

# THE NOISE-FREE FAR SIDE OF THE MOON AND THE FUTURE OF RADIOASTRONOMY

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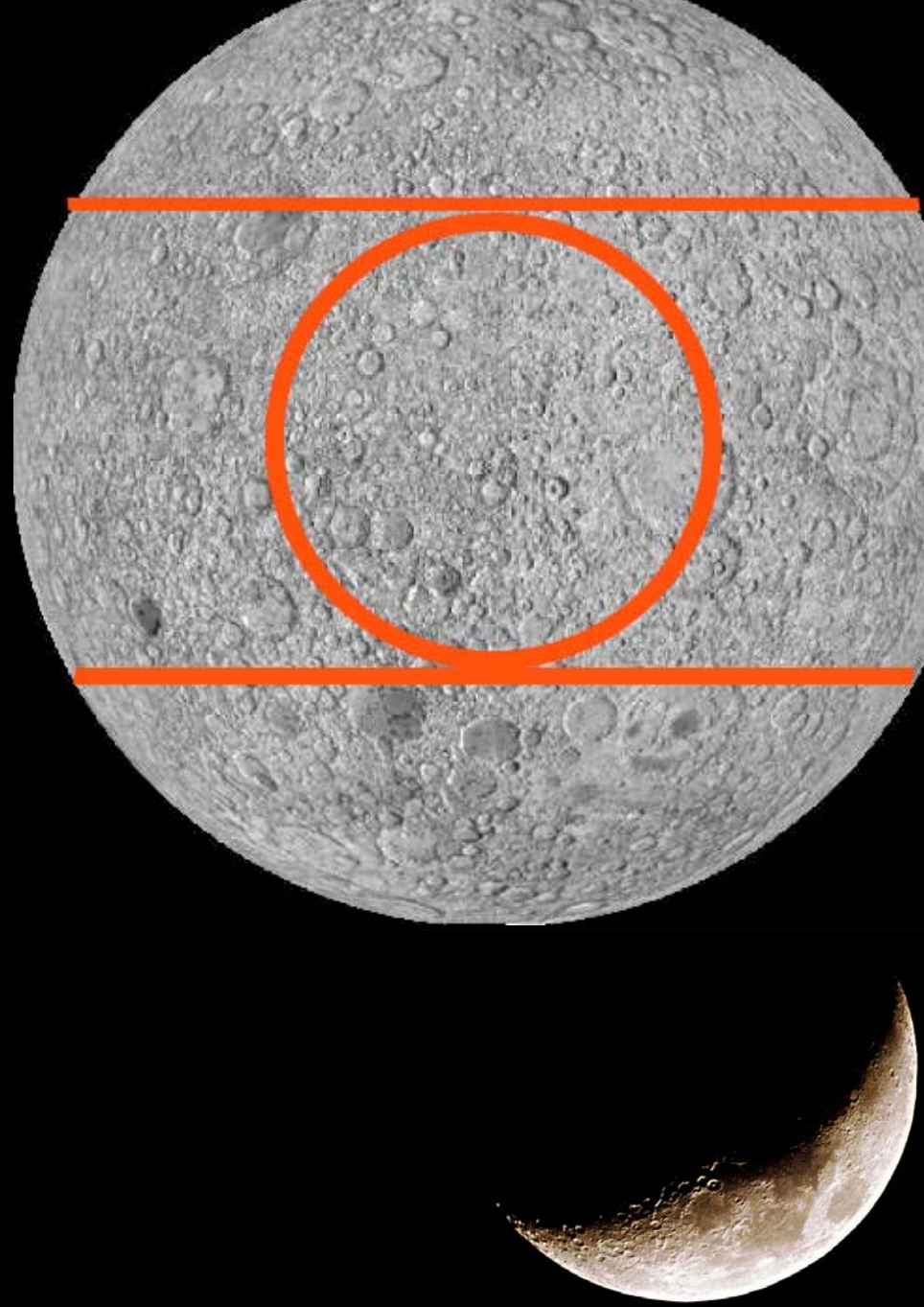
## PAC: Protected Antipode Circle.

is a circular piece of land, 1820 km = 1131 miles across in diameter along the Moon surface on the Farside of the Moon. We propose it to be reserved for scientific purposes only.

PAC is tangent to two Parallels:  $\pm 30^\circ$  latitude, North and South.

At the center of PAC is the Antipode of the Earth (on the equator and at 180 degrees longitude). Near to the Antipode is crater Daedalus, an 80 km crater proposed by the author in 2005 as the best location for the future Lunar Farside Radio Lab.

Inside Daedalus, the expected attenuation of the man-made RFI (Radio Frequency Interference) coming from the Earth is of the order of 100 dB



PAC is a consequence of the  
Lunar Farside Radio Lab

“Cosmic Study” of the  
International Academy of  
Astronautics (IAA)



# Timeline For That “Cosmic Study”

- 1994 – Jean Heidmann proposes SETI observatory in Farside Saha Crater with link to nearside Mare Smythii plain and then to Earth
- 1994 Lunar Farside Study Sub-committee established within IAA SETI Committee
- 1996 – IAA approves Cosmic Study concept
- 1998 – COSPAR meeting to solicit ideas
- 2000 – Heidmann dies, Maccone takes over
- 2001 – Meeting at JPL
- 2003 – Cosmic Study presented to IAA
- **2005 – Publication of the Cosmic Study in:**  
*Acta Astronautica, Vol. 56, pp. 629-639.*



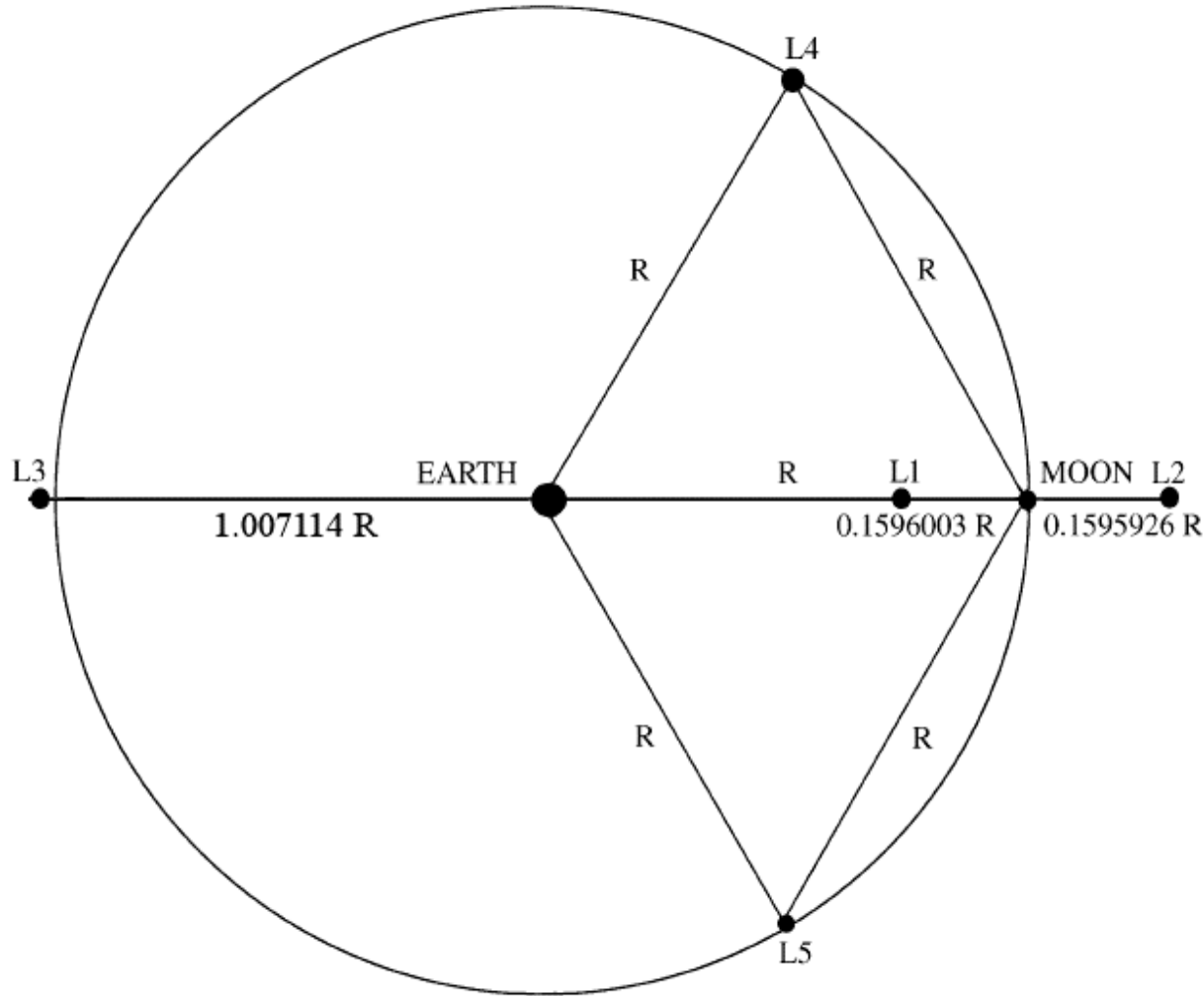


This presentation is  
Dedicated to the memory of

Jean  
Heidmann  
(1920 – 2000)



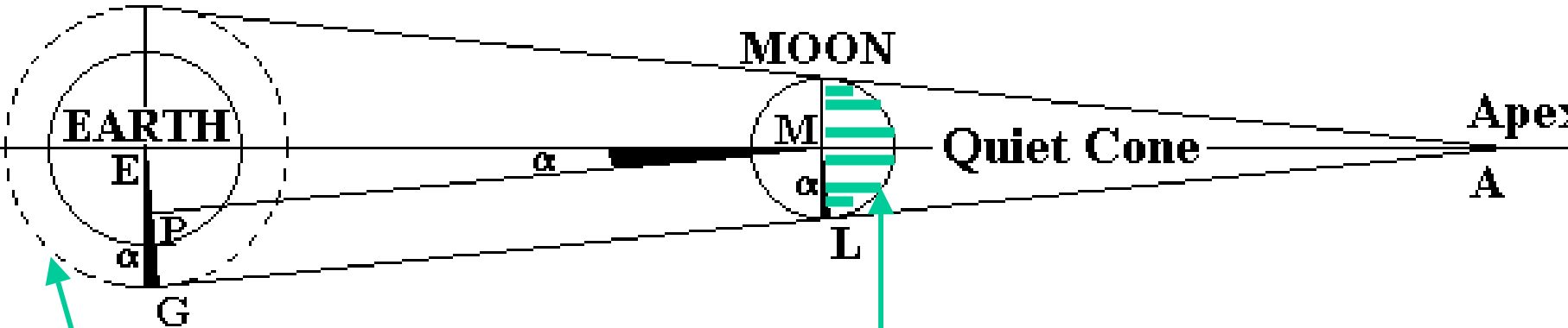
# Five Earth-Moon Lagrangian Points exist:



# Shielded Zone of the Moon

ITU Radio Regulations Article S22

Telecom Satellite Orbit



If this is 100,000 km orbit

Then this is the ITU Shielded Zone of the Moon



## Space Services <sup>(1)</sup>

[Section I](#) Cessation of Emissions

[Section II](#) Control of Interference to Geostationary-Satellite Systems

[Section III](#) Station Keeping of Space Stations

[Section IV](#) Pointing Accuracy of Antennae on Geostationary Satellites

[Section V](#) Radio Astronomy in the Shielded Zone of the Moon

[Section VI](#) Earth Station Off-Axis Power Limitations in the Fixed-Satellite Service

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### Section V. Radio Astronomy in the Shielded Zone of the Moon

#### 2.22

3. (1) In the shielded zone of the Moon <sup>(9)</sup> emissions causing harmful interference to radio astronomy observations <sup>(10)</sup> and to other users of passive services shall be prohibited in the entire frequency spectrum except in the following bands:

#### S22.23

a) the frequency bands allocated to the space research service using active sensors;

#### S22.24

b) the frequency bands allocated to the space operation service, the earth exploration-satellite service using active sensors, and the radiolocation service using stations on spaceborne platforms, which are required for the support of space research, as well as for radiocommunications and space research transmissions within the lunar shielded zone.

#### 2.25

(2) In frequency bands in which emissions are not prohibited by Nos. [S22.22](#) to [S22.24](#), radio astronomy observations and passive space research in the shielded zone of the Moon may be protected from harmful interference by agreement between administrations concerned.

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#### 2.22.1

The shielded zone of the Moon comprises the area of the Moon's surface and an adjacent volume of space which are shielded from emissions originating within a distance of 100 000 km from the centre of the Earth.

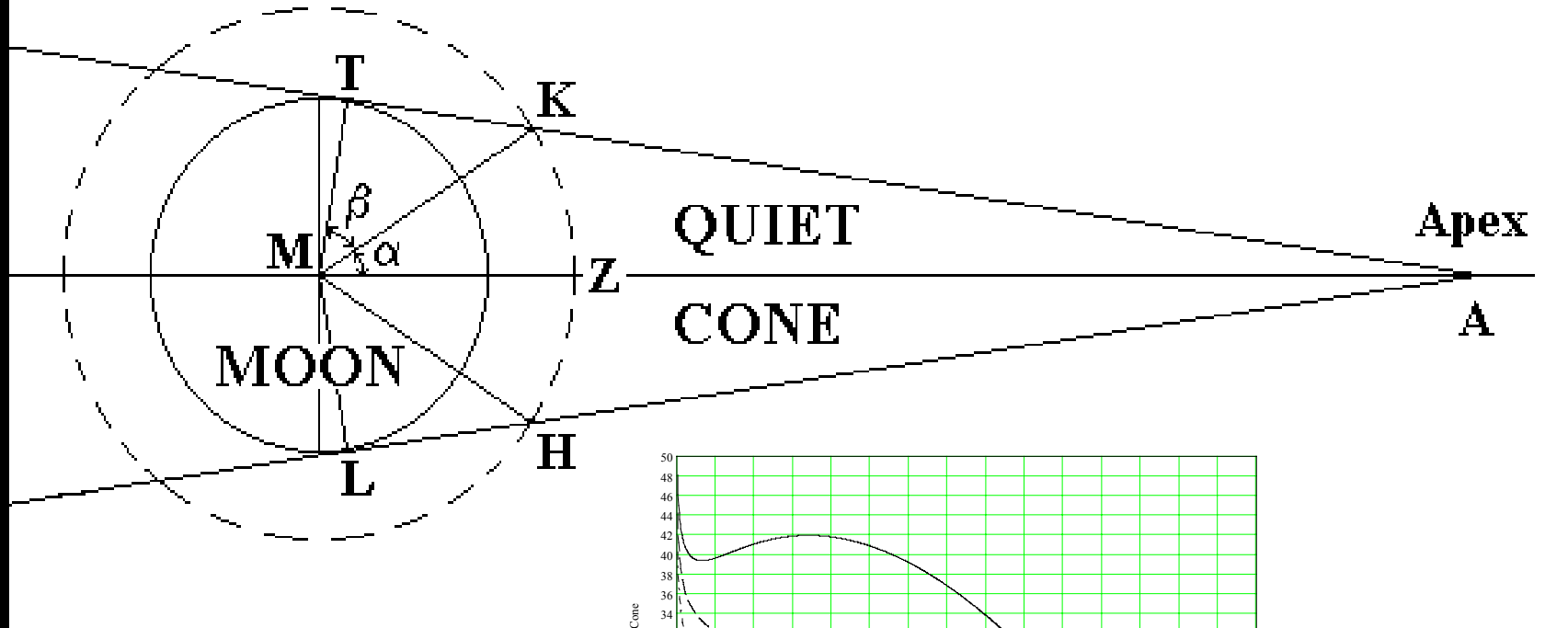
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#### 2.22.2

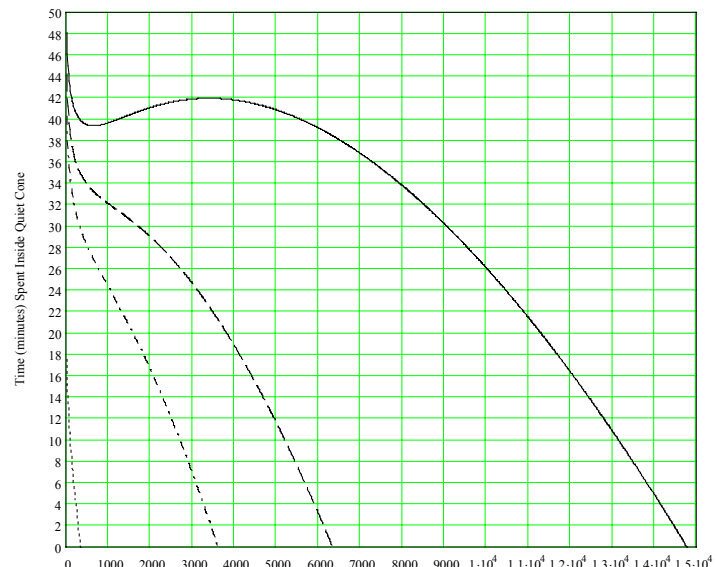
- The level of harmful interference is determined by agreement between the administrations concerned, with the guidance of the relevant ITU-R

# Satellites In Orbit Around Moon

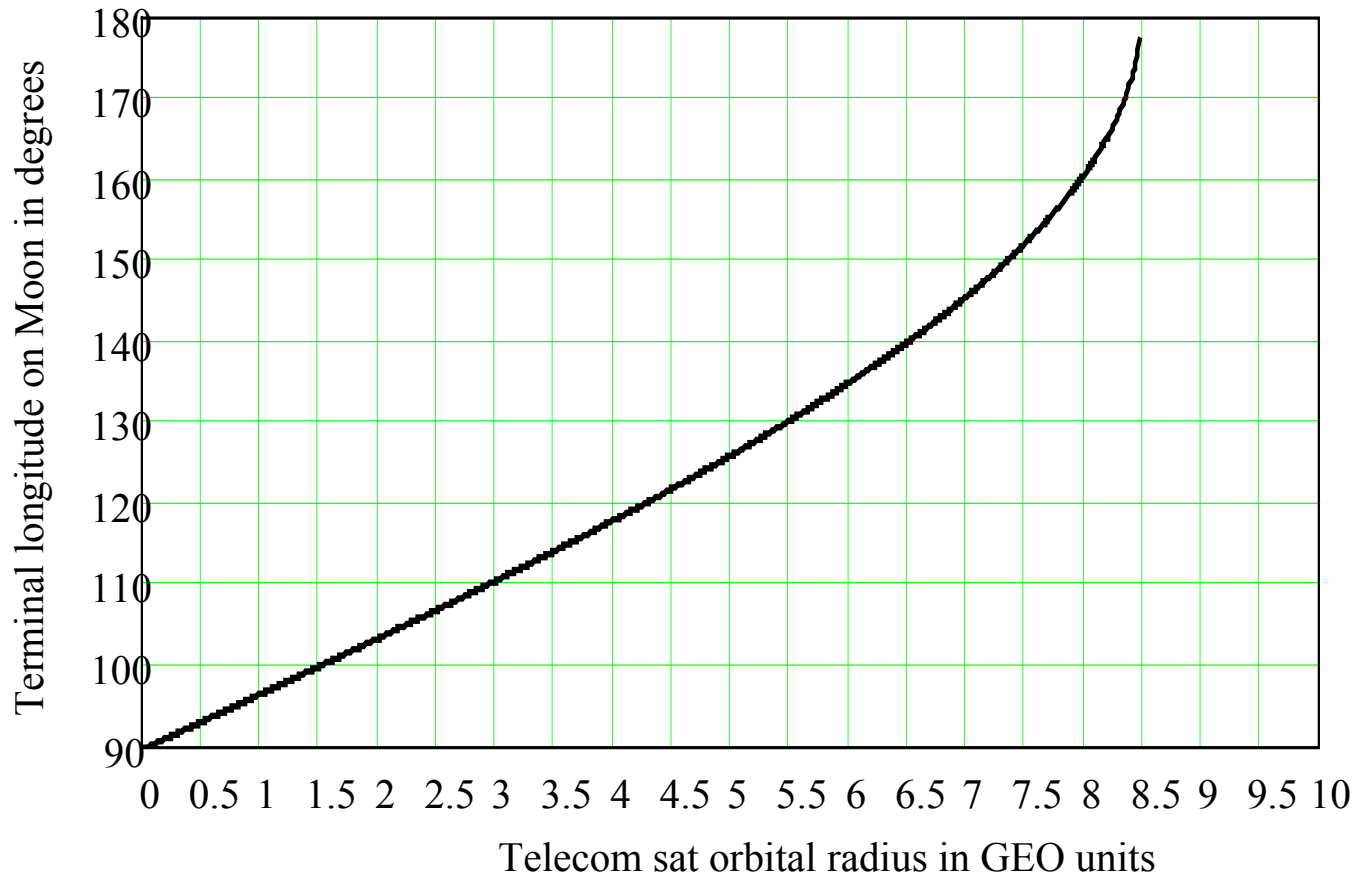
**RadioMoon Orbit**



Depends on height of communication satellites around Earth



# Orbits Higher Than Geostationary Move Shielded Zone Back



# Daedulus Crater Is Proposed

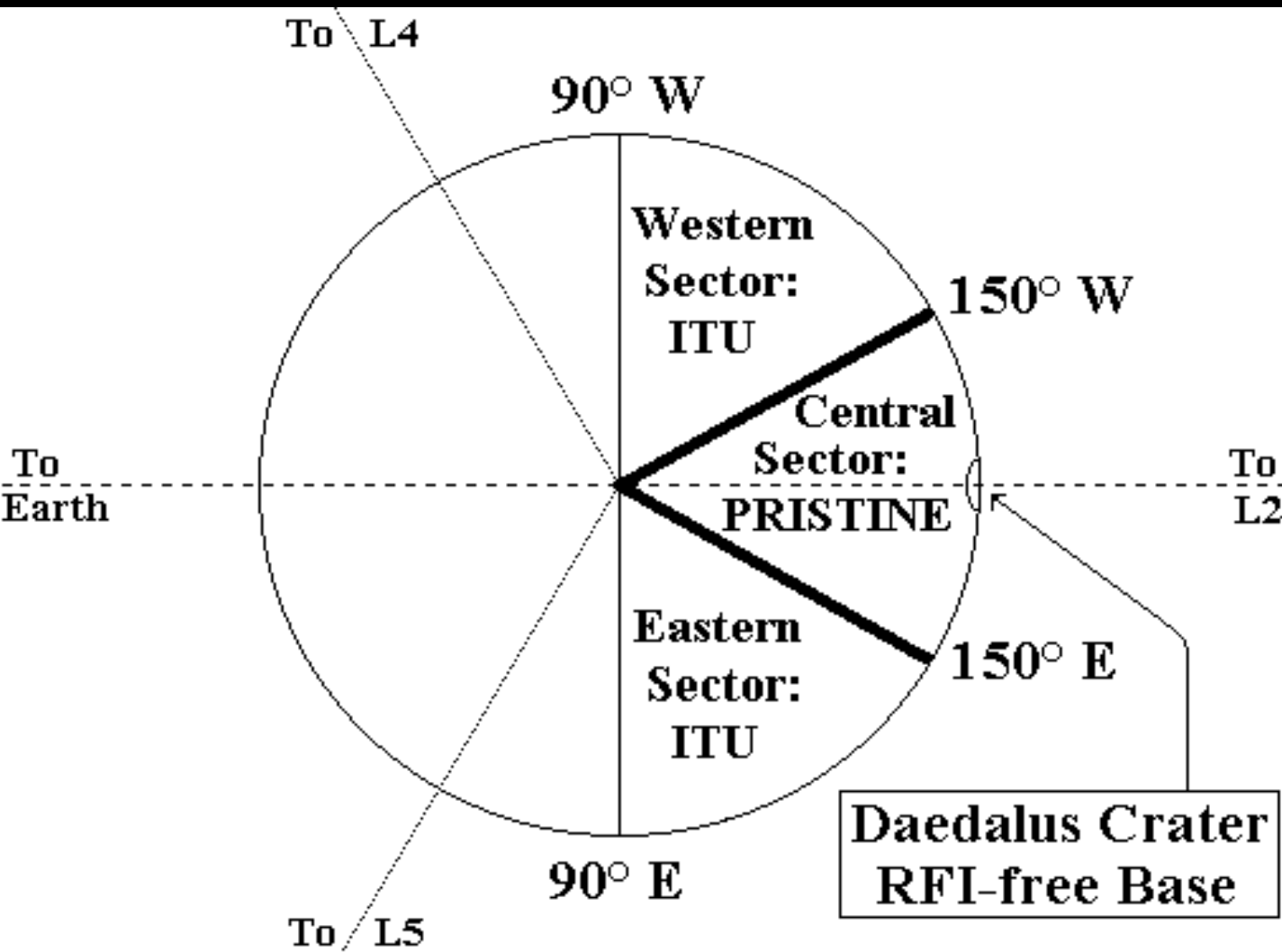


- Formerly I.A.U. Crater No. 308
- 179 degrees east longitude
- 5.5 degrees south latitude
- 80 km diameter



# Three Zones On Farside

## “Sharing The Farside By Thirds”



# ATTENUATION of man-made RFI at the Daedalus Crater (~ Antipode)

Frequency of radio waves	$f = 100$ kHz	$f = 100$ MHz	$f = 100$ GHz
Source in GEO	- 42 dB	- 72 dB	- 102 dB
Source in an orbit passing through the L1 point	- 30 dB	- 60 dB	- 90 dB
Source still at L4 or L5 Lagrangian points	- 29 dB	- 59 dB	- 89 dB



# ATTENUATION of man-made RFI at the Daedalus Crater (~ Antipode)

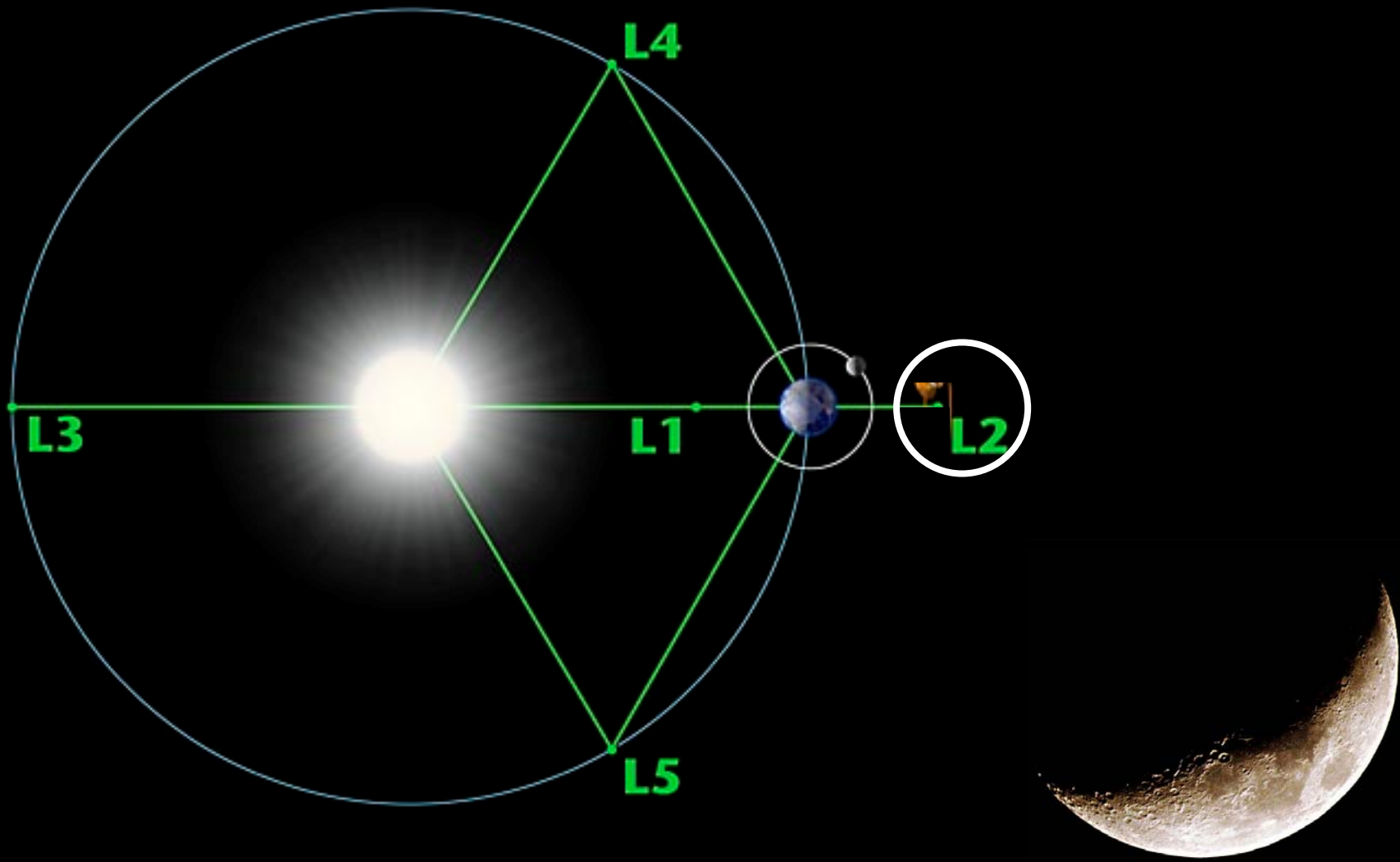
Origin of radio waves	Radio frequency $f$	Source in GEO	Source in orbit at L1 distance	Source still at L4 or L5
ELF	0.003 MHz	-27 dB	-15 dB	-14 dB
VLF	0.030 MHz	-37 dB	-25 dB	-23 dB
Jupiter's storm	20 MHz	-65 dB	-53 dB	-52 dB
Deuterium	327.384 MHz	-77 dB	-65 dB	-64 dB
Hydrogen	1420.406 MHz	-84 dB	-71 dB	-70 dB
Hydroxyl radical	1612.231 MHz	-84 dB	-72 dB	-71 dB
Formaldehyde	4829.660 MHz	-89 dB	-77 dB	-75 dB
Methanol	6668.518 MHz	-90 dB	-78 dB	-77 dB
Water vapor	22.235 GHz	-96 dB	-83 dB	-82 dB
Silicon monoxide	42.519 GHz	-98 dB	-86 dB	-85 dB
Carbon monoxide	109.782 GHz	-103 dB	-90 dB	-89 dB
Water vapor	183.310 GHz	-105 dB	-92 dB	-91 dB

# But How Quiet Is The Farside?

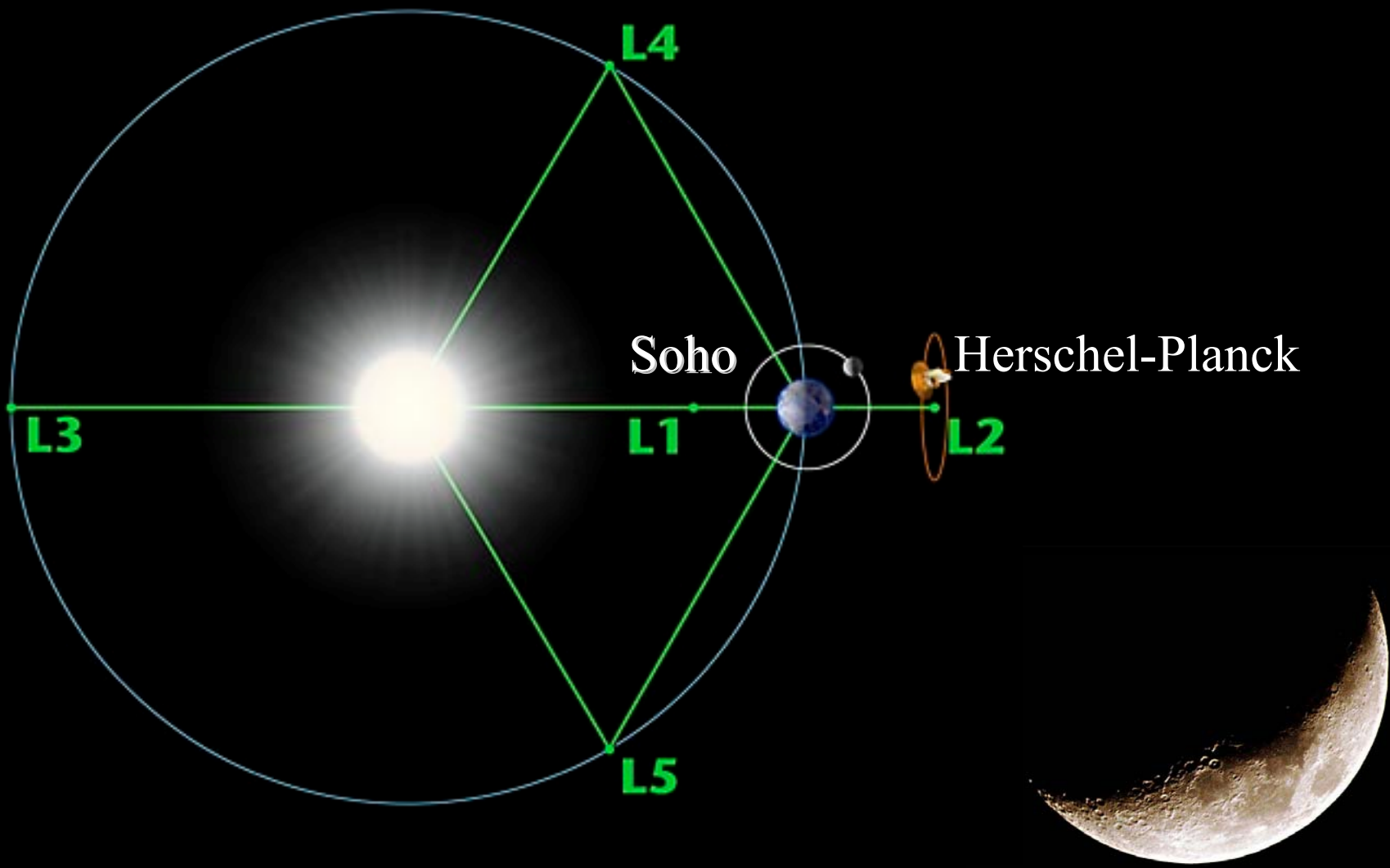
- L5 Society wants to have a space colony in orbit at L5
  - Western third would be shielded from this by the body of the moon
- Symmetric situation for L4
- Leave L2 alone!
- But there is another L2 that matters... that is the Earth-Sun L2 Lagrangian point...



# Five Earth-Sun Lagrangian Points

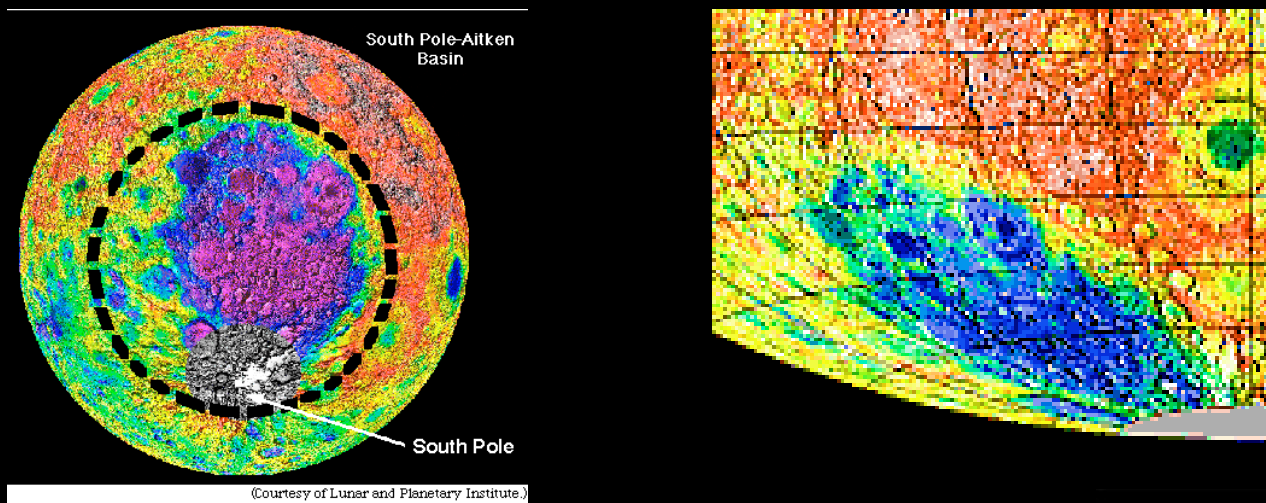


# Five Earth-Sun Lagrangian Points



# Evolving Space Competition

- A new 'moon rush' by 2018: USA vs. China (?)
- Lunar Prospector and Clementine find water (?)



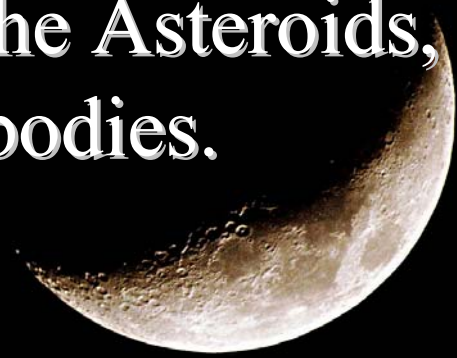
South Pole Aitken Basin



# Next Steps in Exploring Deep Space

Suggestion by IAA Cosmic Study S1.1, titled  
“The Next Steps in Exploring Deep Space”:

- Use the Earth-Sun L2 ONLY (and NOT the Earth-Moon L2) as a servicing station
- and as a Low-gravity launching platform for large spacecrafts to Mars, the Asteroids, and all the outer solar system bodies.



# No “astronautical competition” exists between the two L2s

In other words, the Earth-Moon L2 is “let alone”  
or “let empty” in the race to the outer solar system

- The PAC will now be safe from (much of)  
the future man-made radiation produced at  
the Earth-Moon L2.

- Still the PAC needs to be **APPROVED  
POLITICALLY** (by the United Nations?)



# POLITICS and the PAC CREATION

- The “Outer Space Treaty” was signed in 1967.
- NO COUNTRY can “colonize” the Moon, Planets and Asteroids for that Country only!
- Back in 1967, however, it was hard to envisage a time when PRIVATE INVESTORS could reach the Moon by their own means.
- So **no-one knows what will happen when some PRIVATE INVESTORS LAND ON THE MOON...**



# POLITICS and the PAC CREATION

- Will private investors stay away from the PAC?
- Maybe NOT!
- It is thus URGENT to reach some kind of INTERNATIONAL AGREEMENT...
- The U.N. COPUOS should APPROVE the PAC



# POLITICS and the PAC CREATION

- One Country must raise the issue at the U.N.
- Then the U.N. turns to COPUOS...
- Then COPUOS turns to the IAA and IISL...
- Then PAC IS APPROVED BY THE U.N.
- These matters are LEGALLY UNCERTAIN...
- THE POLITICIANS WILL DECIDE...



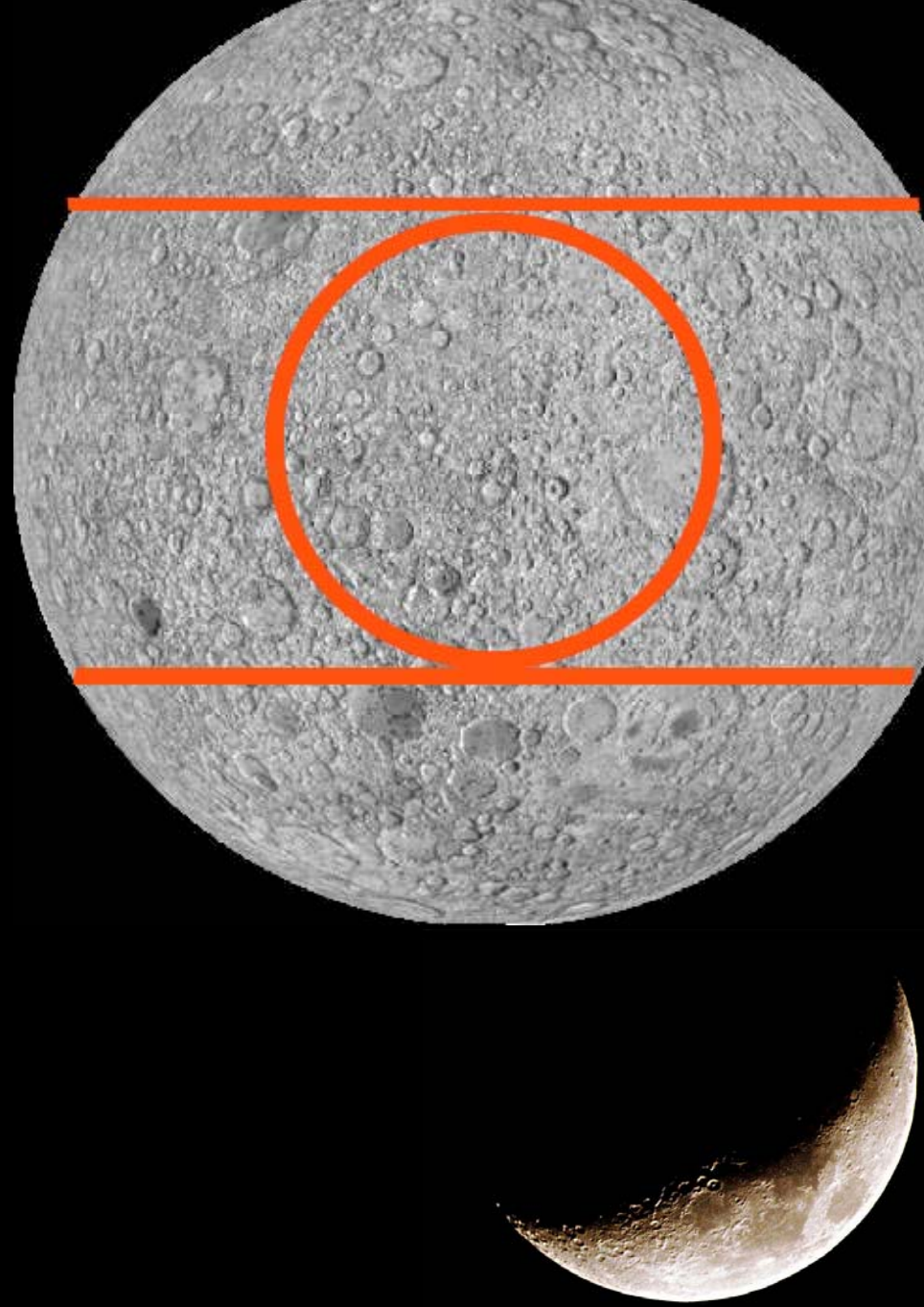
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*Thank you !*

