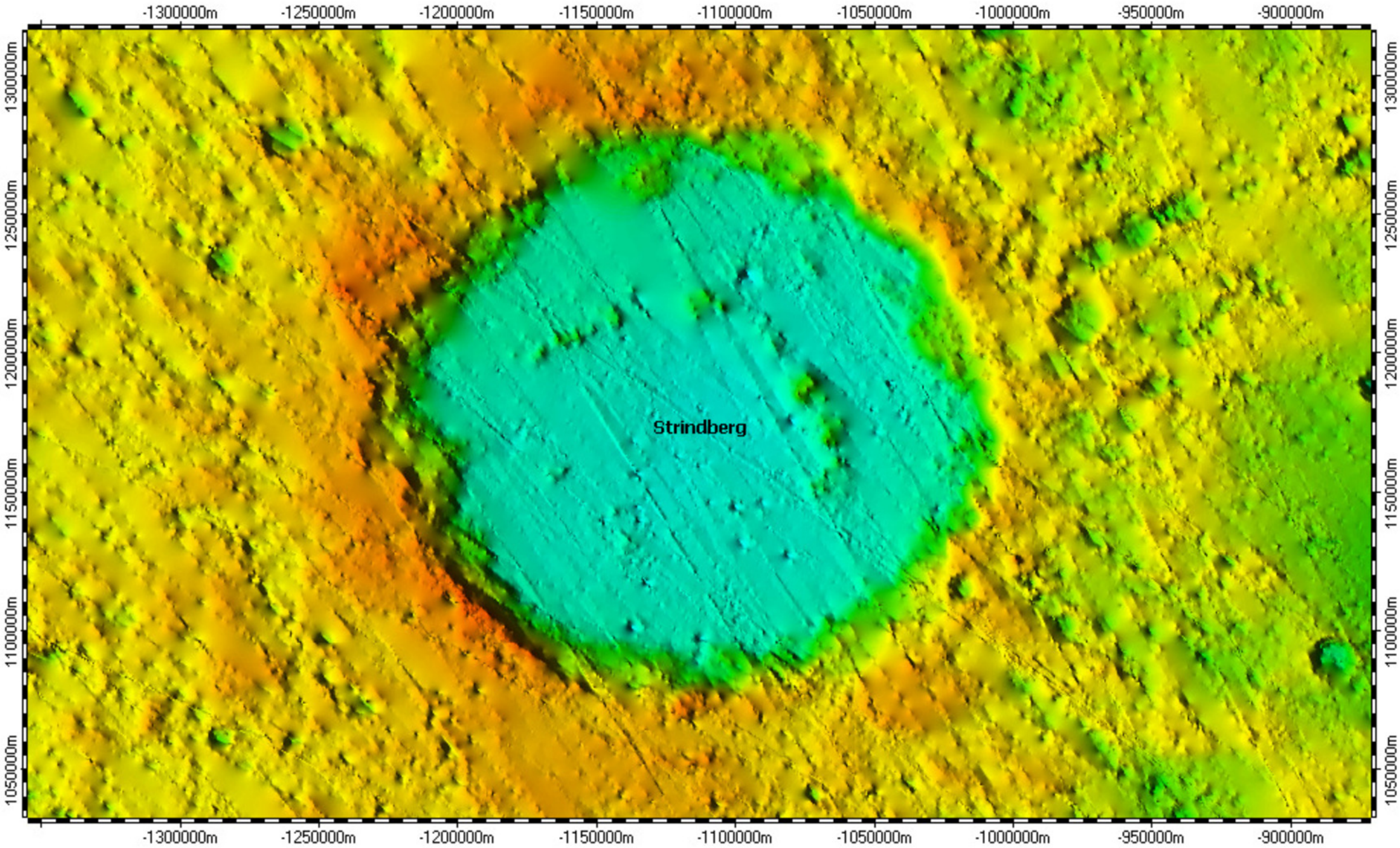


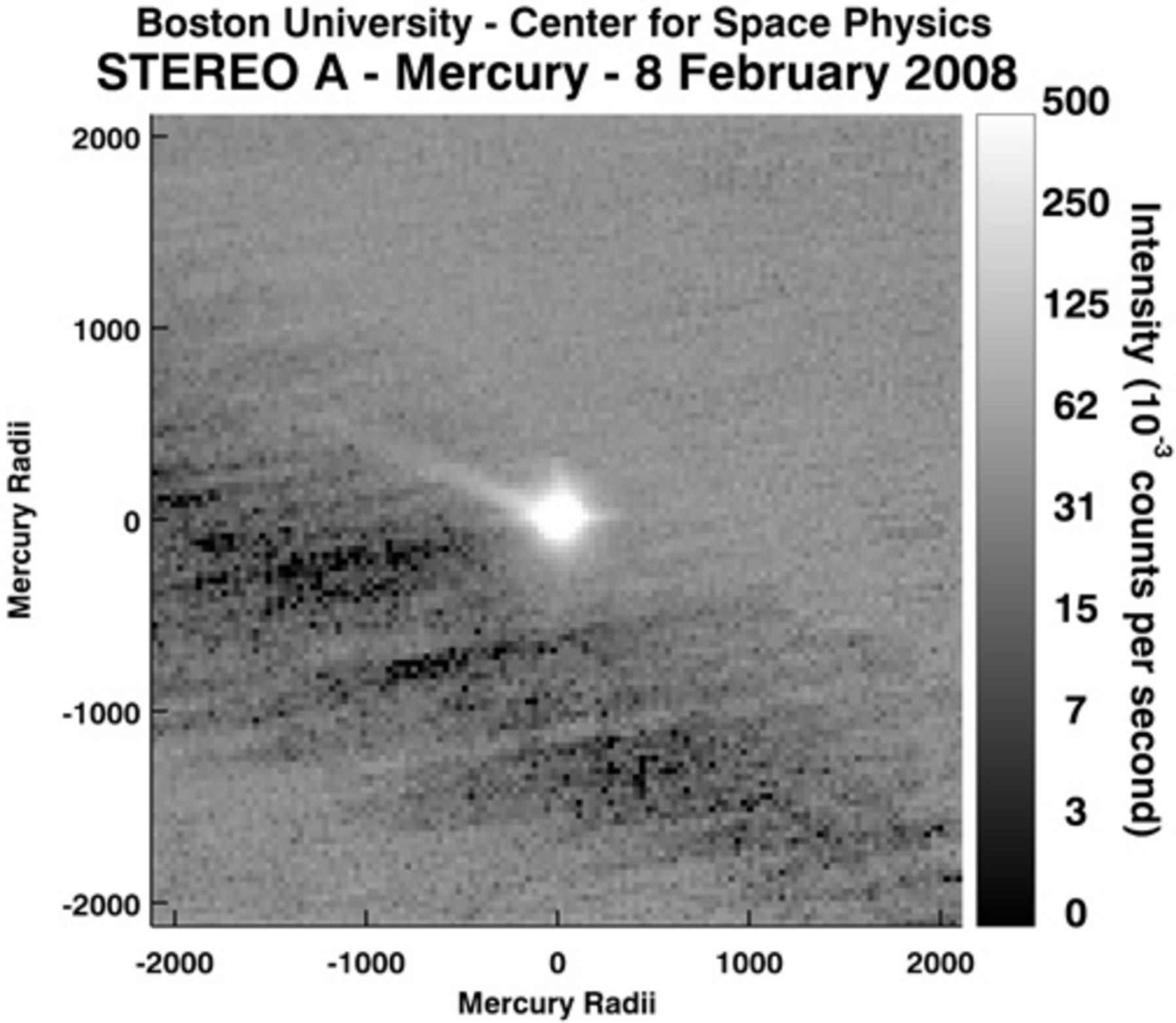

Molten outer core
Mantle
Solid inner core
EARTH
Molten outer core
Mantle
Solid inner core
MERCURY




1
2
3
4
5
1. CAROLAN
2. ENHEDUANNA
3. KULTHUM
4. RIVERA
5. KARSH

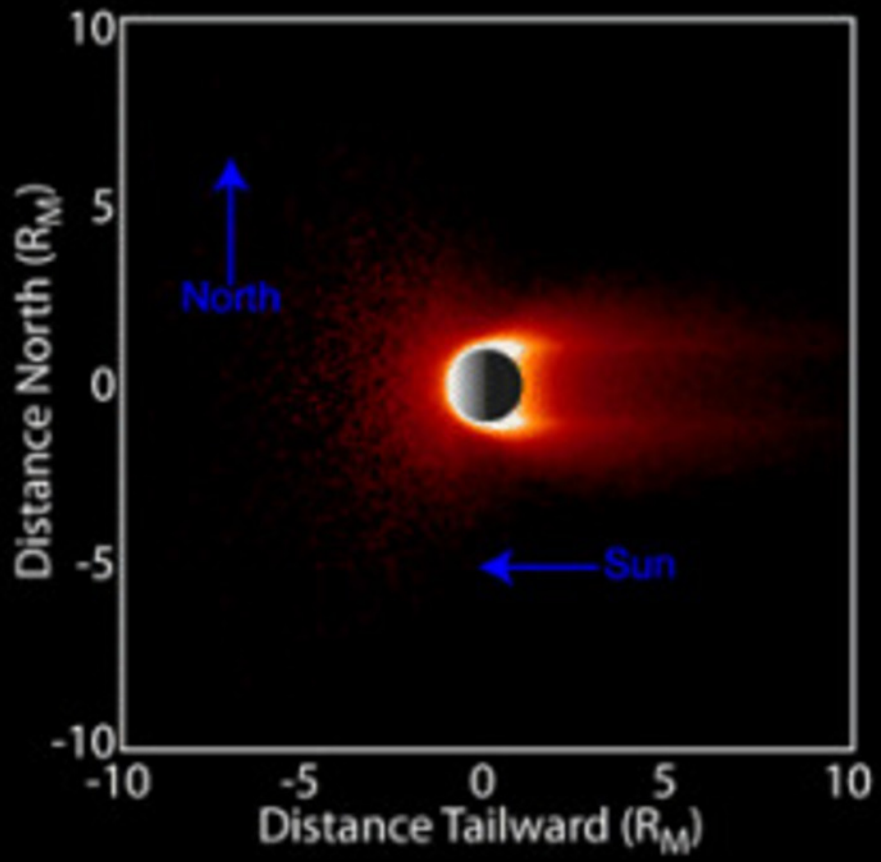



-1300000m
-1250000m
-1200000m
-1150000m
-1100000m
-1050000m
-1000000m
-950000m
-900000m
1300000m
1250000m
1200000m
1150000m
1100000m
1050000m
Strindberg

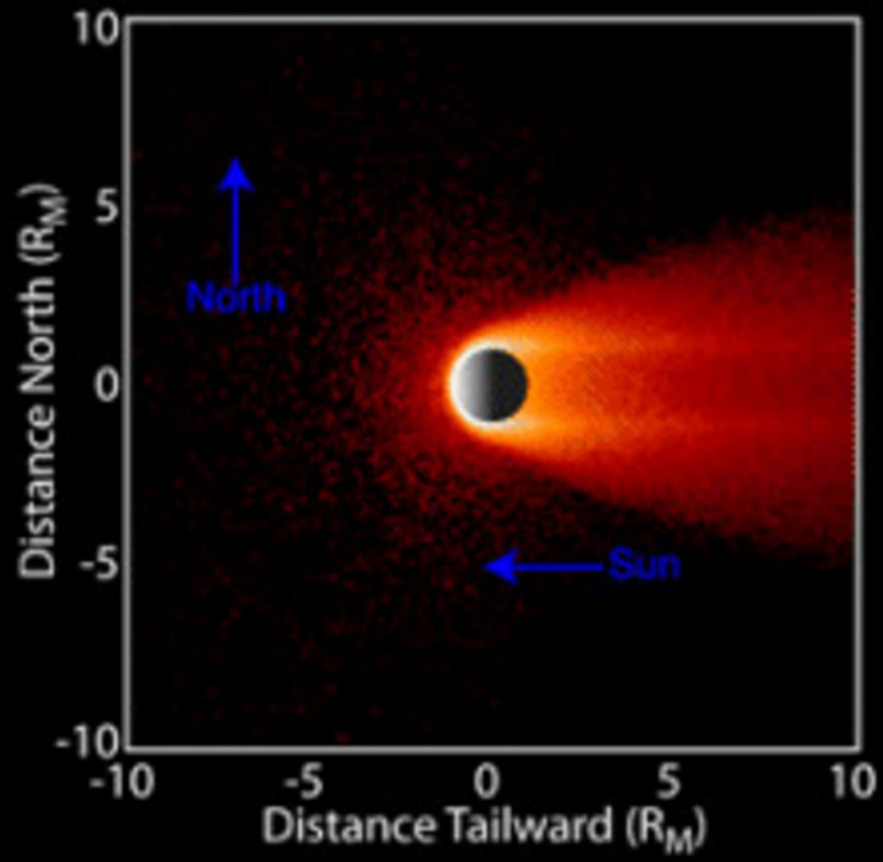

Boston University - Center for Space Physics
STEREO A - Mercury - 8 February 2008
Mercury Radii
2000
1000
0
-1000
-2000
-2000
-1000
0
1000
2000
Mercury Radii
500
250
125
62
31
15
7
3
0
Intensity (10^{-3} counts per second)

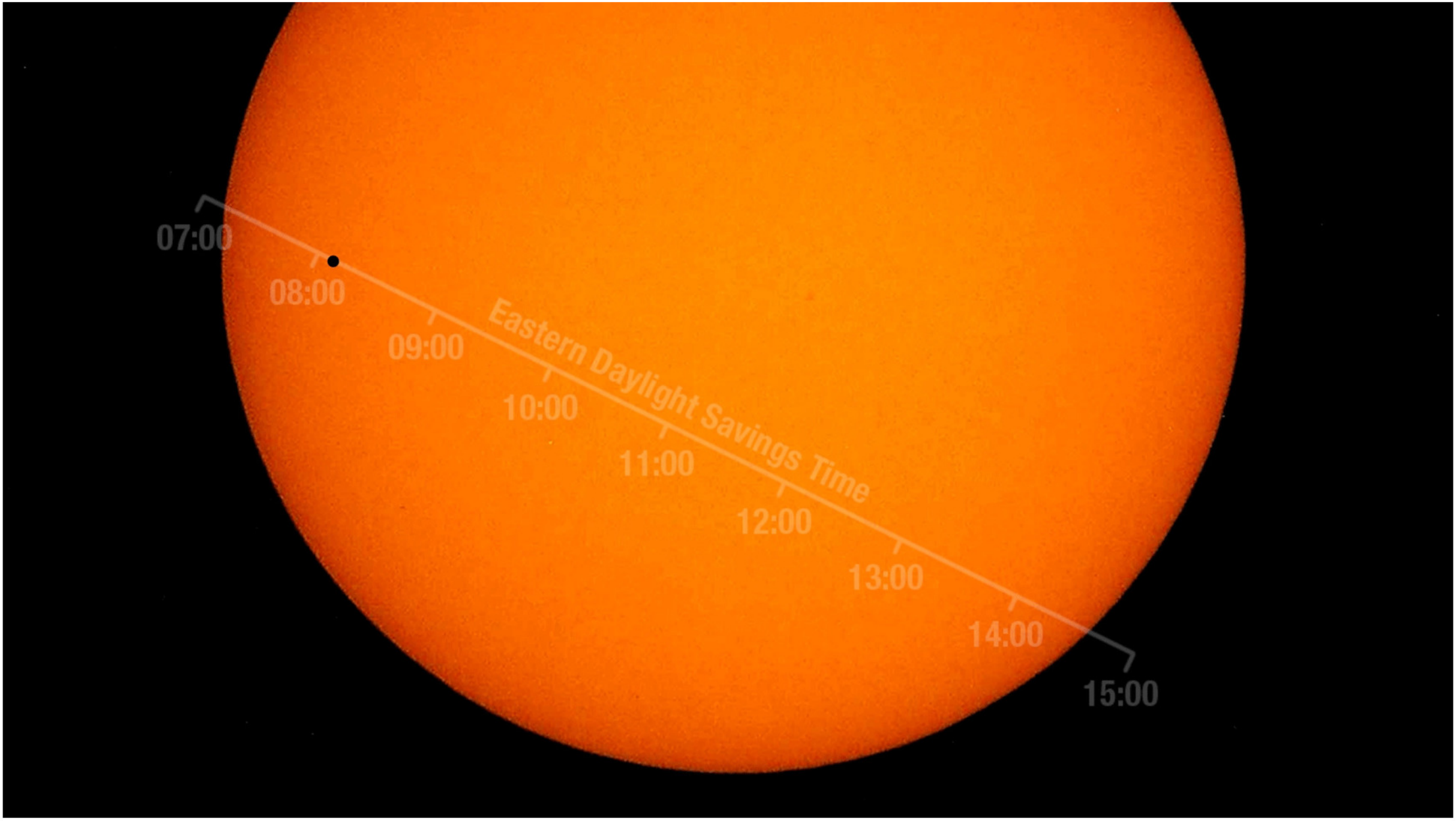
Mercury's Sodium Tail

Third Flyby



Second Flyby

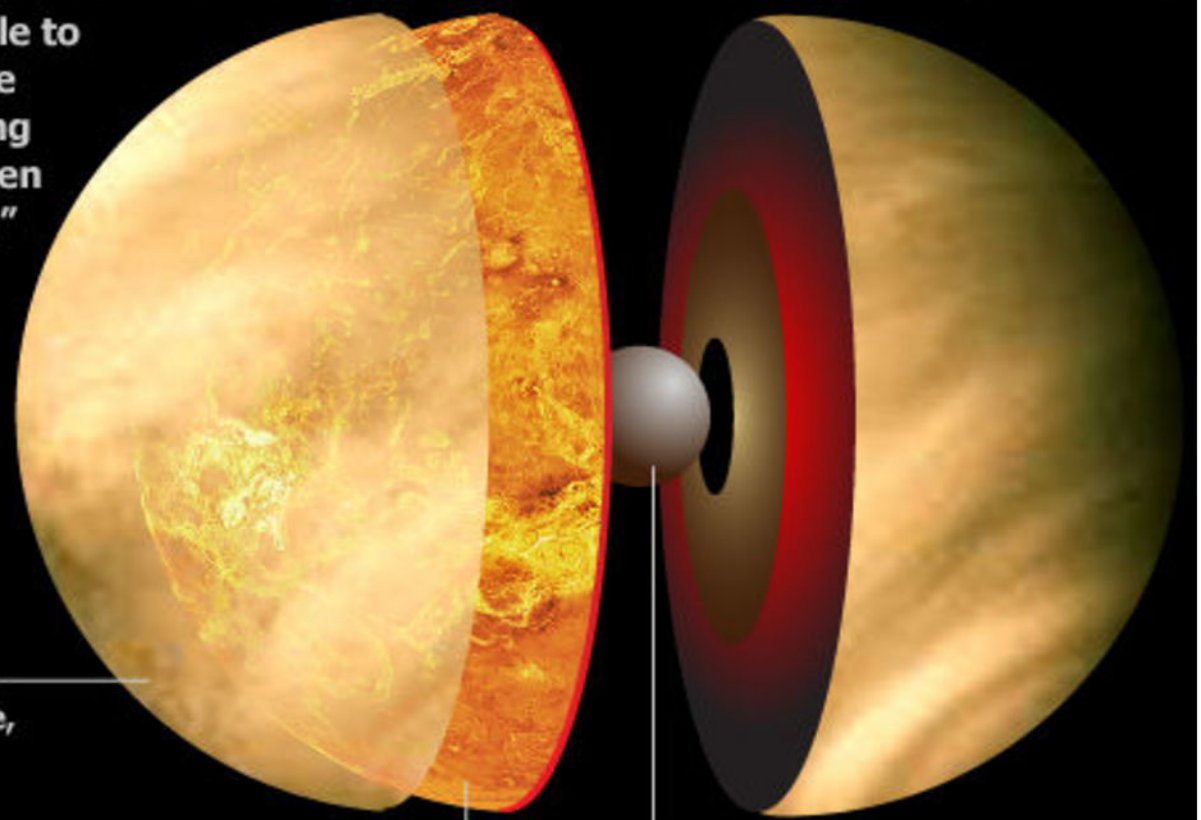



07:00
08:00
09:00
10:00
11:00
12:00
13:00
14:00
15:00
Eastern Daylight Savings Time

Inside Planet VENUS

SPACE.COM

Venus is often visible to the naked eye in the morning and evening sky. It has often been called Earth's "twin" because of its similar size, but space probes have discovered that the environment there is actually quite inhospitable.

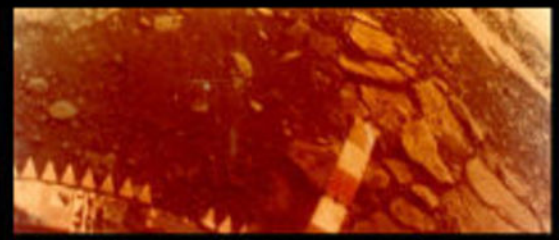


THICK ATMOSPHERE
96.5% carbon dioxide, 3.5% nitrogen plus trace gases

GRAVITY 0.9 OF EARTH

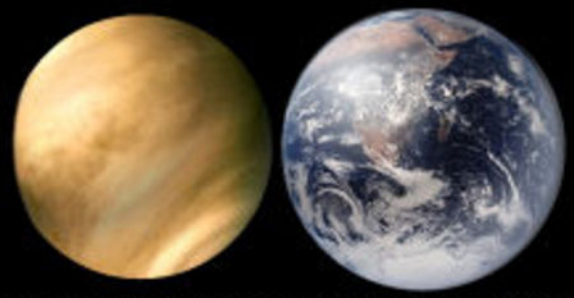
EARTH	VENUS
10ft dunk	**11ft dunk**

SURFACE CONDITIONS
AIR PRESSURE: 90x Earth
TEMPERATURE: 870°F (465°C)
WINDS: up to 220 mph (100 m/s)



The surface of Venus photographed by a Russian probe in 1982

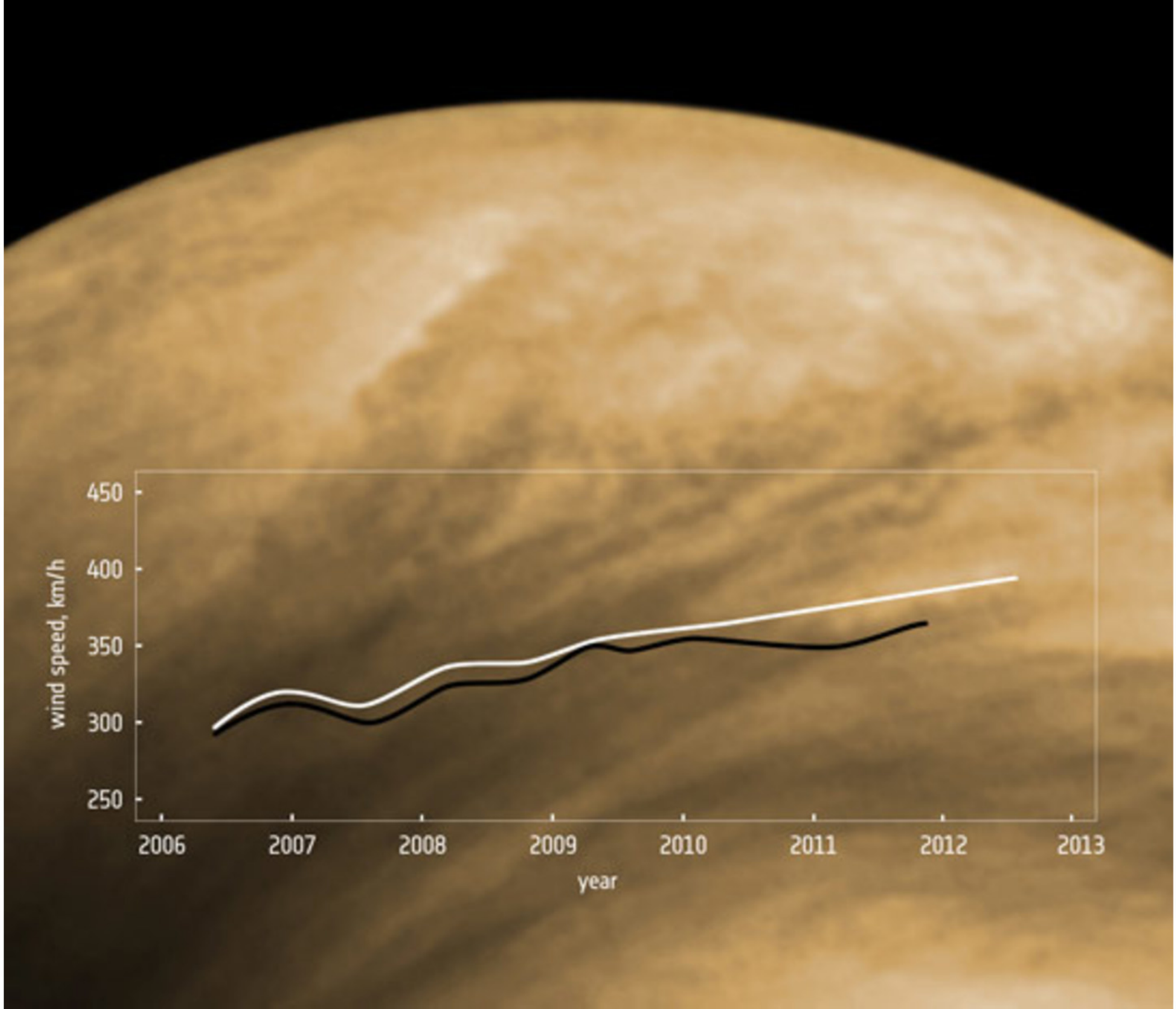
METAL CORE It is not known if Venus' core is solid. Unlike Earth, Venus' weak magnetic field is not produced by a dynamo in the core.

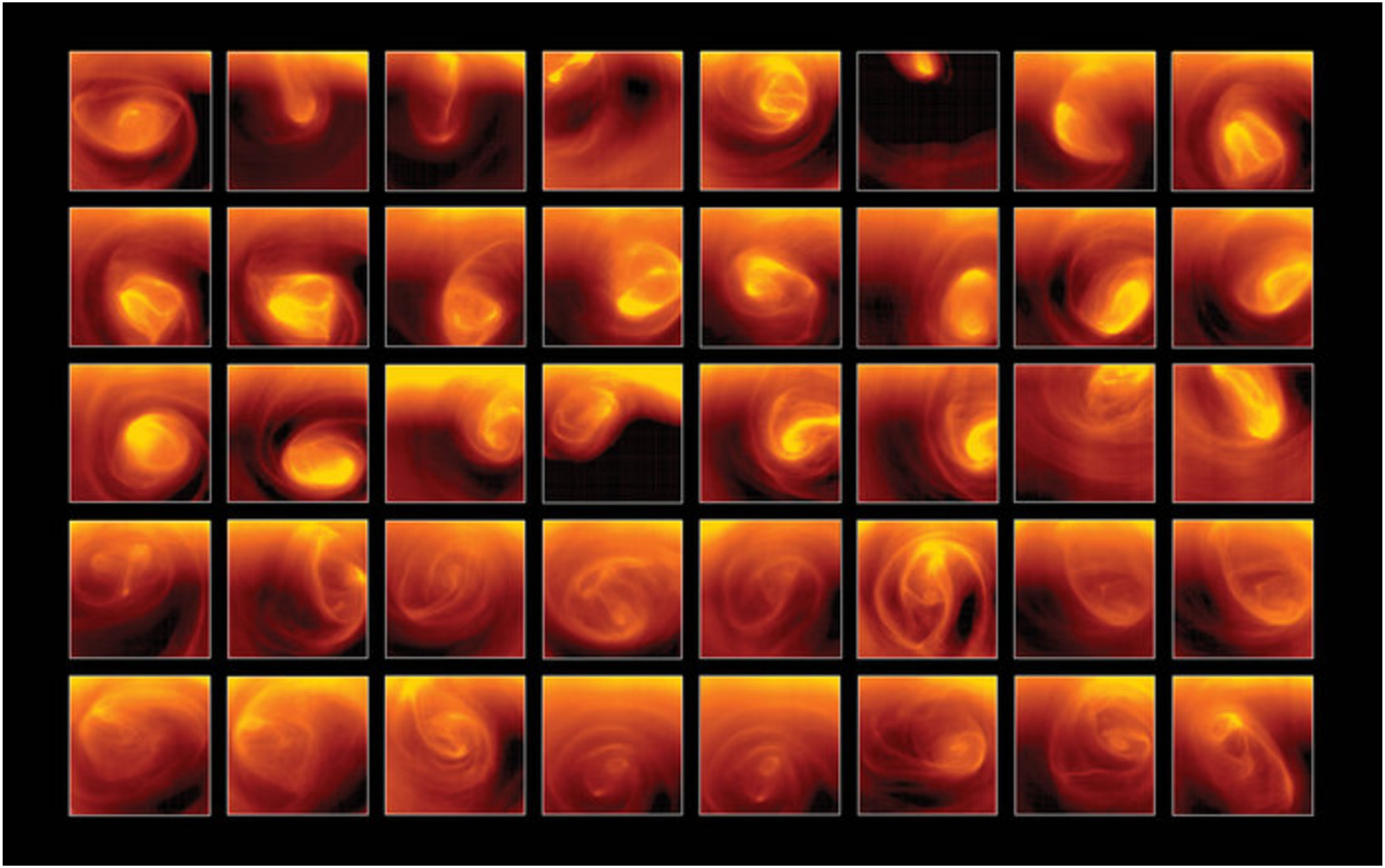


Venus, 7,520 mi (12,100 km) in diameter, is slightly smaller than Earth

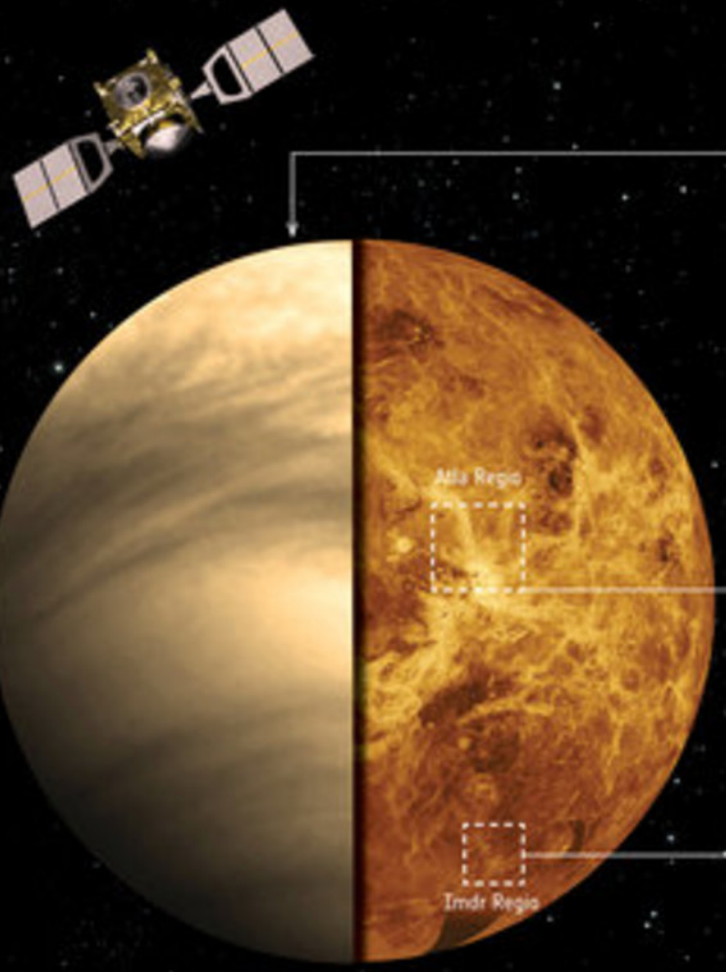
SOURCE: NASA

KARL TATE, SPACE.com


450
400
350
300
250
wind speed, km/h
2006
2007
2008
2009
2010
2011
2012
2013
year

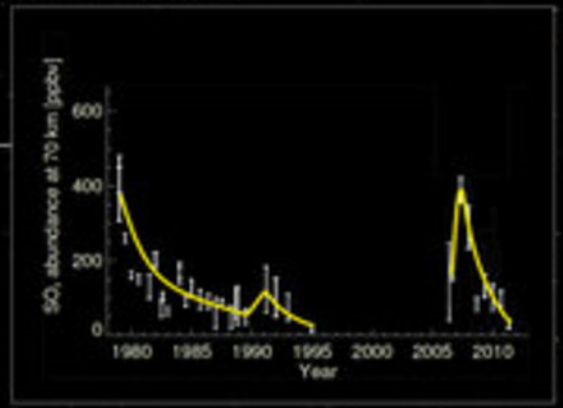


→ EVIDENCE FOR ACTIVE VOLCANOES ON VENUS



Left: False-colour image of Venus cloud tops (credits: ESA/MPS/DLR/IDA); right: Magellan radar map of Venus (credits: NASA/JPL). The cloud tops image is a local view over high southern latitudes whereas the radar image is a global view centred on the equator.

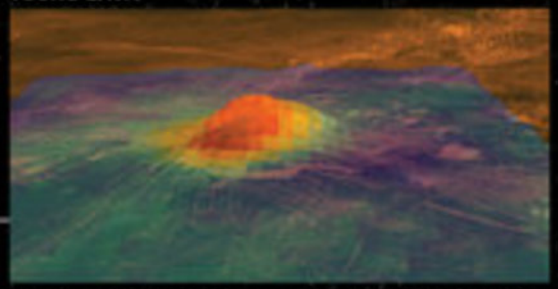
ATMOSPHERIC CHANGES



The rise and fall of sulphur dioxide (SO_2) in the upper atmosphere of Venus over the last 40 years, seen by NASA's Pioneer Venus and other spacecraft between 1978 and 1985, and ESA's Venus Express between 2006 and 2012. A possible explanation is the injection of SO_2 into the atmosphere by volcanic eruptions.

Credits: E. Marcq et al (2012)

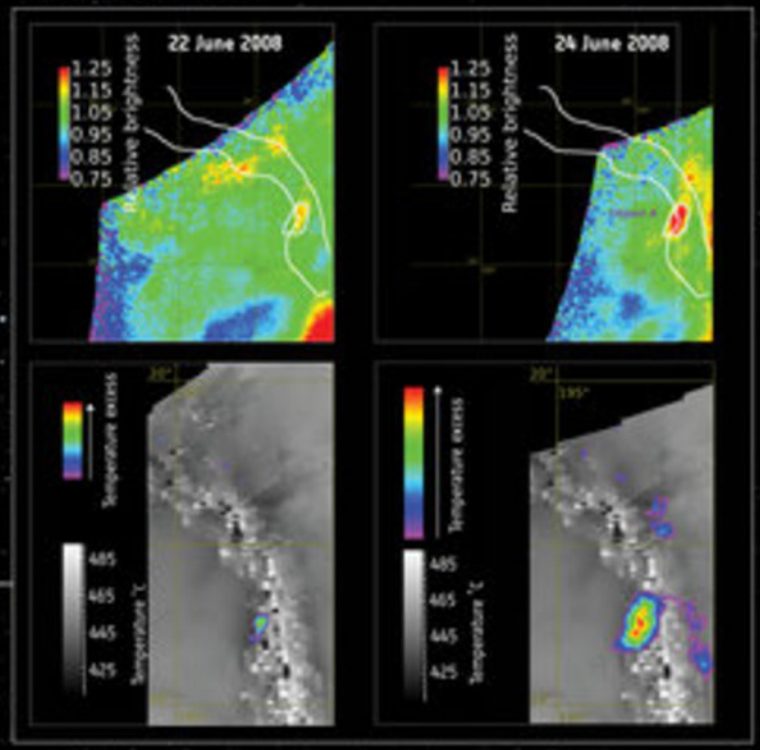
YOUNG LAVA



Venus Express found that the area around Idunn Mons in Imdr Regio was unusually dark compared with its surrounds, suggesting a different, younger, composition, pointing to lava flows within the last 2.5 million years. The map shows near-infrared emissivity; red–orange is high emissivity (darkest), purple is the lowest emissivity.

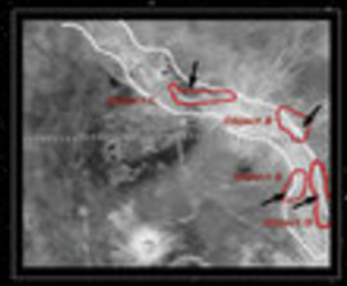
Credits: ESA/NASA/JPL/S. Smrekar et al (2010)

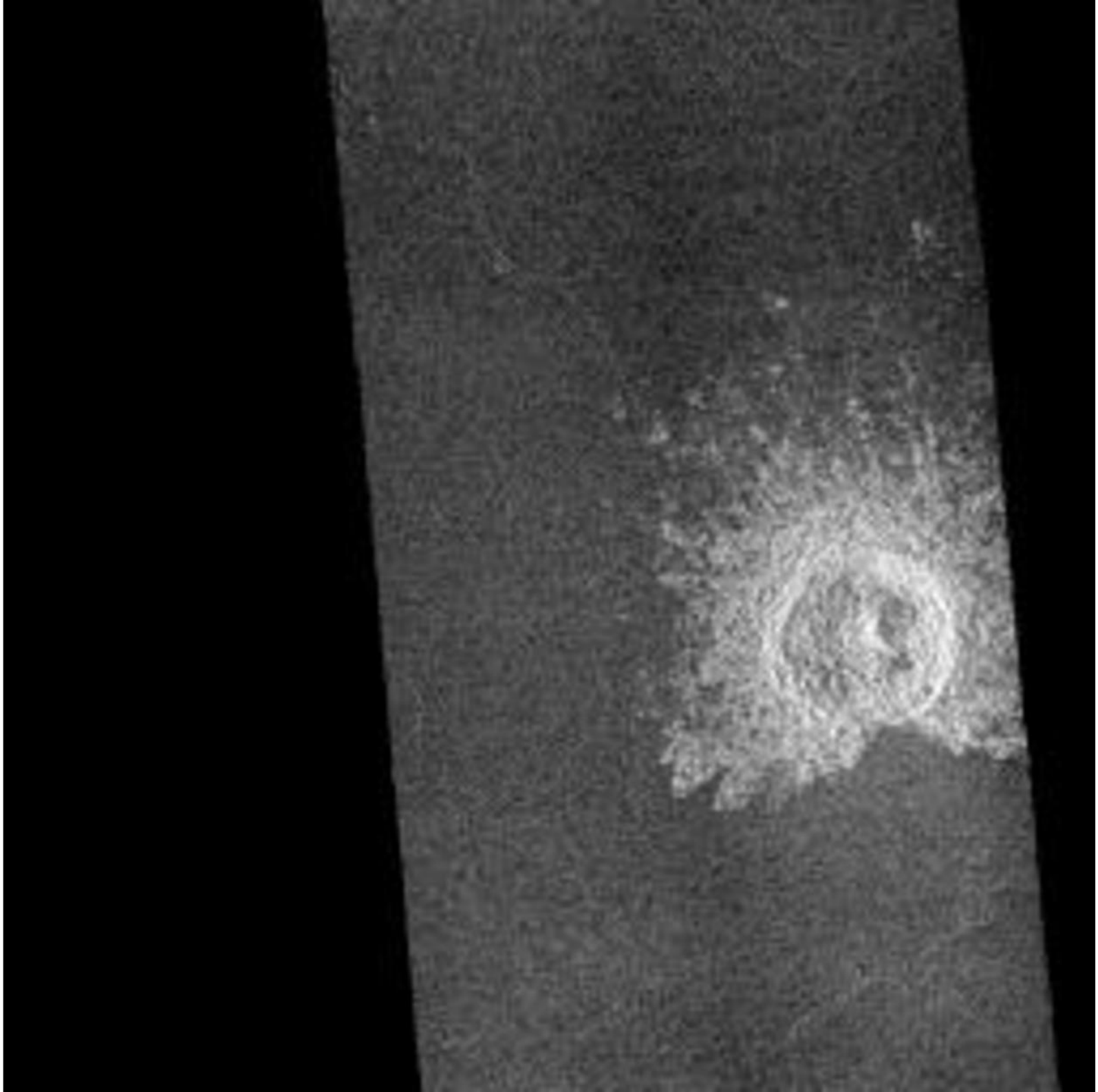
TRANSIENT HOT SPOTS

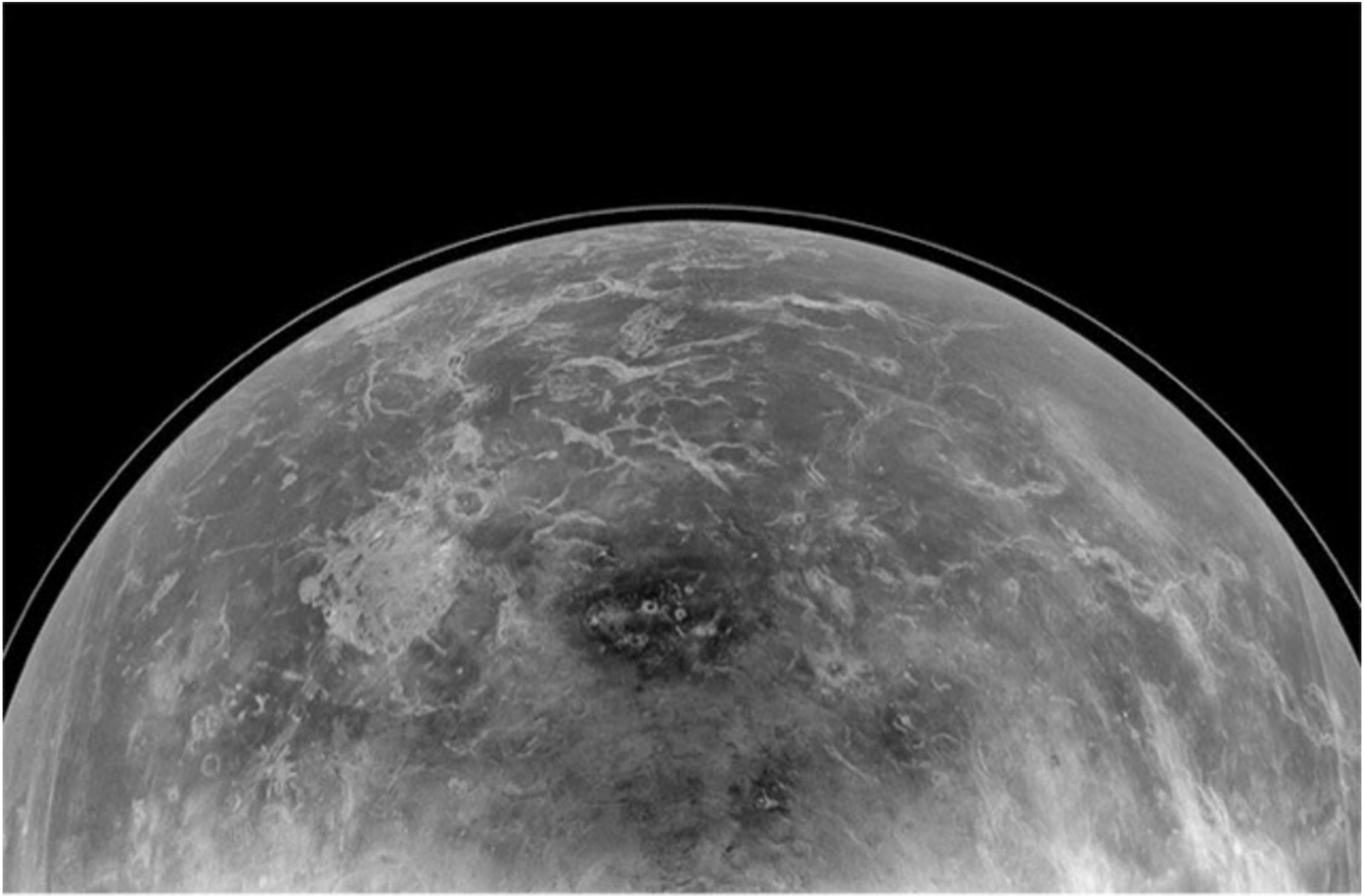


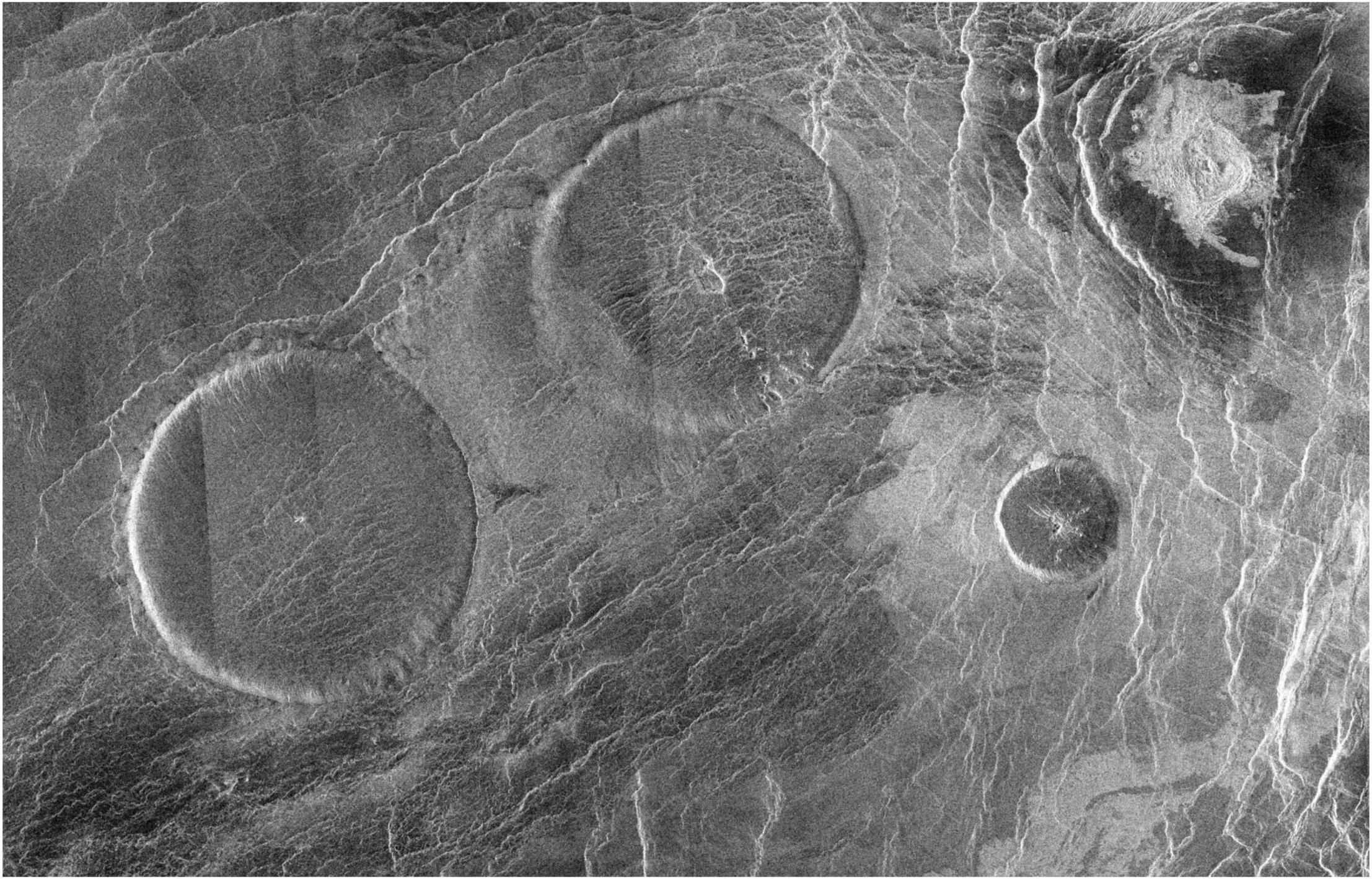
Four transient hotspots were detected by Venus Express in the Ganiki Chasma rift zone in Atla Regio (labelled Objects A–D in the radar map, right). Changes in relative brightness (top row) and temperature (bottom row) are shown for Object A. Some changes due to clouds are also visible in the top row. The bottom row shows the temperature excess compared with the average surface background temperature. Taking into account atmospheric effects, hotspot A is likely only 1 square km with a temperature of 830°C.

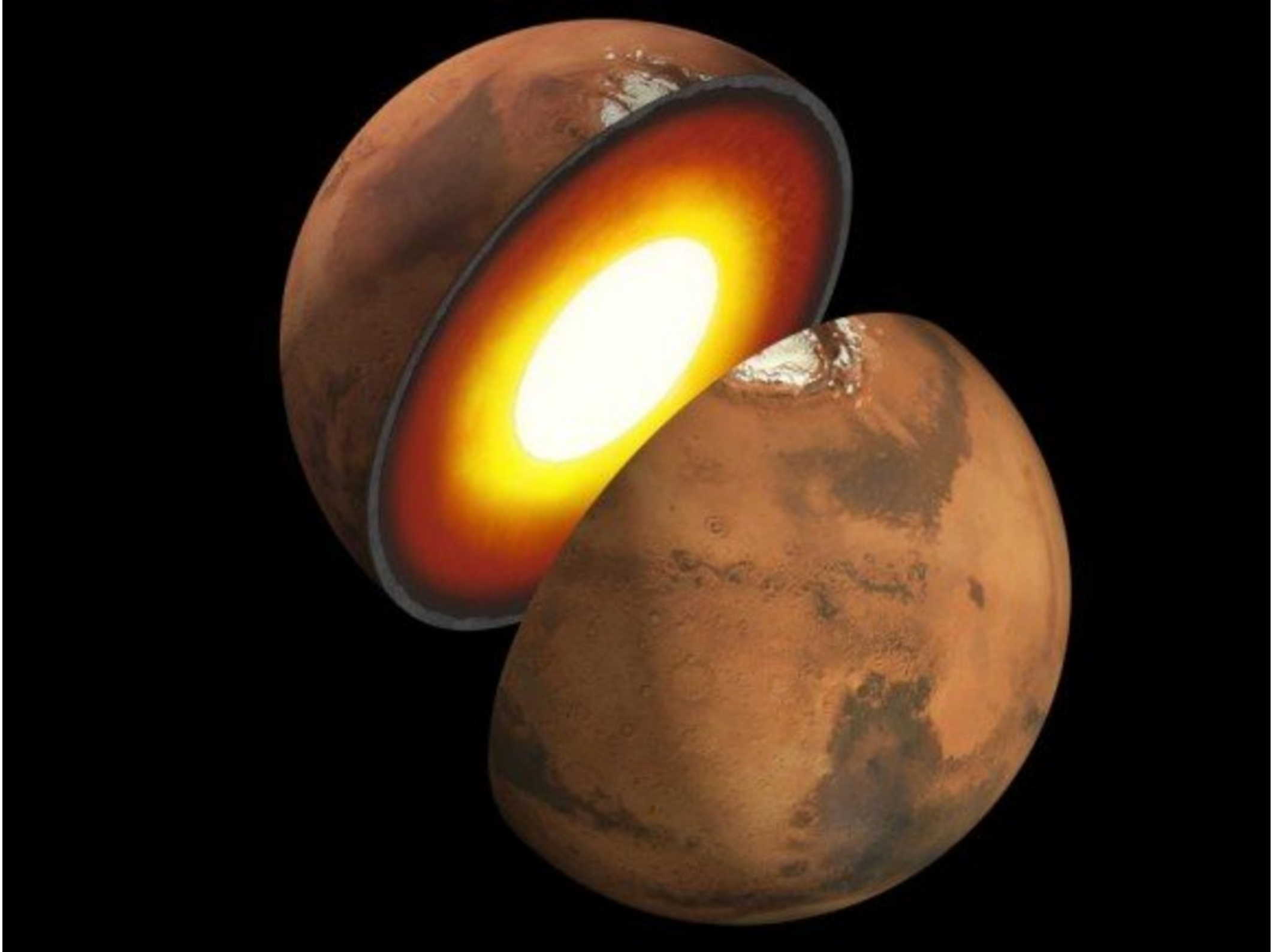
Credits: E. Shalygin et al (2015)



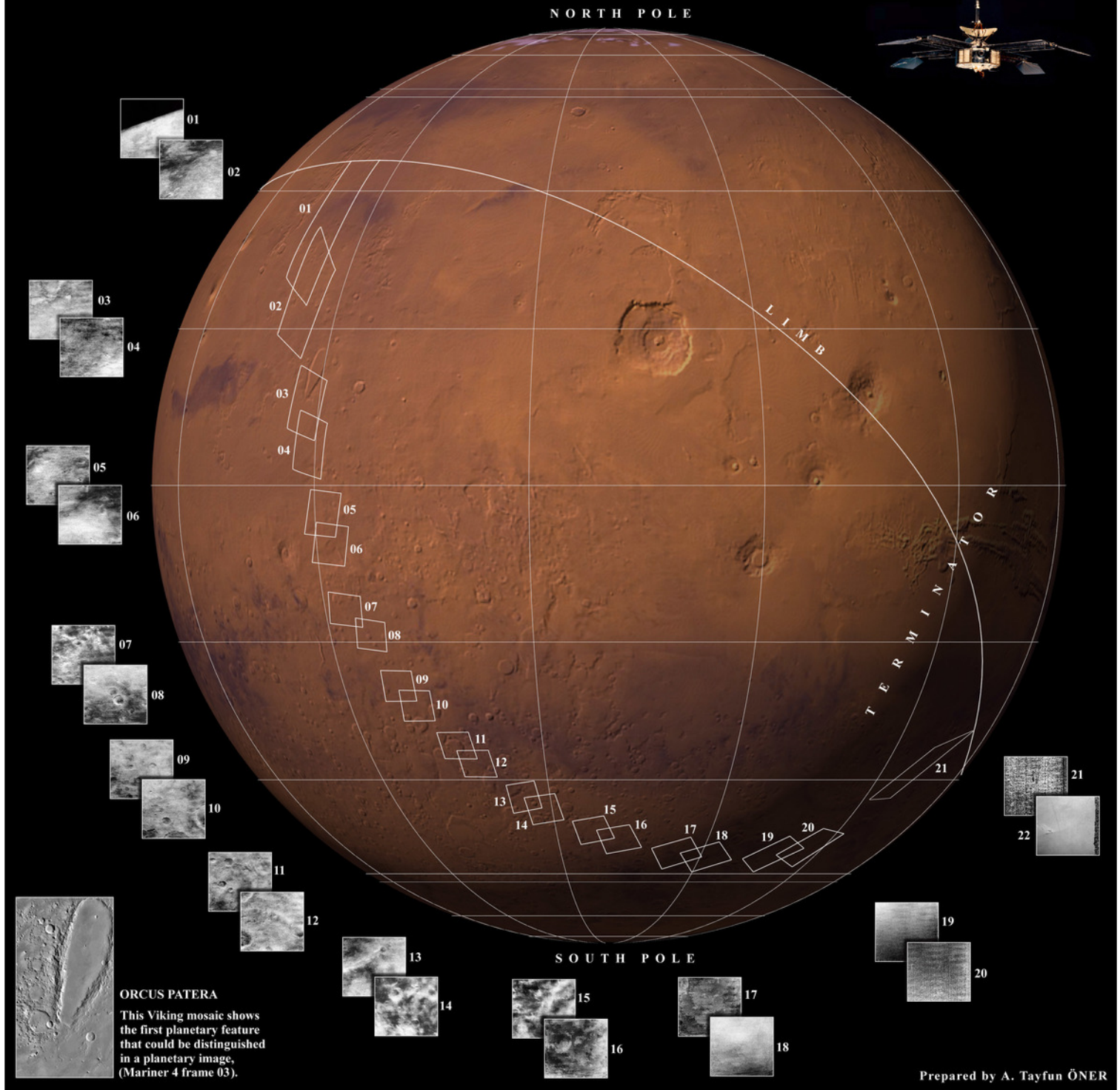








Mariner IV Mars Encounter Imaging Geometry
July 15, 1965



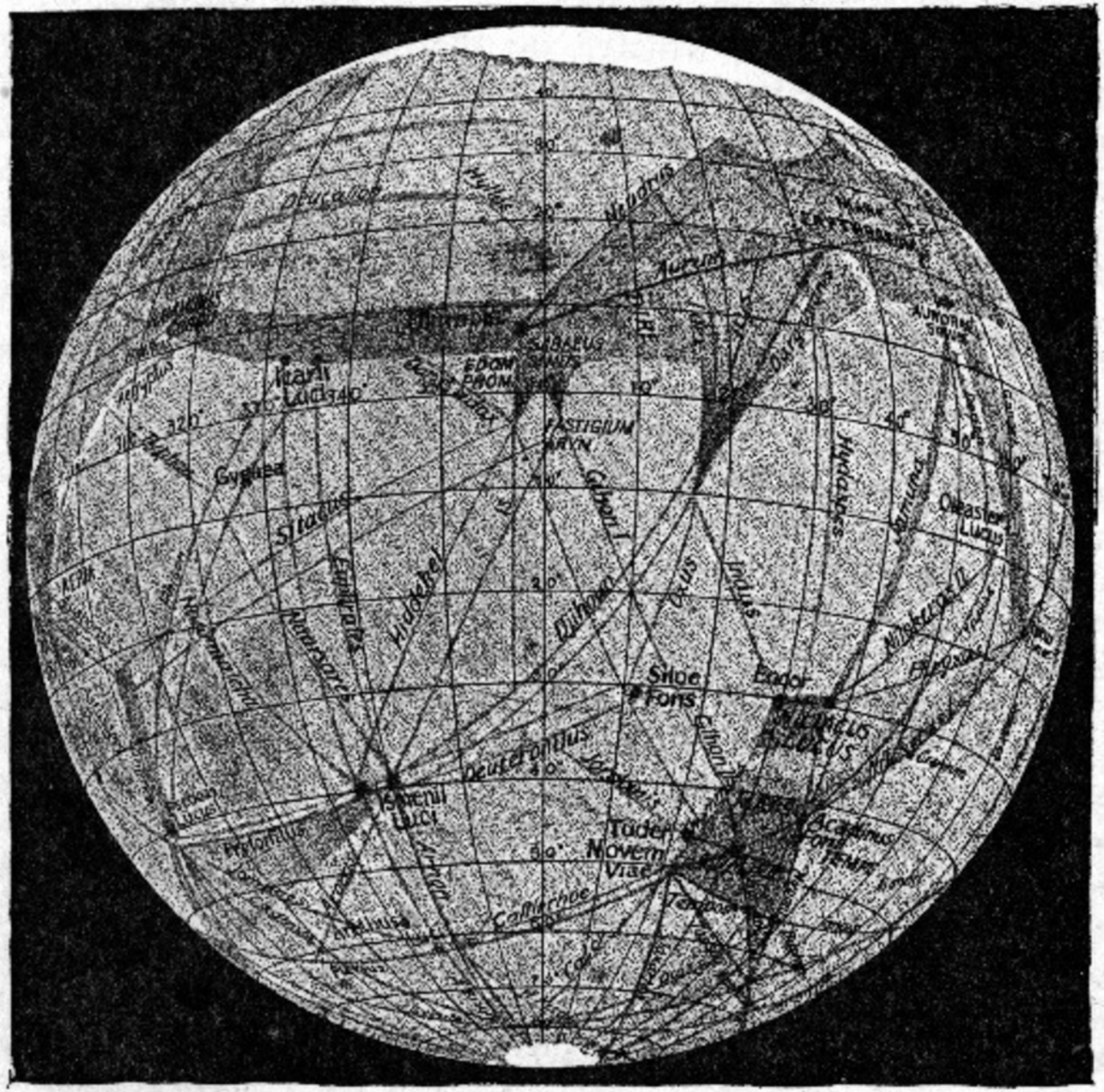
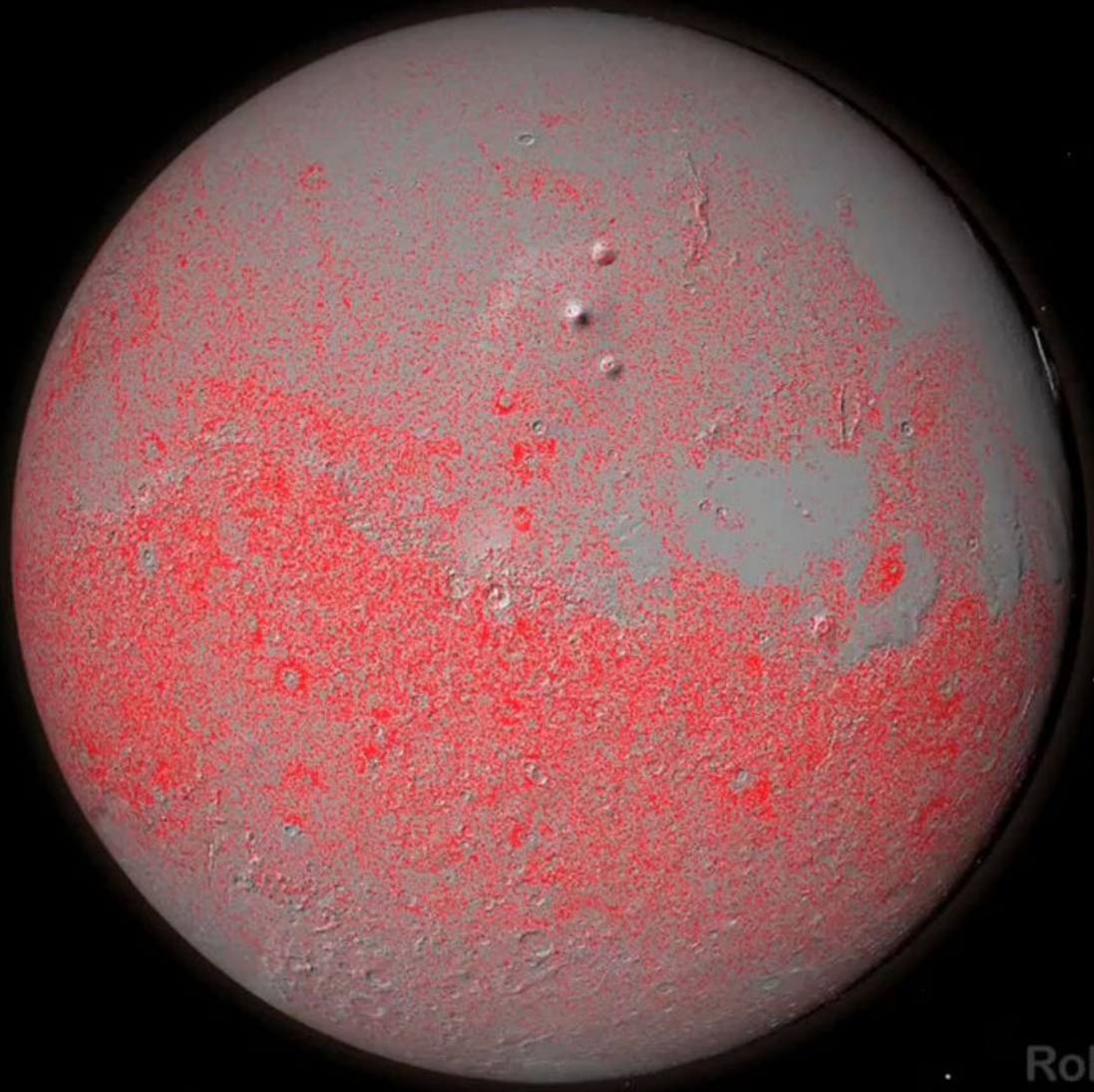
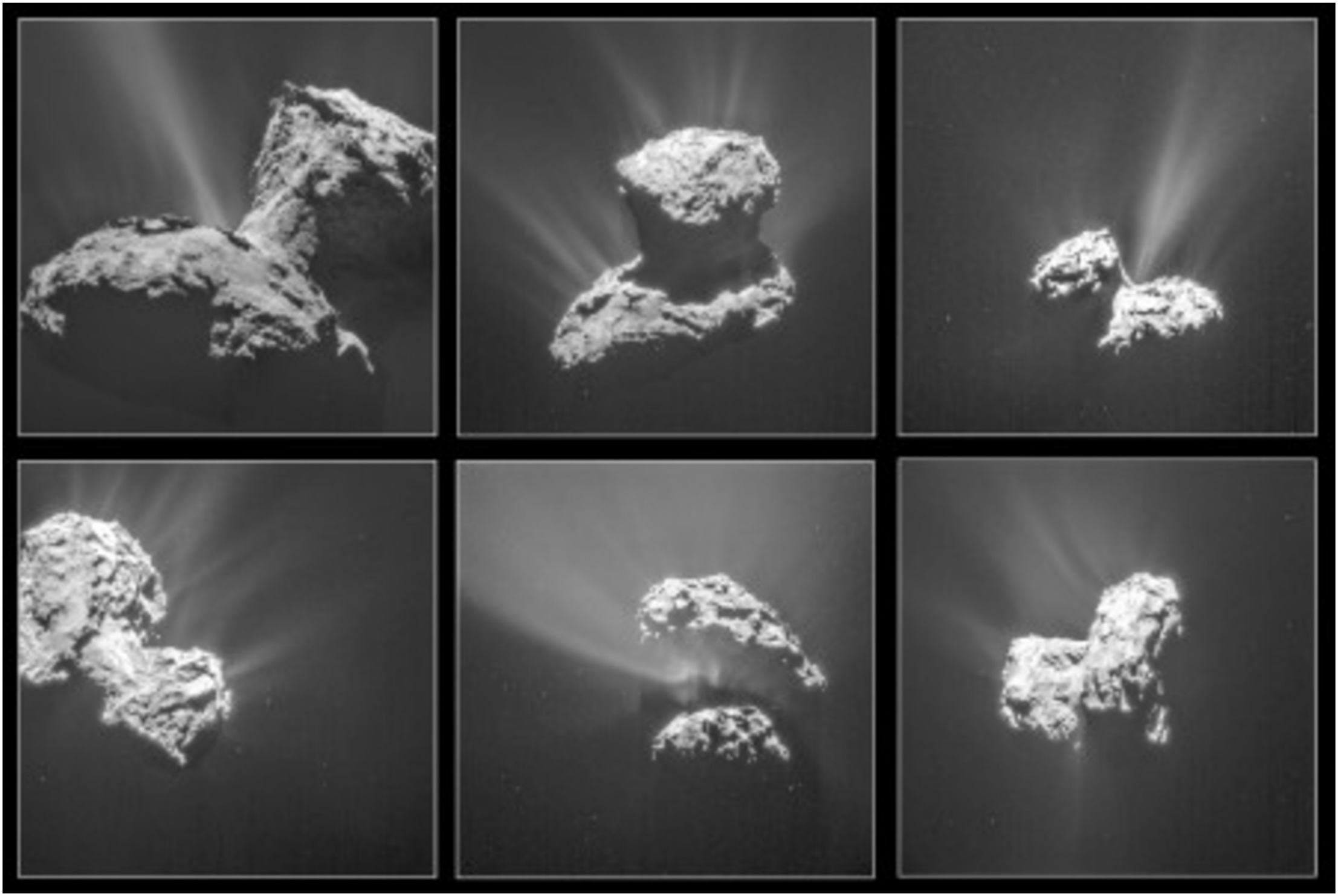
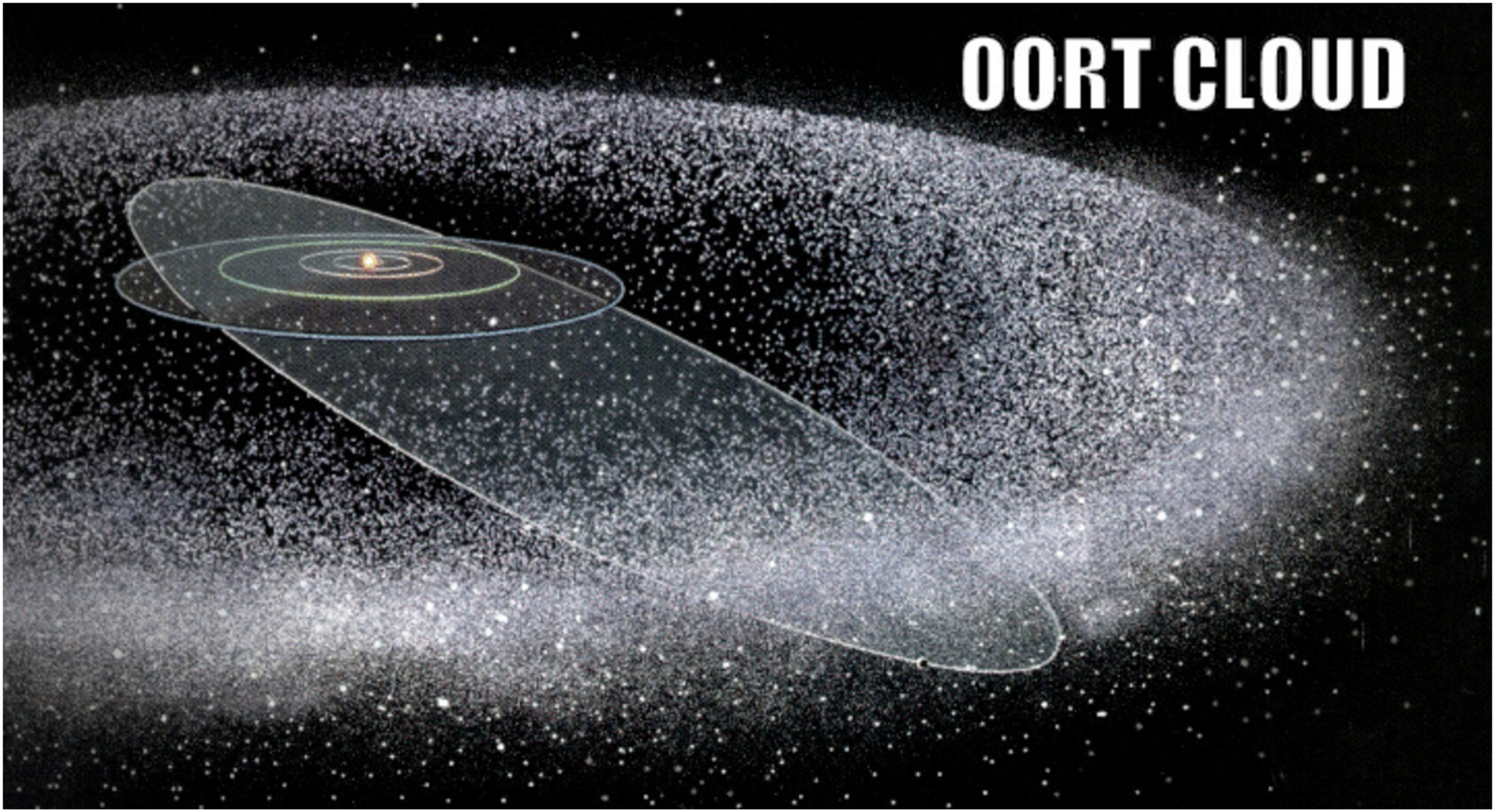

Aurora
Gyges
Stagnum
Eridanus
Hydrobel
Quirinus
Indus
Siloe Fons
Eridanus
Deuteronilus
Tadeh Movem Viae
Camarchoe
Oceanus Lucus
Nilokeras II
Aurora Sinus

FIG. 2.



Robbins & Hynek (2012)
http://dx.doi.org/10.1029/2011JE003966




OORT CLOUD