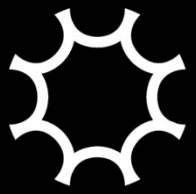
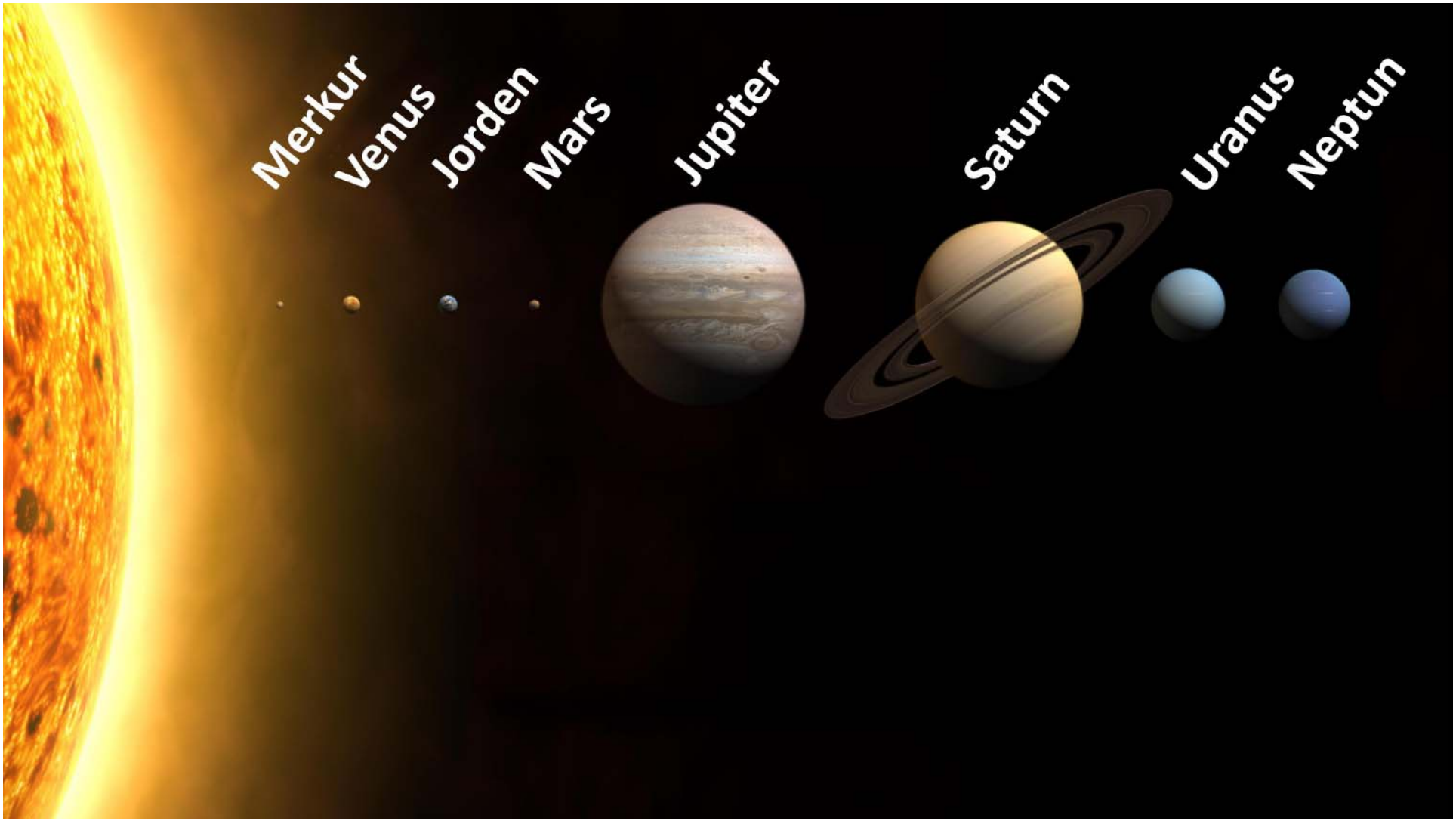
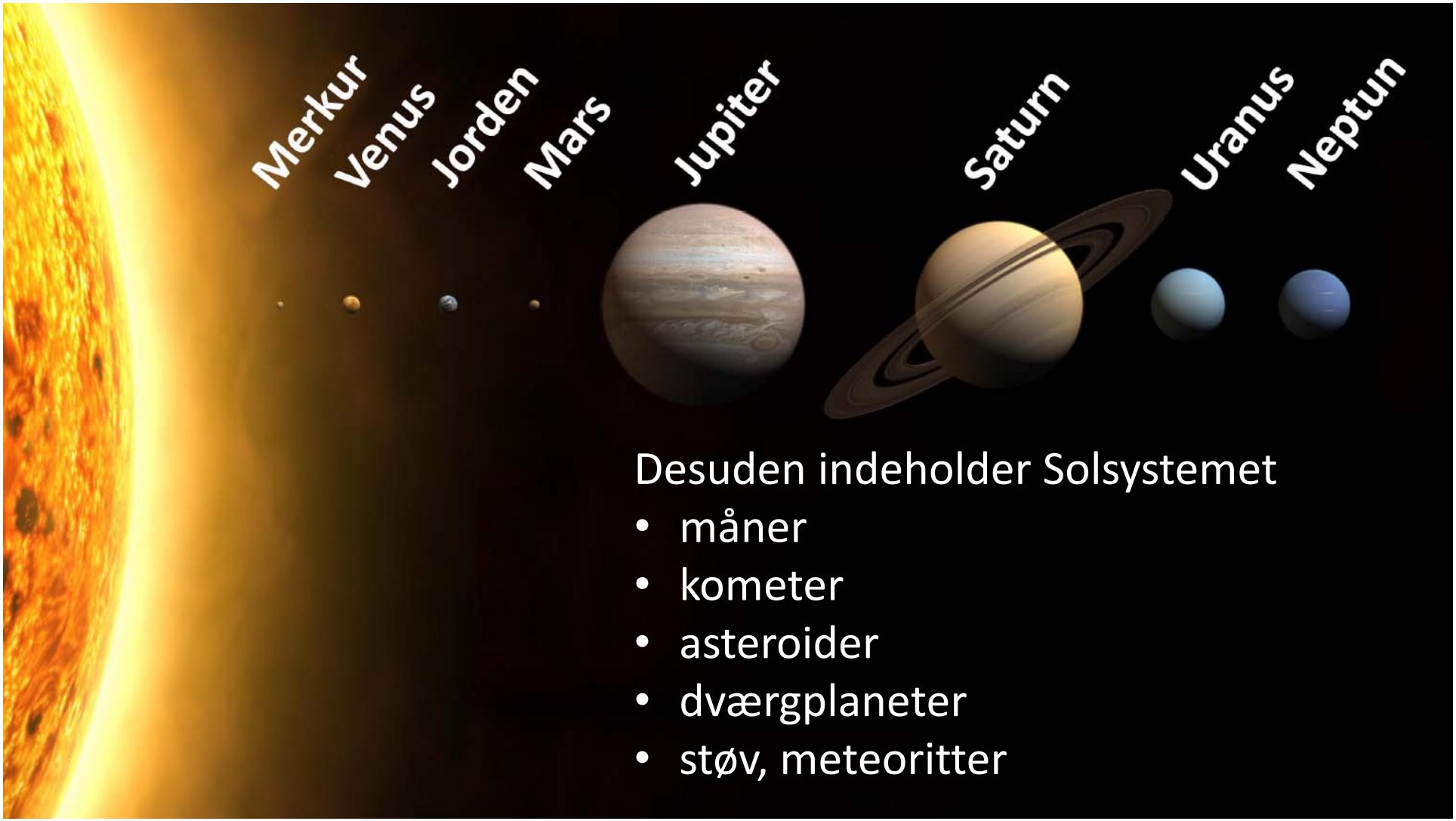
Den ydre del af Solsystemet

Hans Kjeldsen
Aarhus Universitet



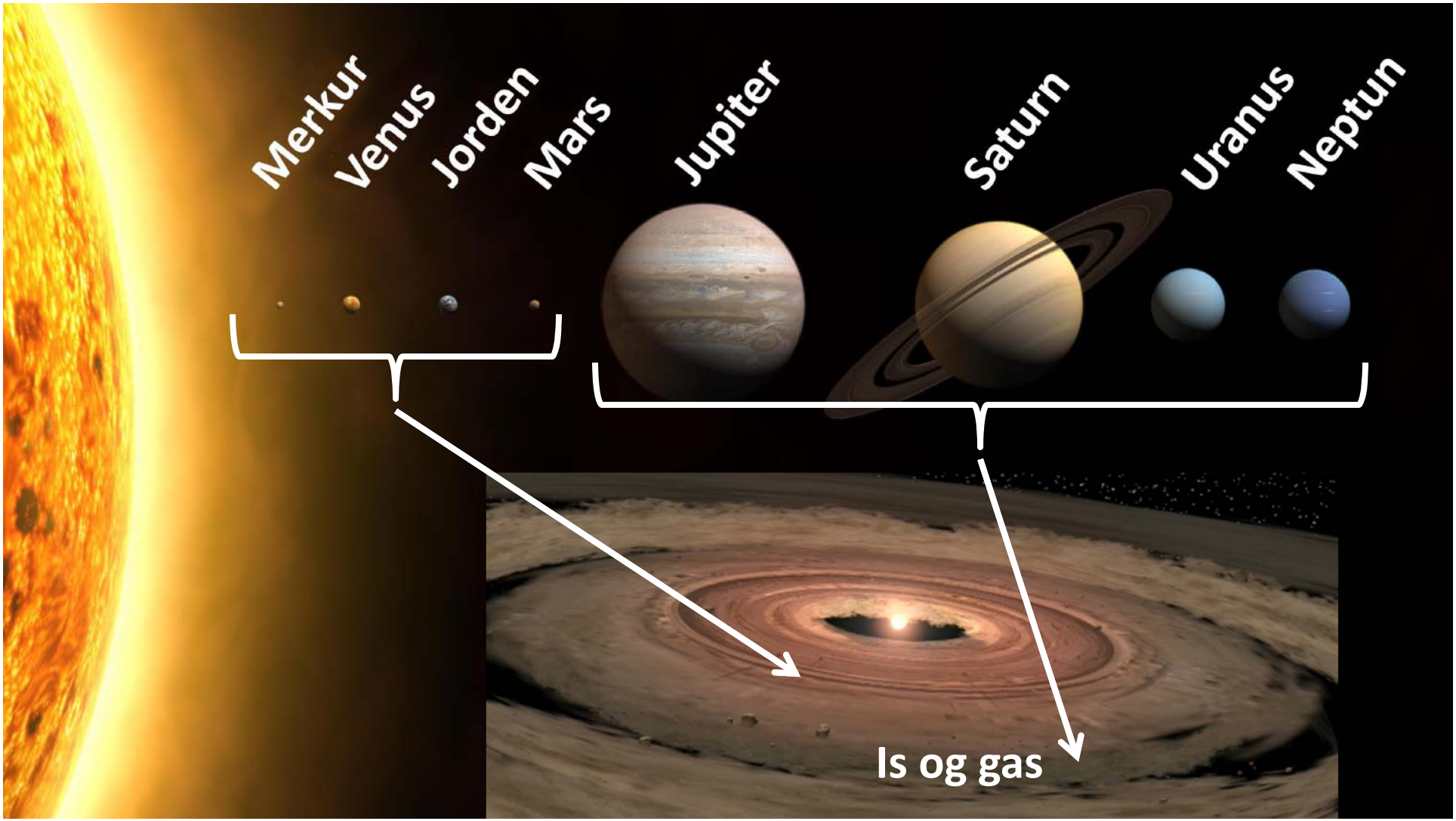
STELLAR ASTROPHYSICS CENTRE


Merkur
Venus
Jorden
Mars
Jupiter
Saturn
Uranus
Neptun



Desuden indeholder Solsystemet

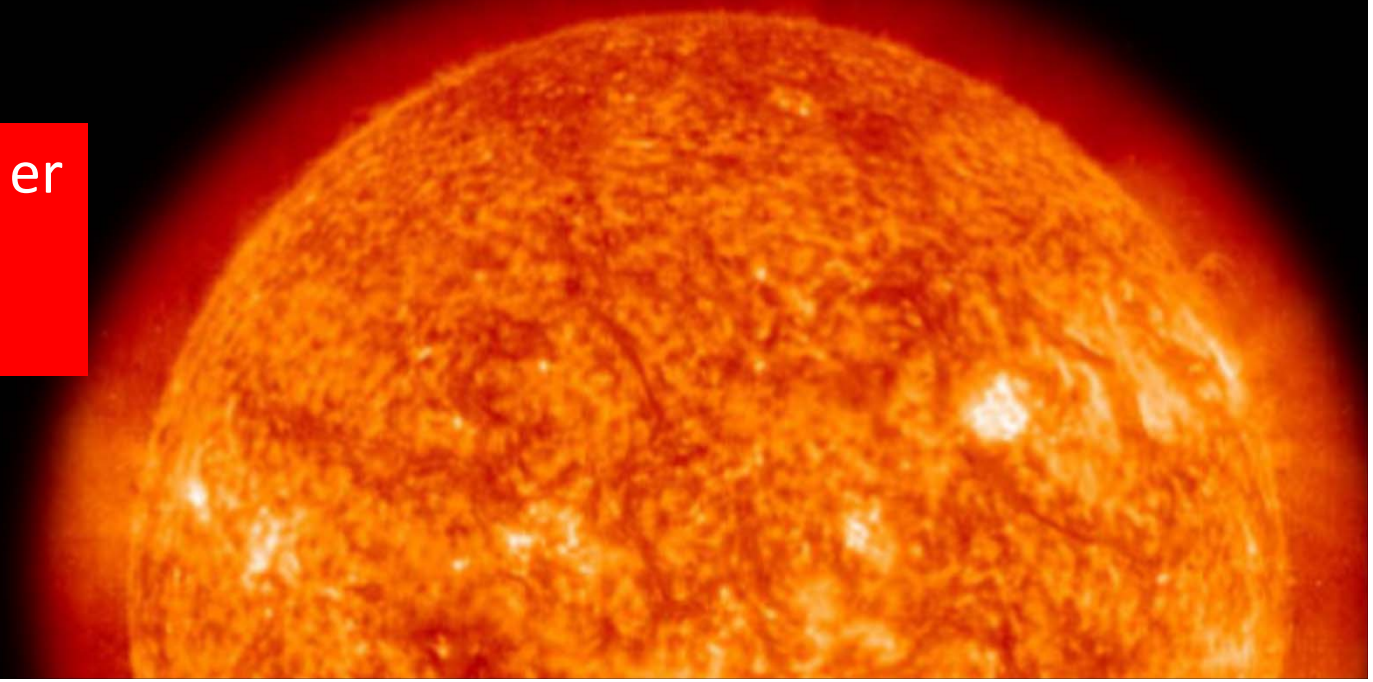
- måner
- kometer
- asteroider
- dværgplaneter
- støv, meteoritter


Merkur
Venus
Jorden
Mars
Jupiter
Saturn
Uranus
Neptun
Is og gas

Hvilke processer former overfladen og atmosfæren på planeterne og månerne ?

- Solens energi varmer atmosfæren og overfladen op

I verdensrummet er temperaturen omkring -270 °C



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- Indre varmekilder skaber bevægelse i overfladen

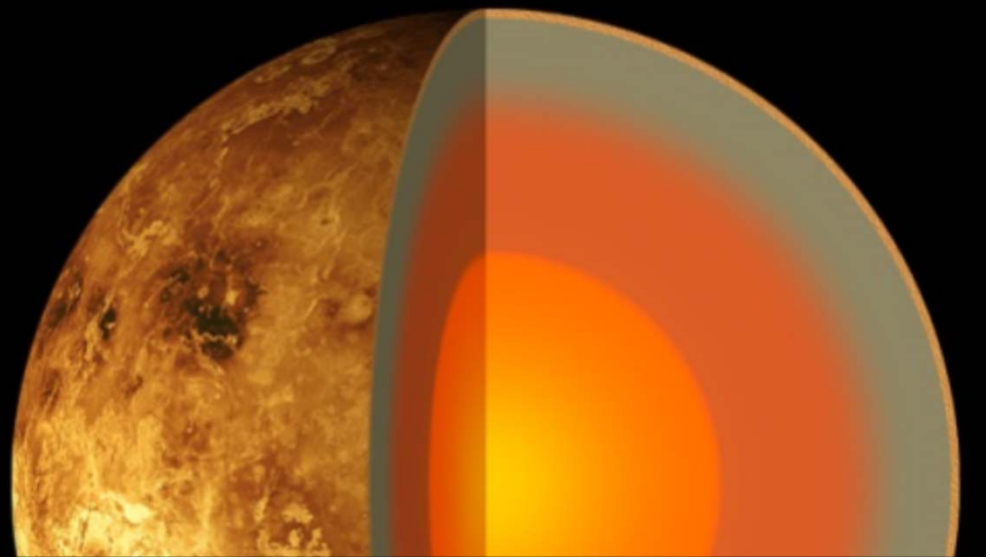
Radioaktivt henfald af isotoper med

- lang halveringstid

  ^{40}K ^{232}Th ^{238}U ^{235}U

- kort halveringstid

  ^{26}Al ^{53}Mn ^{129}I ^{244}Pu



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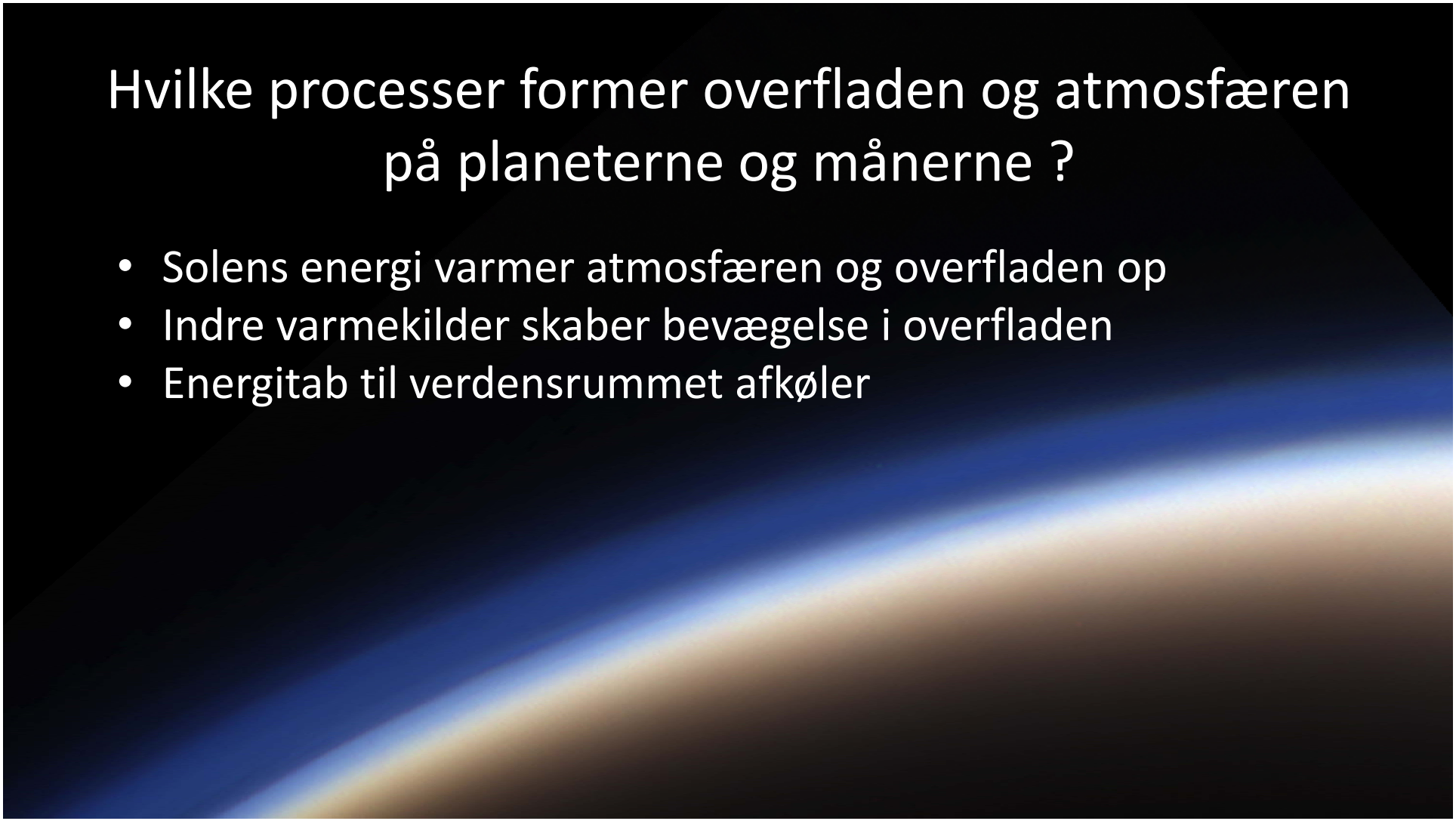

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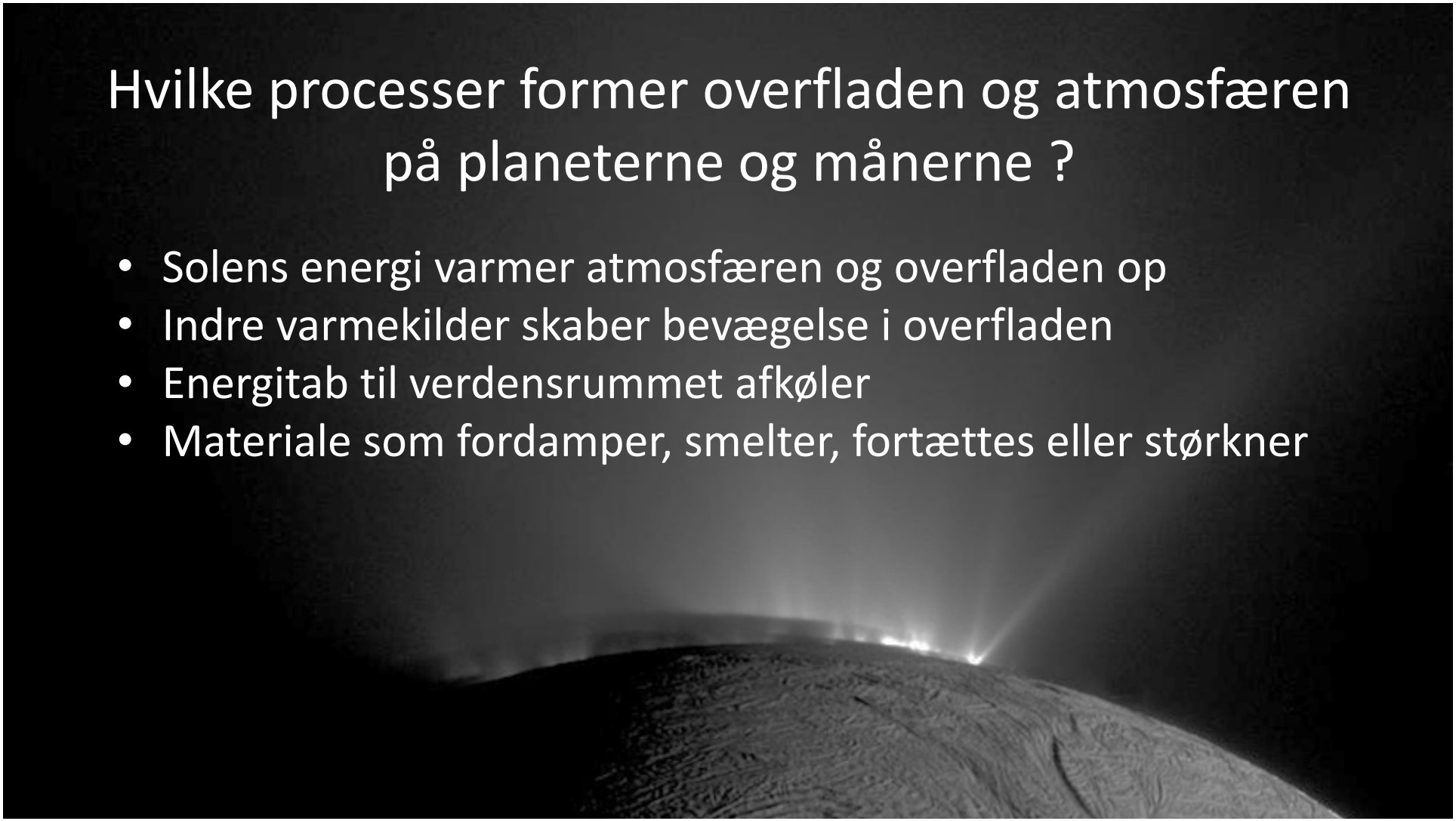

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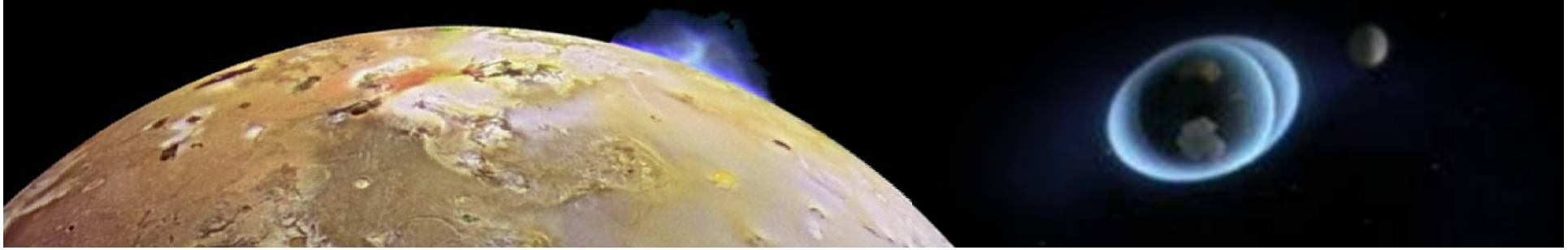
- Tidevandskræfter varmer det indre op



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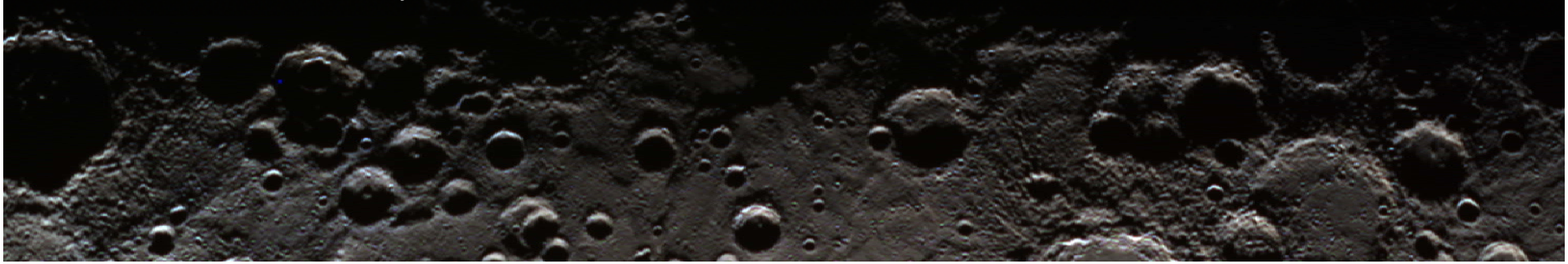

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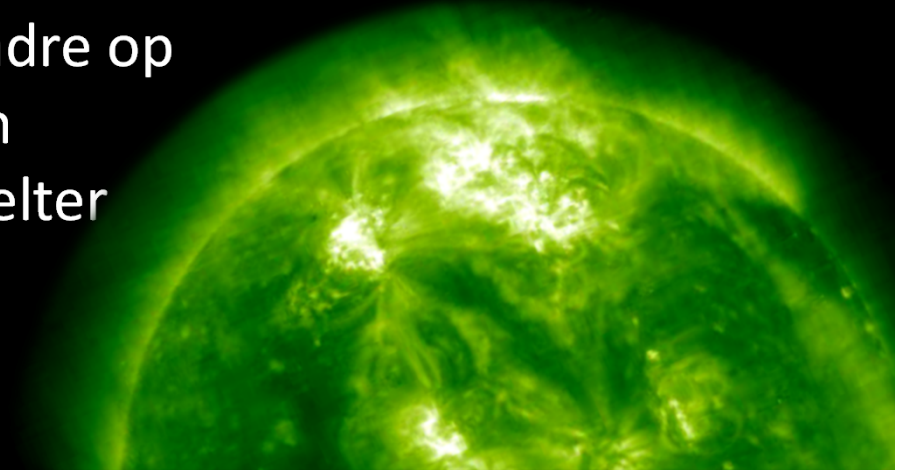
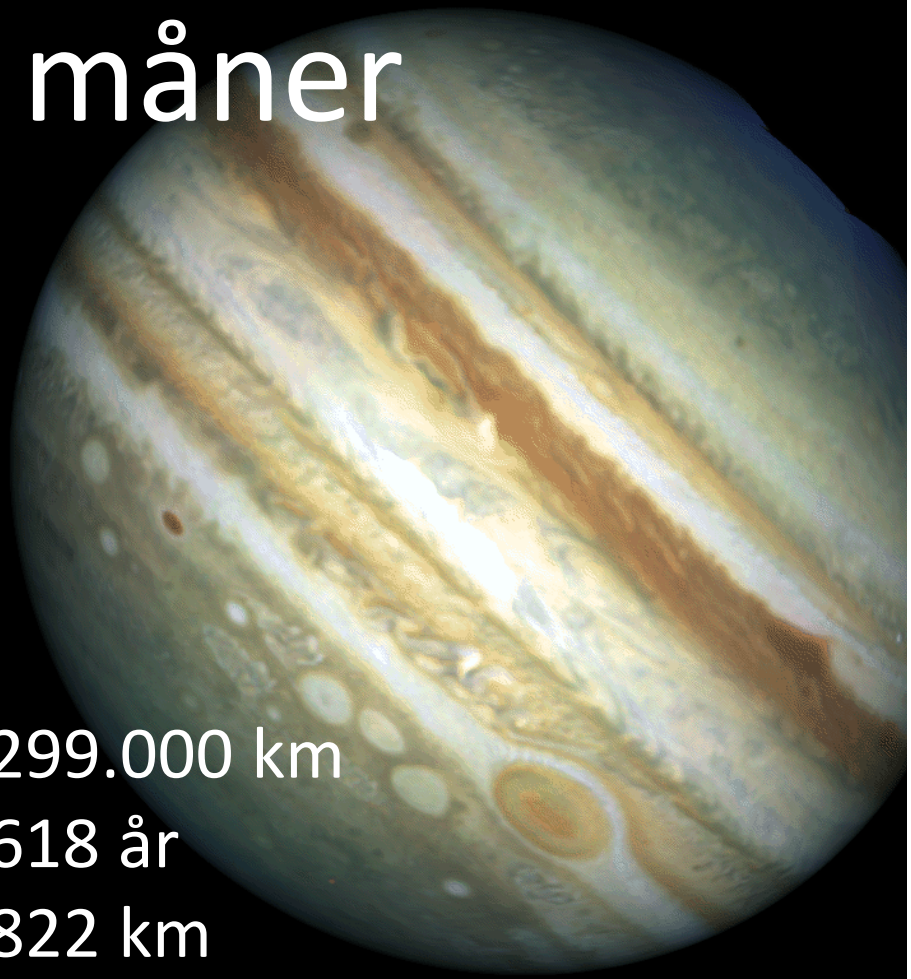
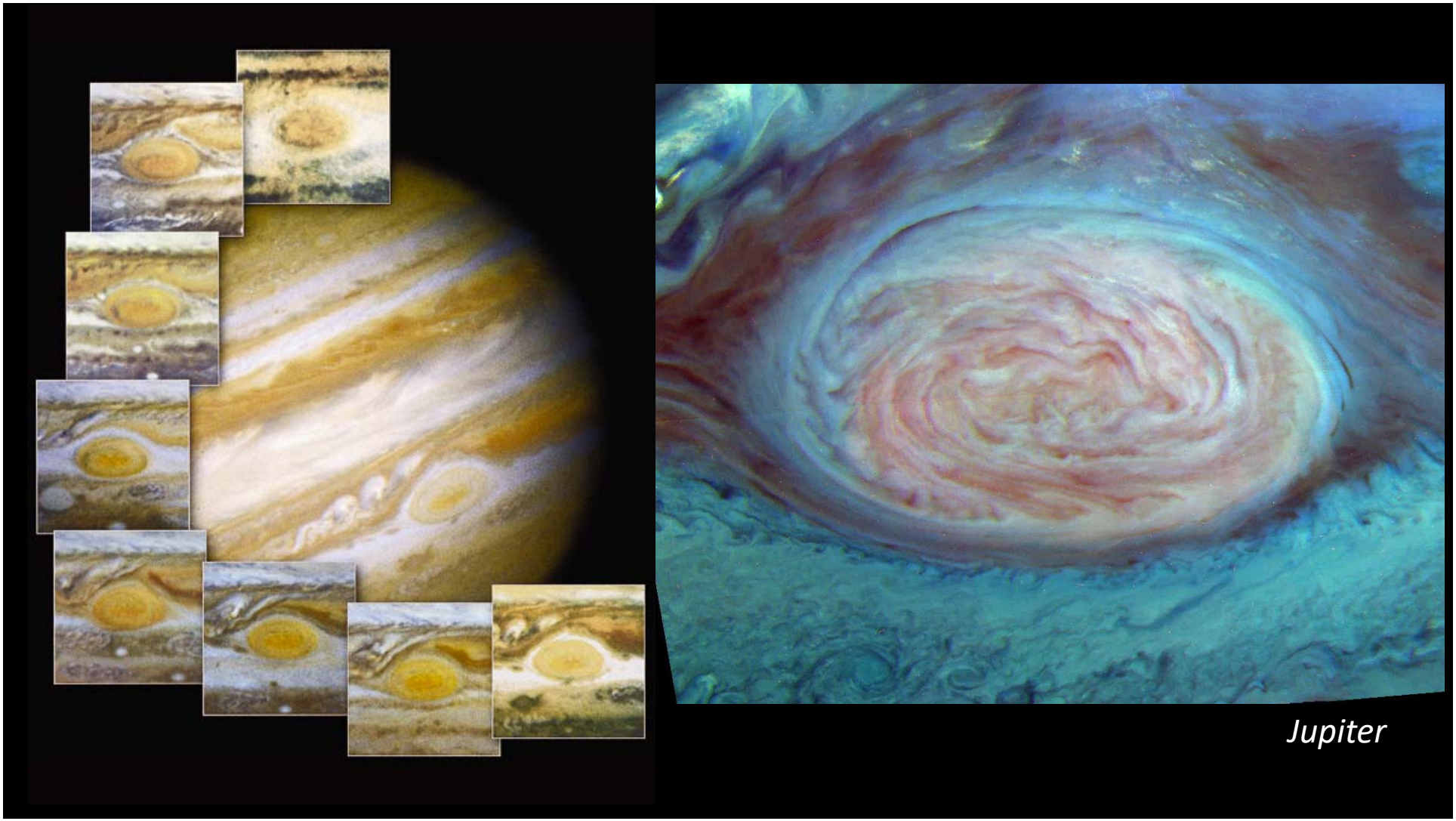
- Sammenstød former overfladen
- Solens og planeternes magnetfelter



Jupiter og dens måner



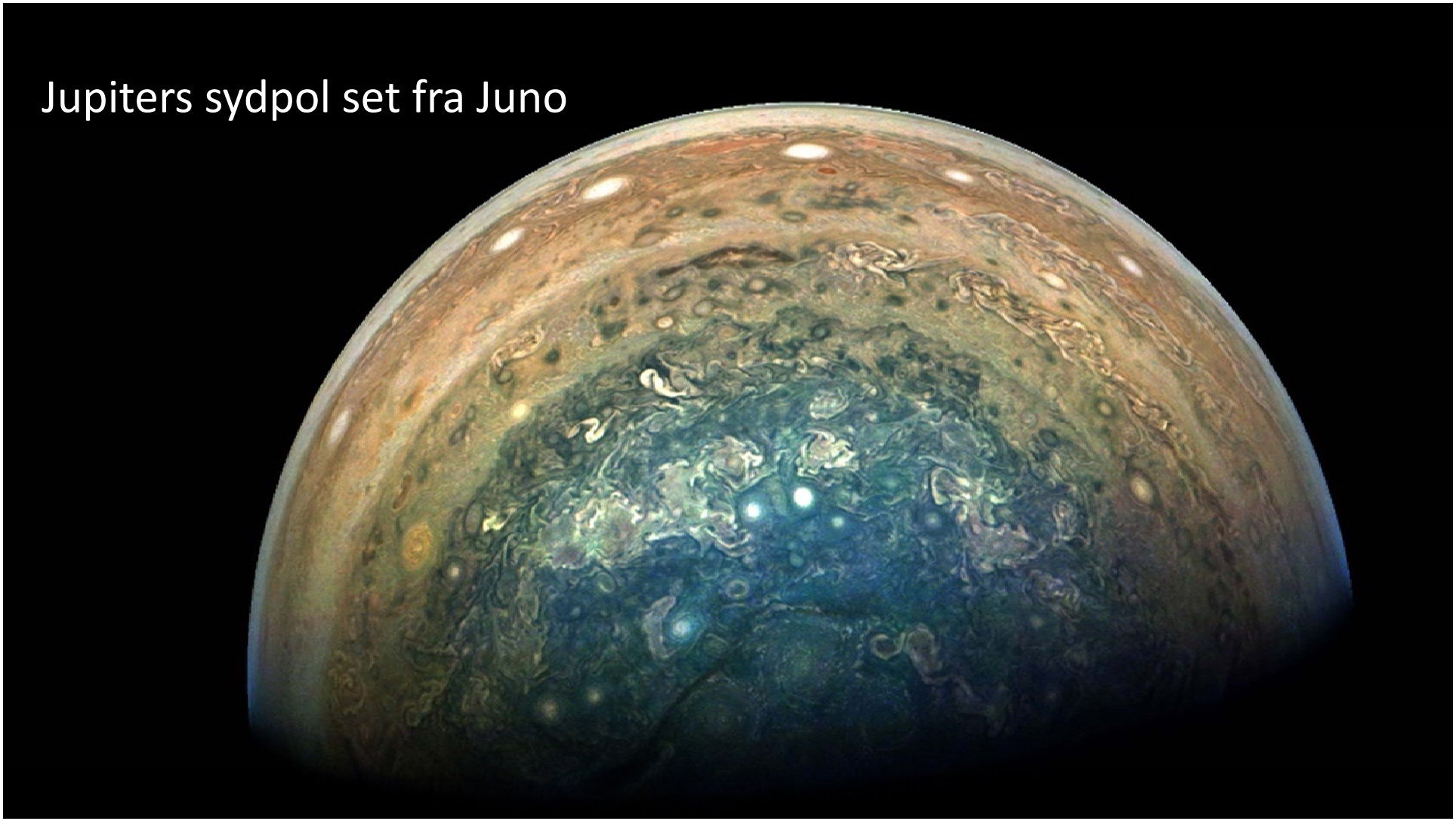
Afstand fra Solen:	778.299.000 km
Omløbstid om Solen:	11,8618 år
Diameter:	139.822 km



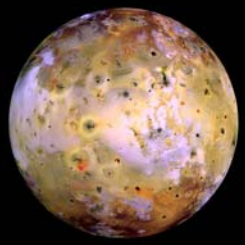
Jupiter

Juno er en rumsonde fra NASA som blev opsendt den 5. august 2011. Juno nåede frem til Jupiter den 4. juli 2016

Jupiters sydpol set fra Juno

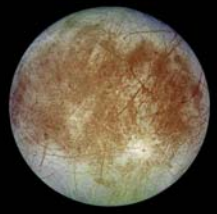


Jupiters 4 store måner



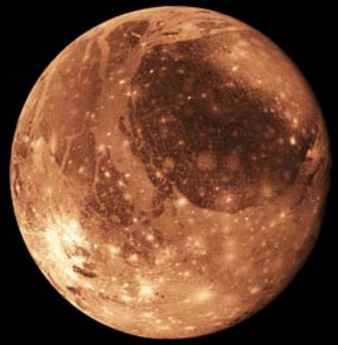
Io

3642 km



Europa

3138 km



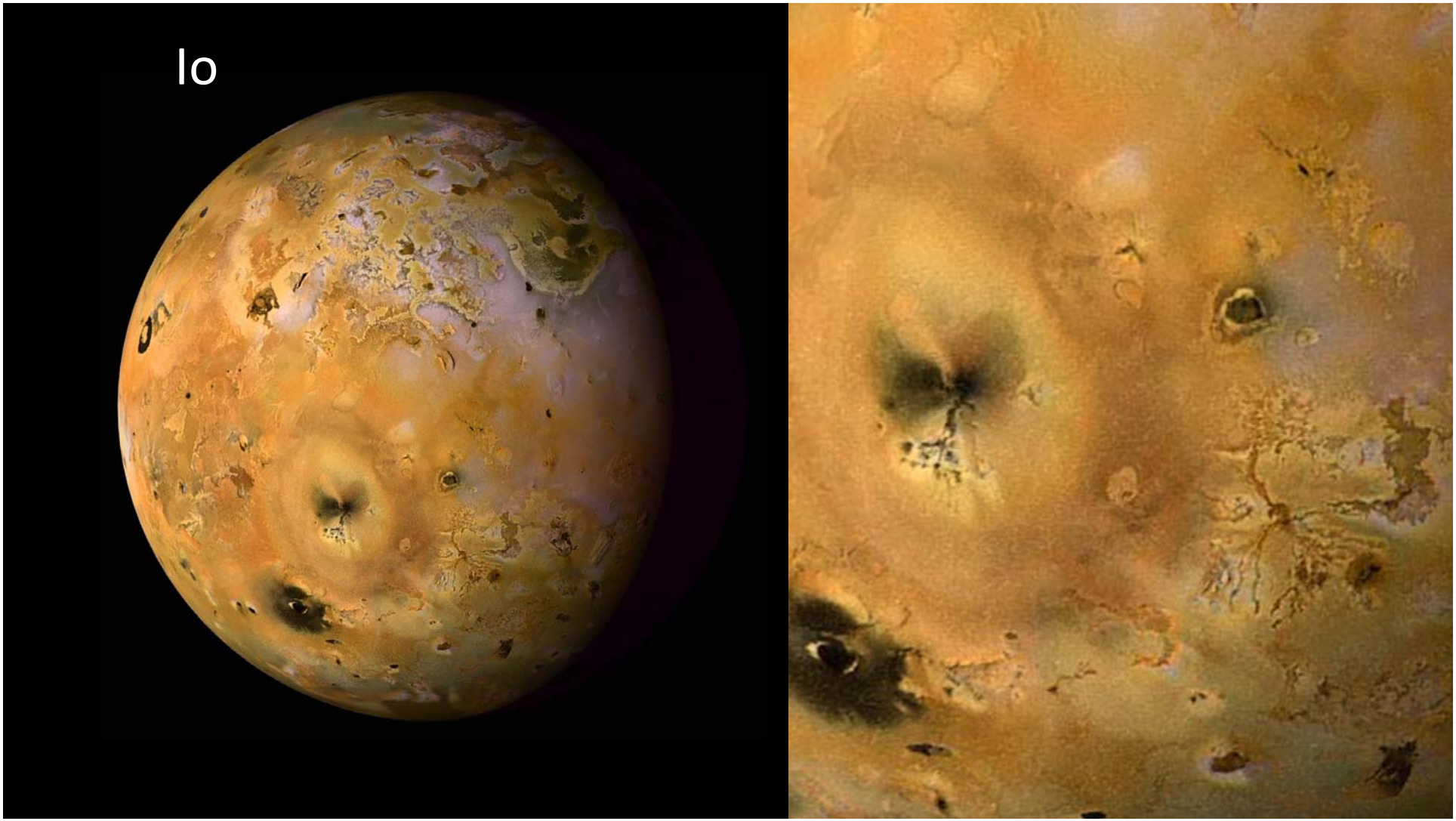
Ganymede

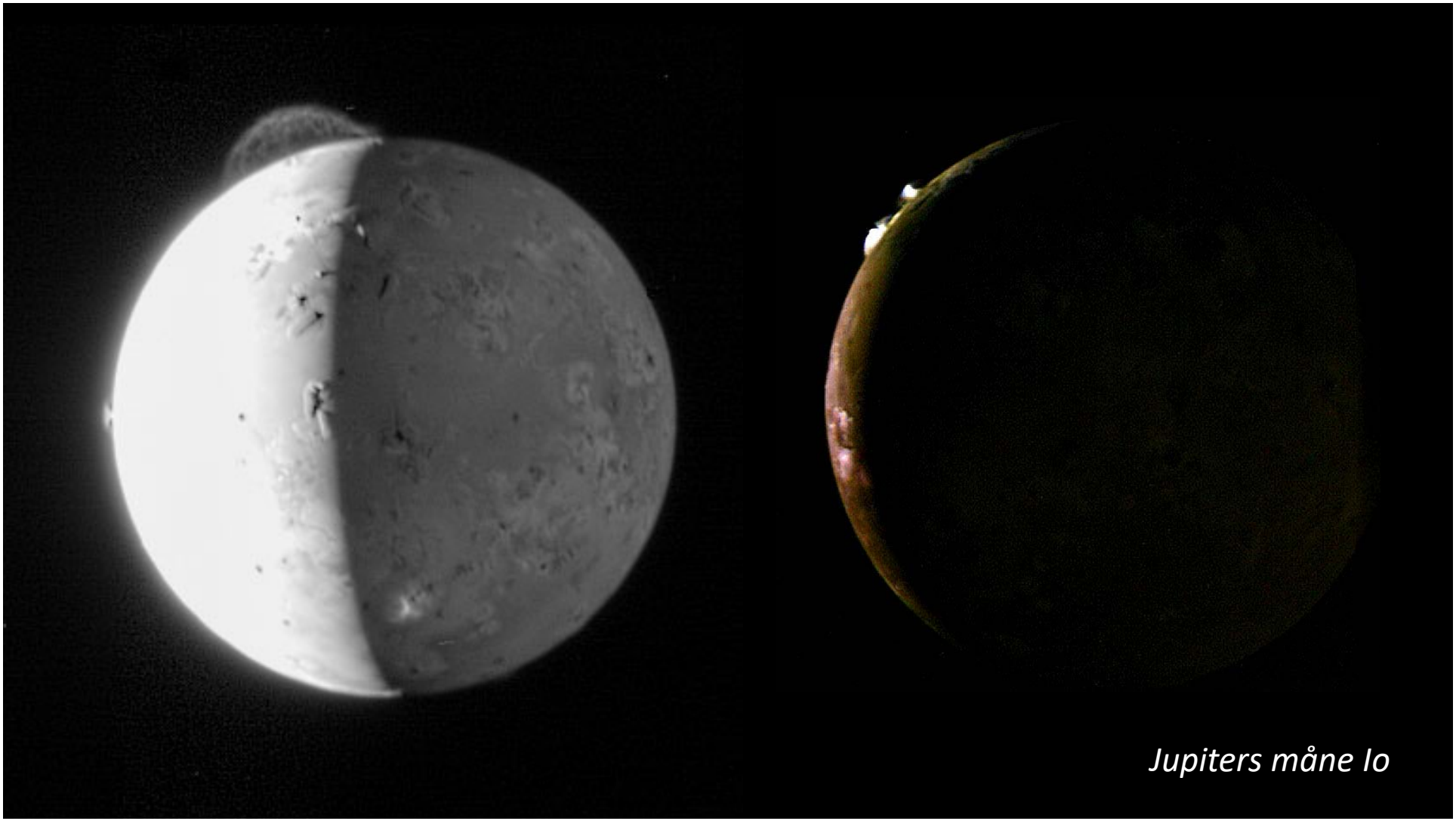
5262 km

Callisto

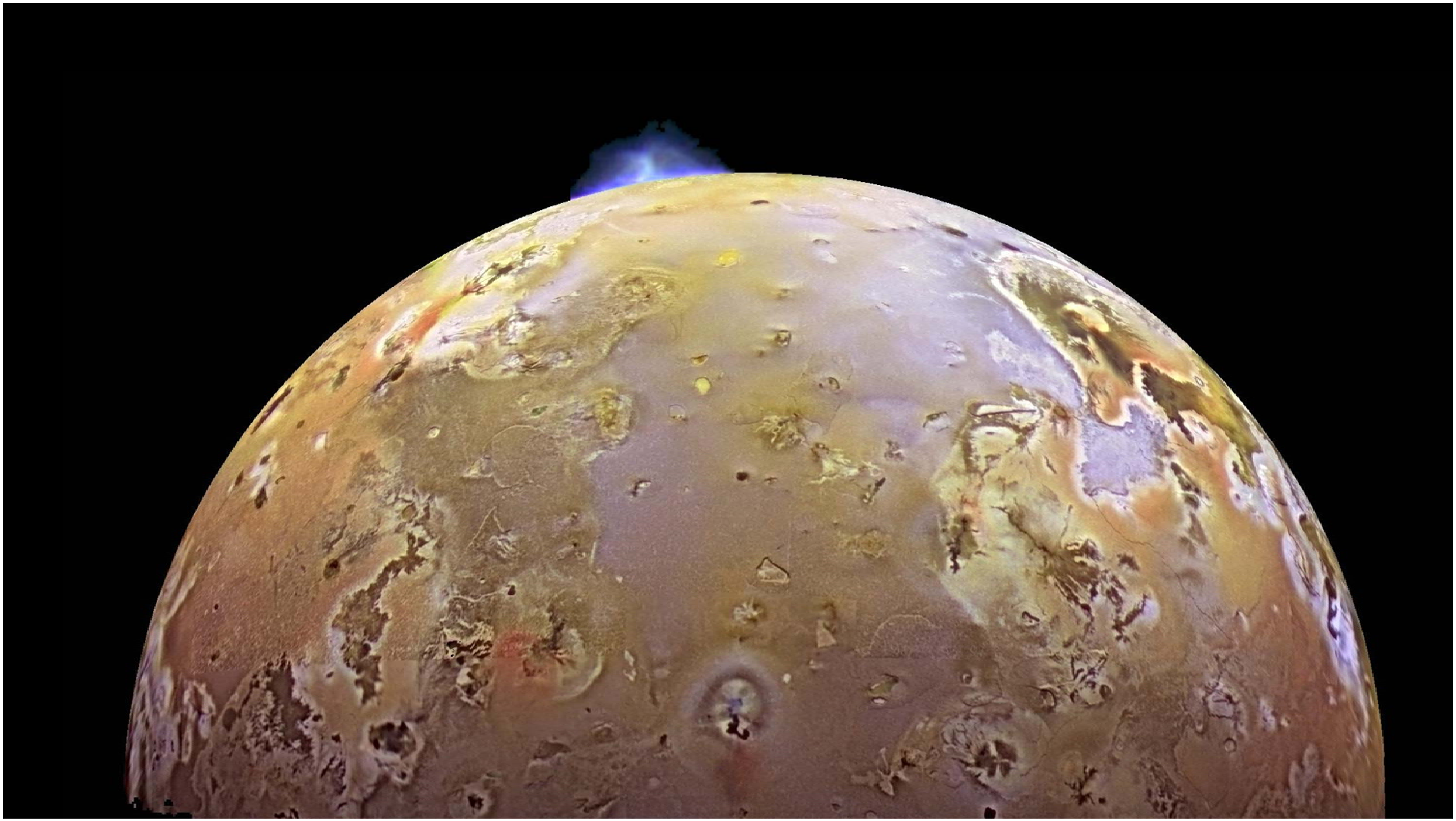
4806 km

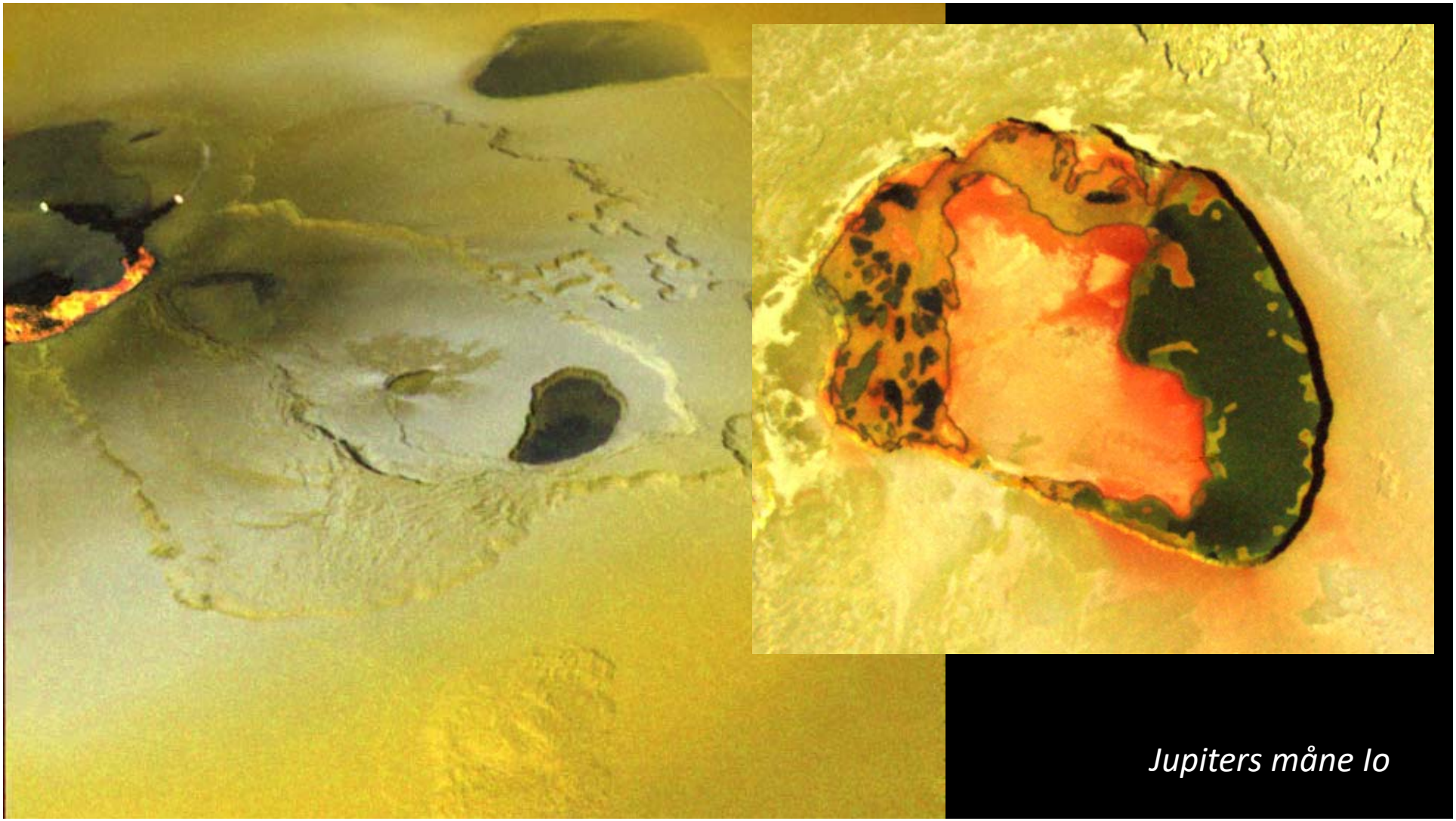
Tidevandskræfter og Solens energi


Io

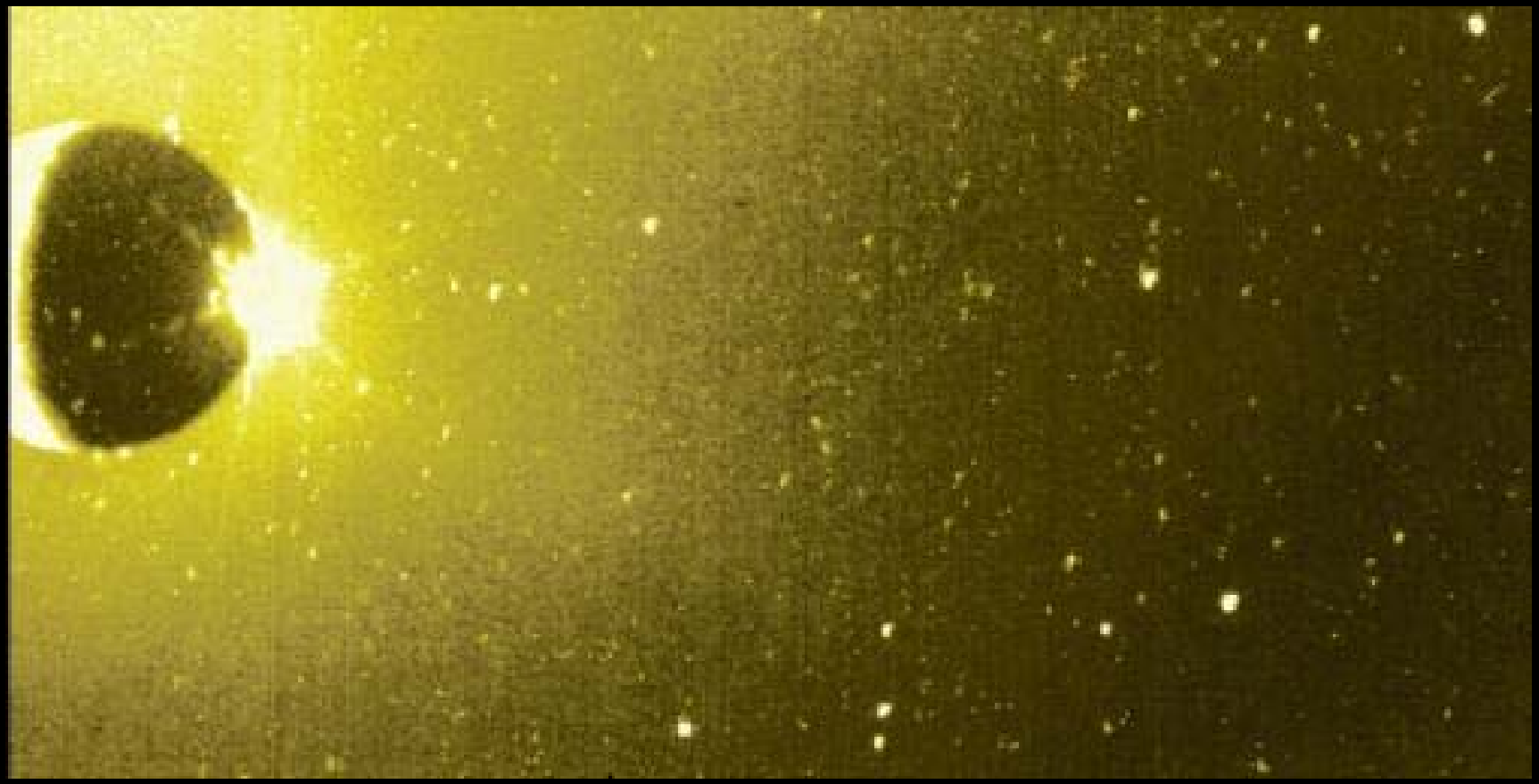


Jupiters måne Io





Jupiters måne Io



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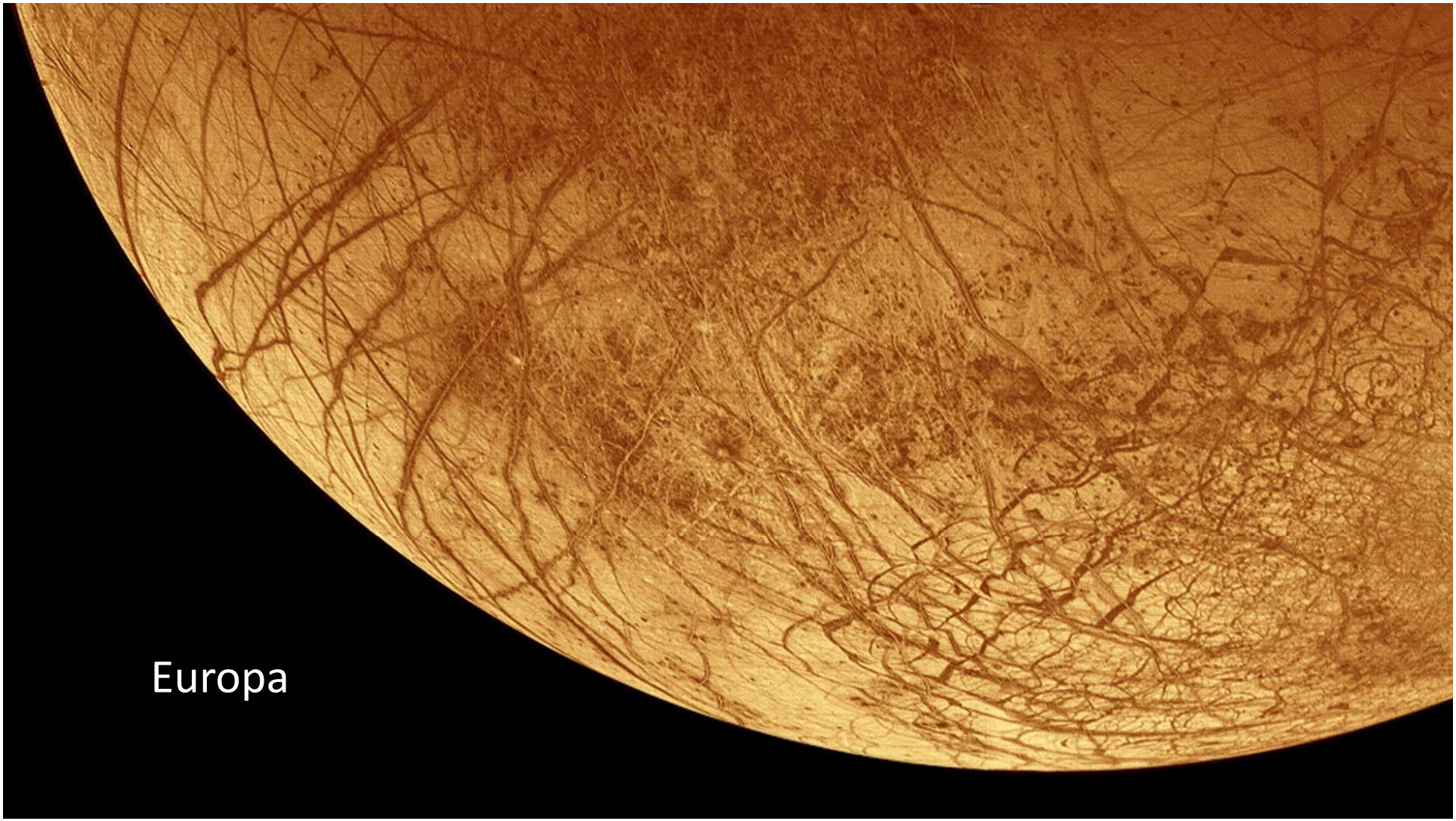
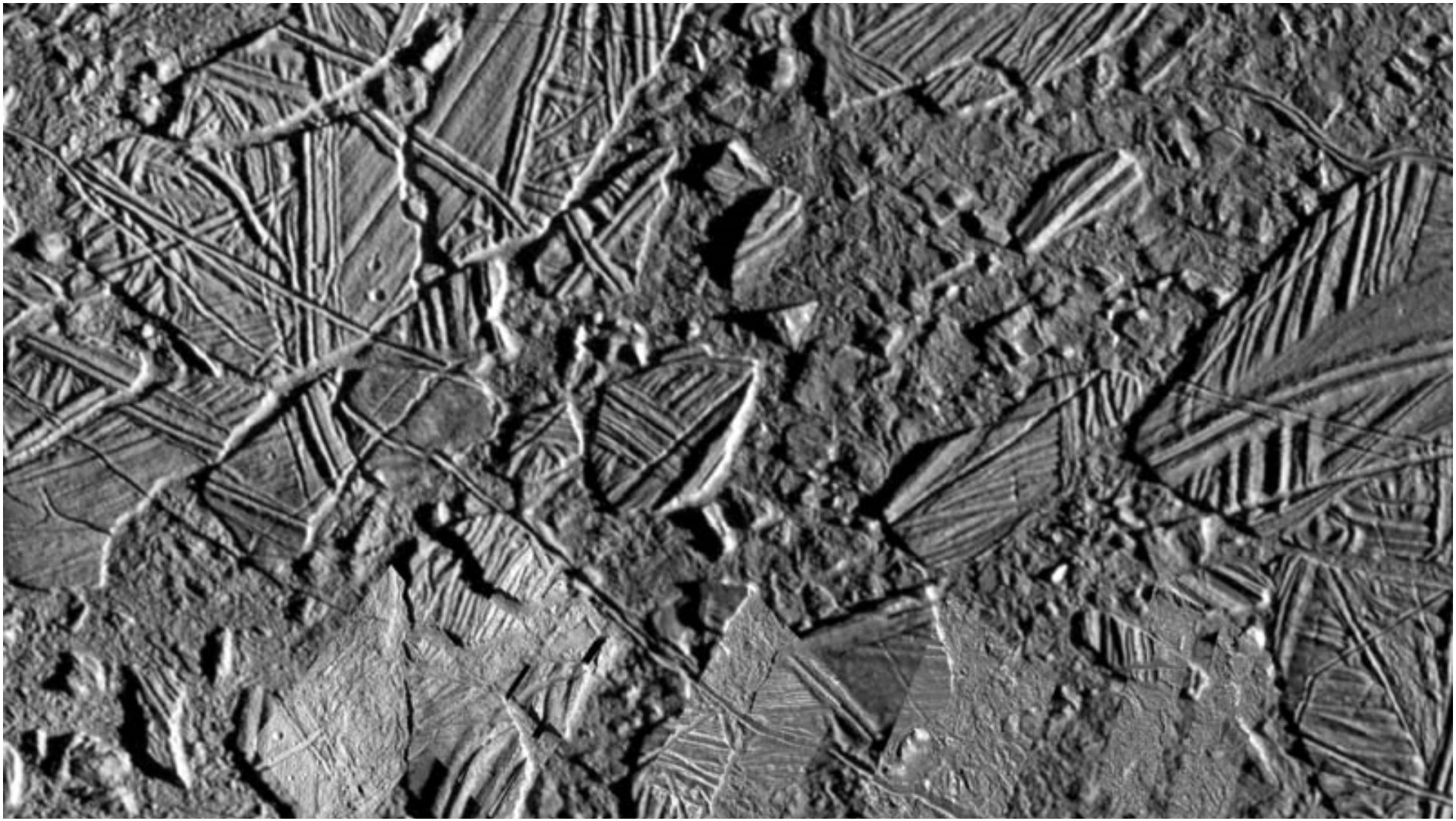
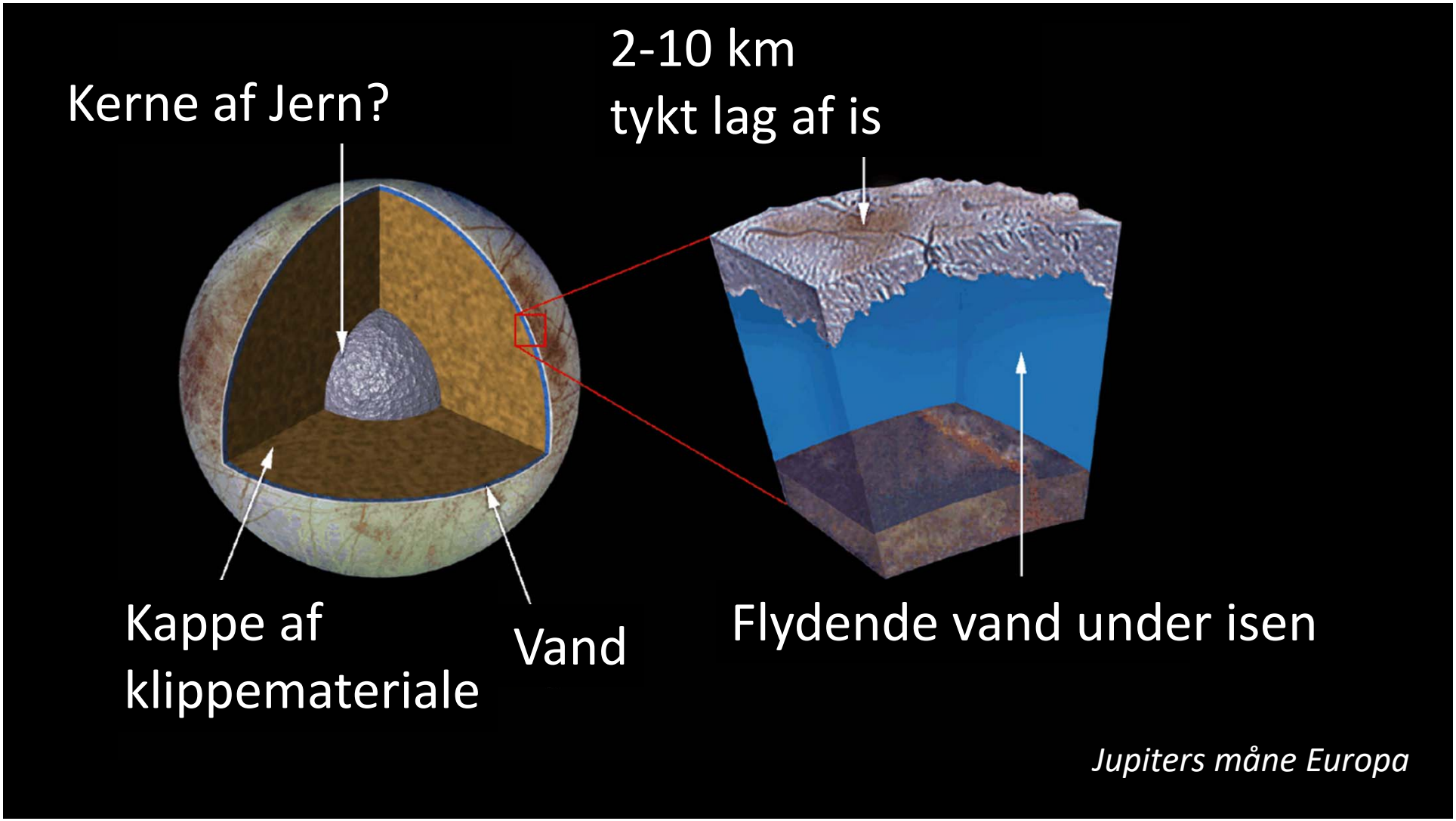
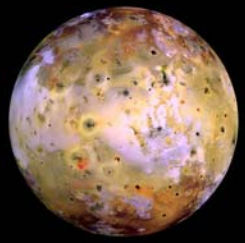

Europa




Kerne af Jern?
2-10 km
tykt lag af is
Kappe af
klippemateriale
Vand
Flydende vand under isen
Jupiters måne Europa

Vulkaner og dybt ocean…



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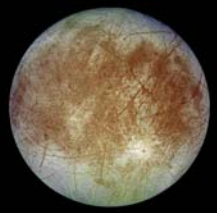

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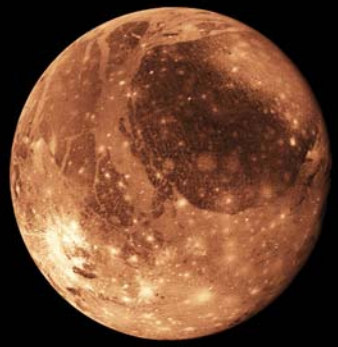

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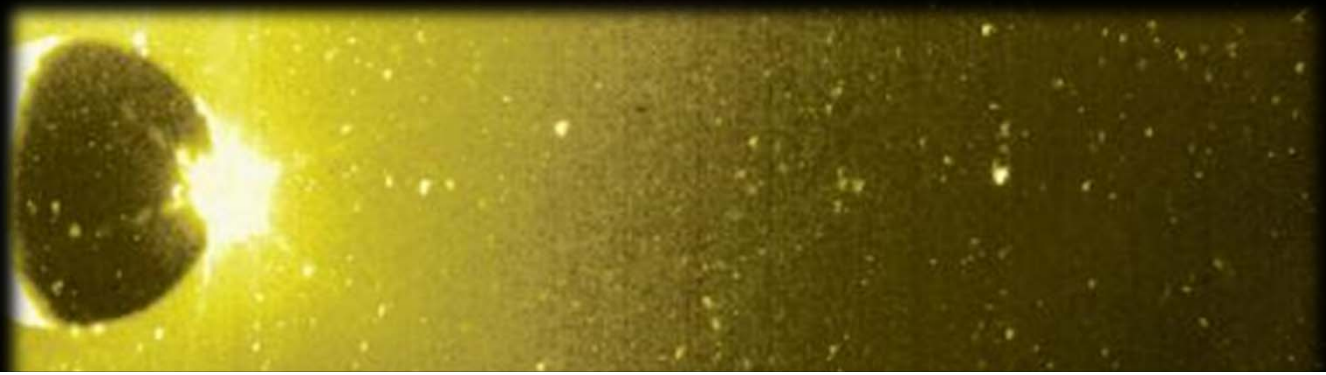

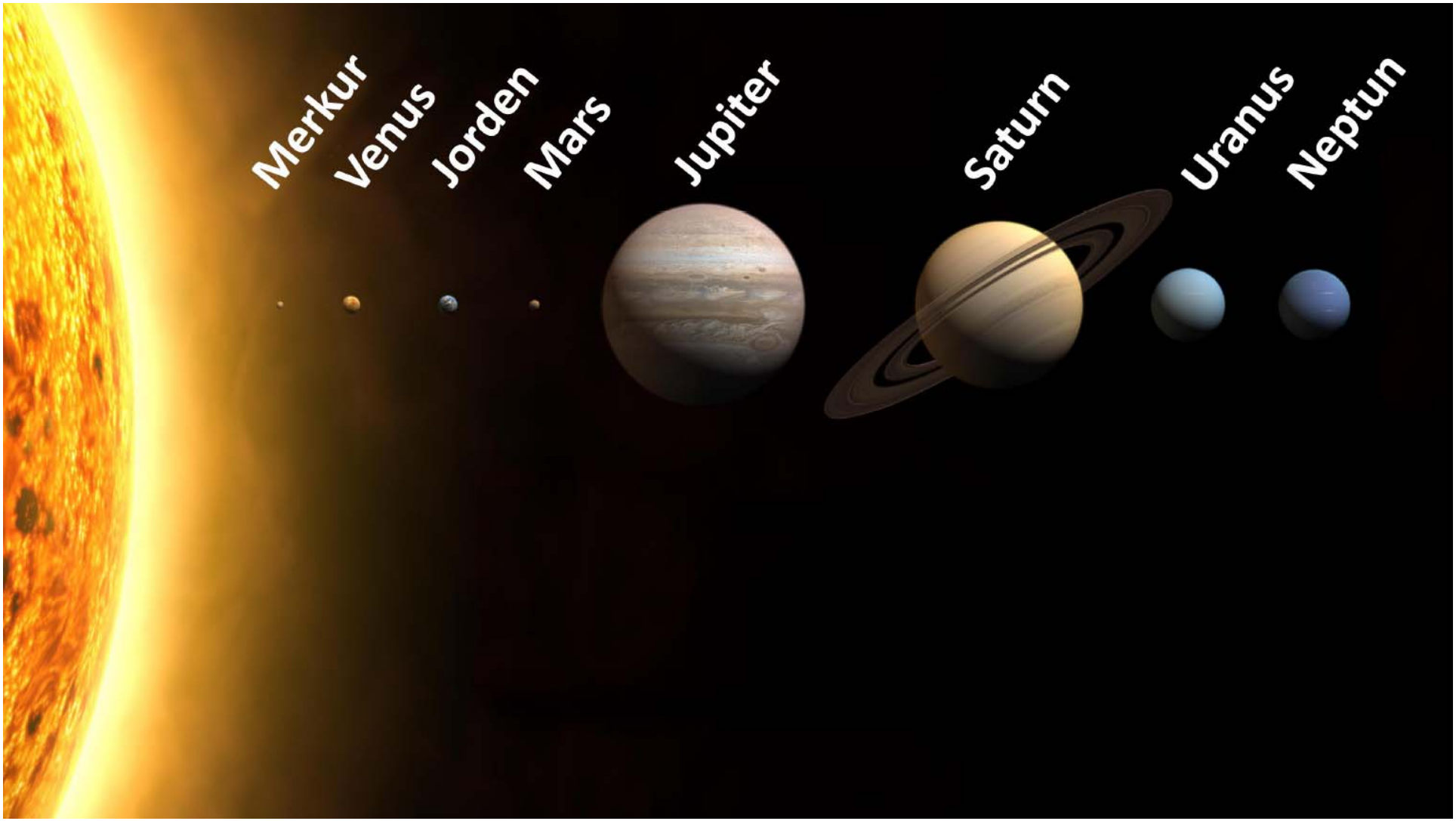
Merkur
Venus
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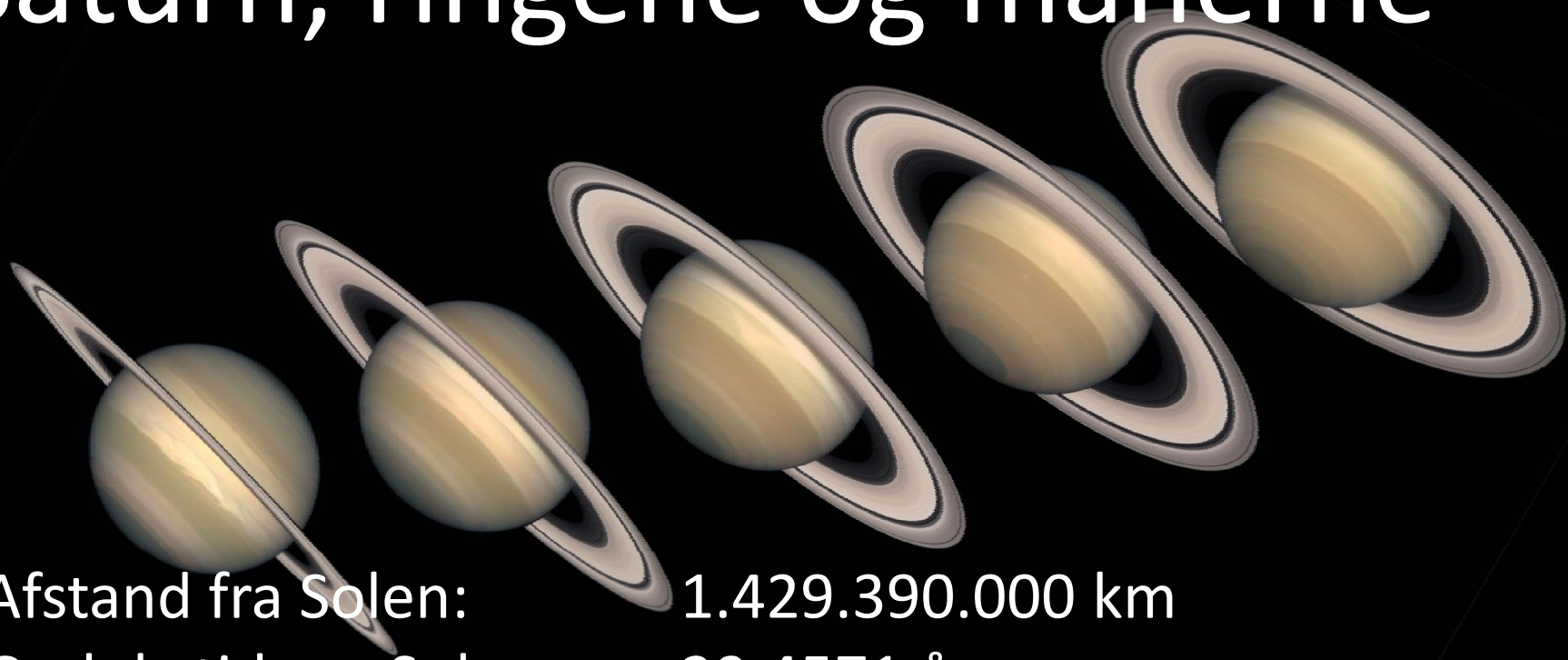
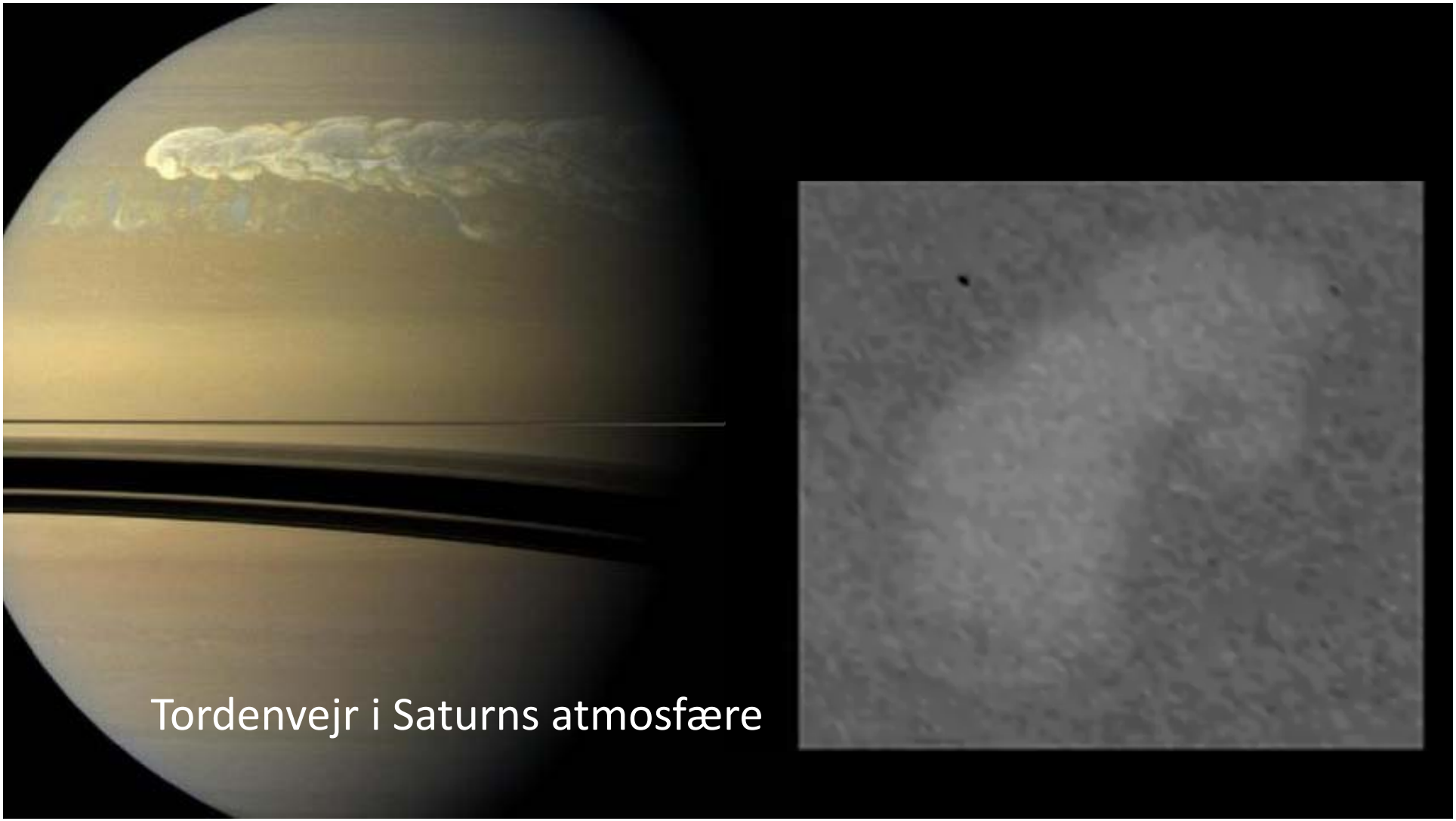
Saturn, ringene og månerne

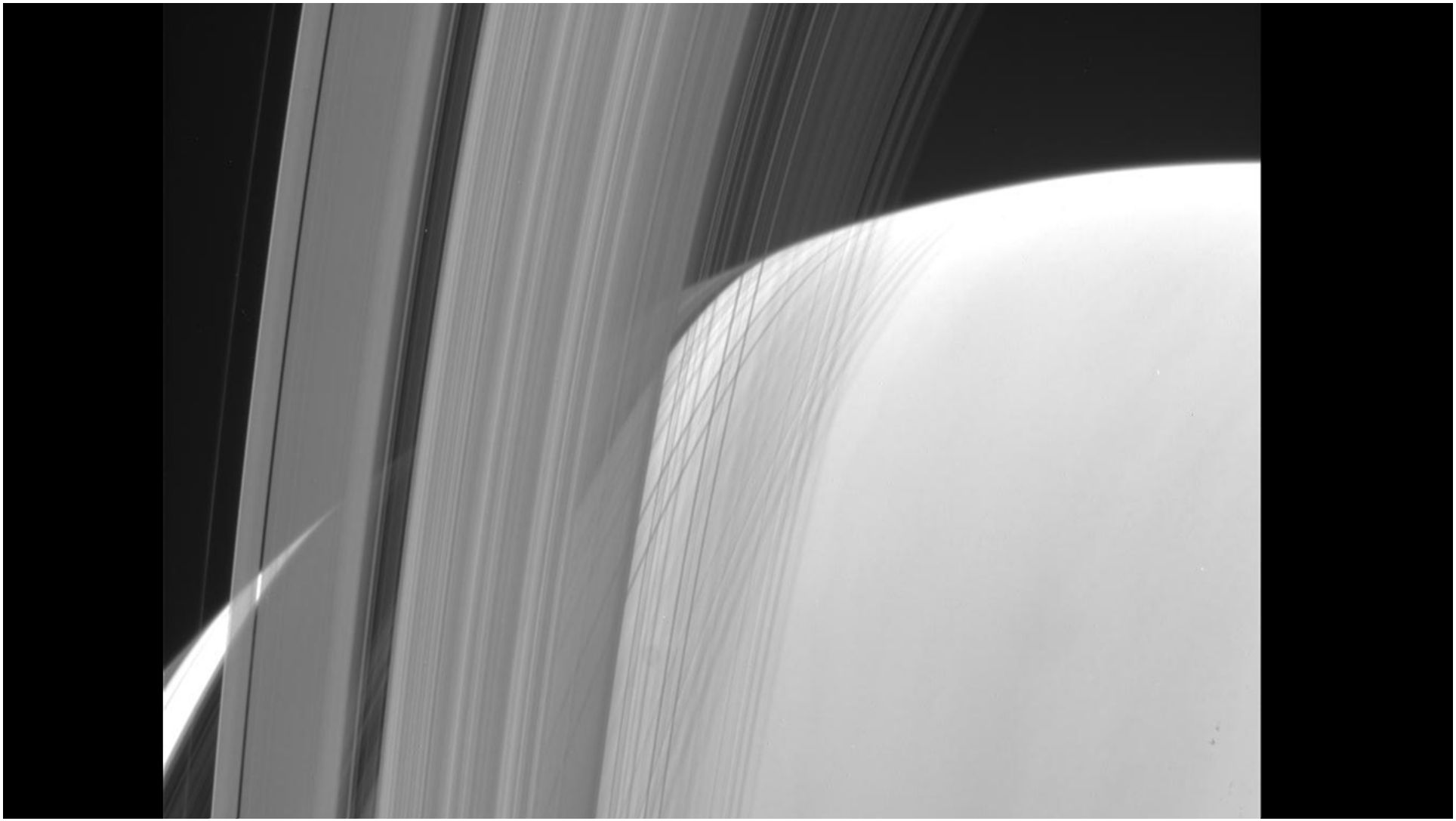


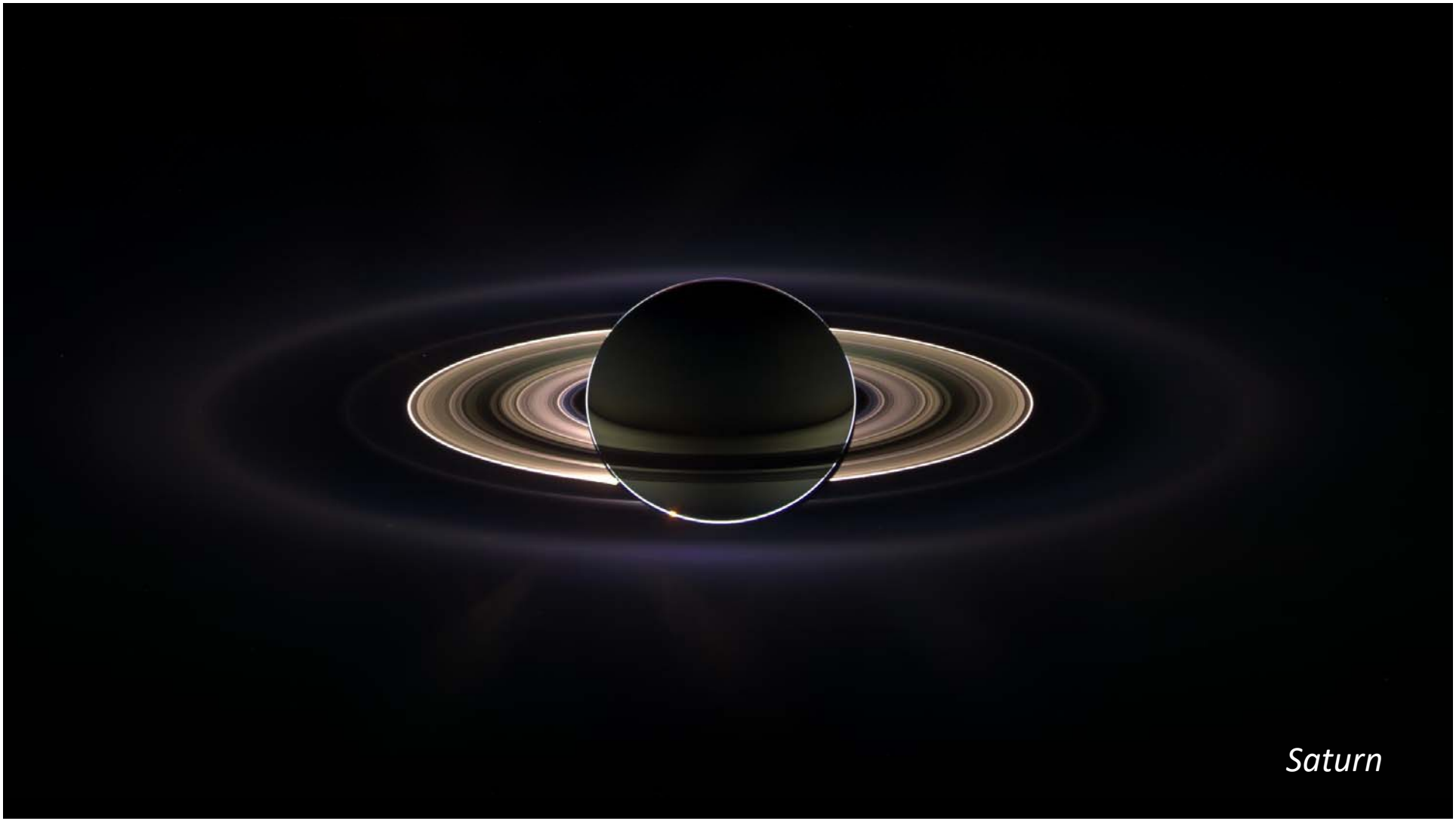
Afstand fra Solen:	1.429.390.000 km
Omløbstid om Solen:	29,4571 år
Diameter:	116.464 km



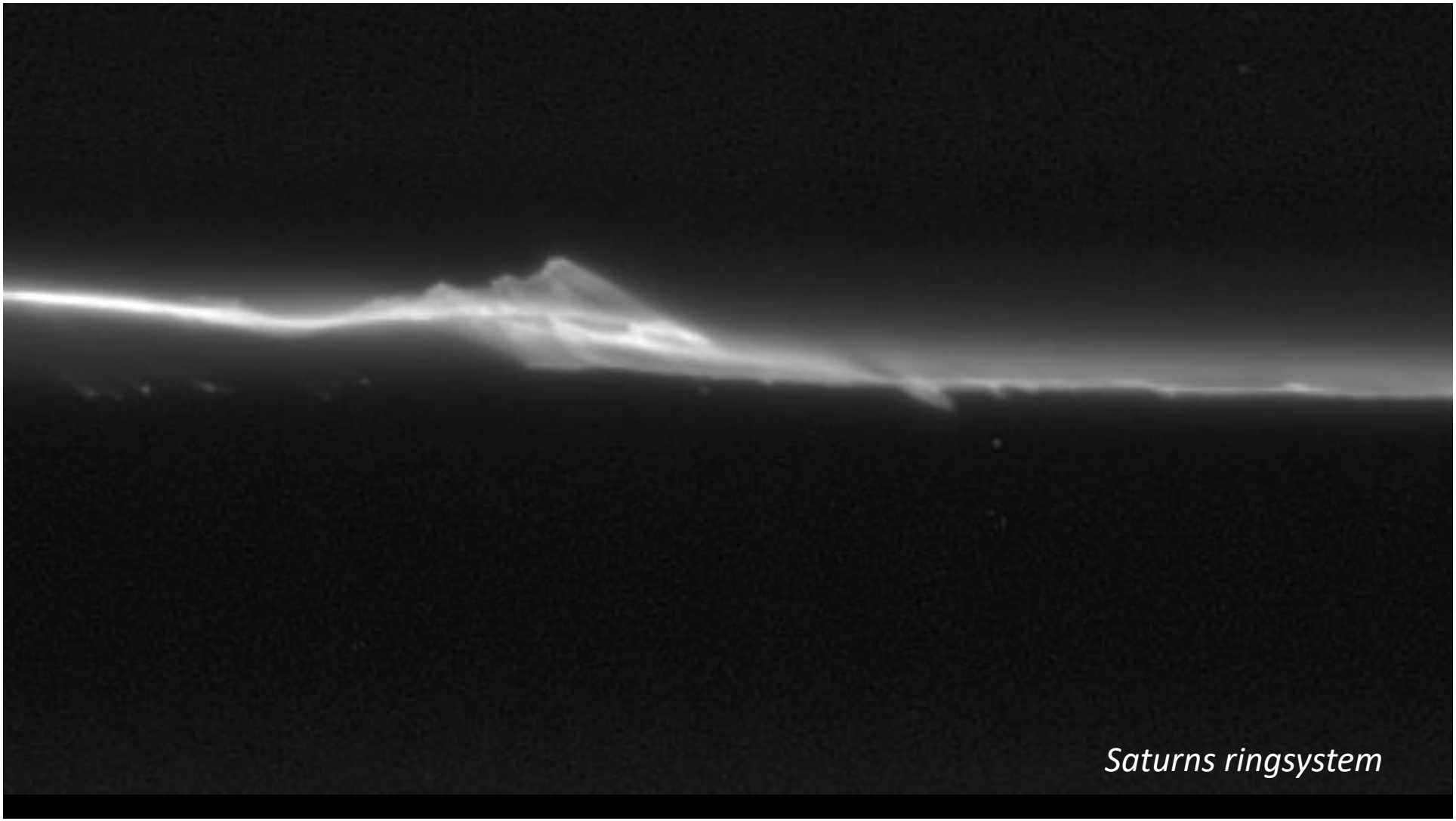
Tordenvejr i Saturns atmosfære

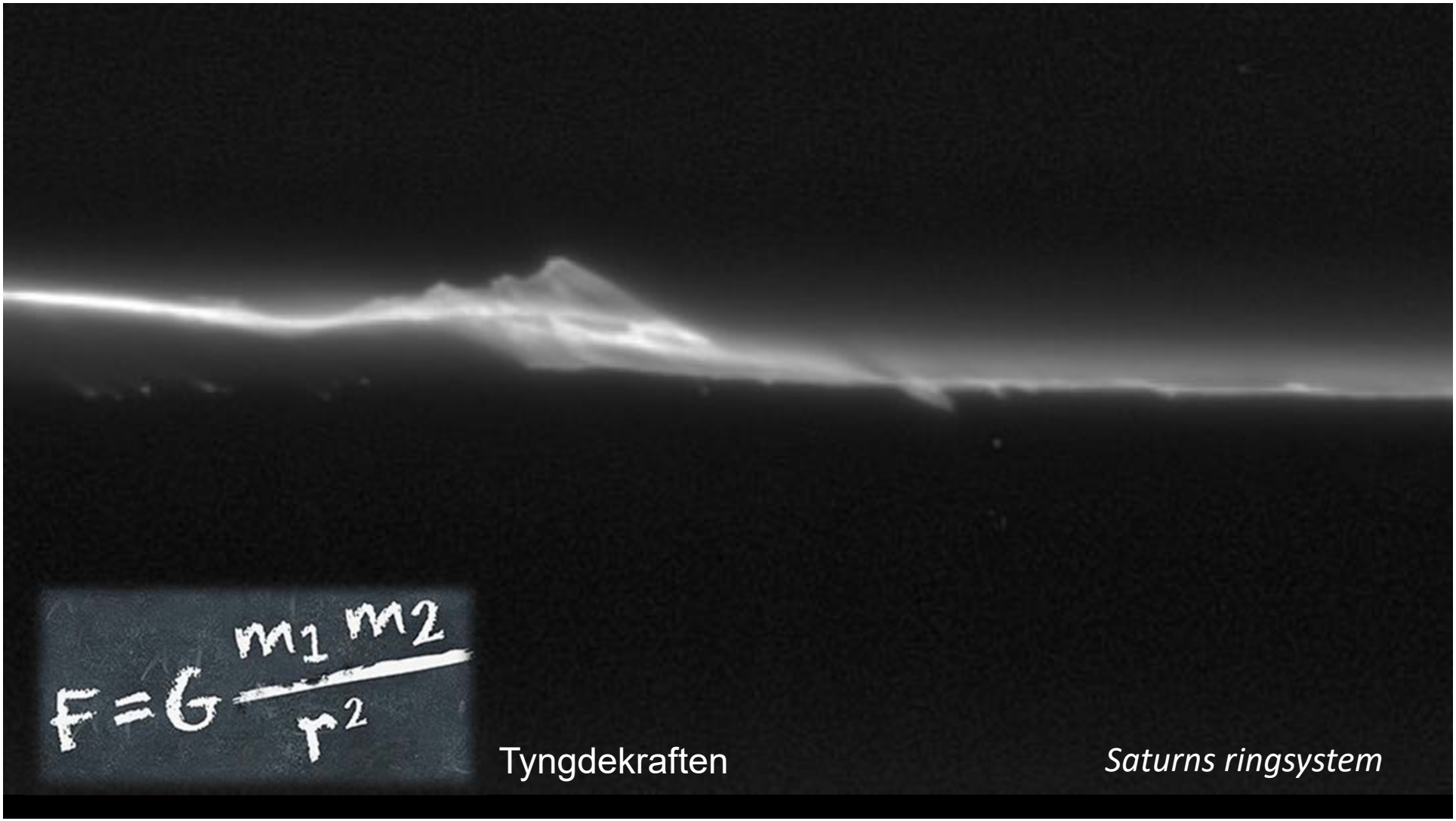

Tegning af ringen…





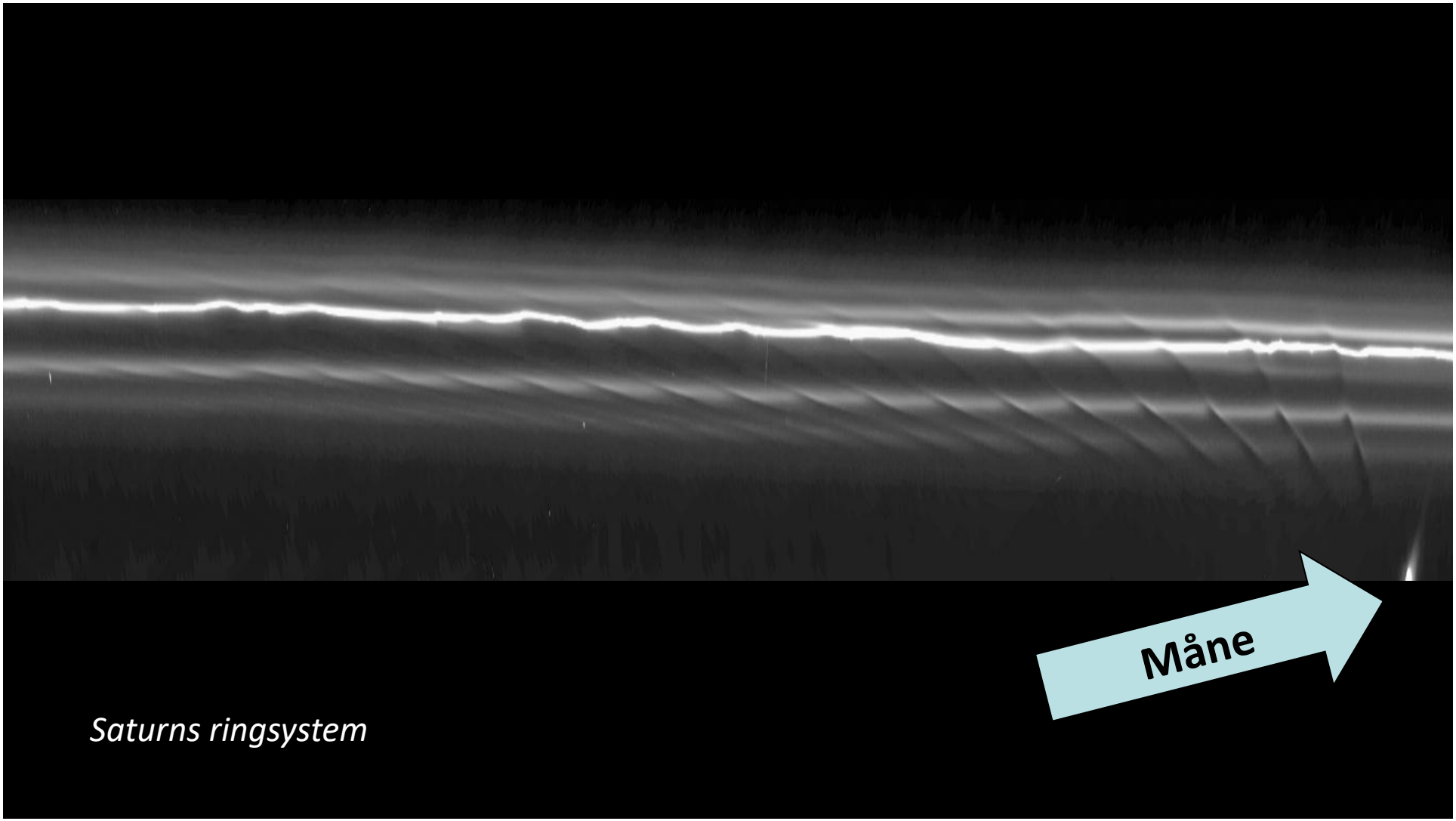
Saturn


Saturns ringsystem

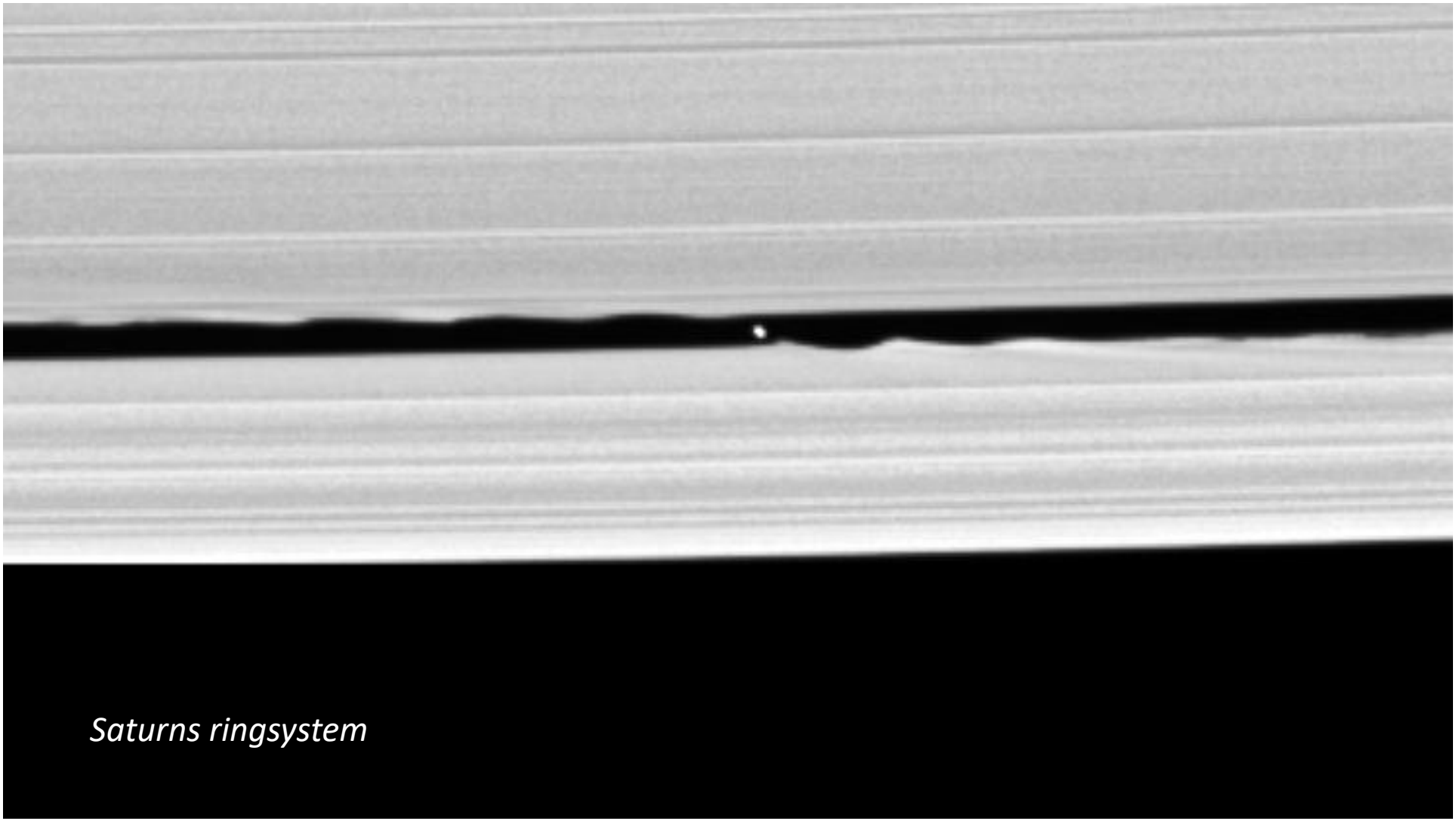


Tyngdekraften

Saturns ringsystem



Saturns ringsystem



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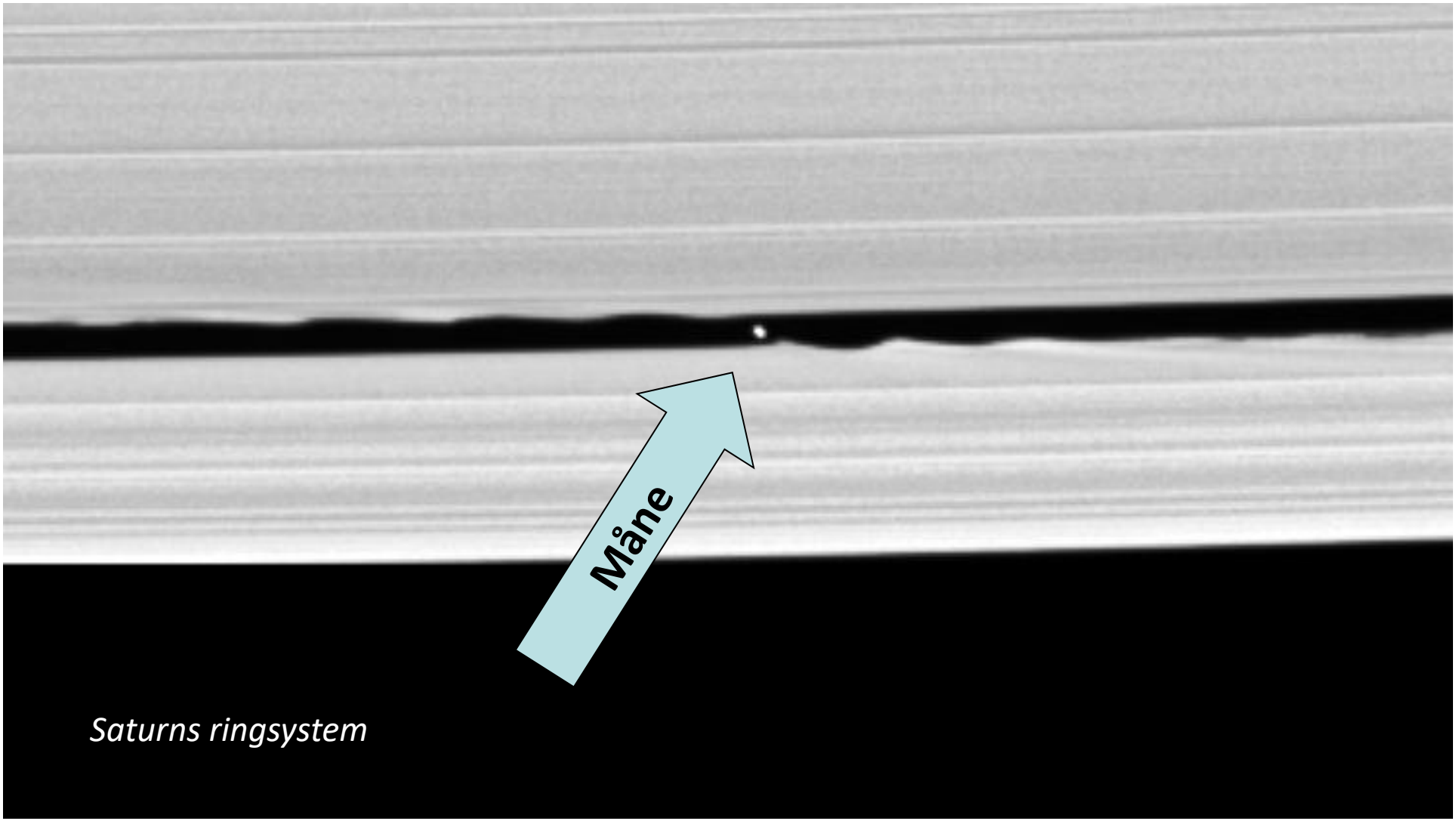

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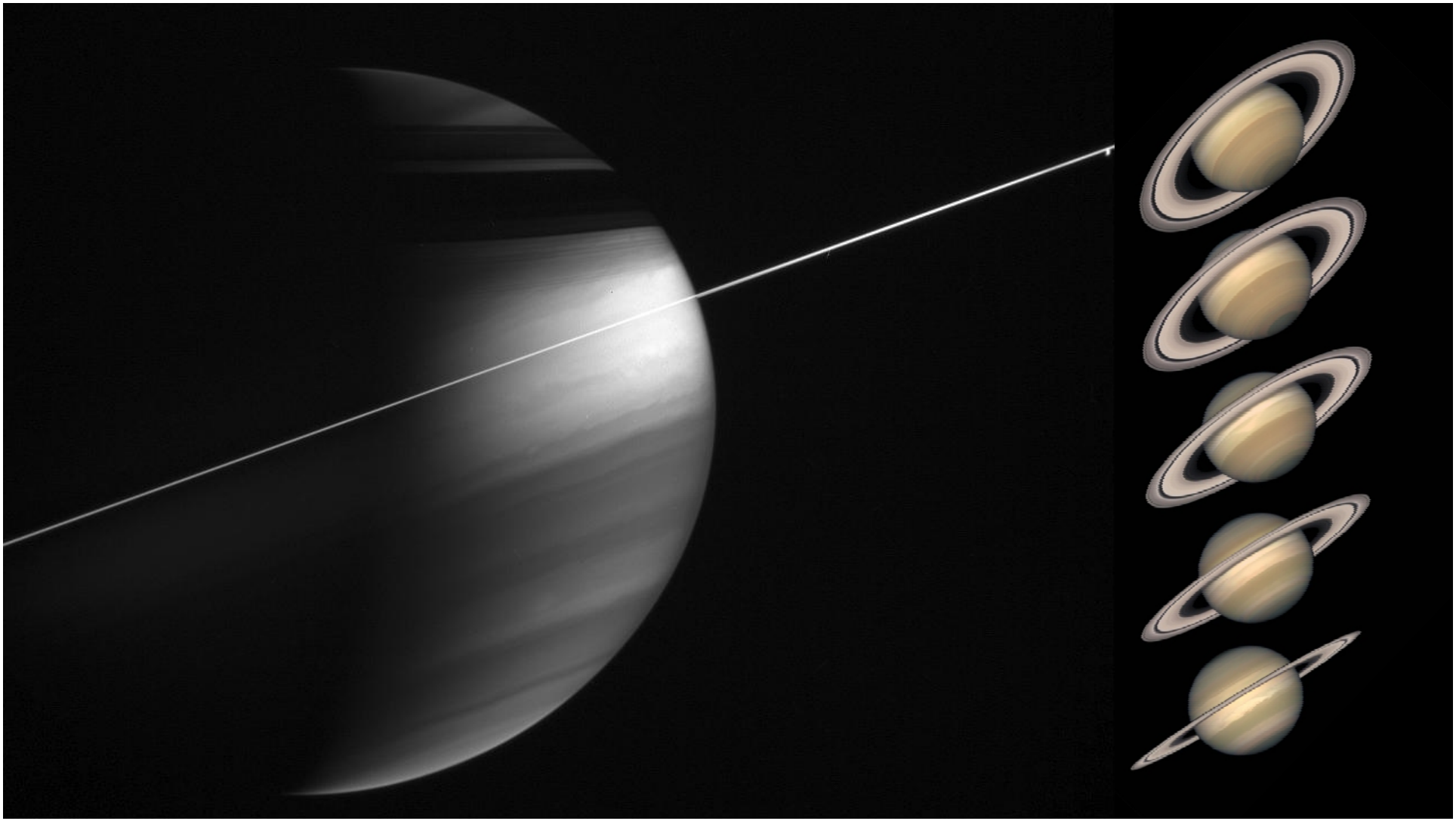
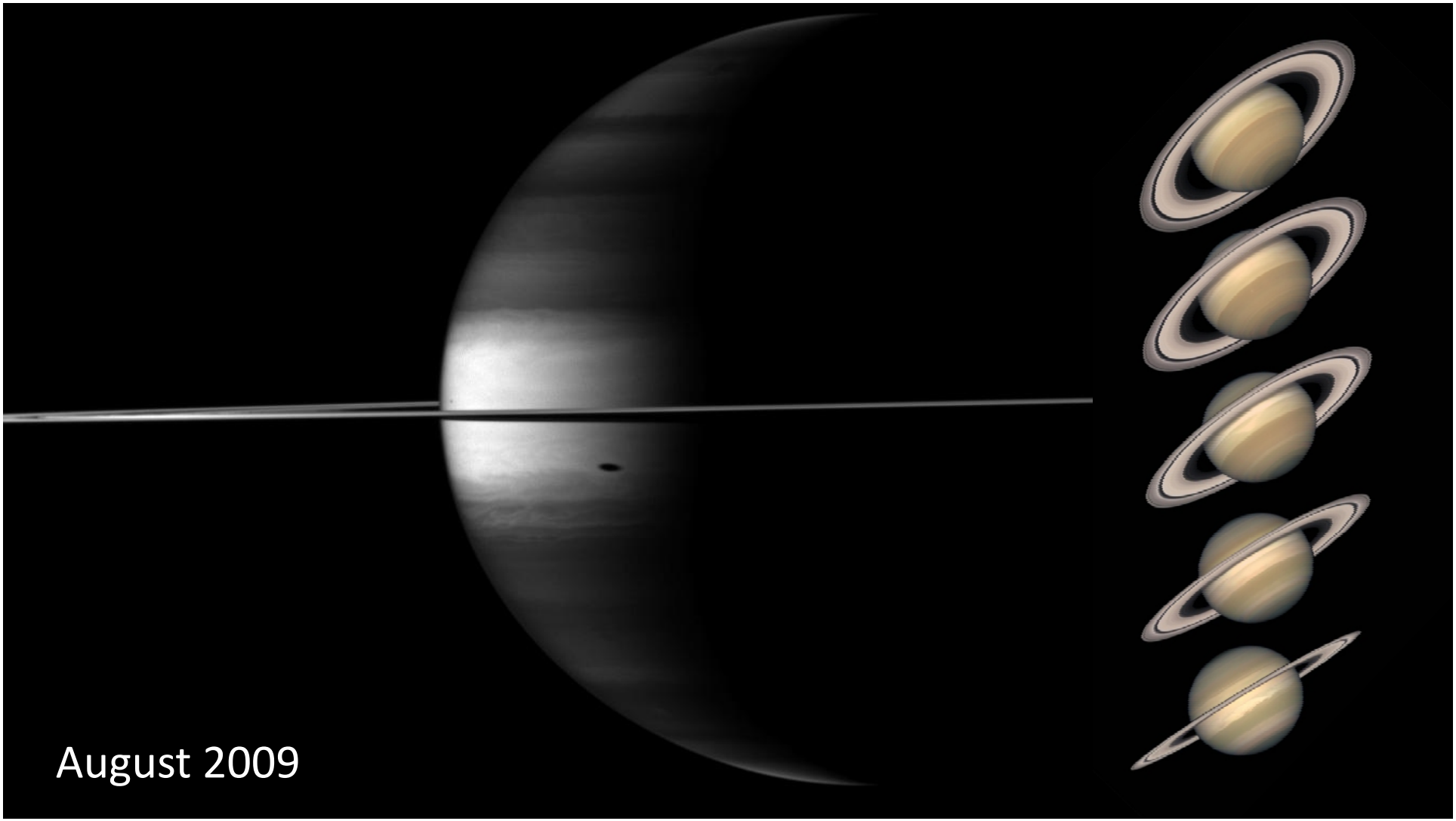
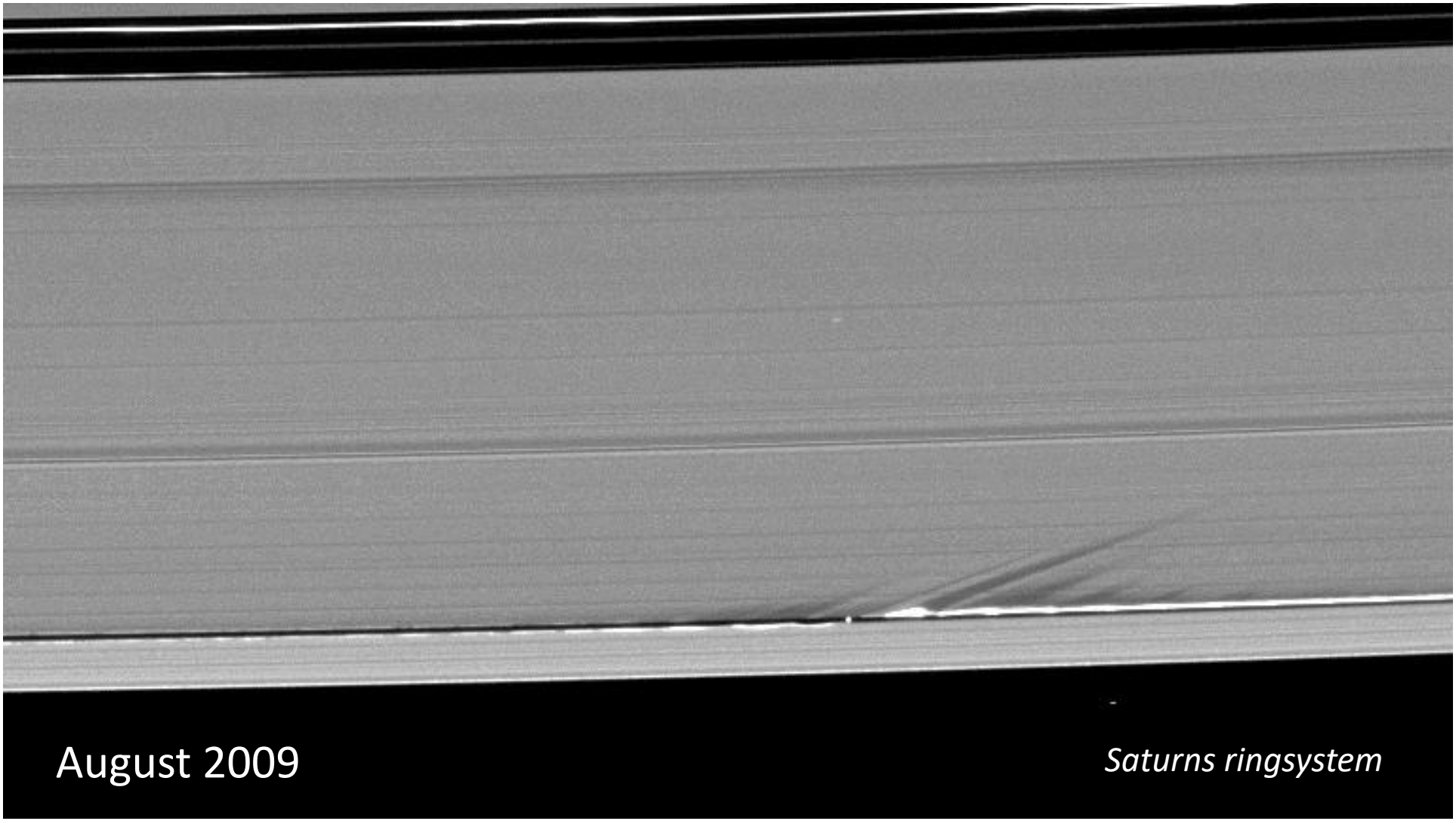



August 2009



August 2009

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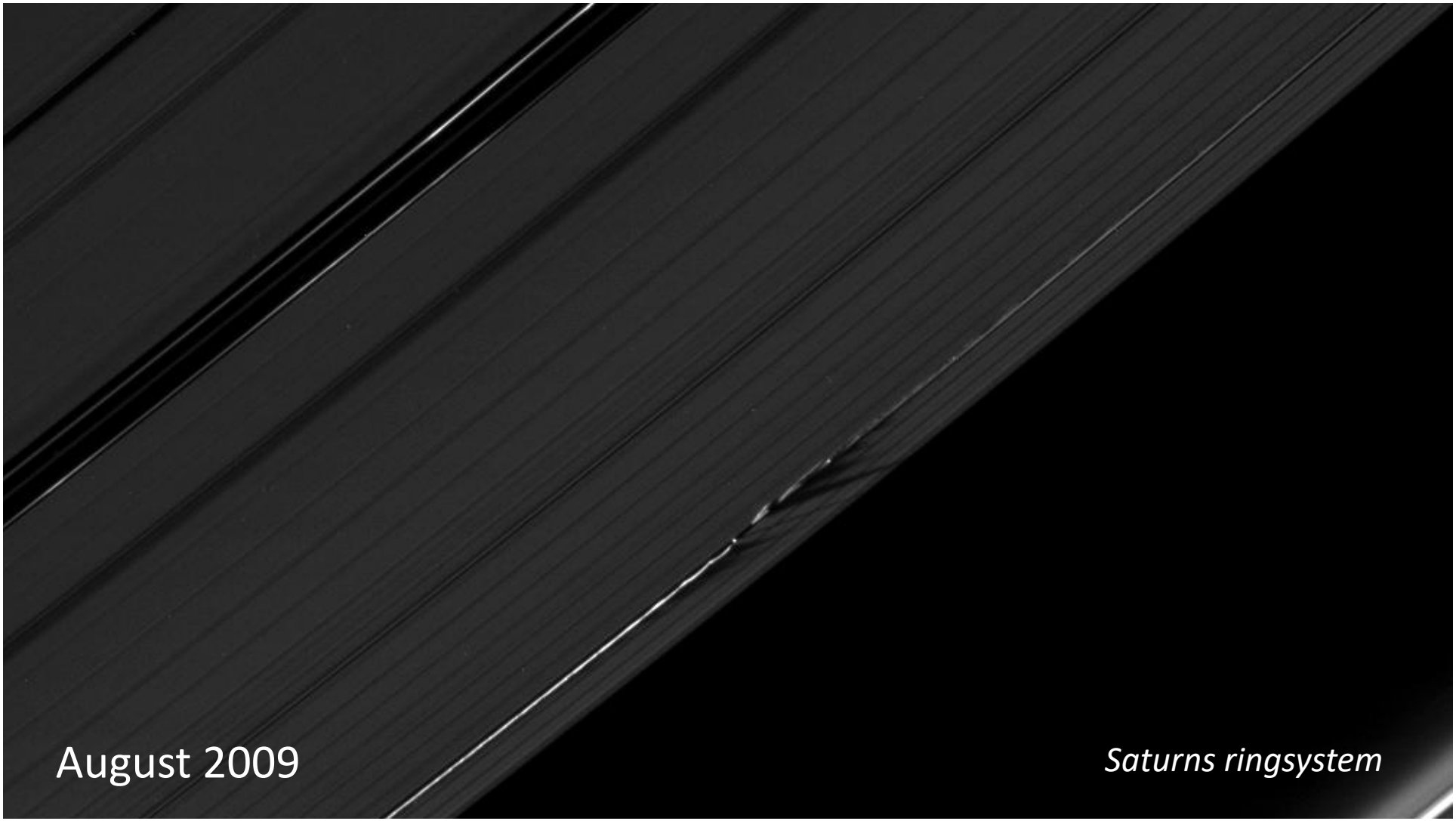
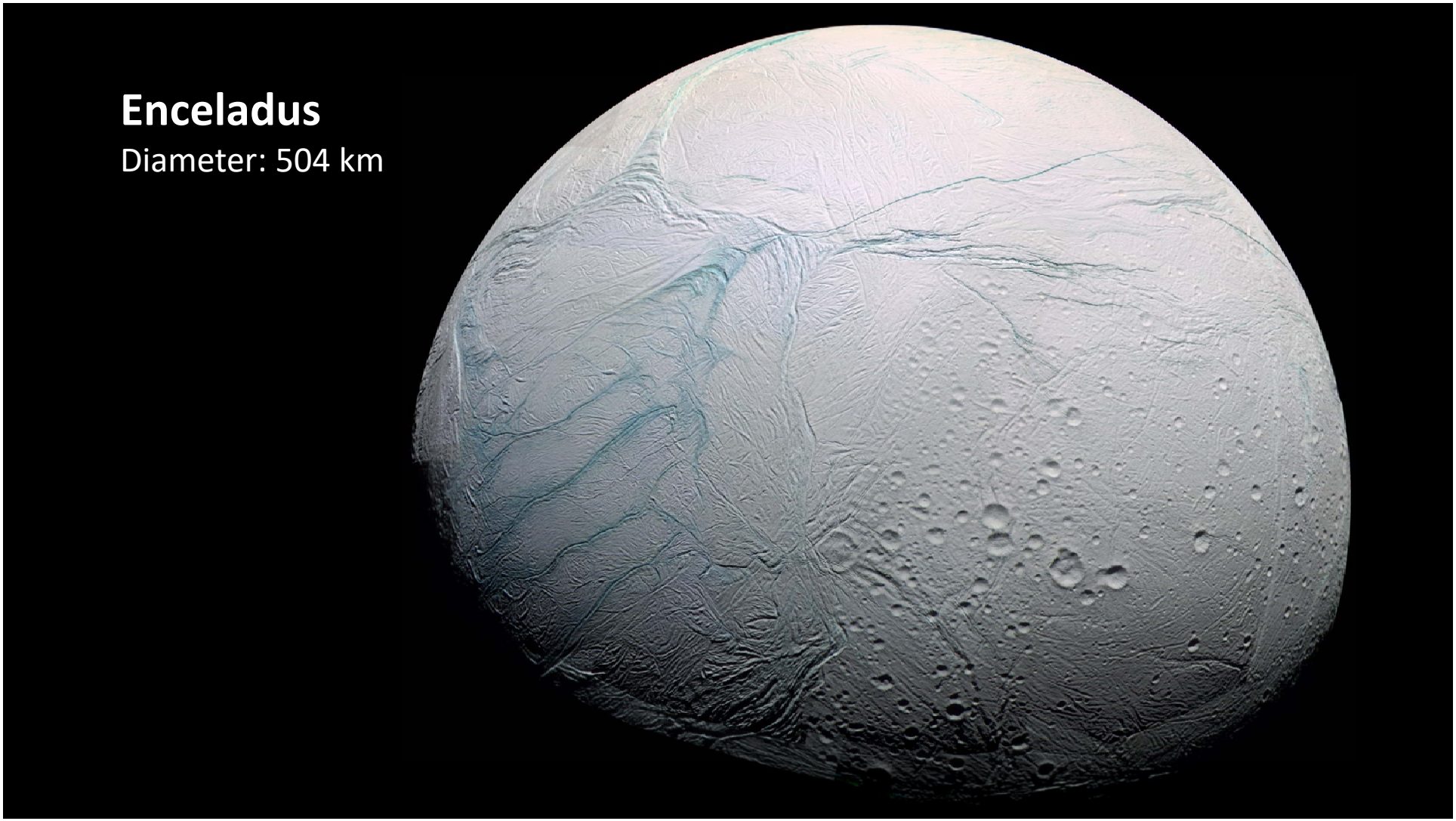
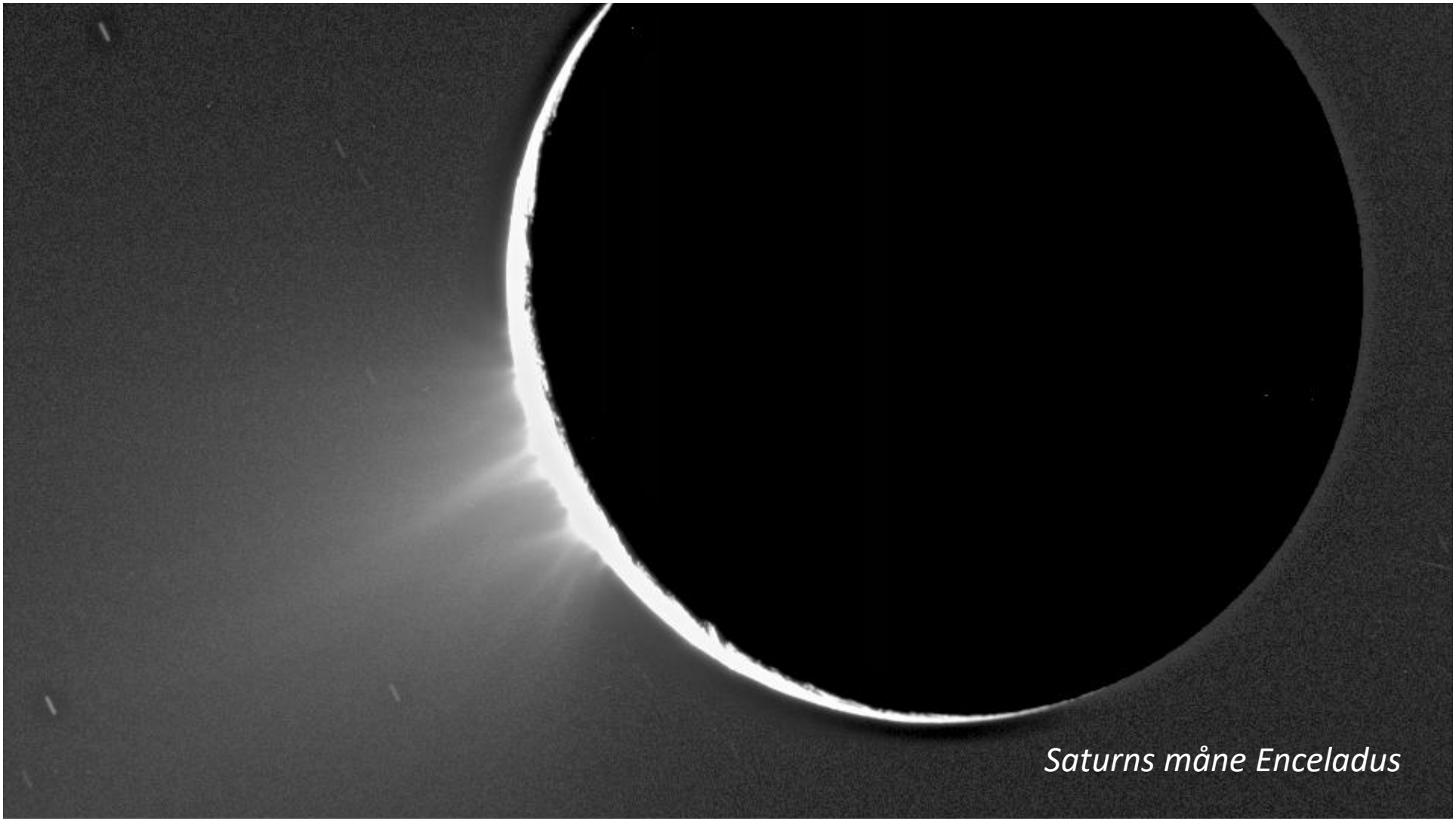

August 2009
Saturns ringsystem

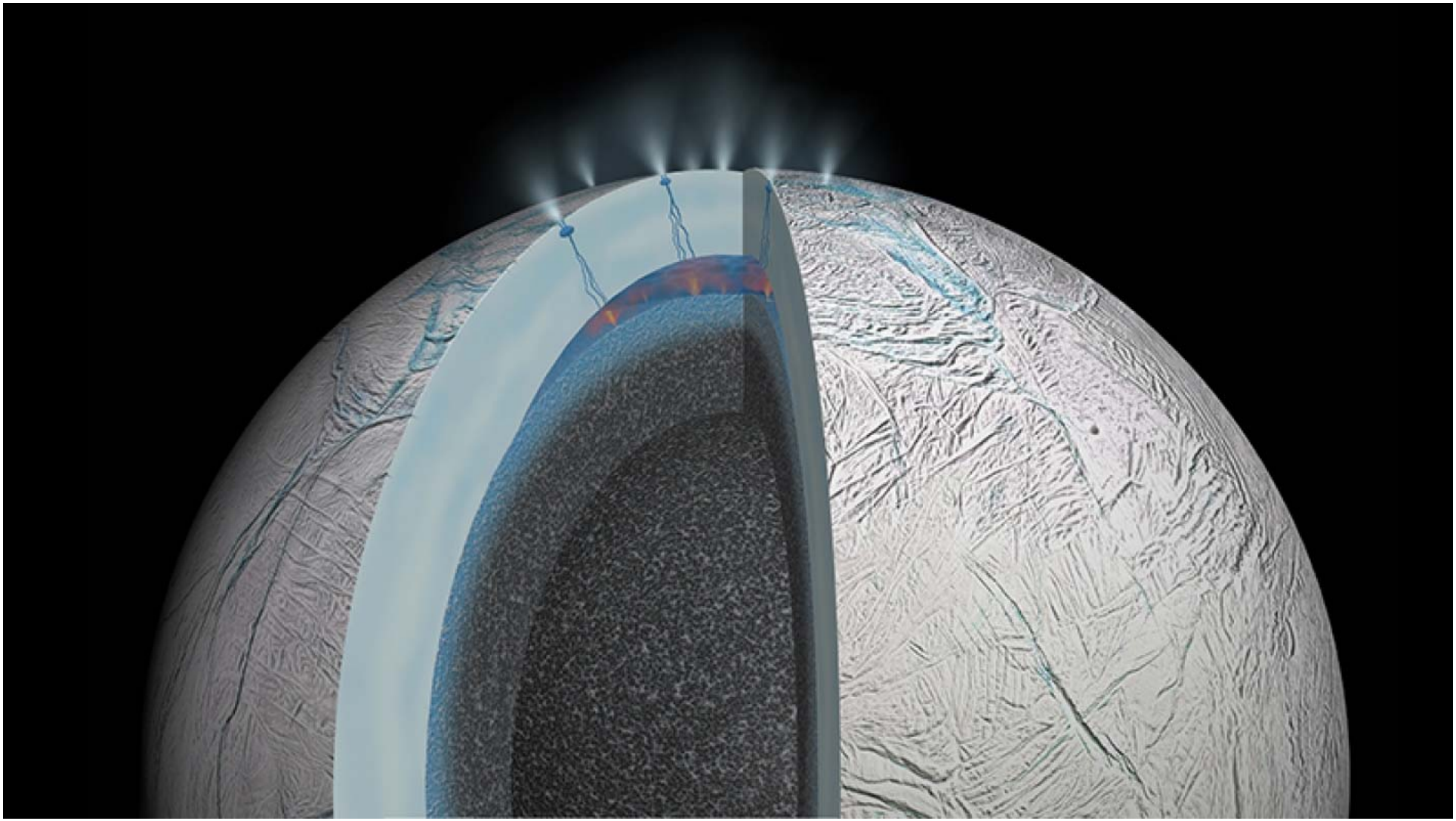
Enceladus

Diameter: 504 km

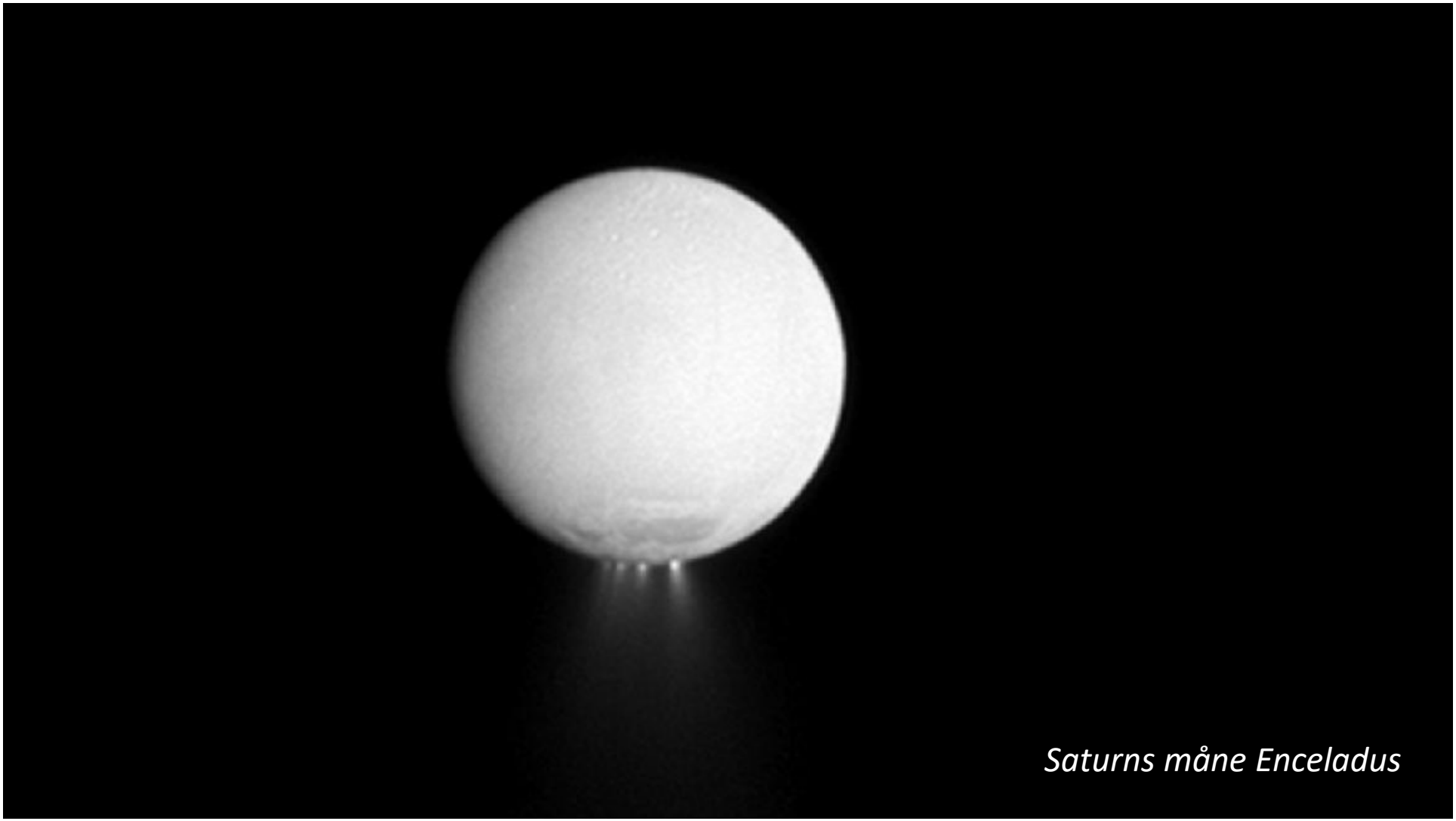




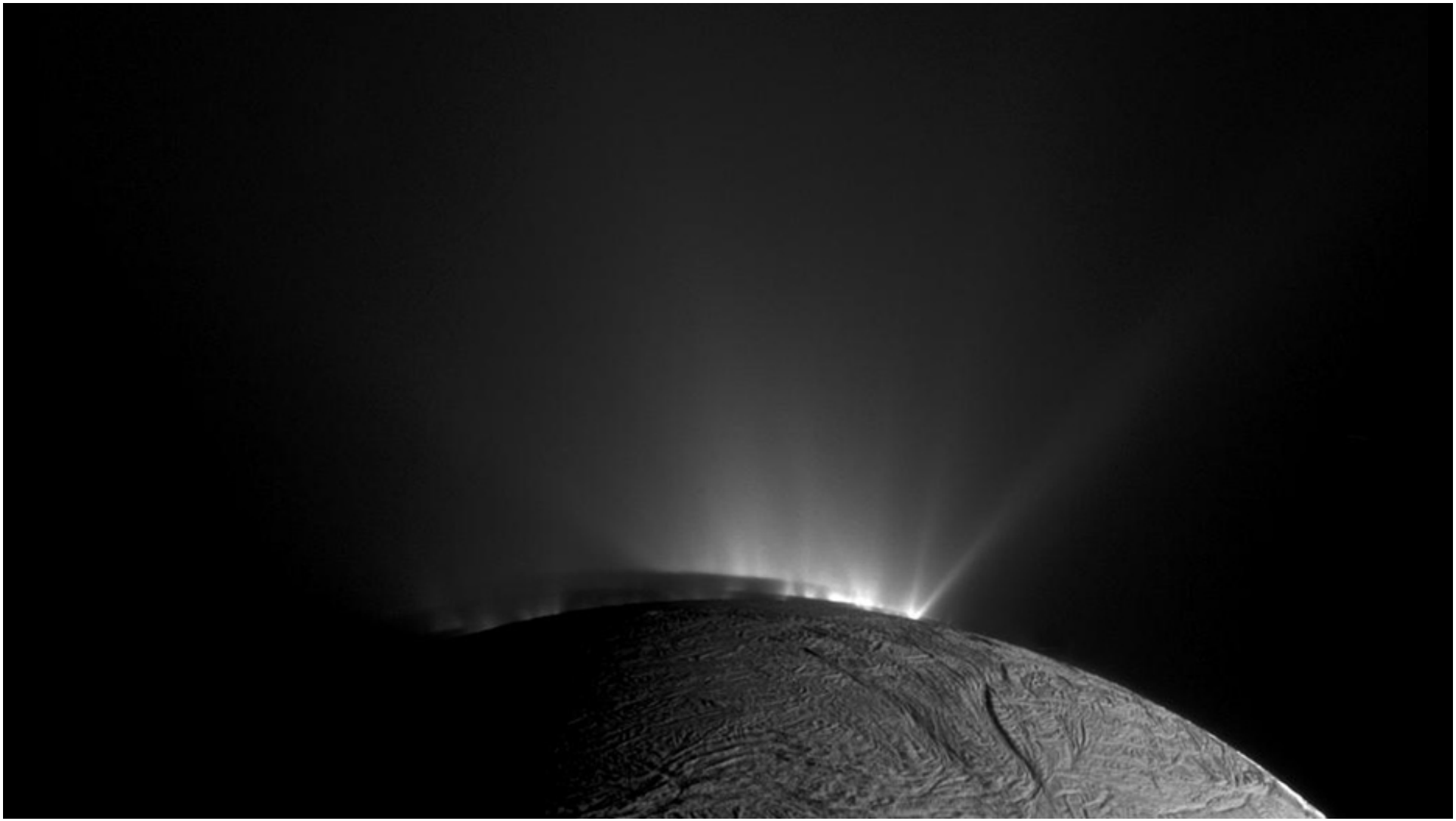
Saturns måne Enceladus



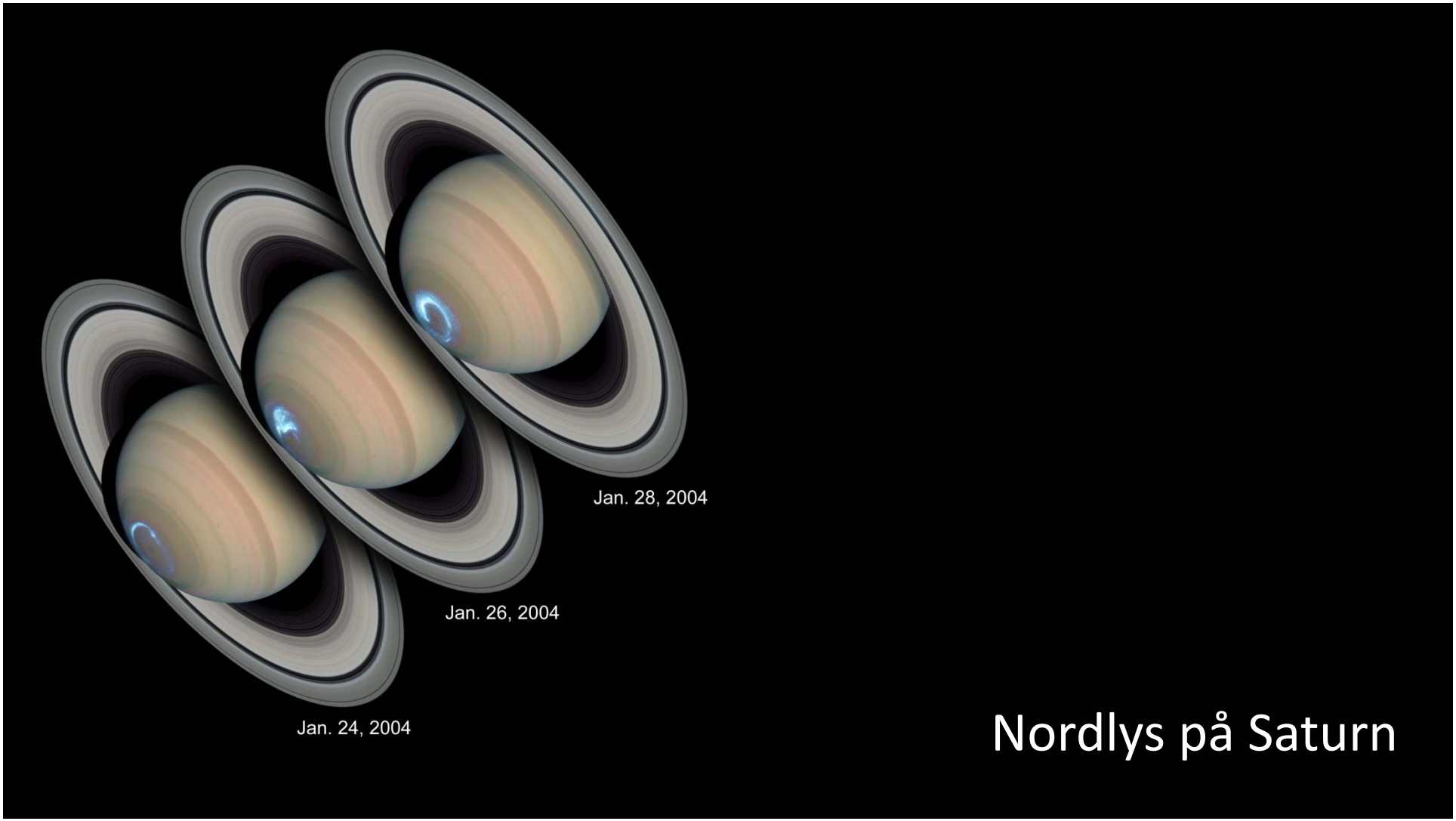
Saturns måne Enceladus



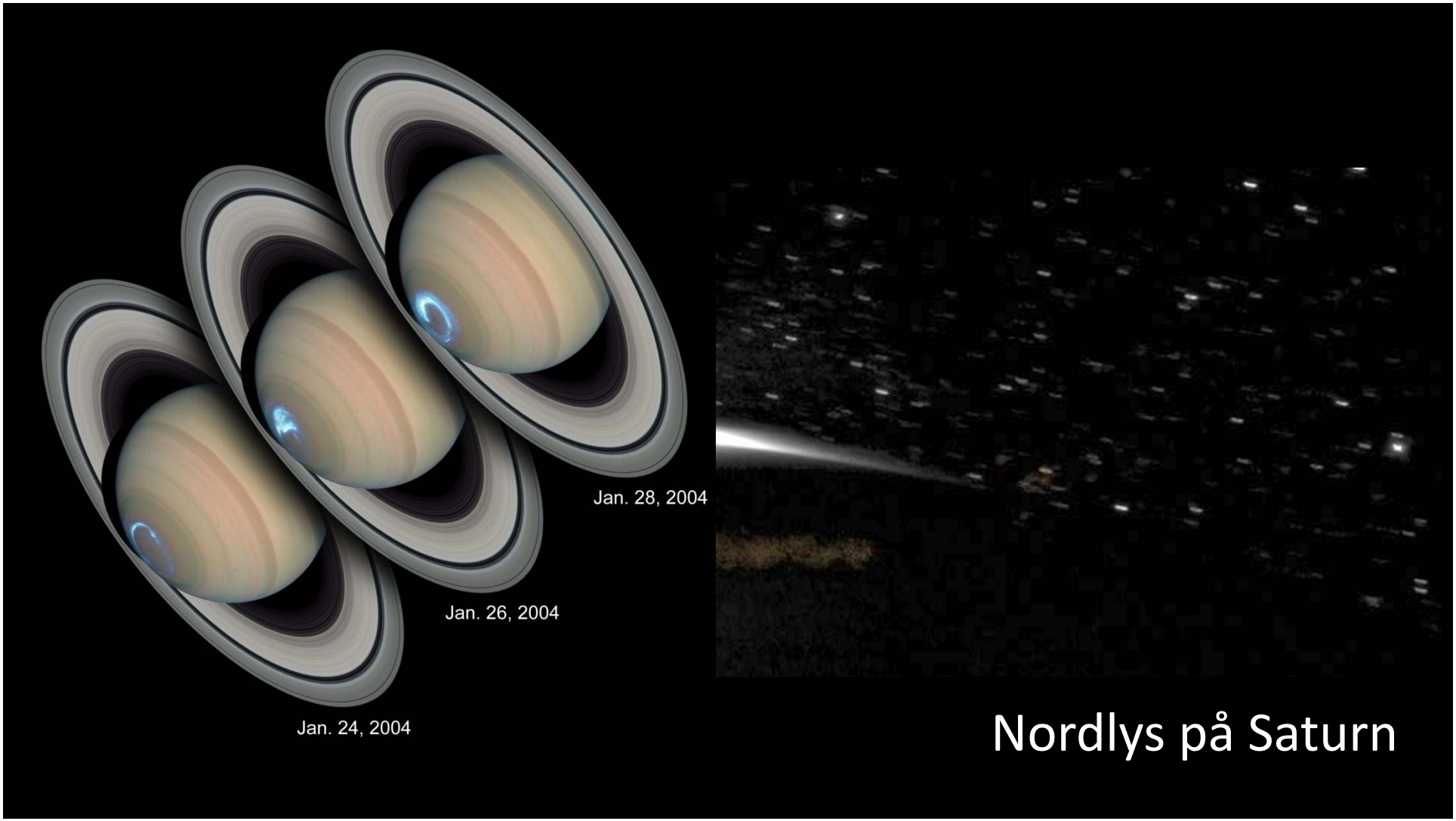
Saturns måne Enceladus



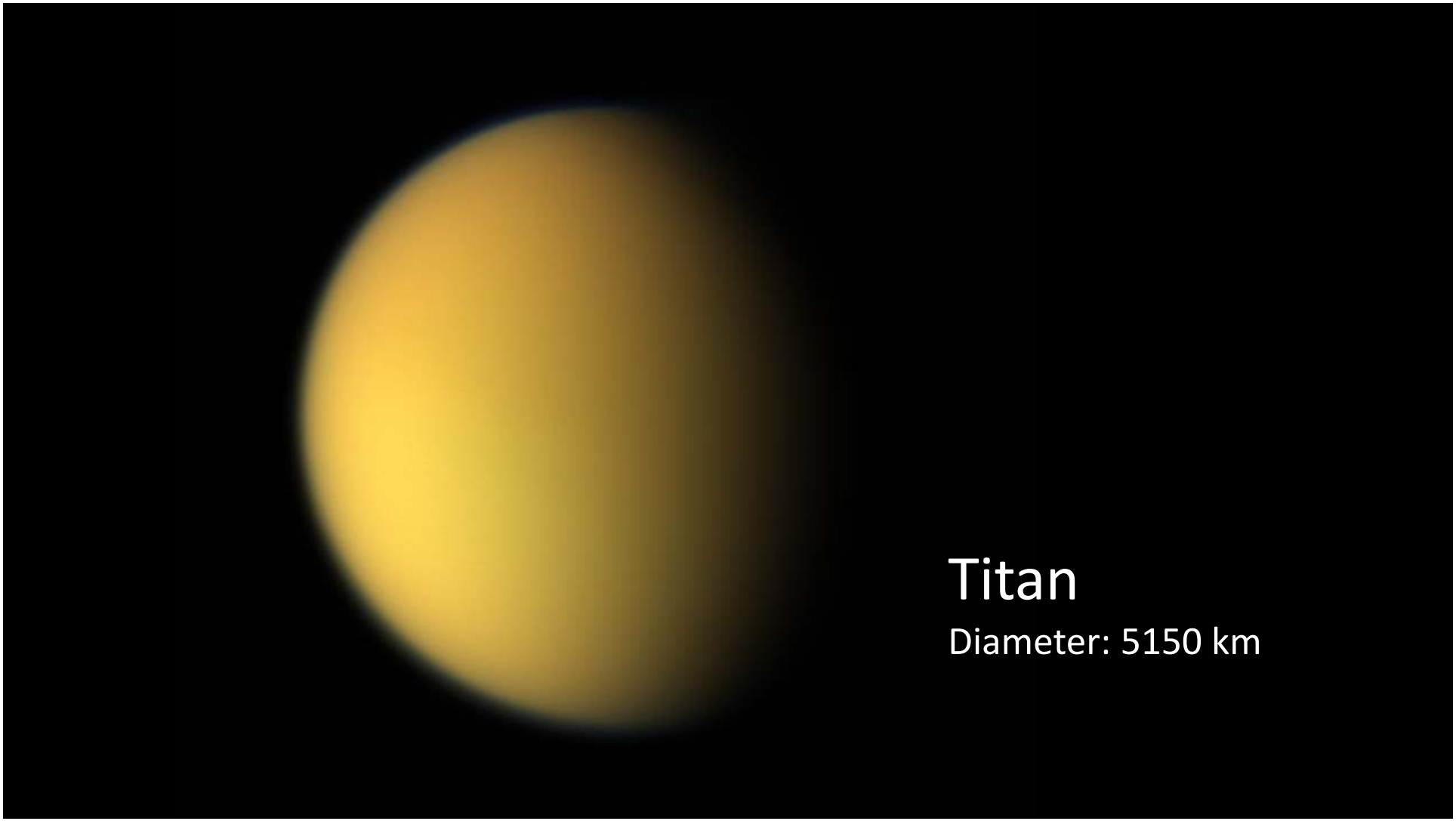

MACIEJ WINIARCZYK ©2014

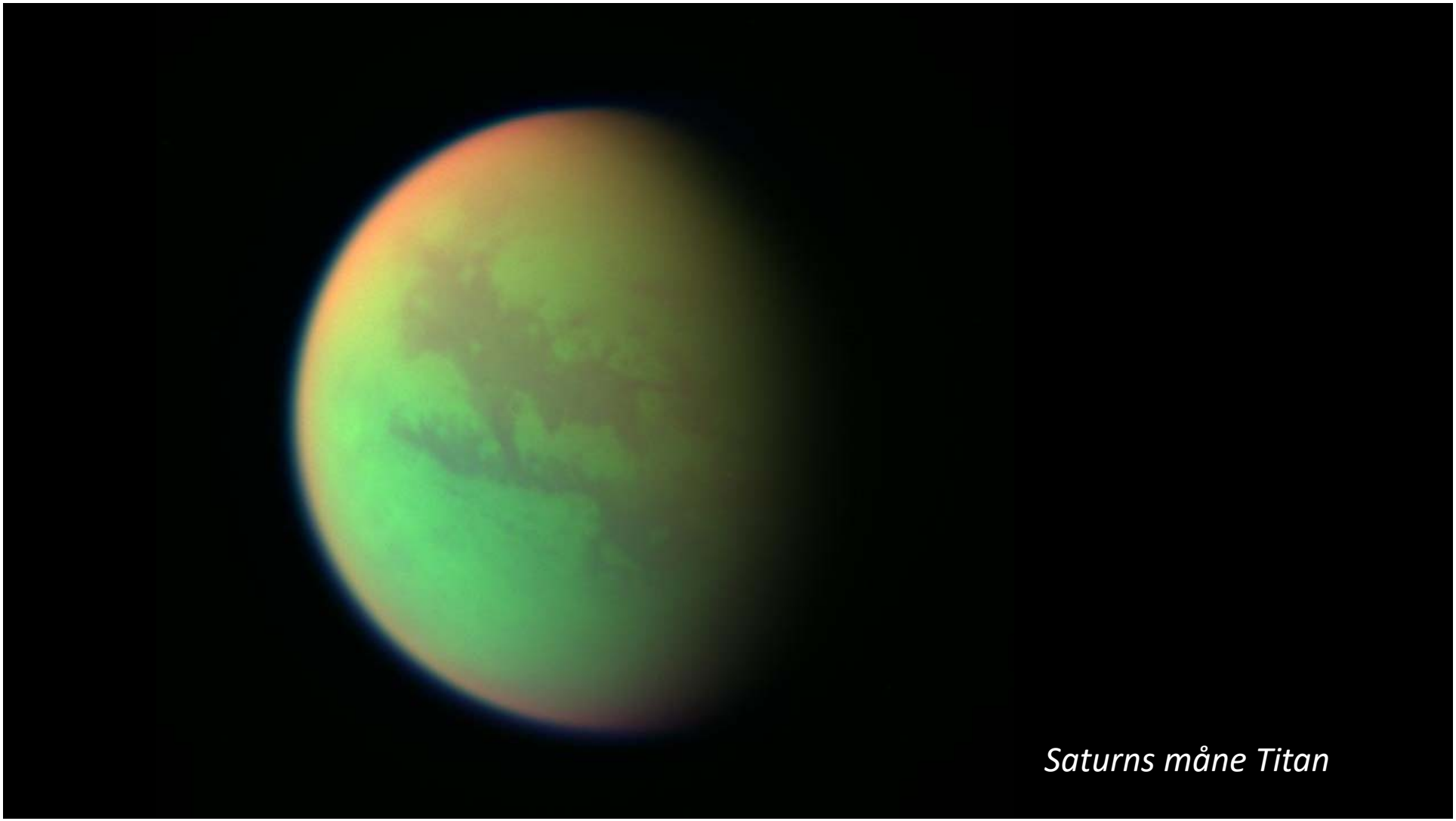


Nordlys på Saturn



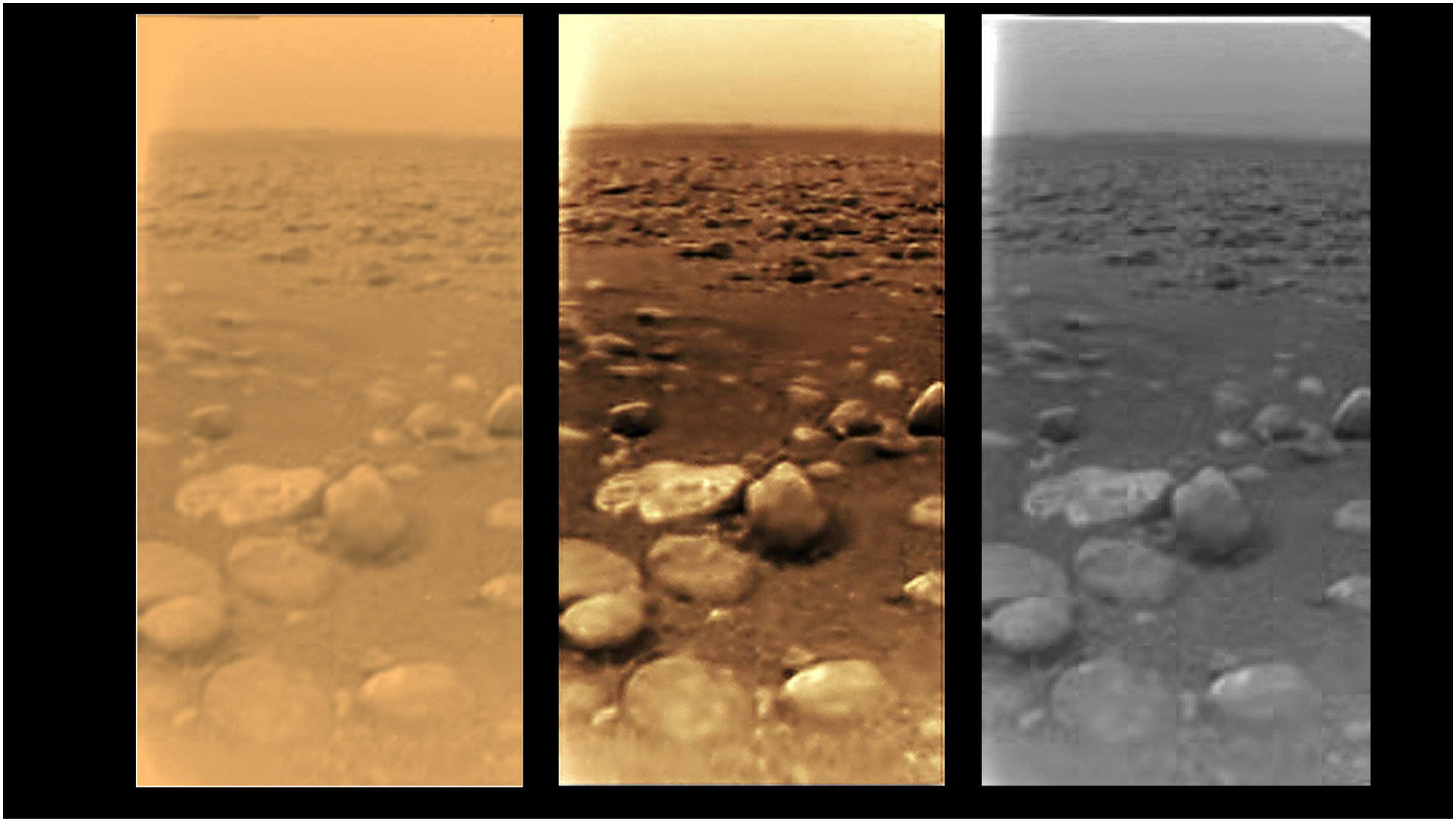
Nordlys på Saturn

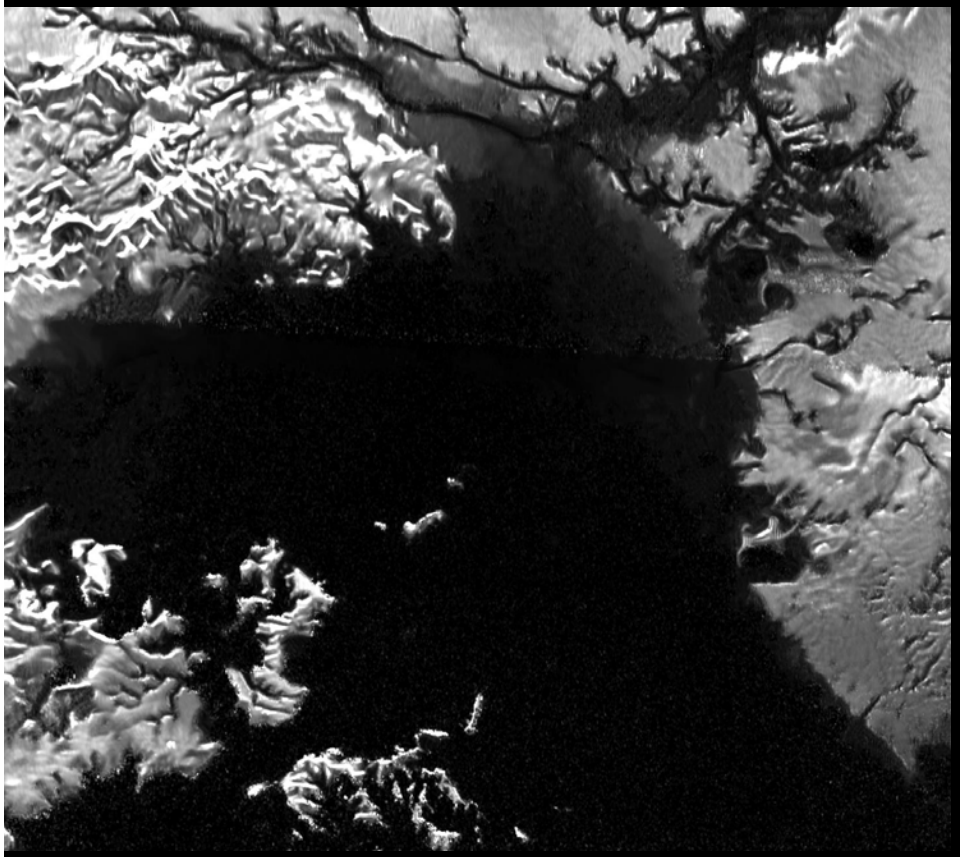

Titan
Diameter: 5150 km



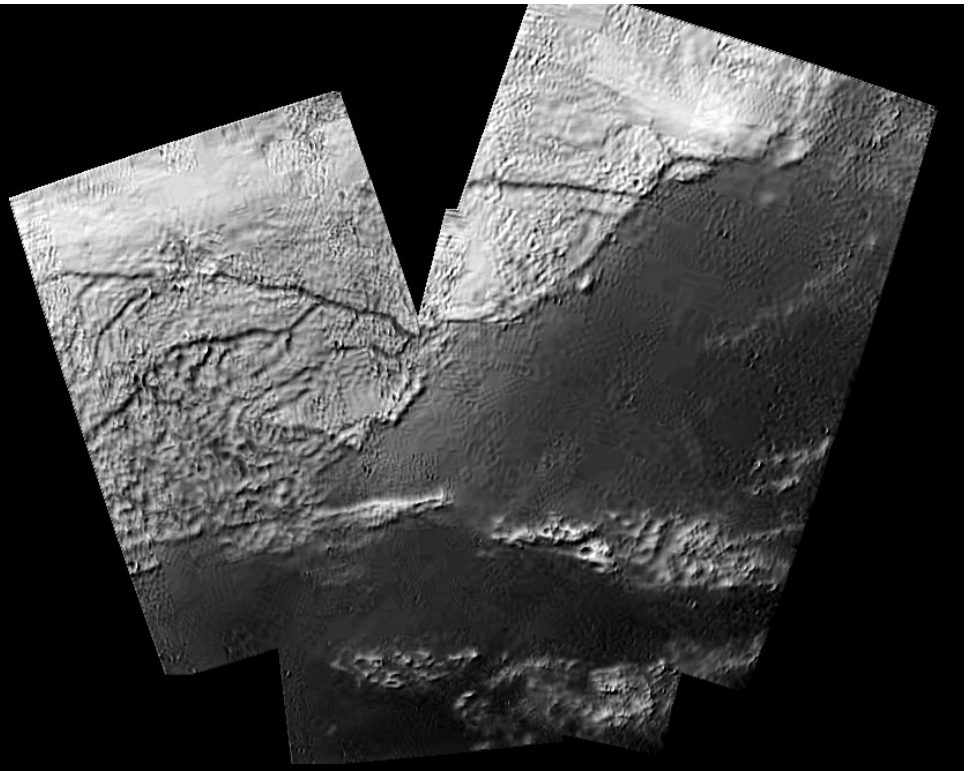
Saturns måne Titan


Huygens rumsonden lander på
Titan den 14. januar 2005



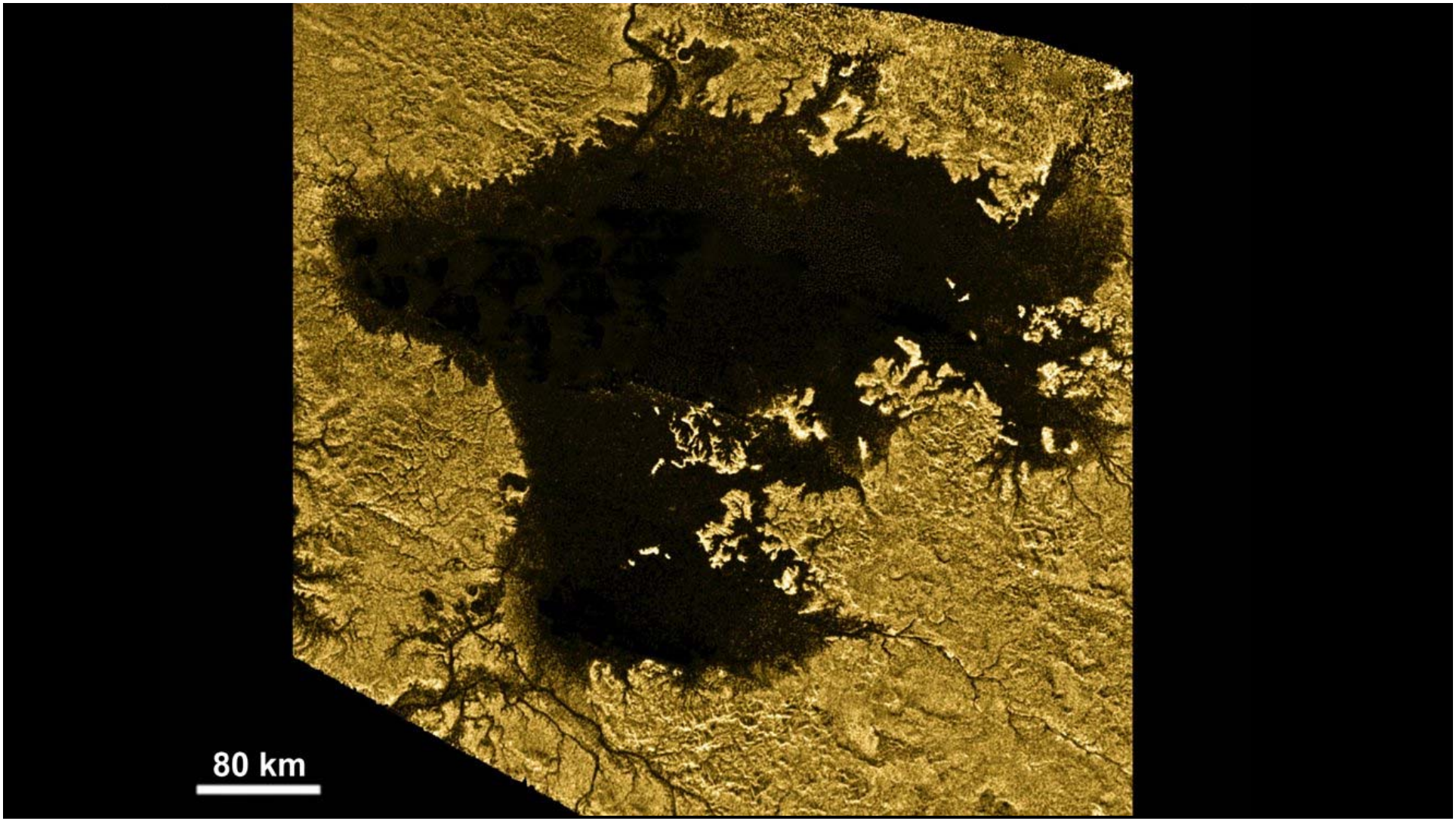


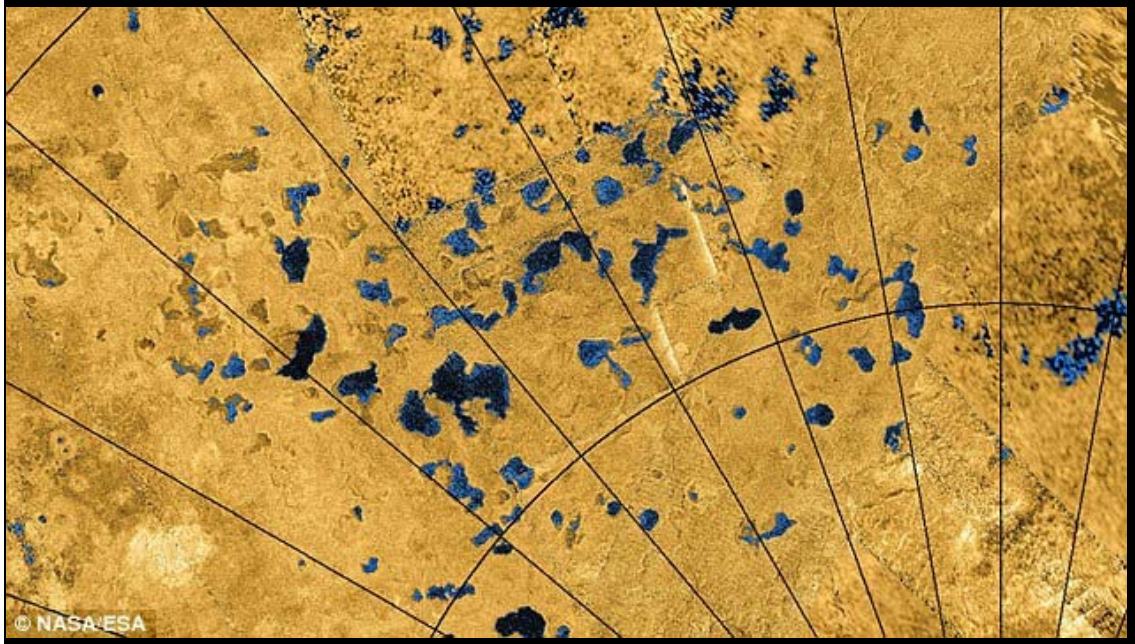
Saturns måne Titan

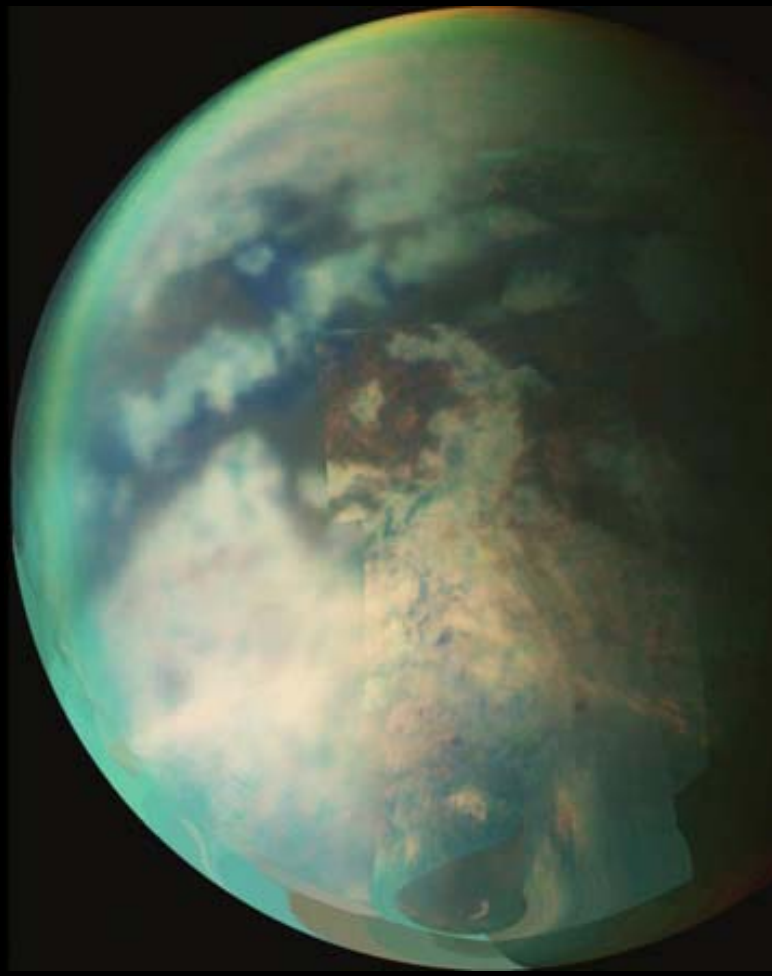


Flydende metan (CH_4) og ethan (C_2H_6)
Smeltepunkt: -182 °C og -183 °C

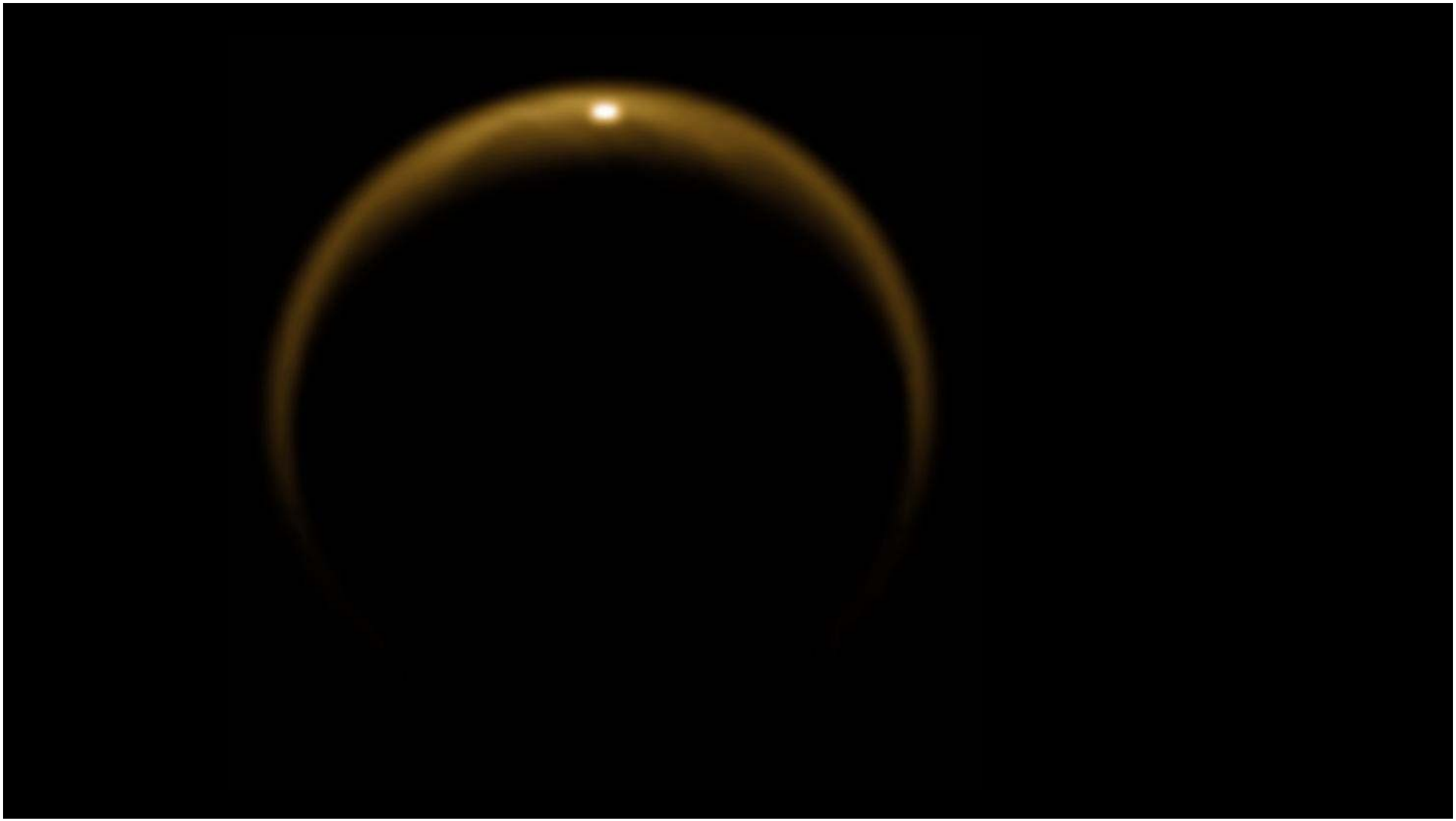
Titans overfladetemperatur er −179 °C

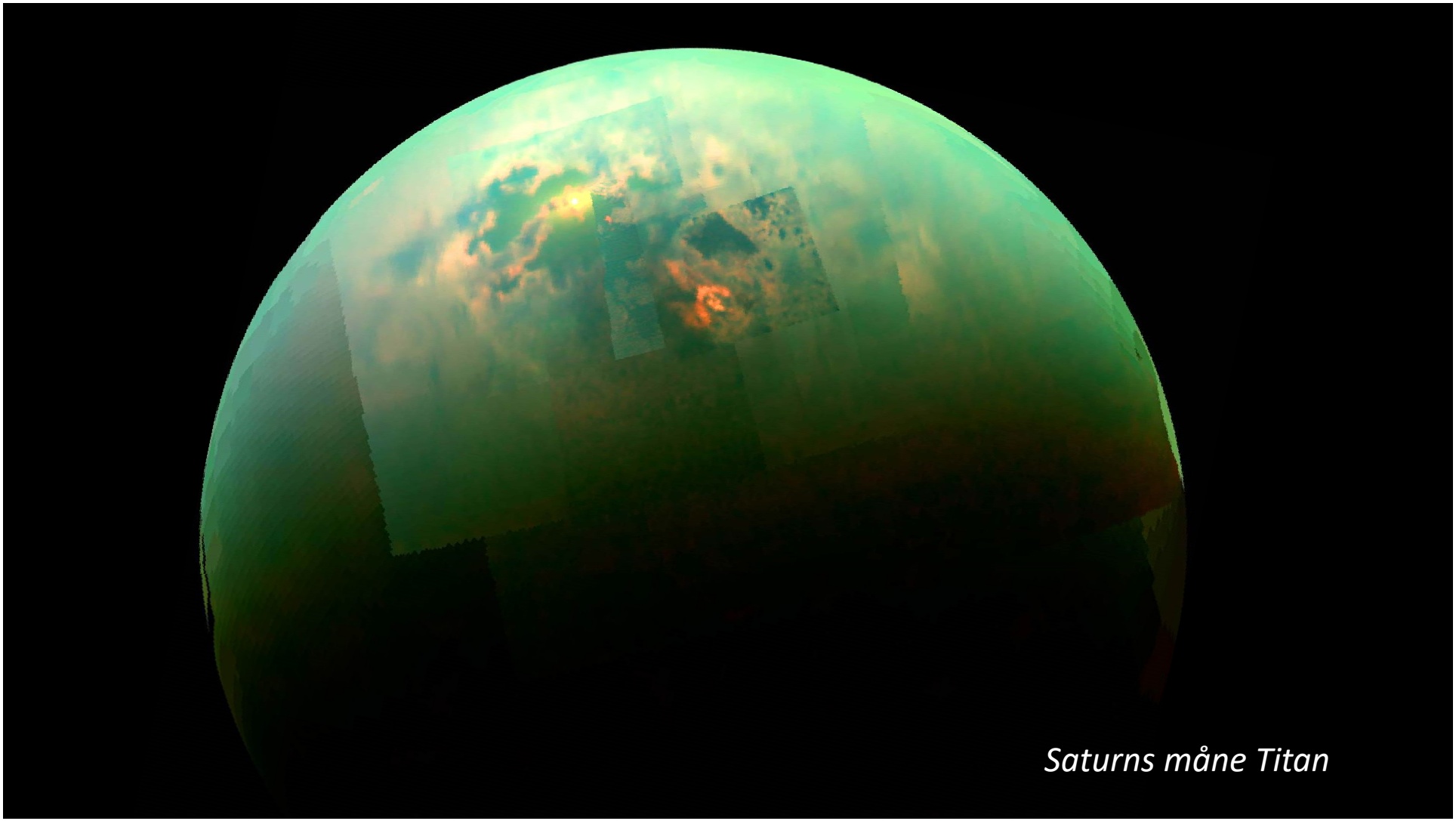

80 km



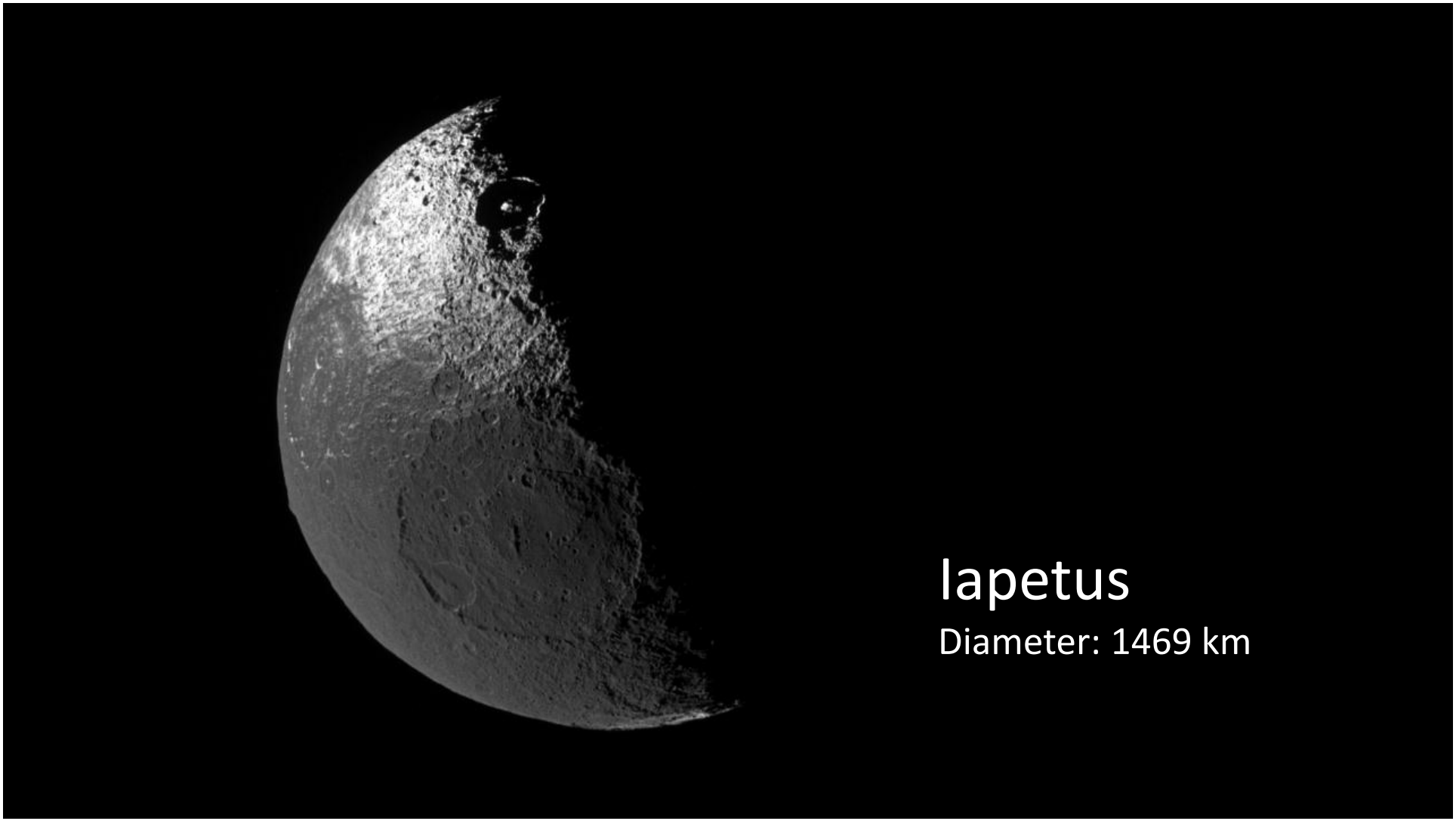


Saturns måne Titan



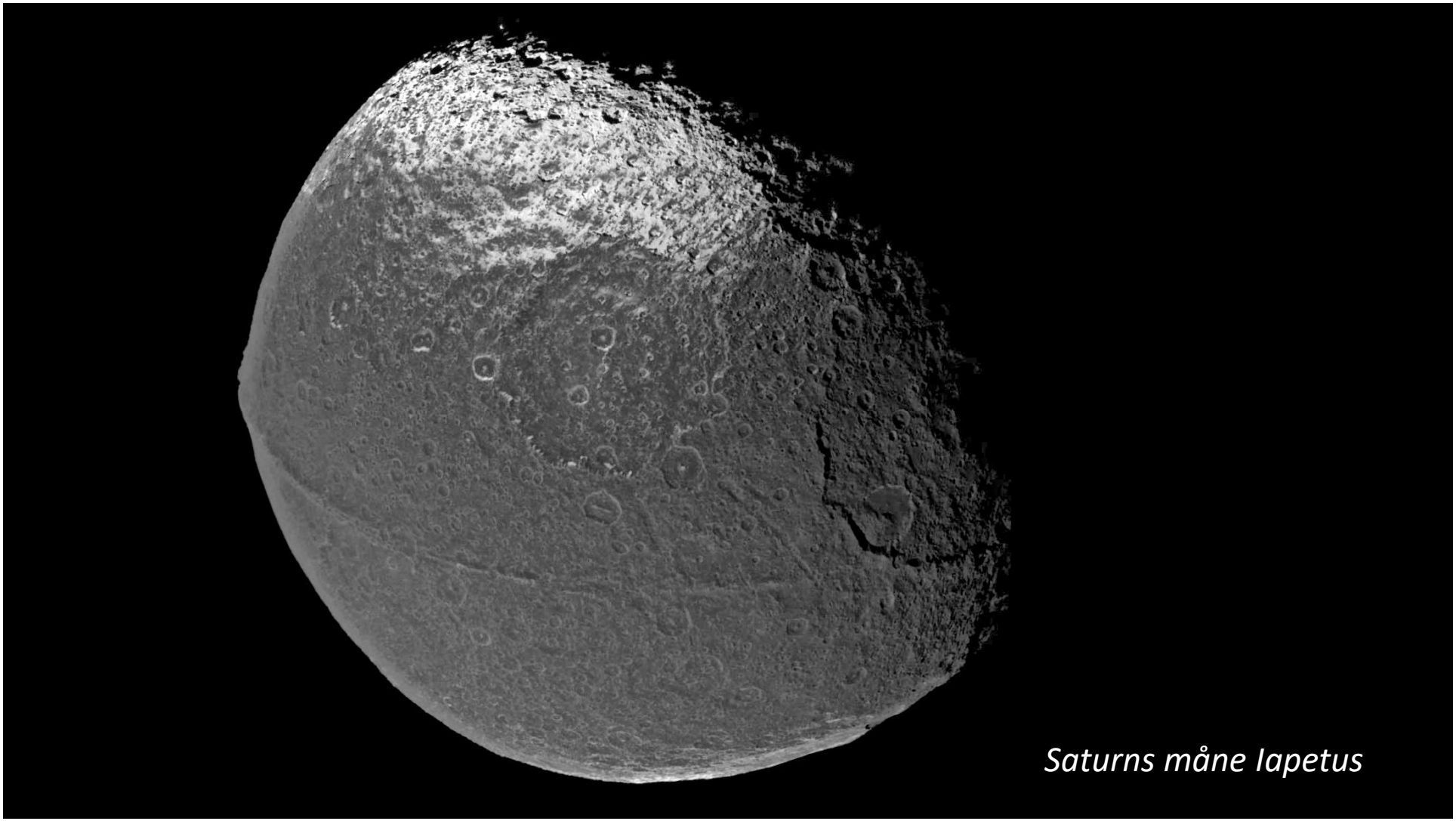


Saturns måne Titan



Iapetus

Diameter: 1469 km

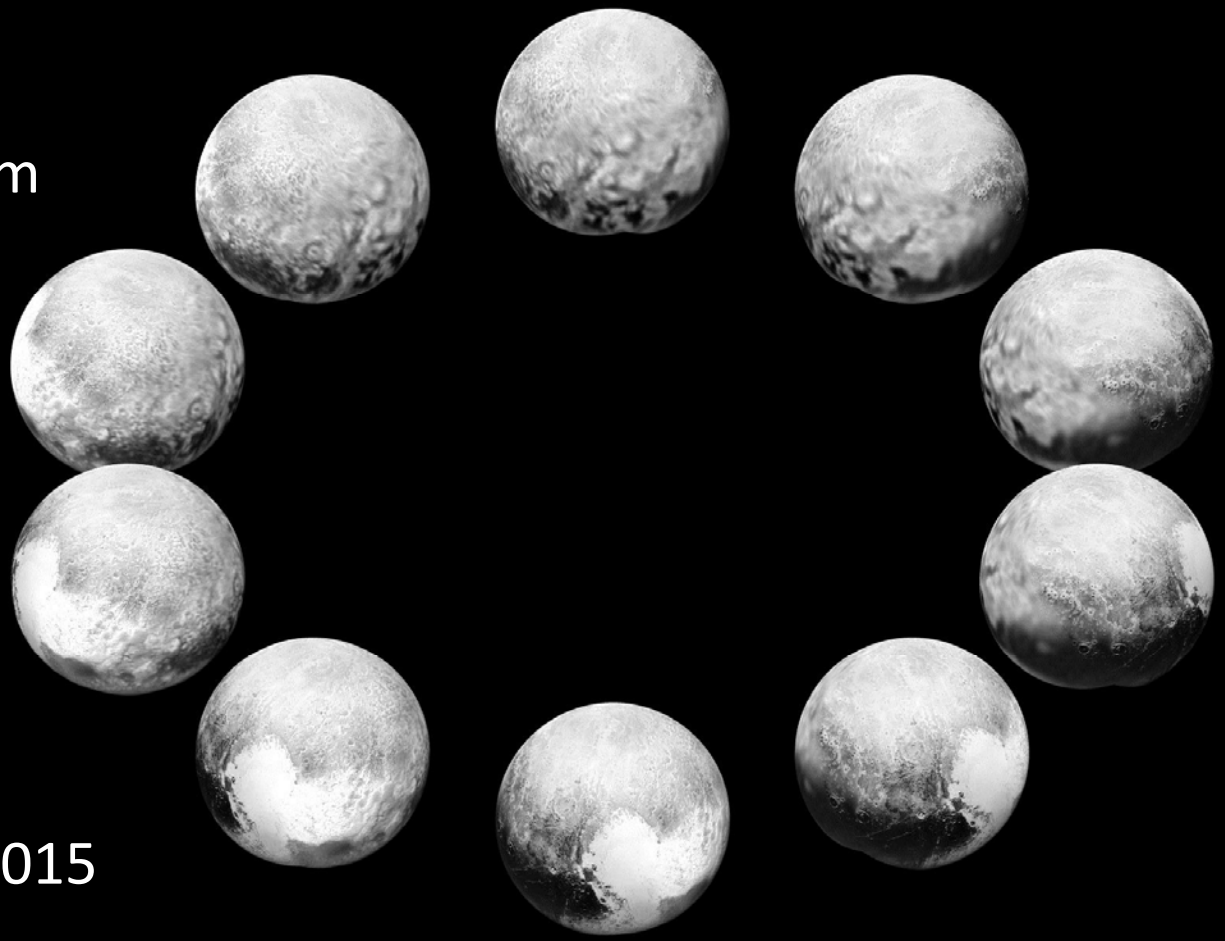


Saturns måne Iapetus

Saturns måne Iapetus

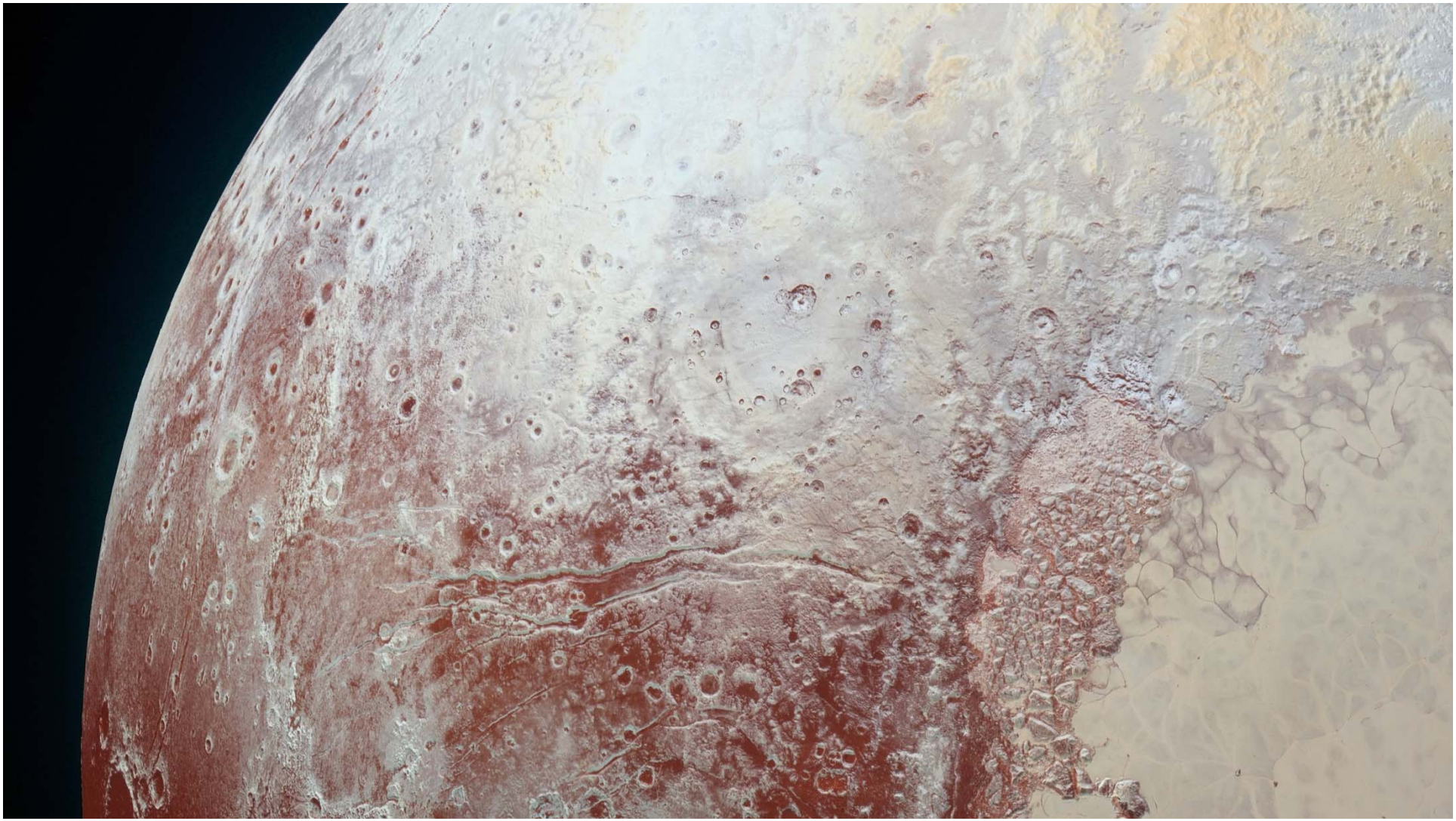
Pluto

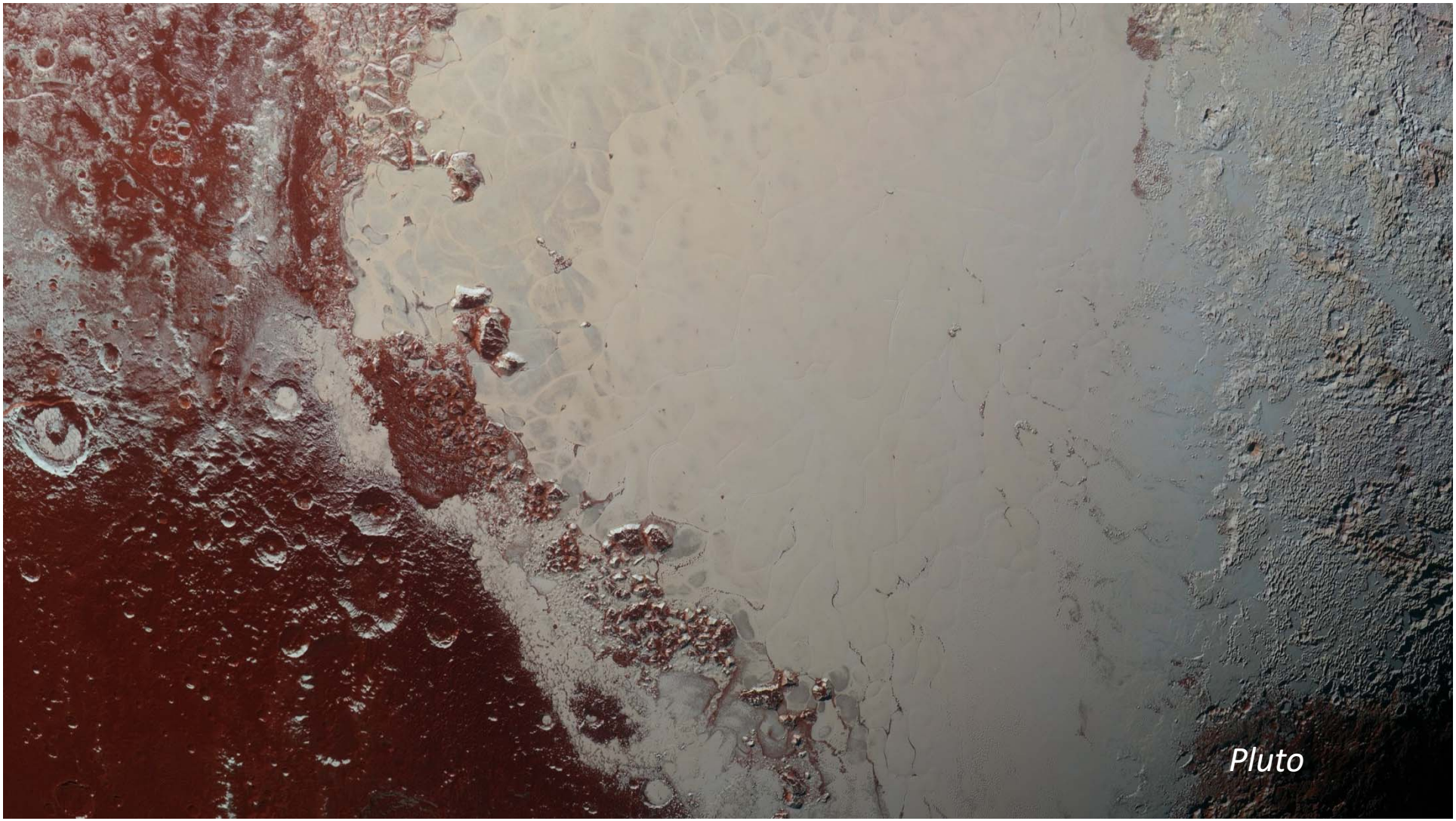
Diameter: 2.372 km

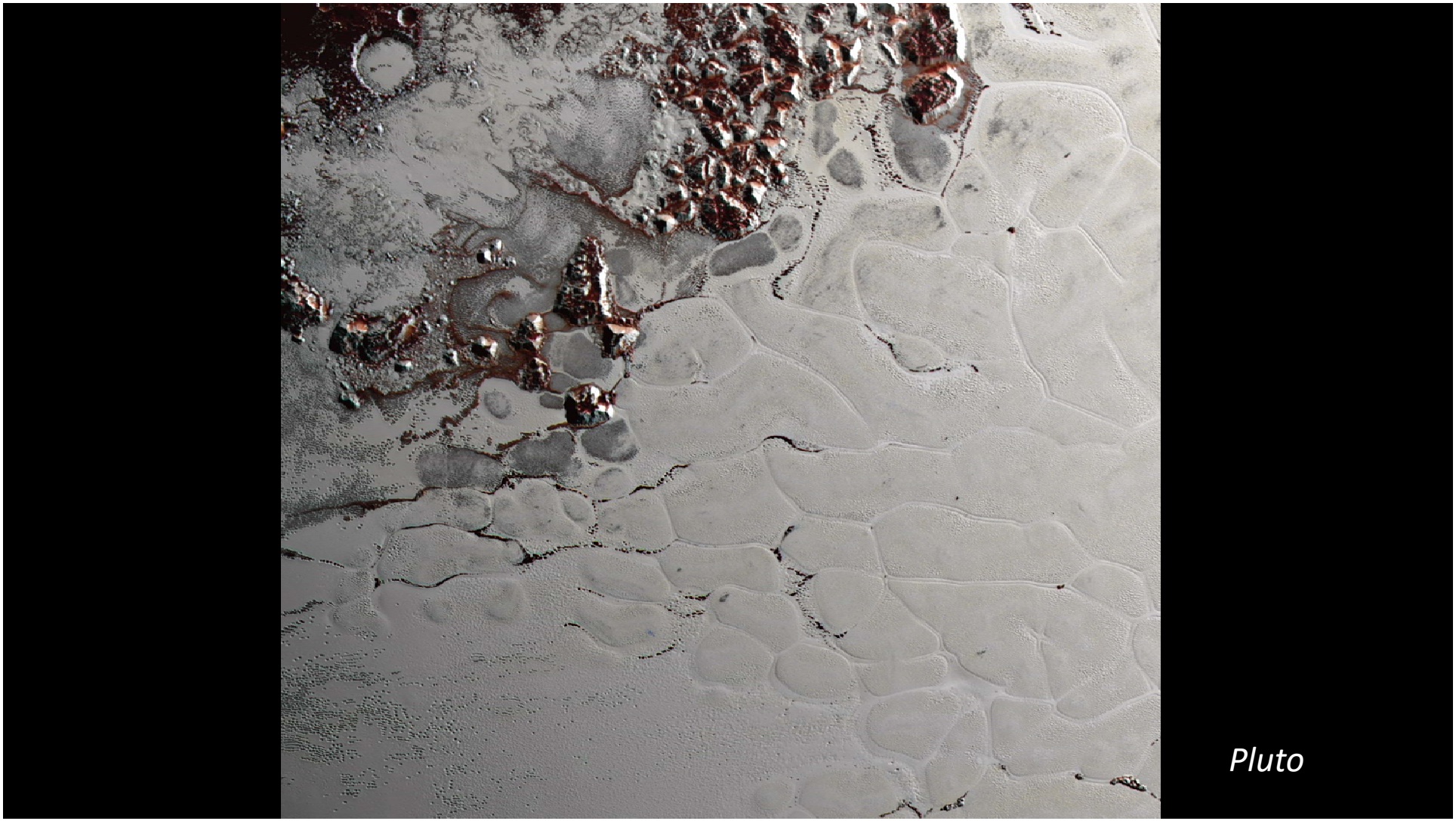


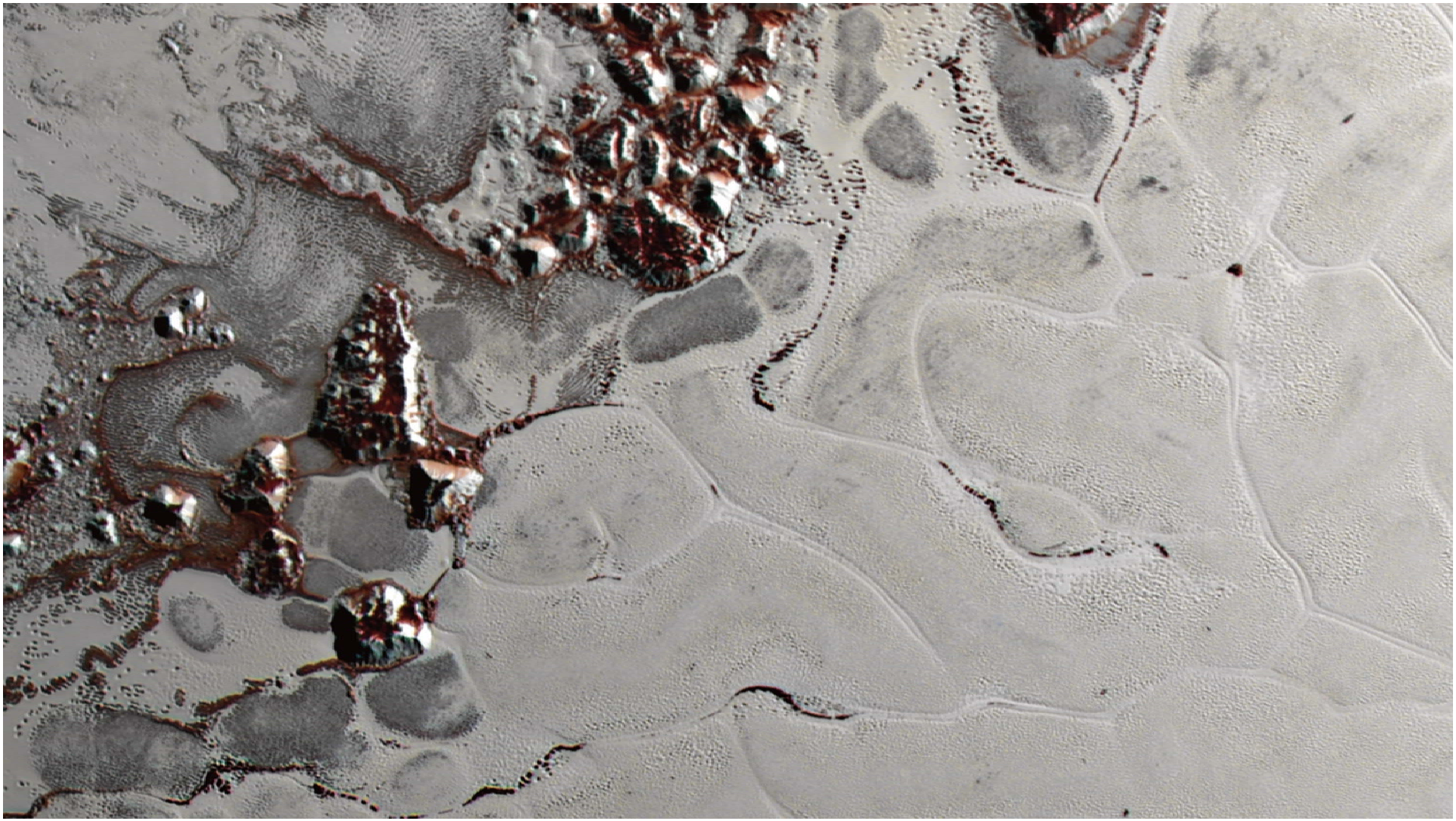
New Horizons
Ankom til Pluto i 2015

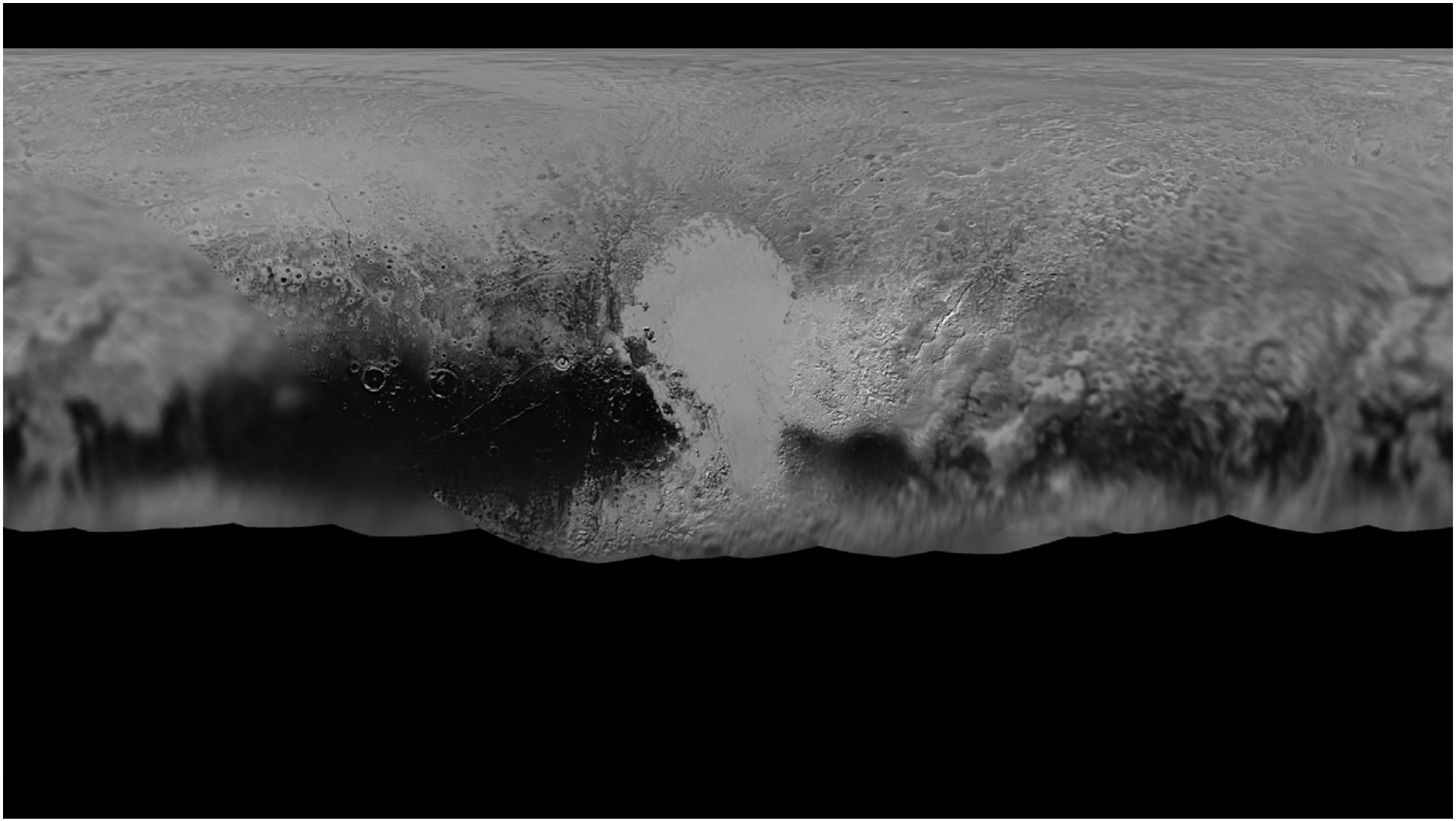
Pluto

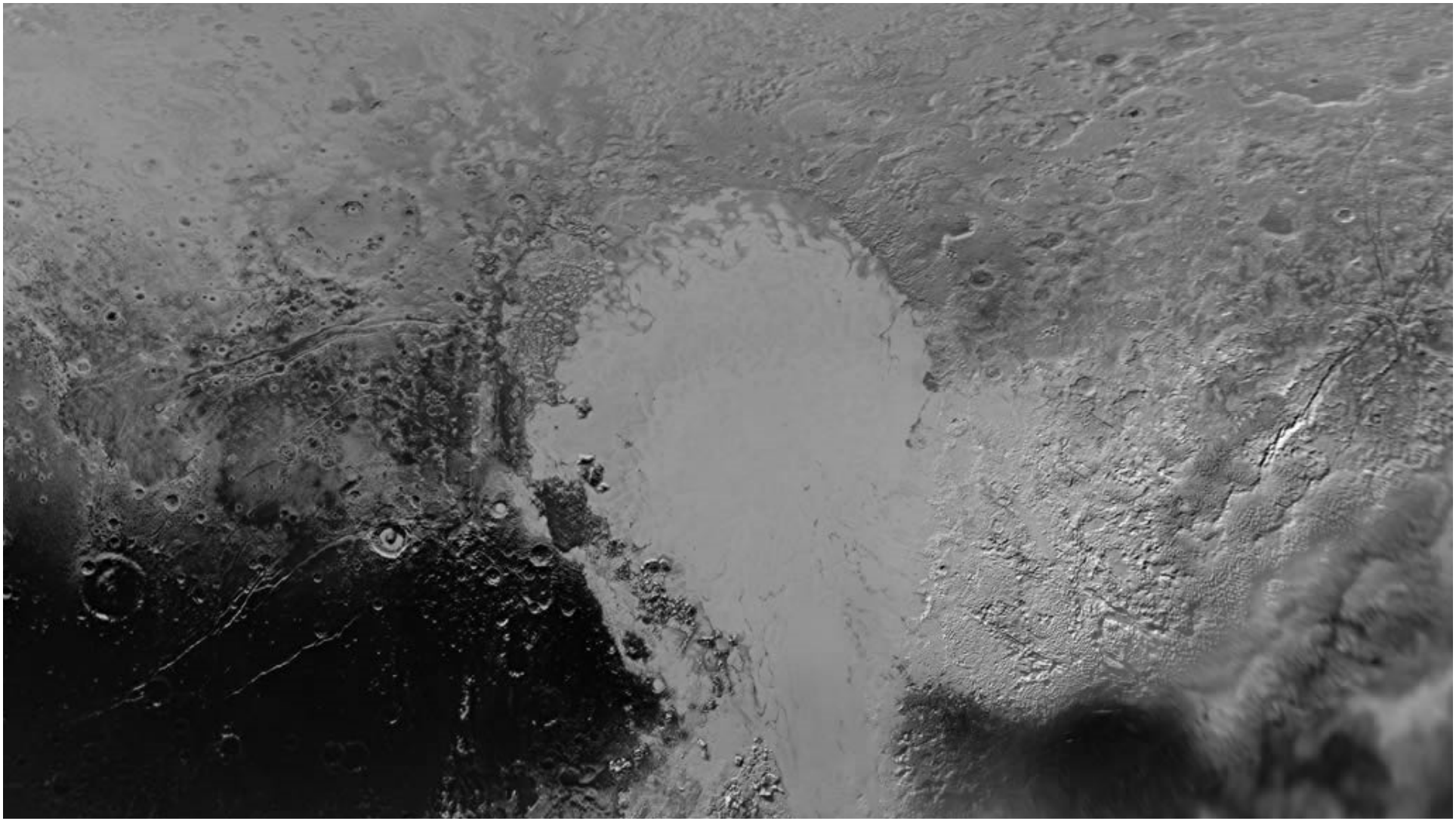


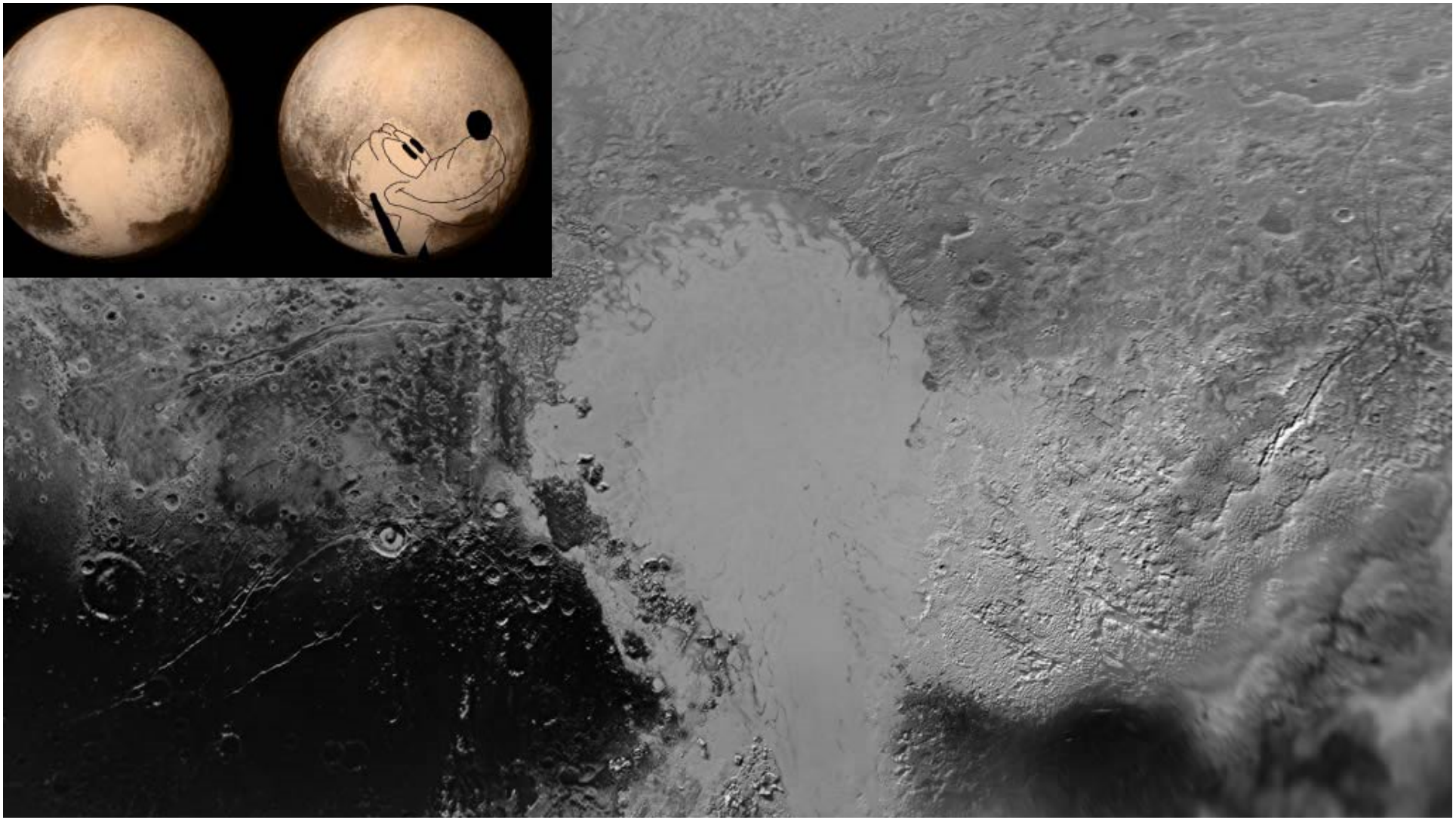

Pluto

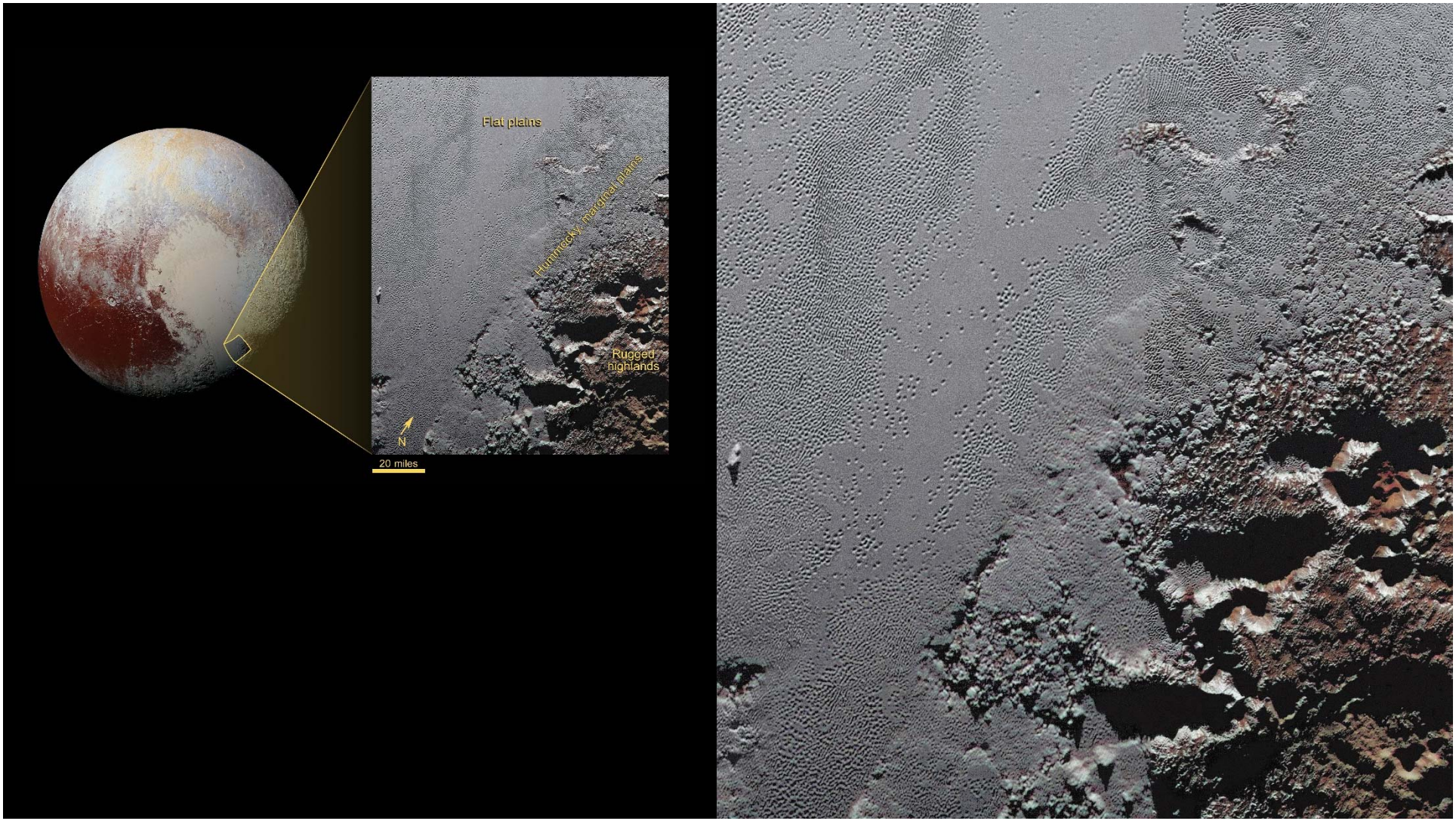

Pluto

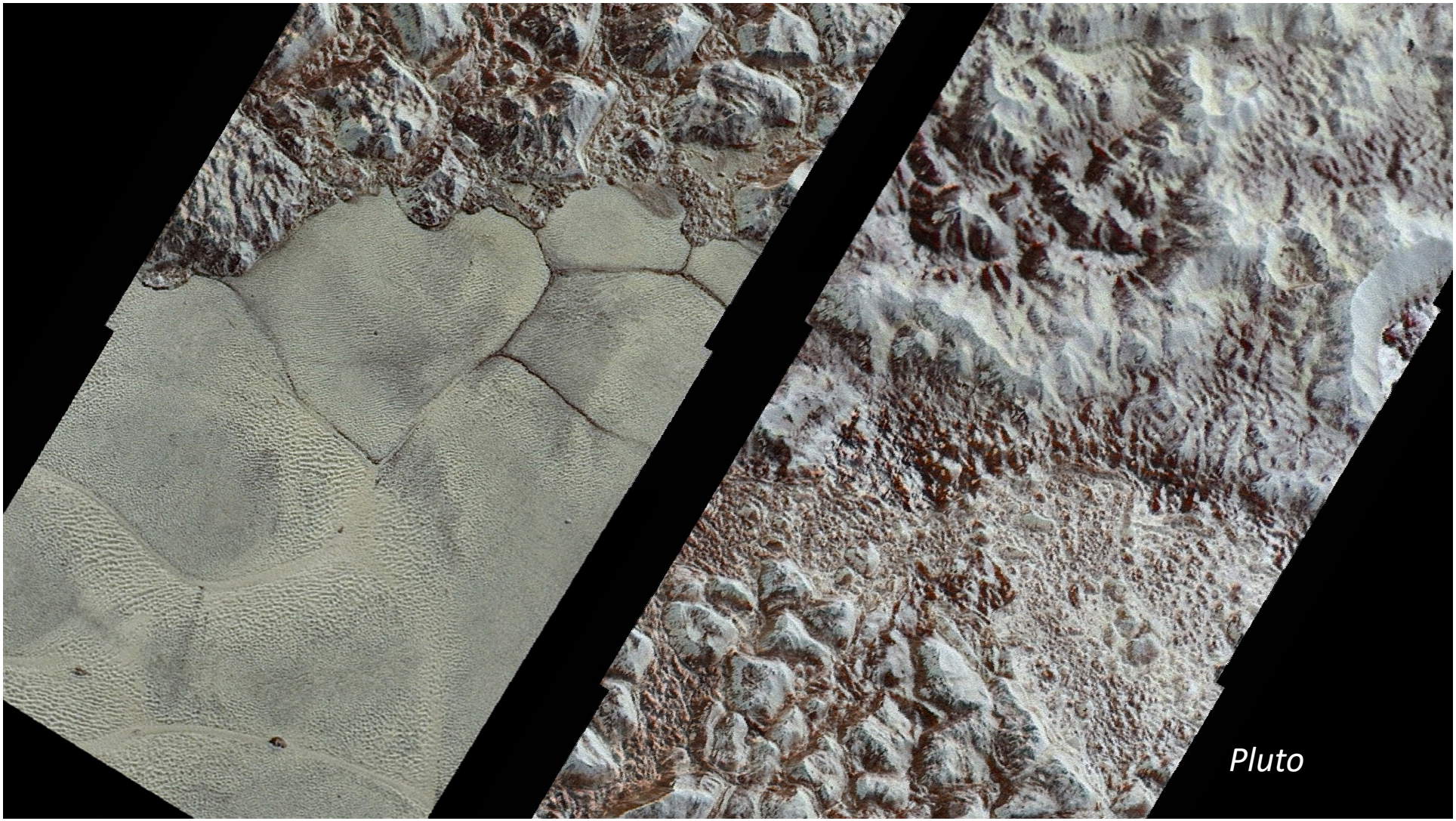


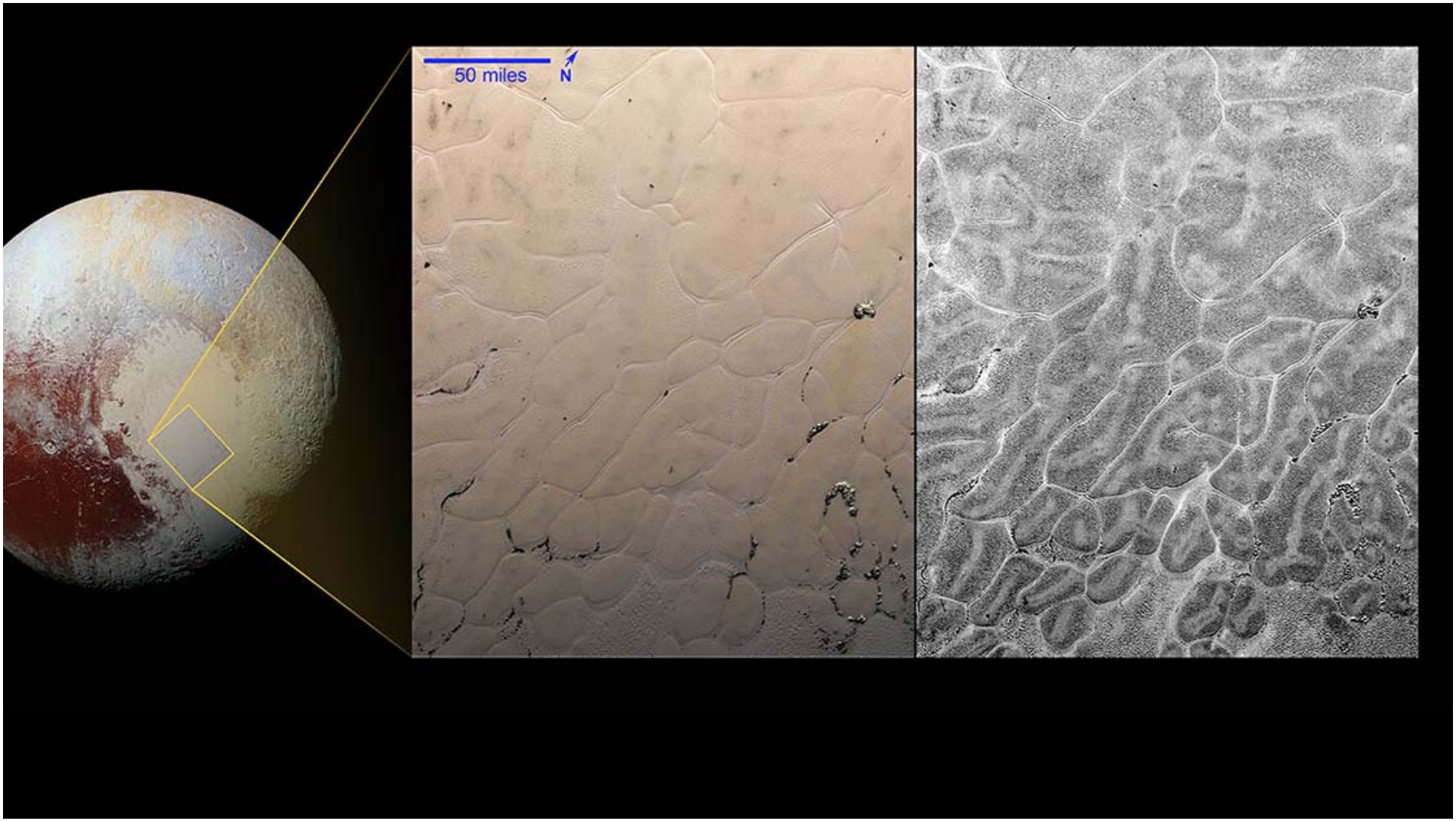


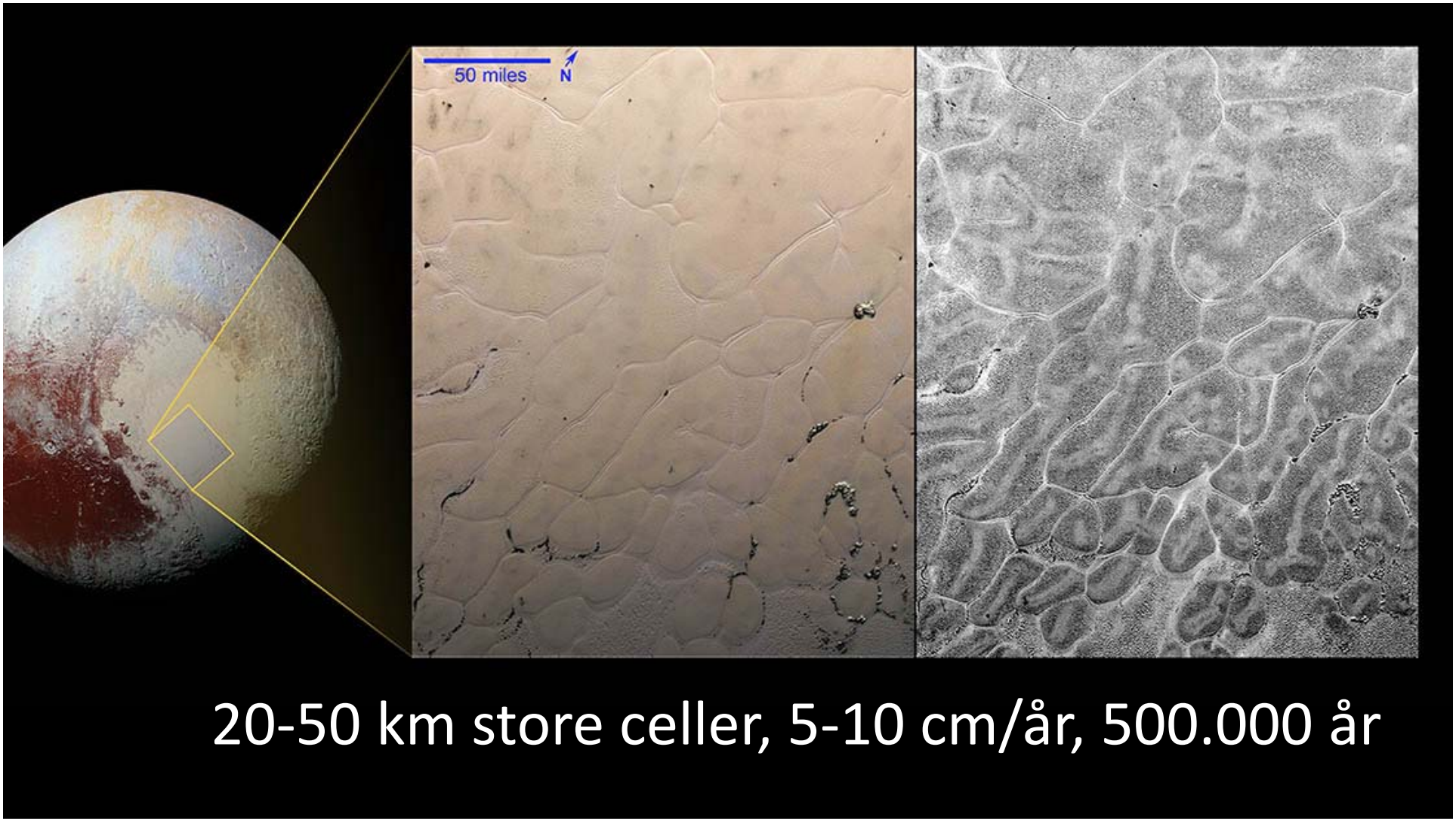




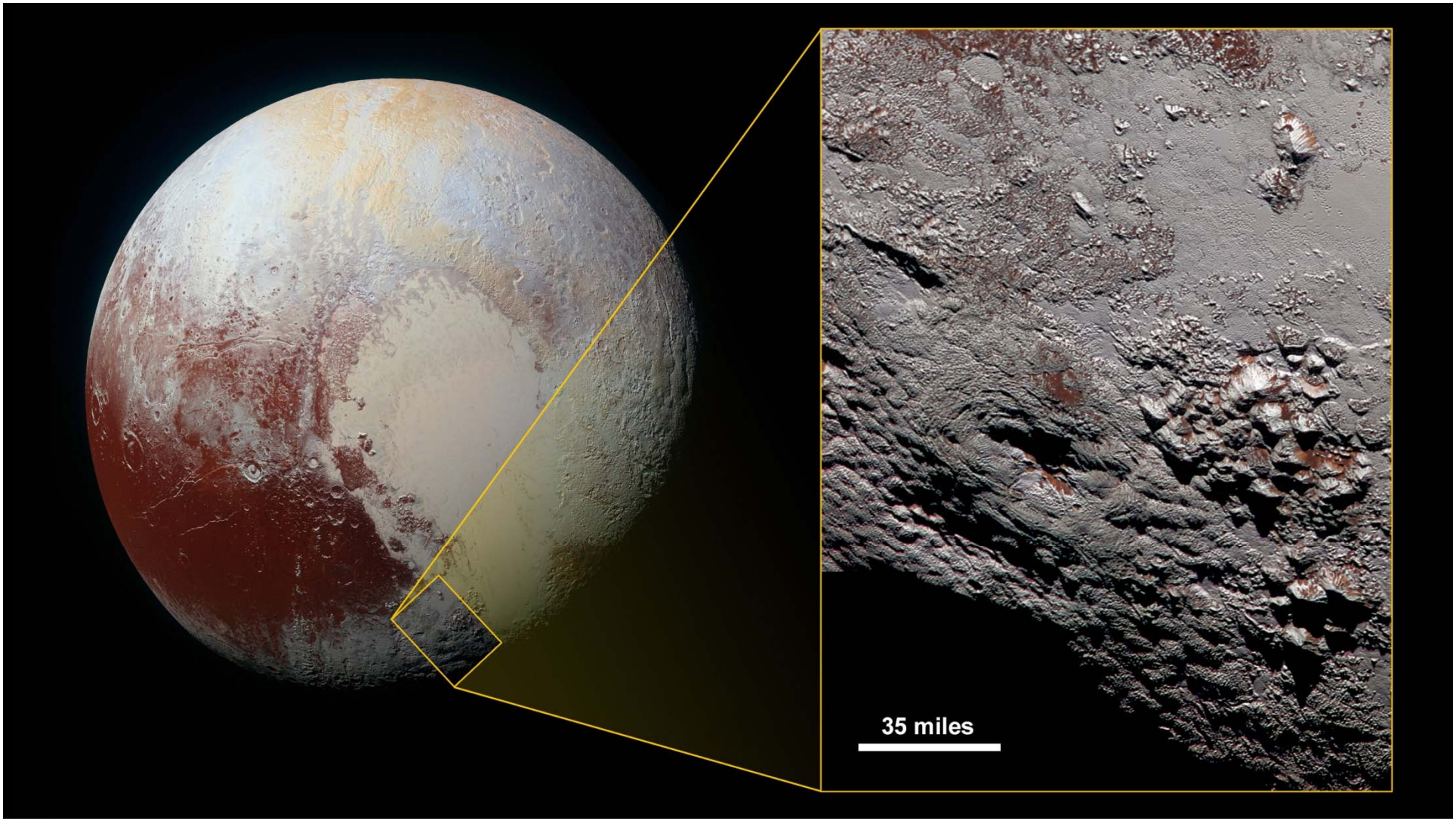

Flat plains
Hummocky, marginal plains
Rugged highlands
N
20 miles

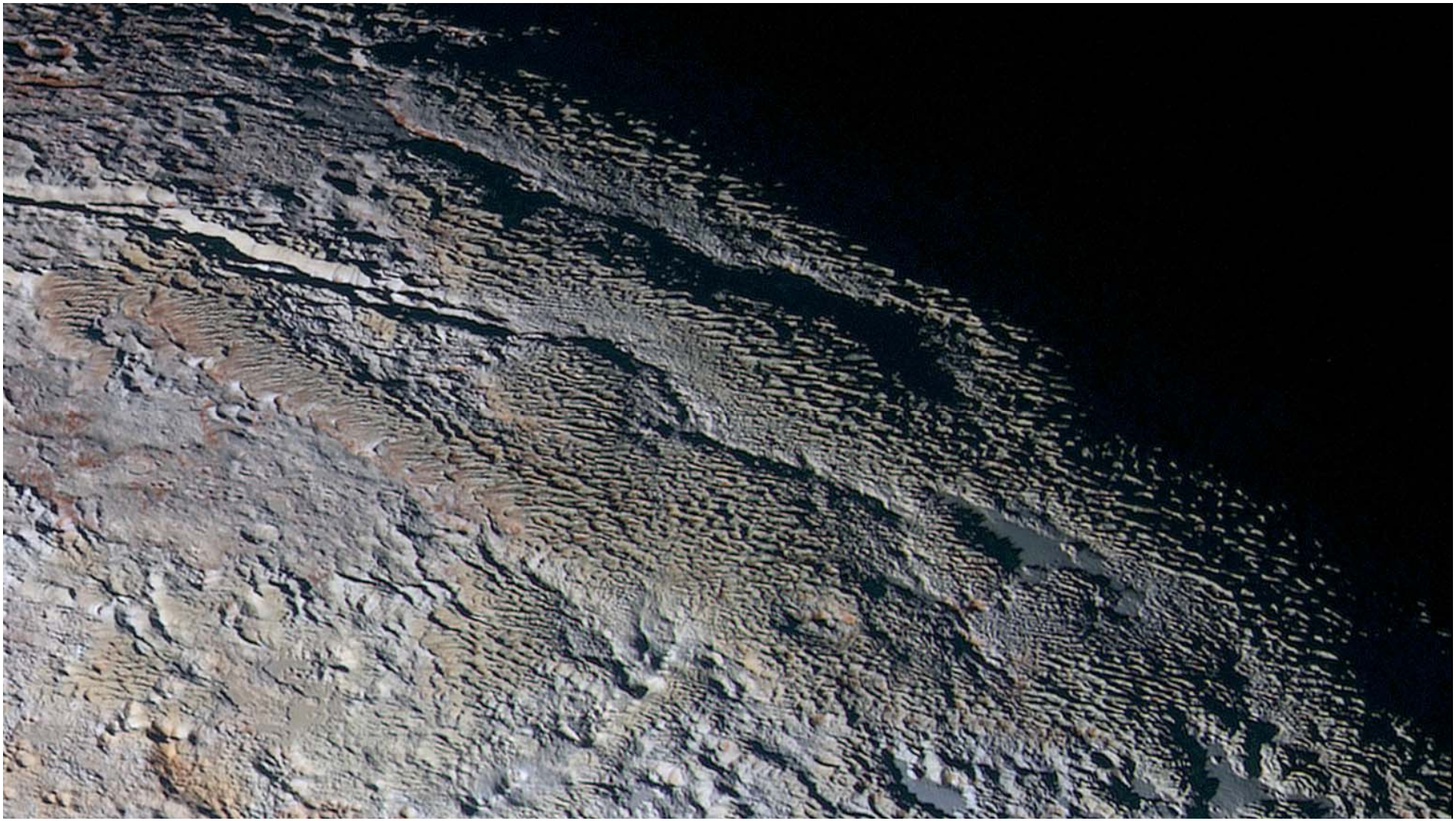

Pluto


50 miles
N

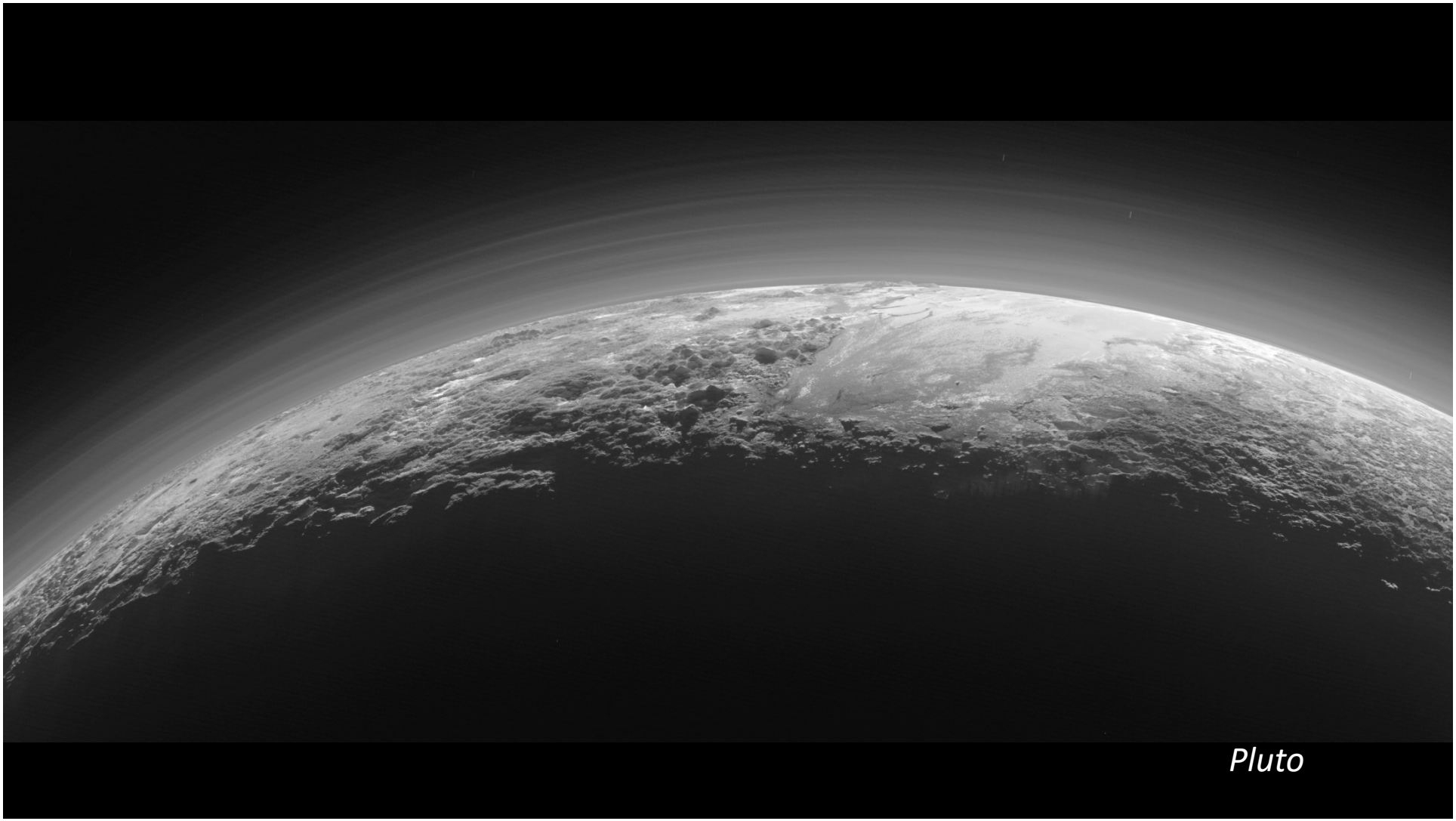


20-50 km store celler, 5-10 cm/år, 500.000 år

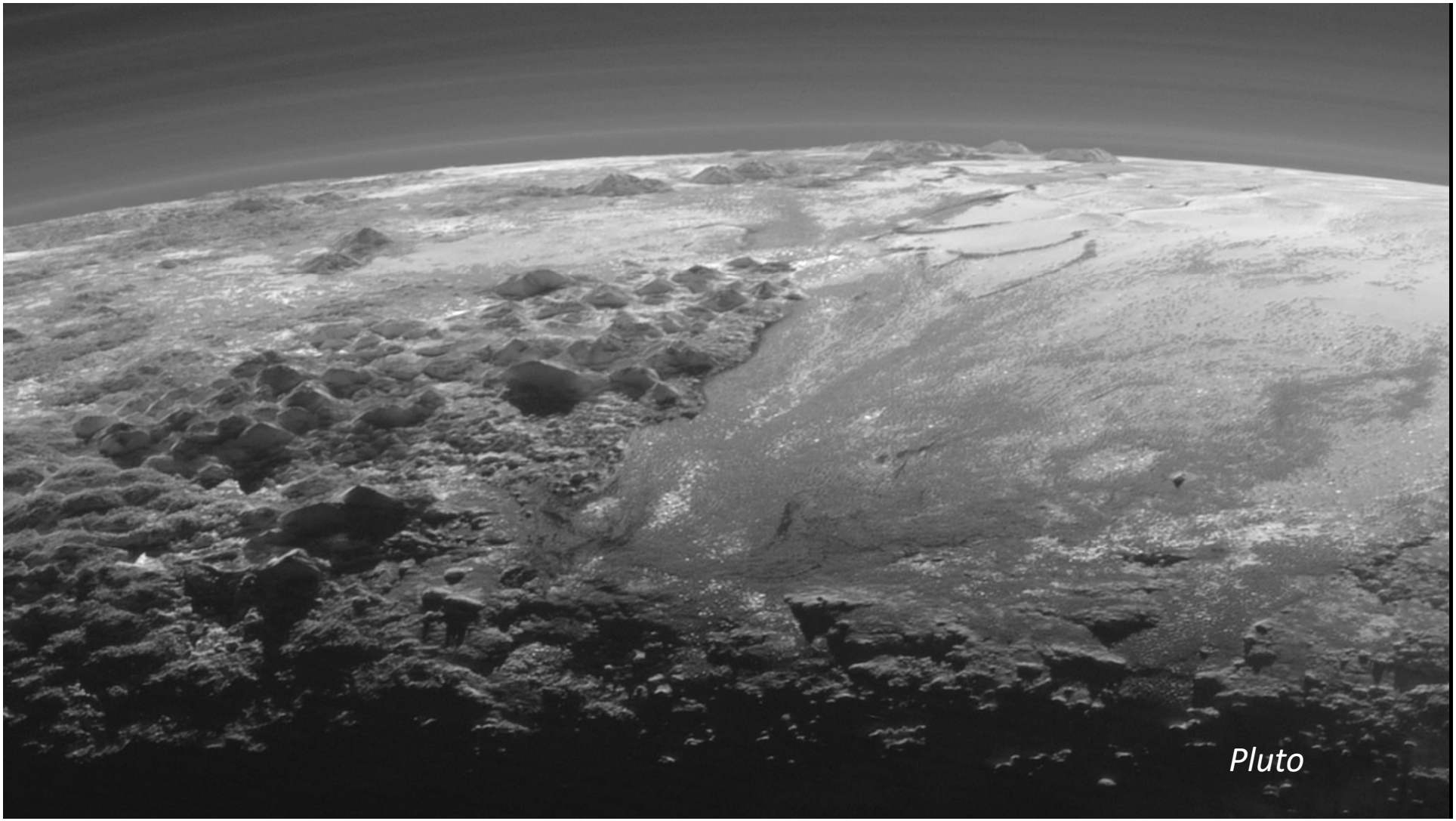

35 miles

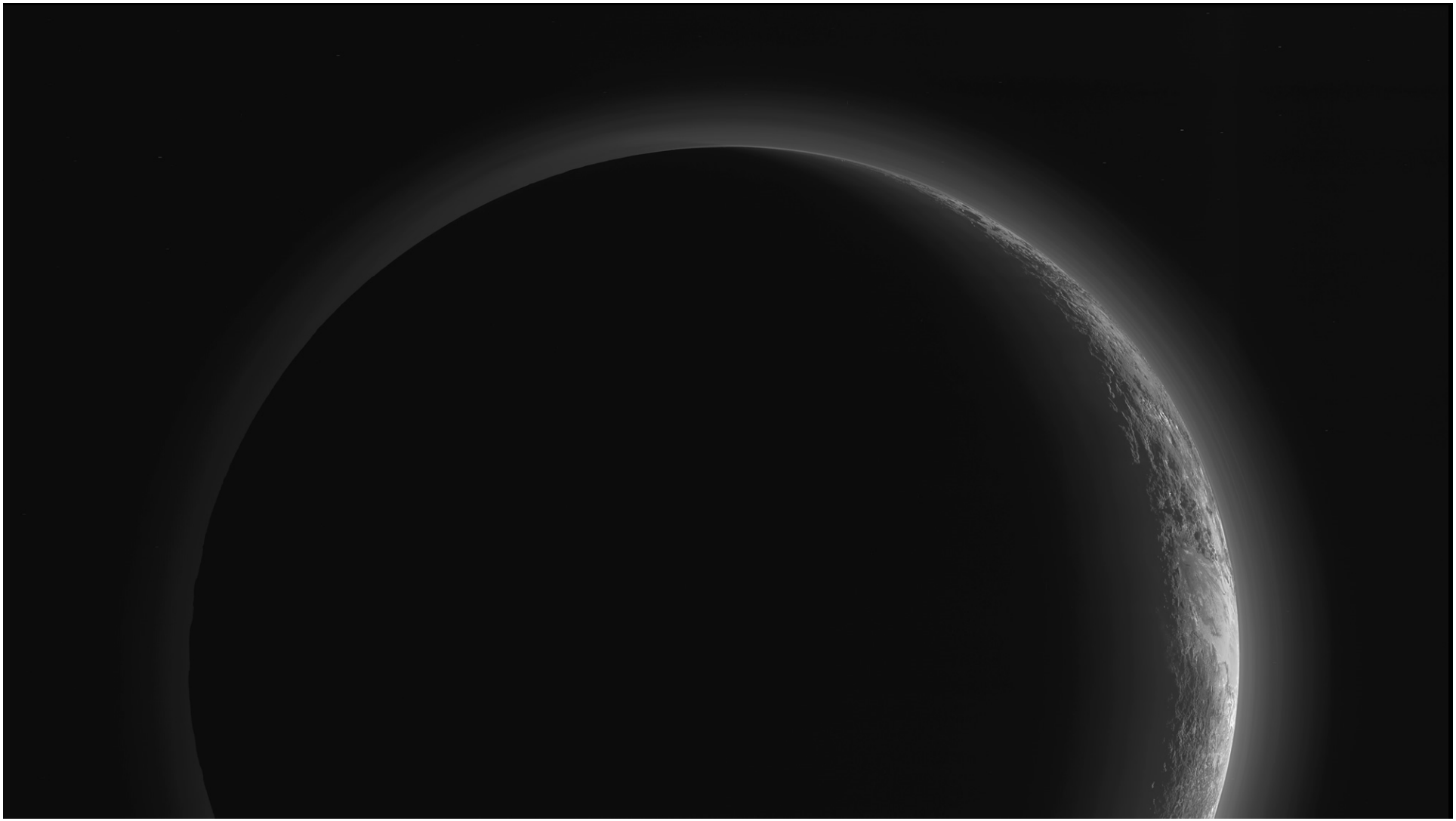



Hvilken energikilde er det som skaber
Plutos ”unge” landskab ?
Flydende Kvælstof (LN2):
Kogepunkt: - 196 °C
Smeltepunkt: –210 °C



Pluto


Pluto

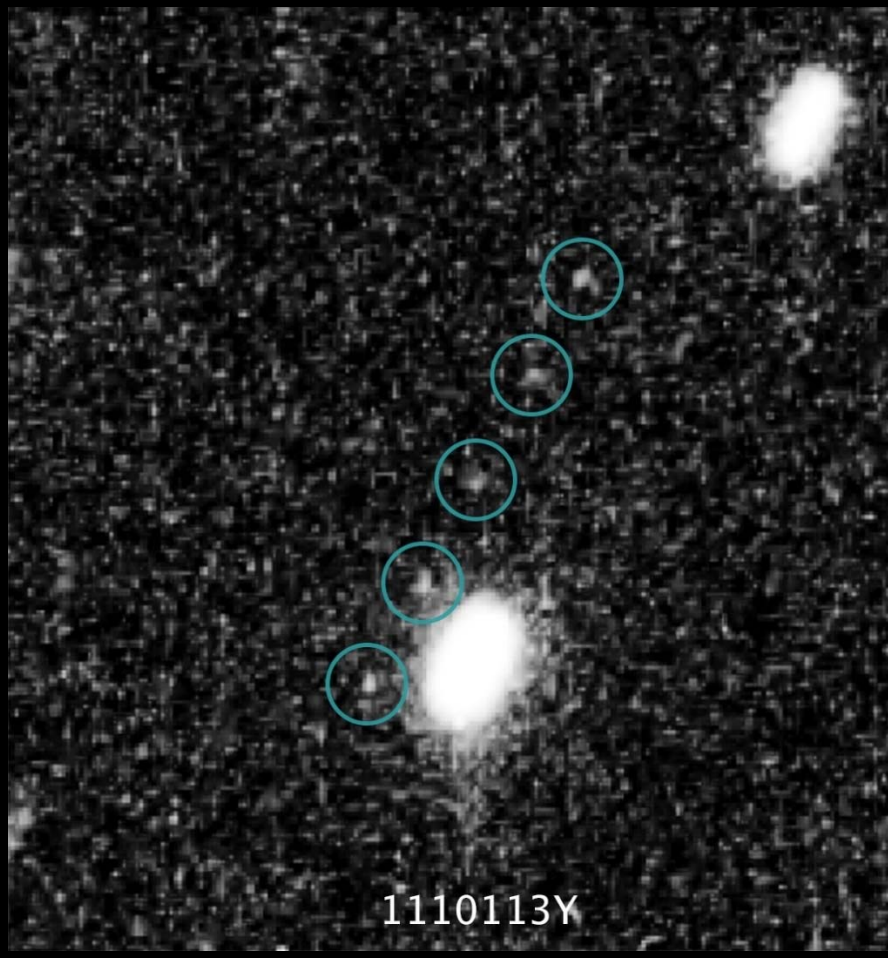



Pluto


Mindre objekter i Solsystemet….

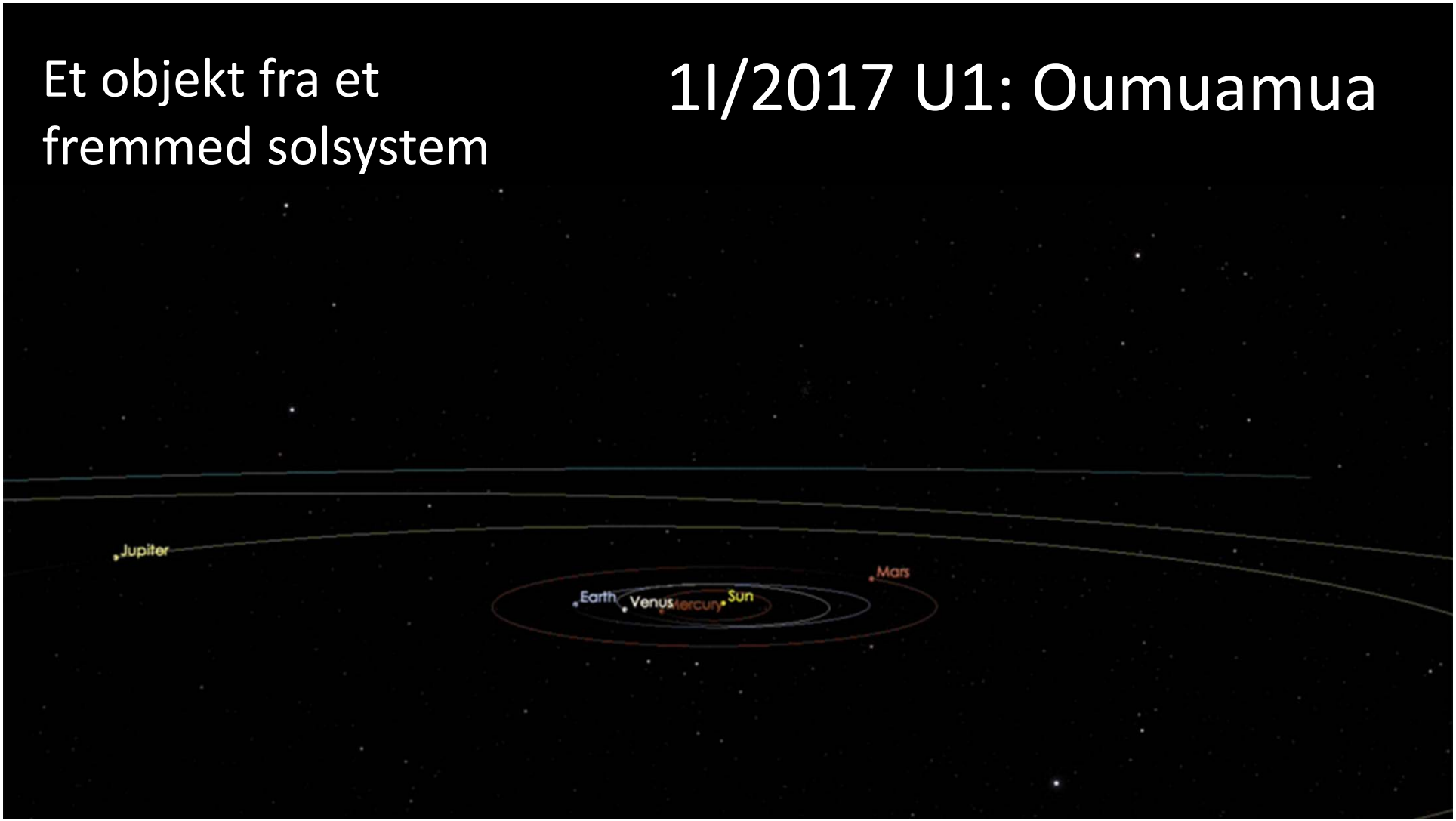
New Horizons flyver forbi 2014 MU_{69}. Nærmeste passage vil ske 1. januar 2019 hvor rumskibet er 43,4 AE fra Solen. De første billeder af 2014 MU_{69} forventes taget den 21. august 2018. Det er planen at lade *New Horizons* nå ind til en afstand af 3500 km. Billeder får en opløsning på kun 30 m - 70 m. Der vil også ske en søgning efter ringe, måner, gasser, støv.

Størrelsen af 2014 MU_{69} er ca. 30 km



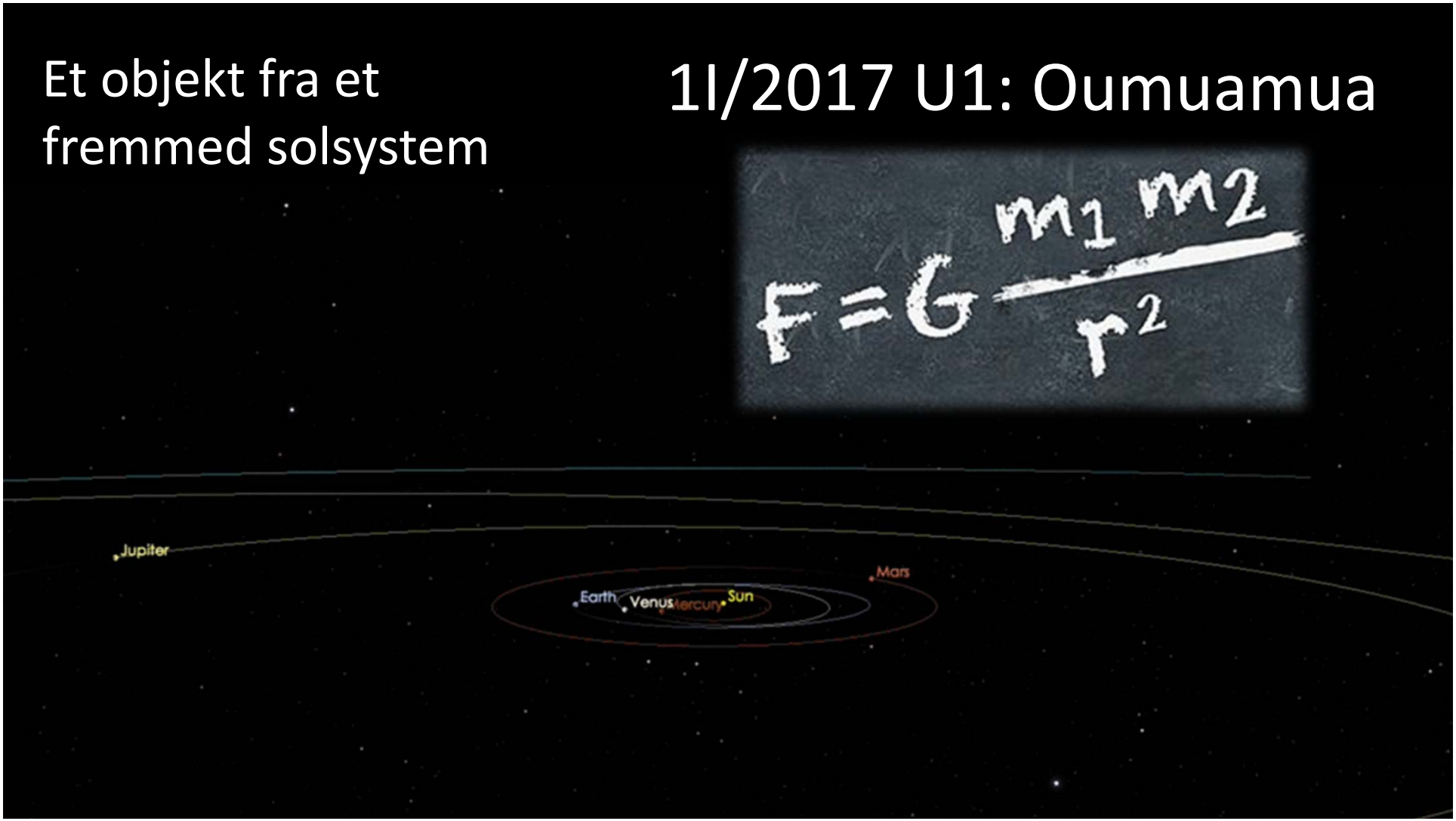
Et objekt fra et fremmed solsystem

1I/2017 U1: Oumuamua



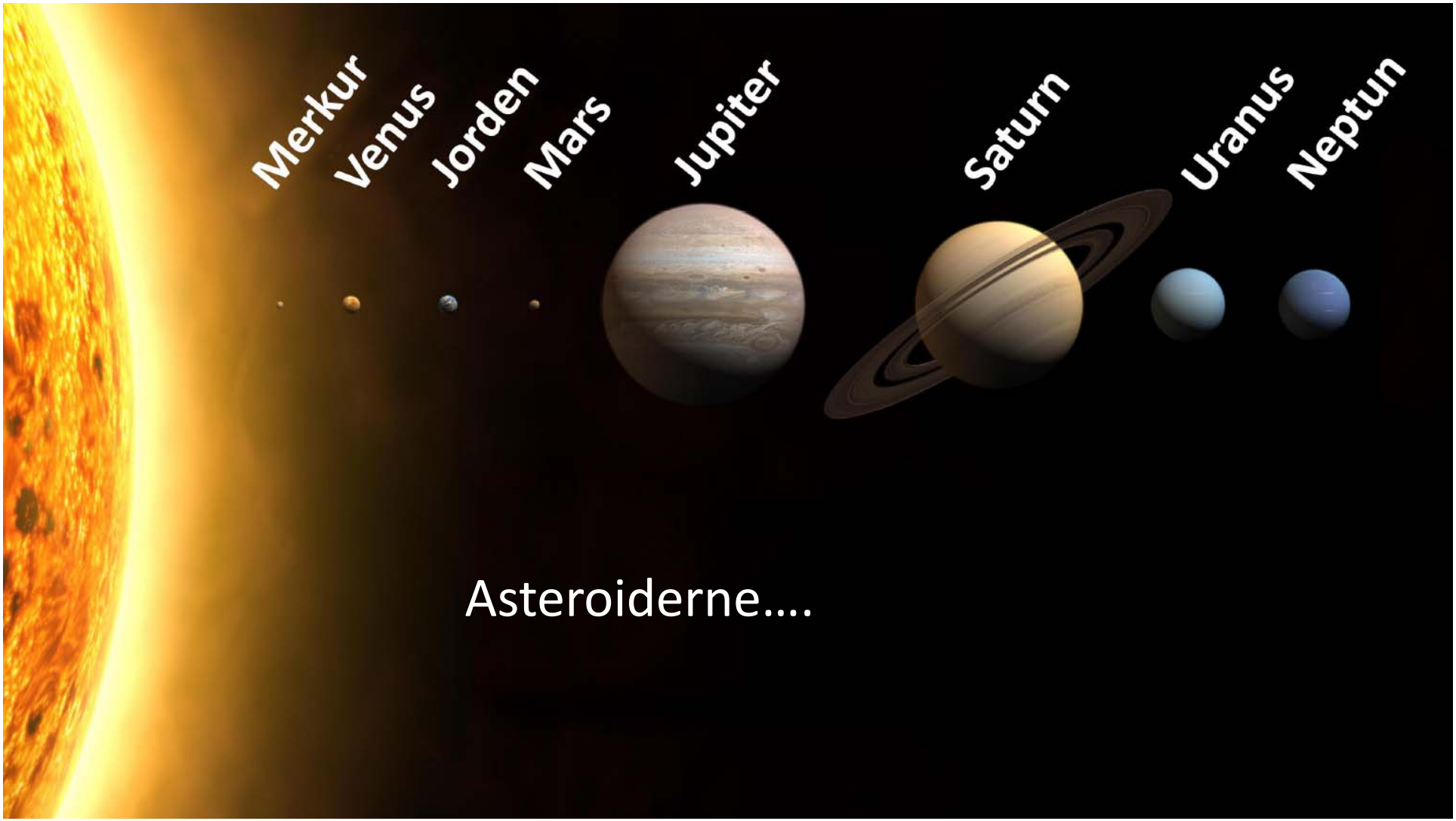
Et objekt fra et fremmed solsystem

1I/2017 U1: Oumuamua

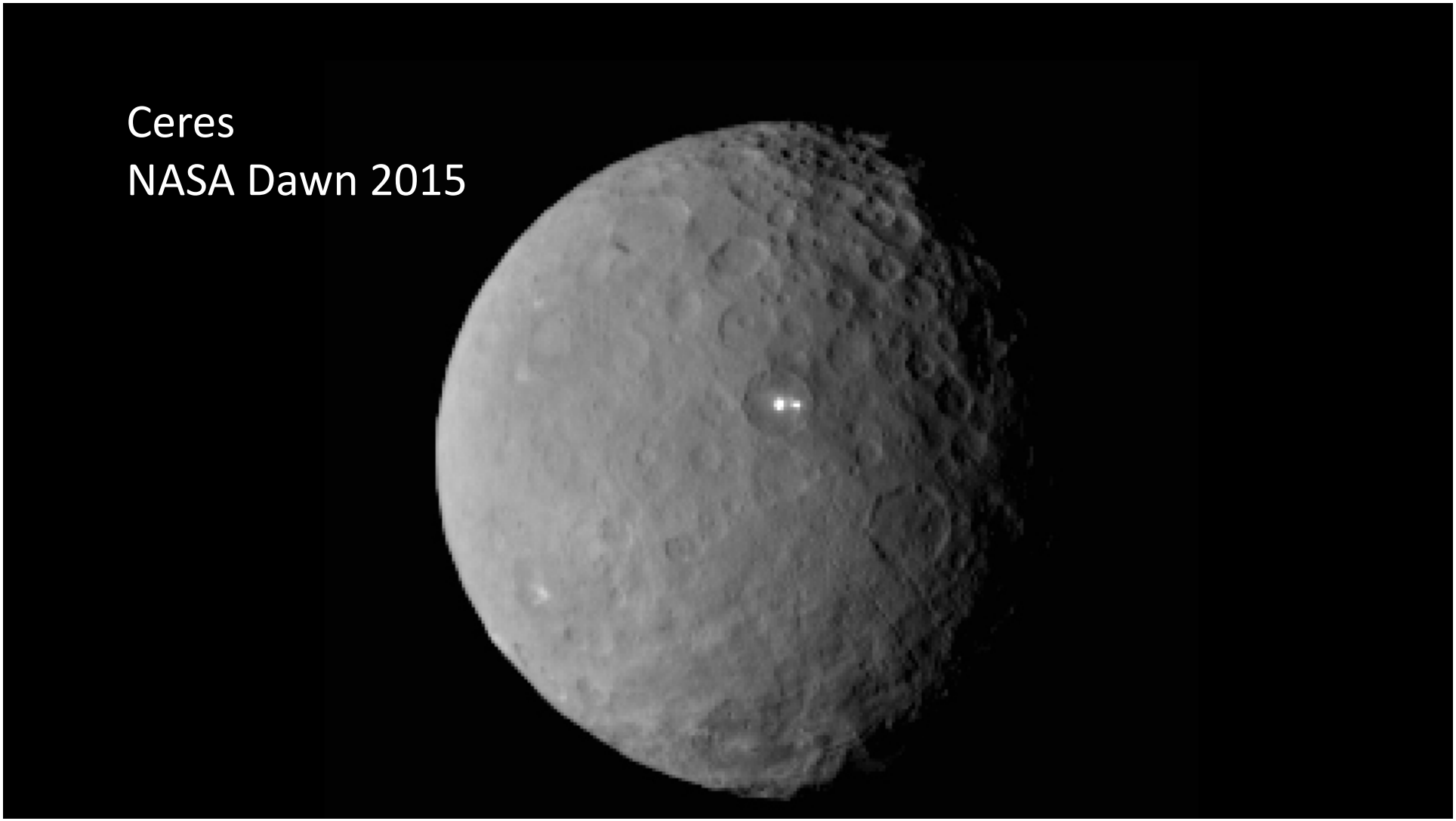



ILLUSTRATION

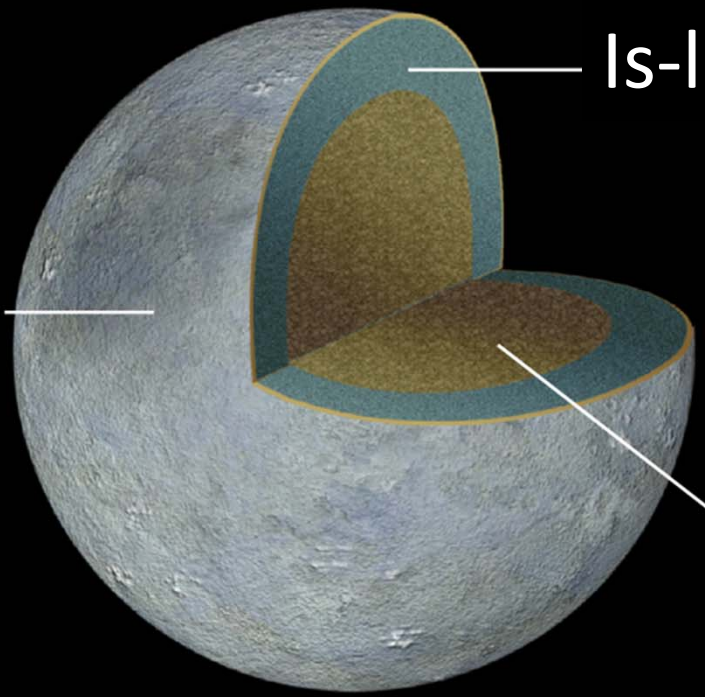

1I/2017 U1: 35 m x 230 m


Merkur
Venus
Jorden
Mars
Jupiter
Saturn
Uranus
Neptun
Asteroiderne….

Ceres
NASA Dawn 2015



Ceres'

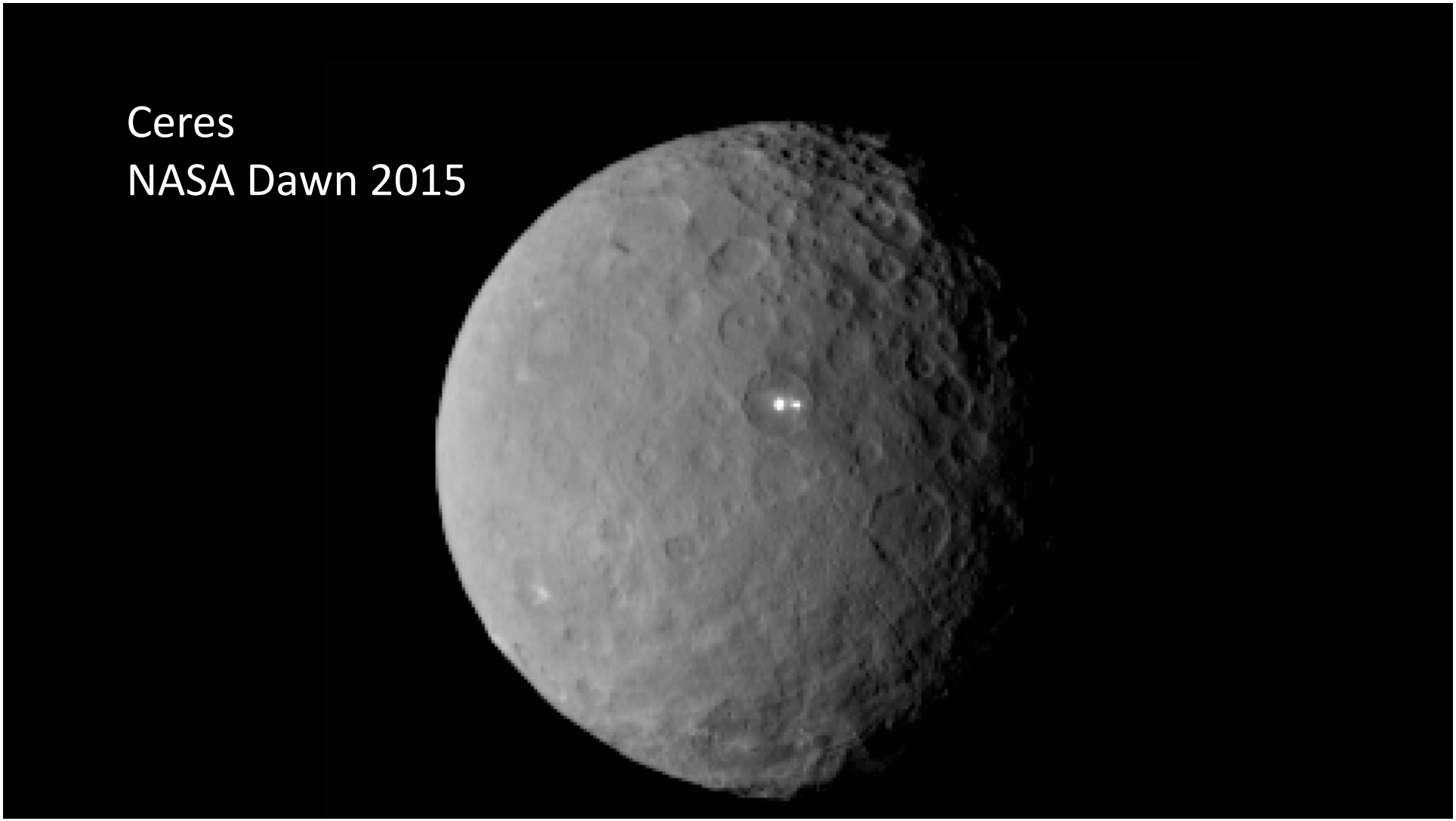


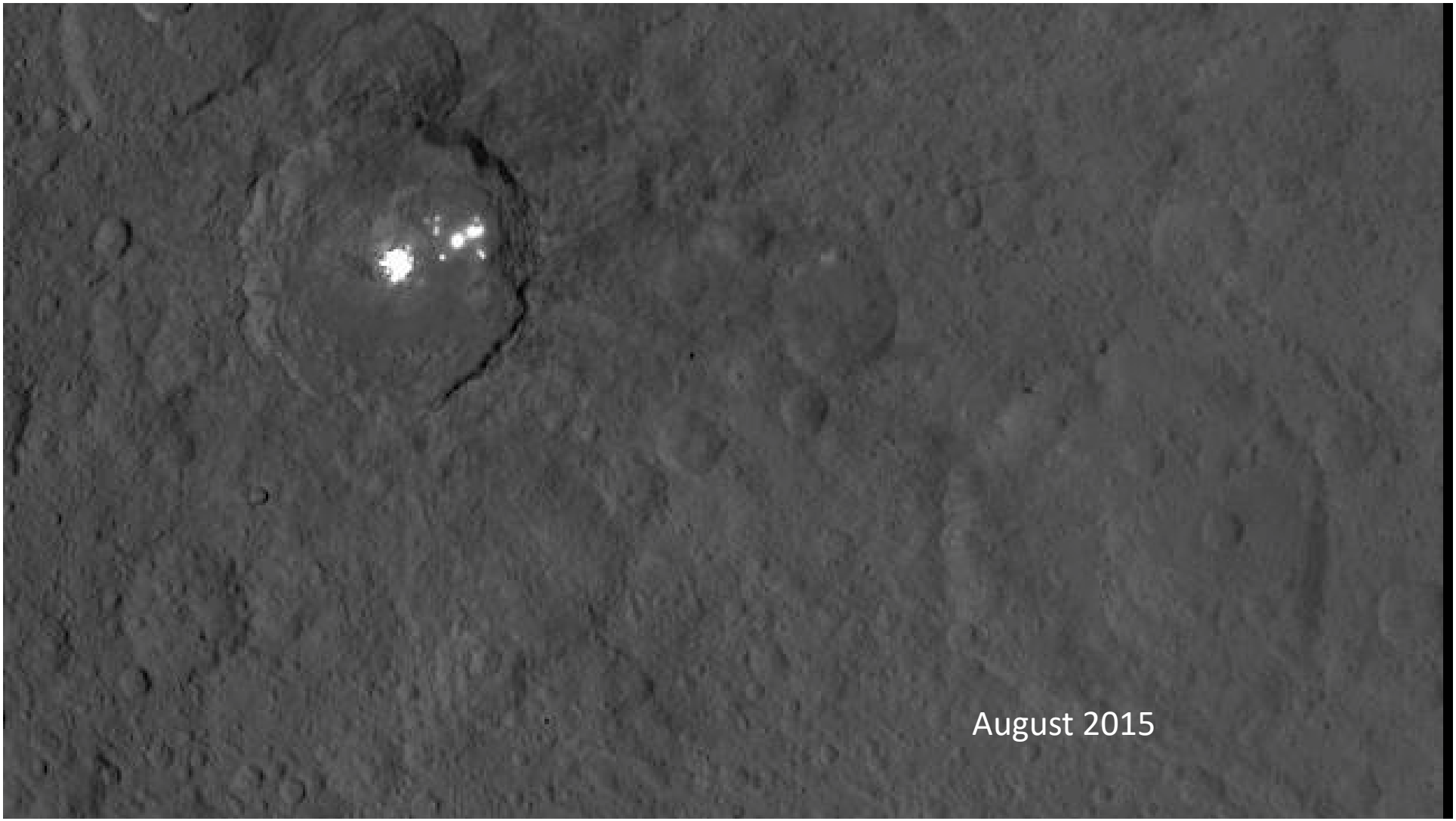
Is-lag (vand-is)

Støv og sten

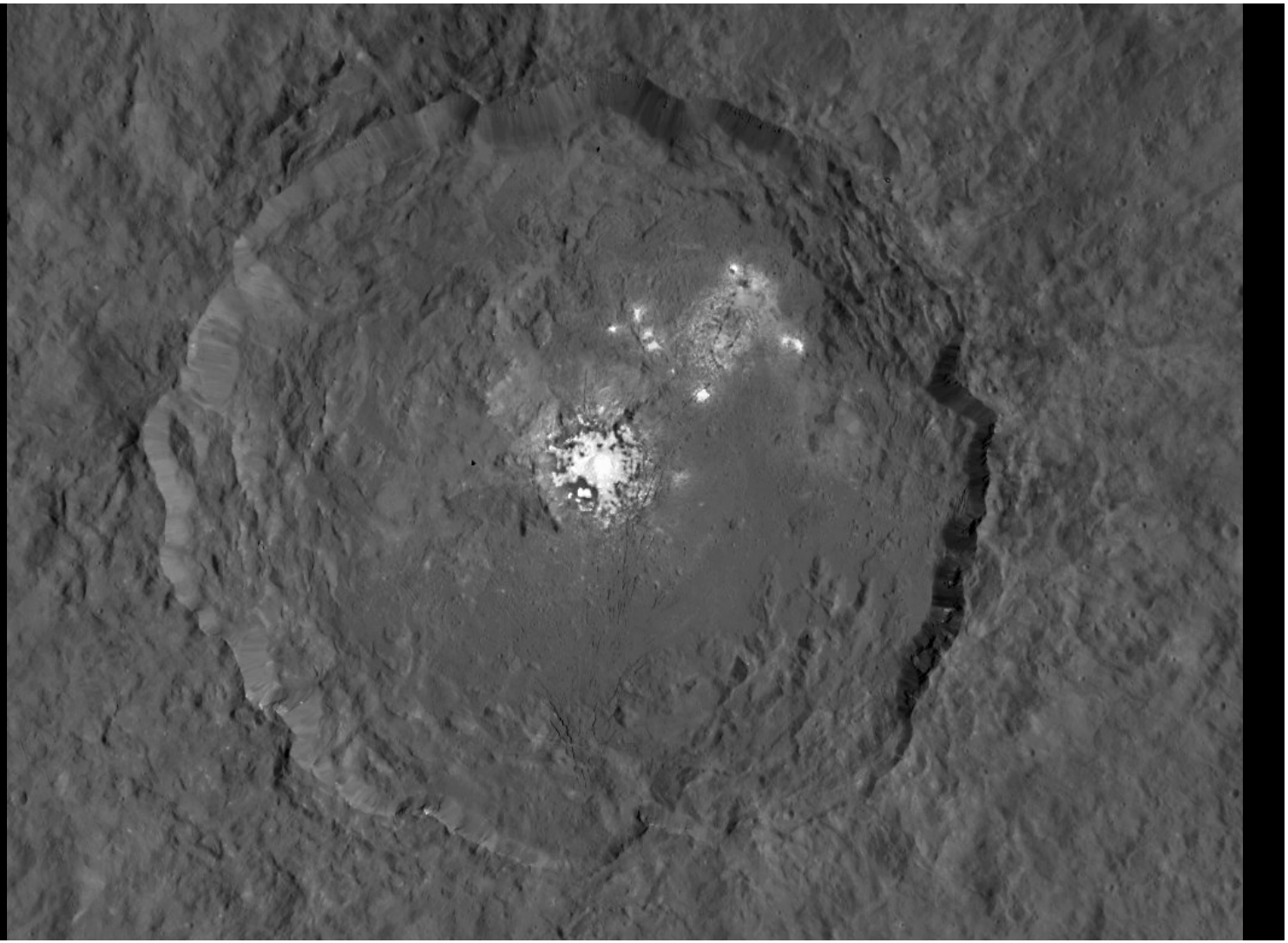
Indre klippekerne

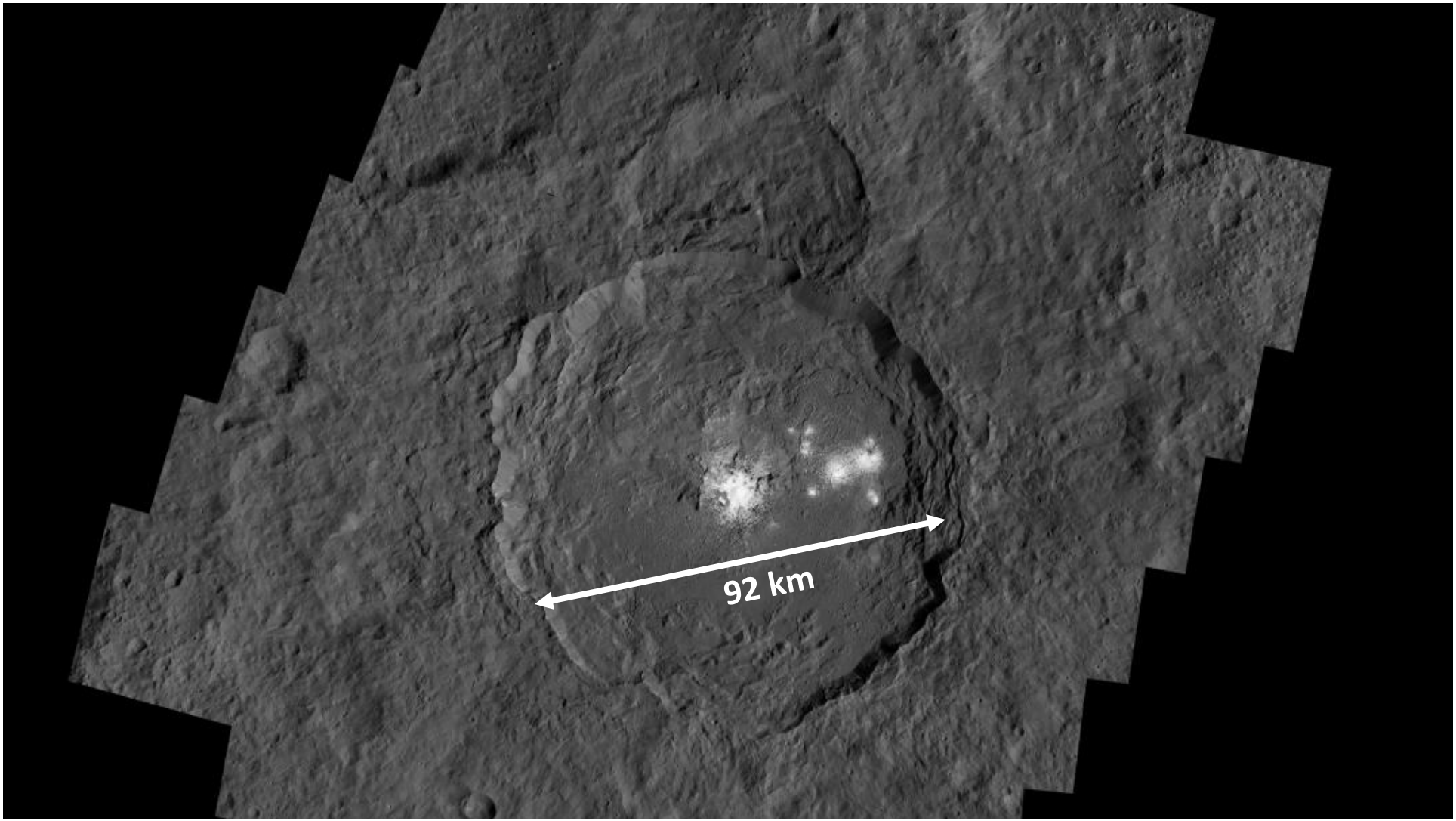
Ceres
NASA Dawn 2015

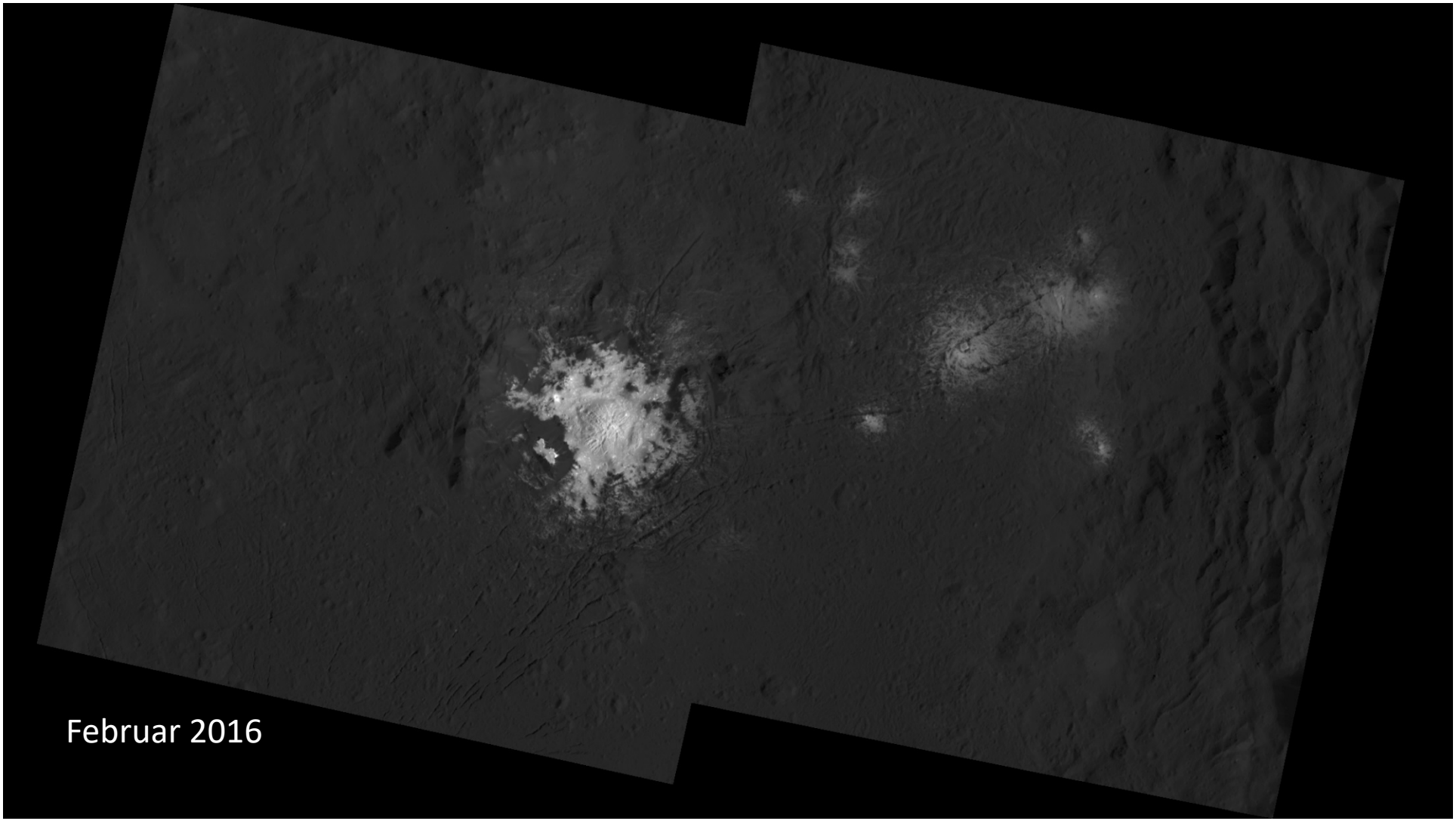


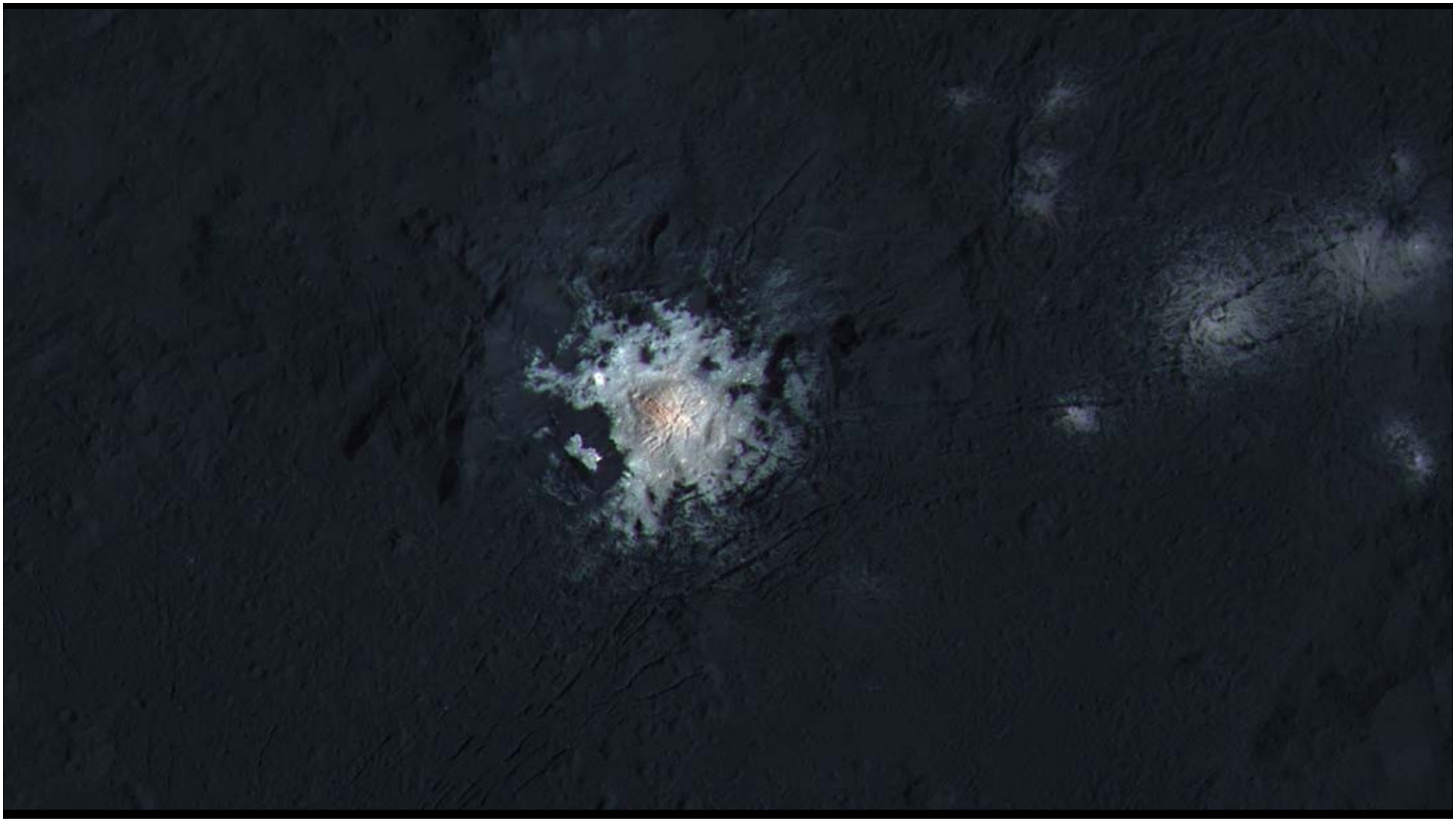

August 2015

September 2015




92 km


Februar 2016



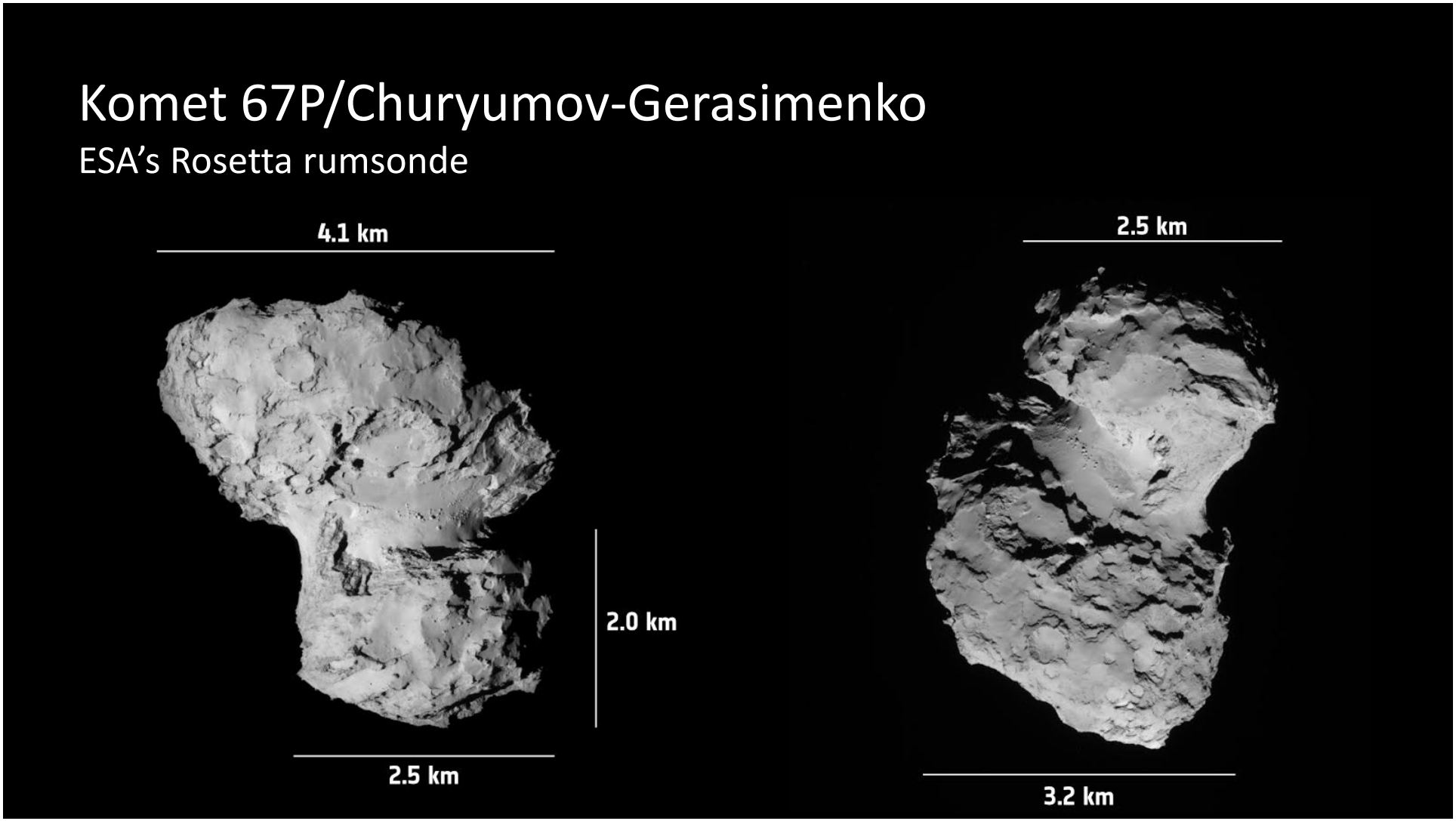

11 km i diameter og højdeforskellene er 400 m

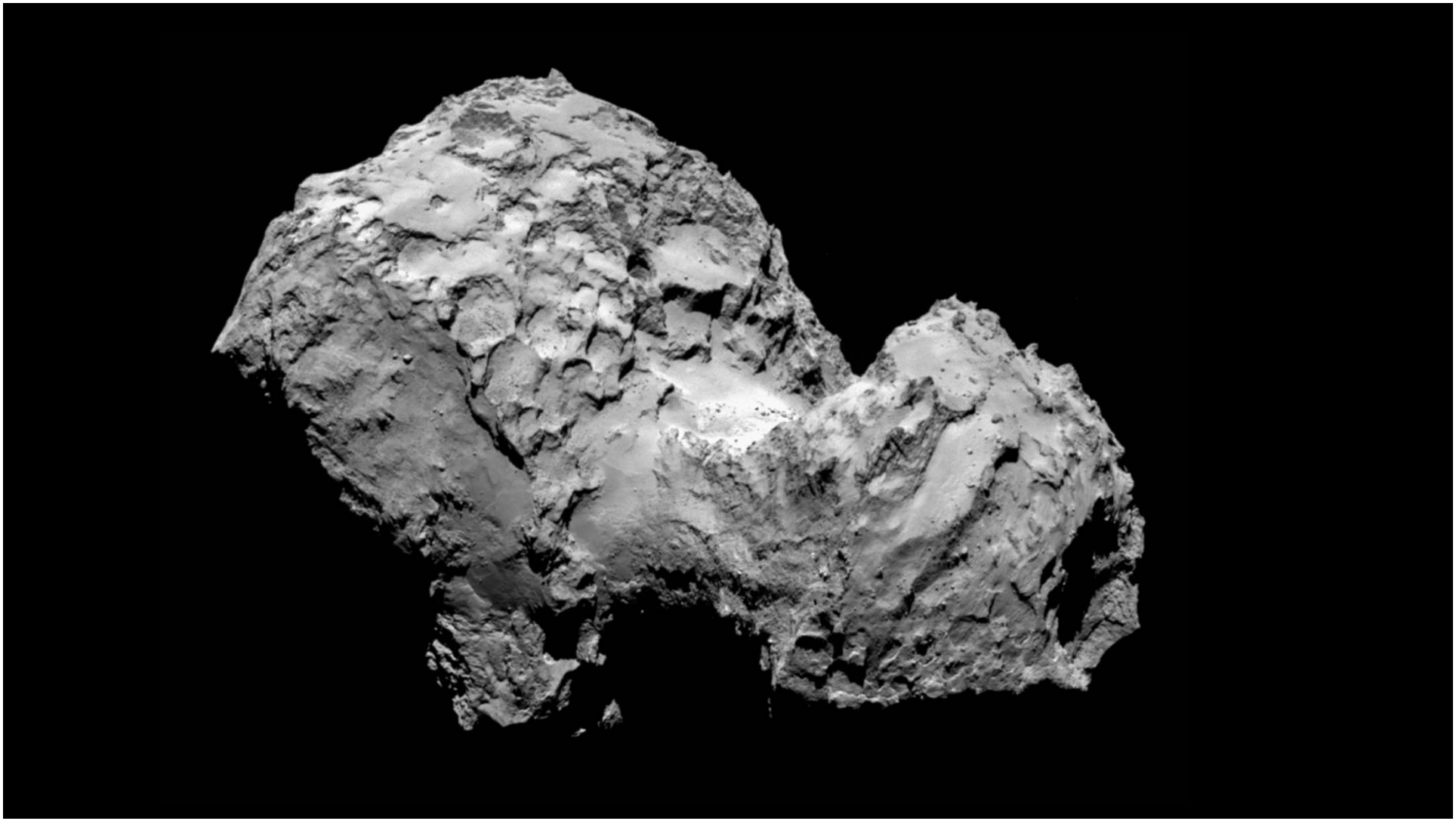
Soda (E-500) eller natriumkarbonat: Na_2CO_3

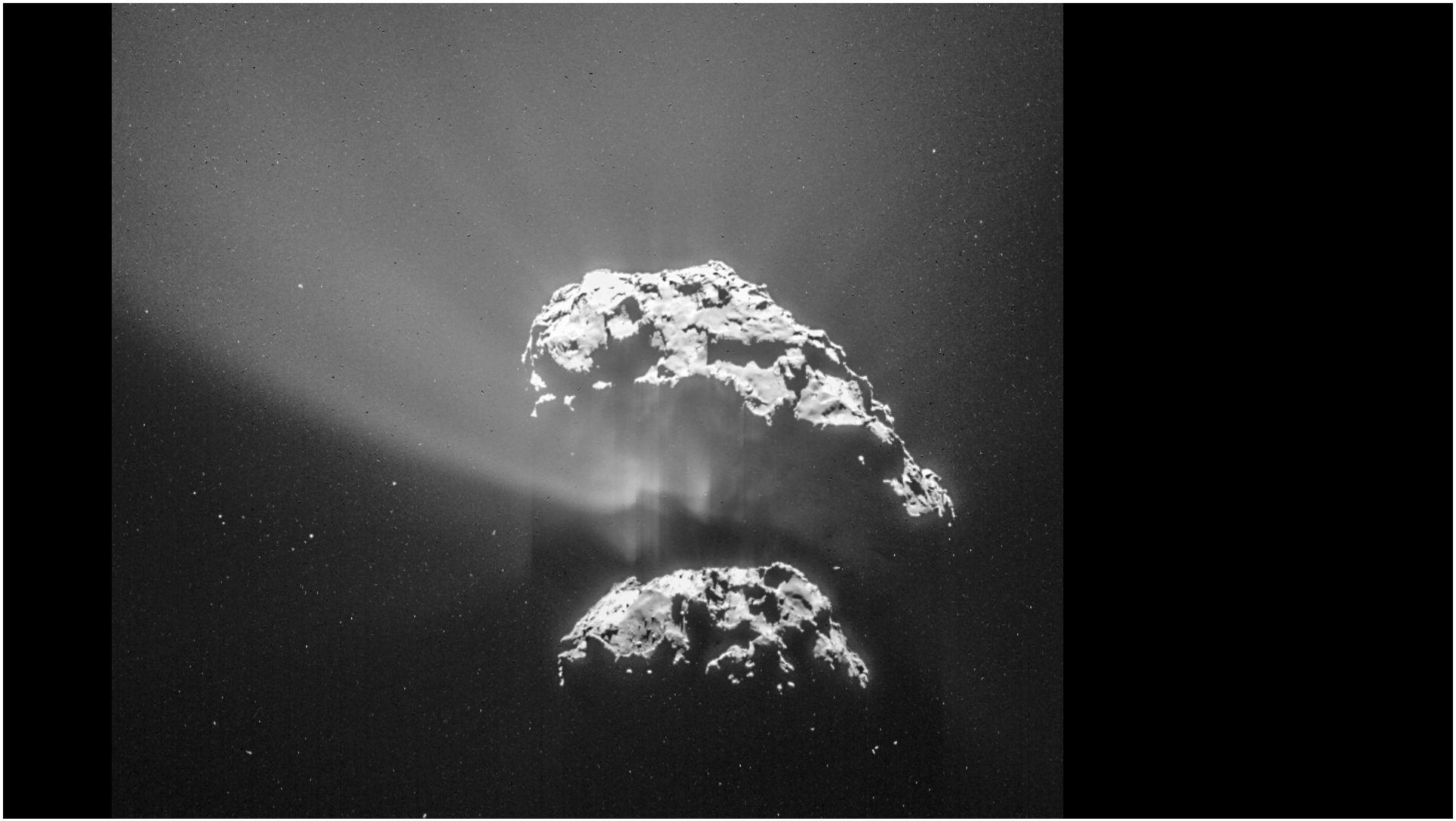

Kometerne i det ydre solsystem

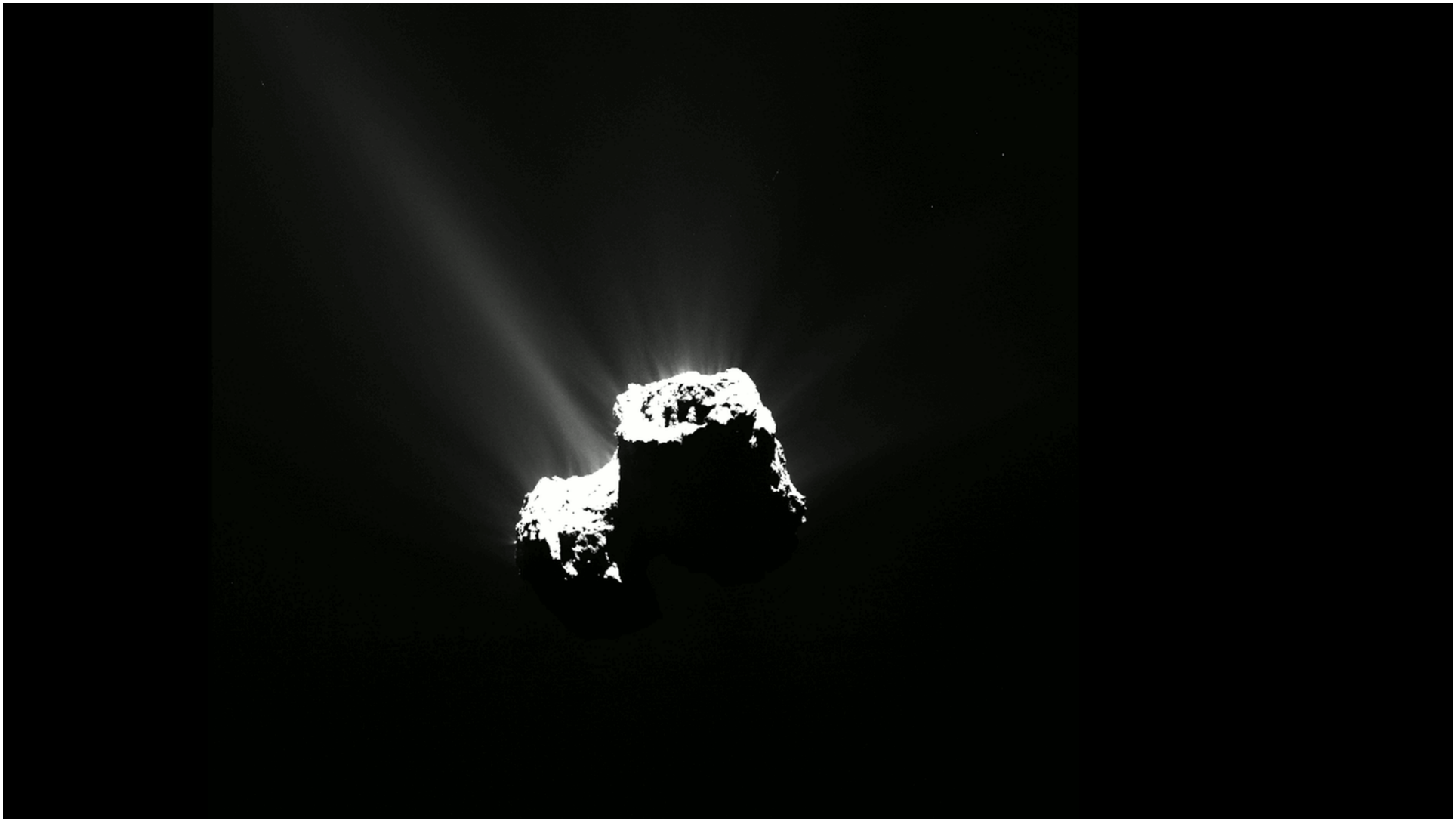
Komet 67P/Churyumov-Gerasimenko

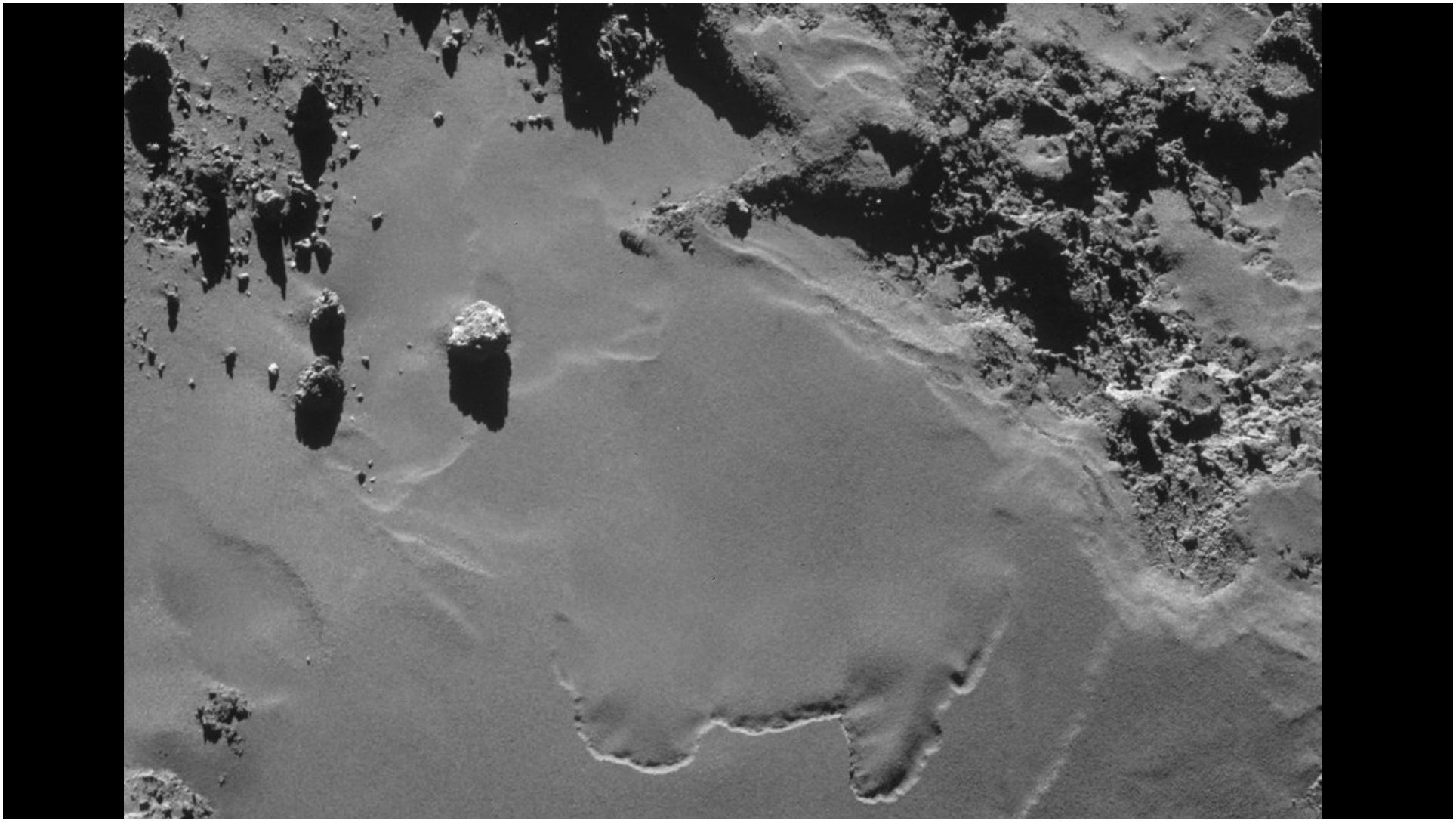
ESA's Rosetta rumsonde

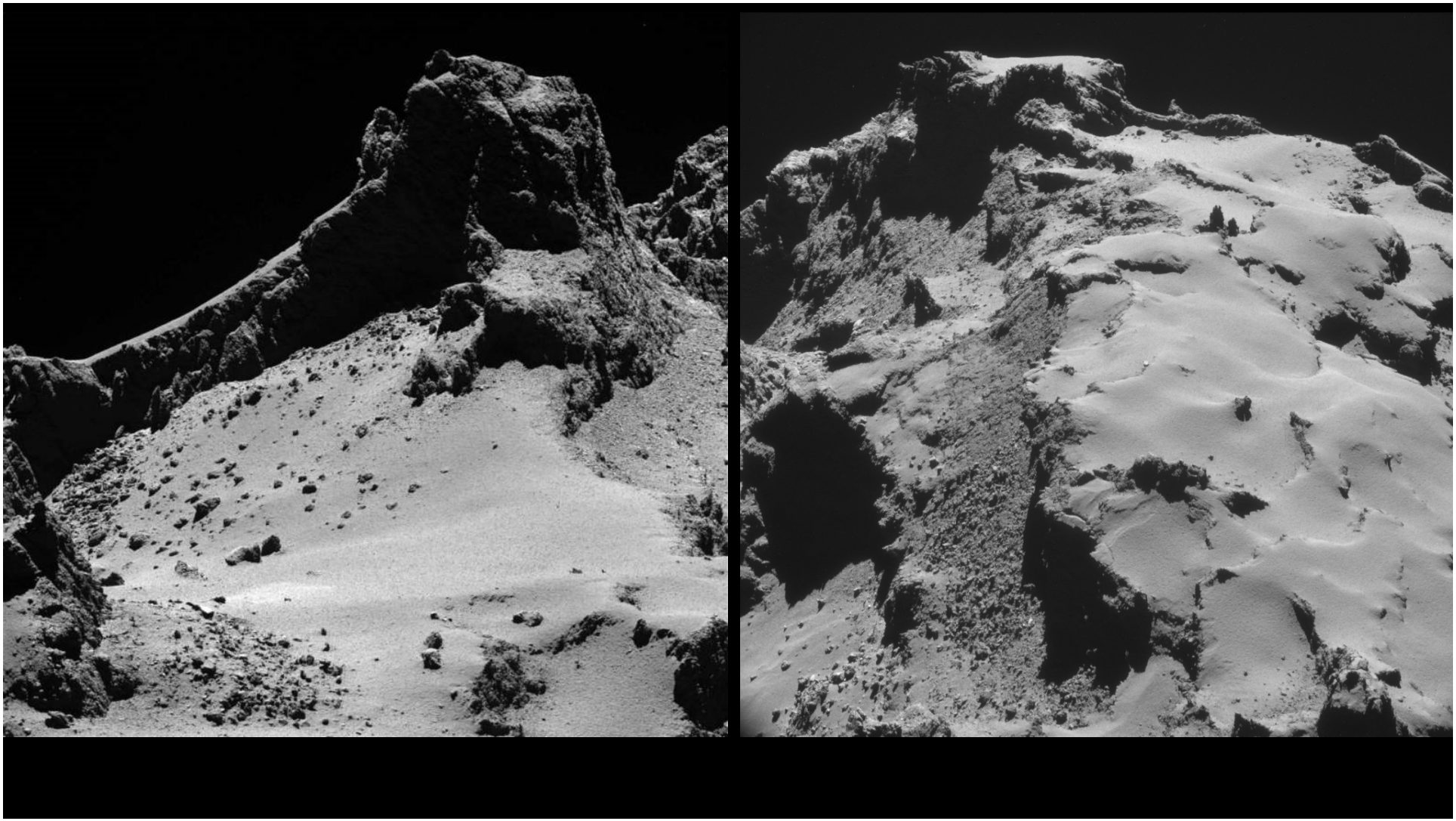


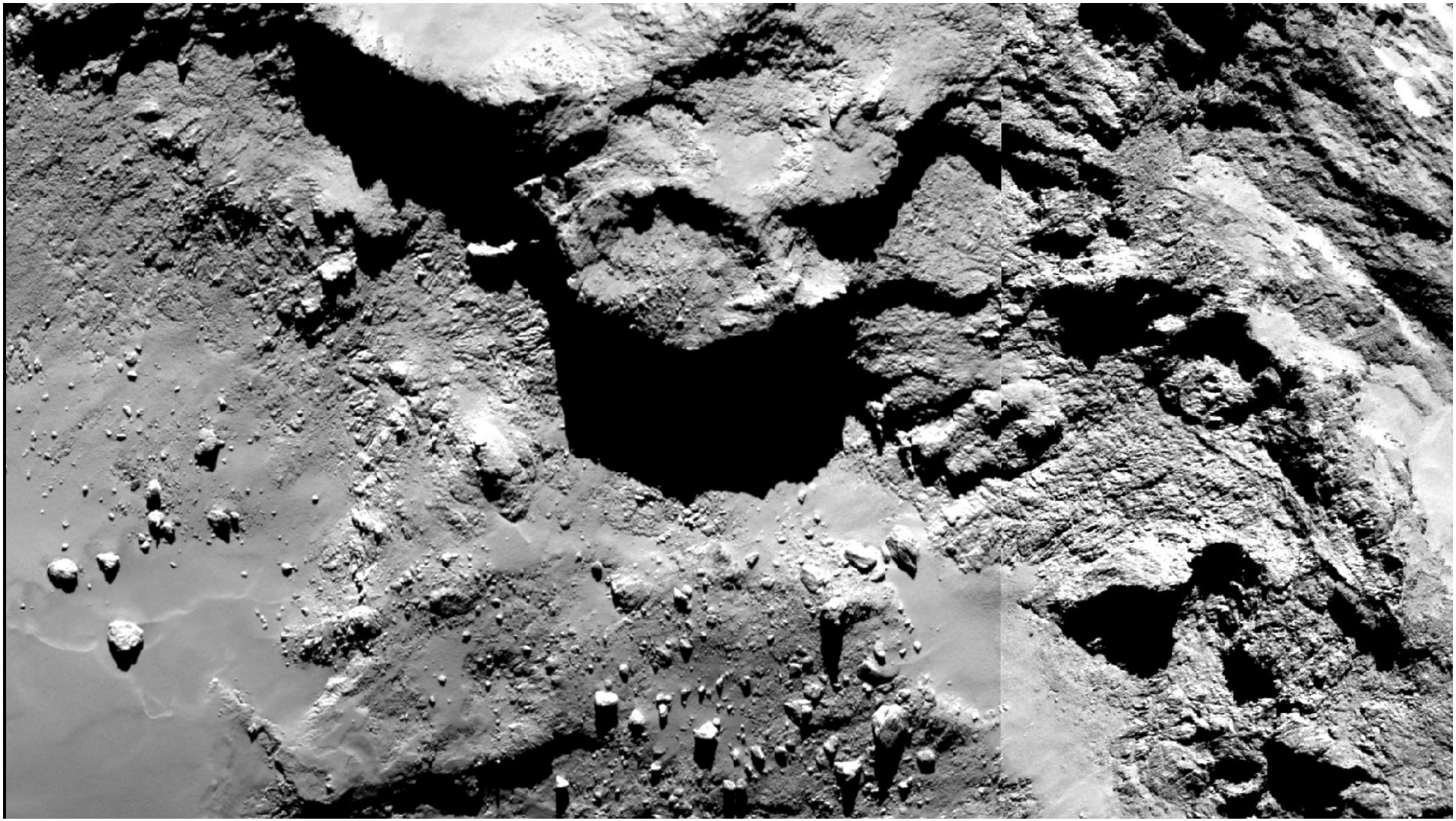


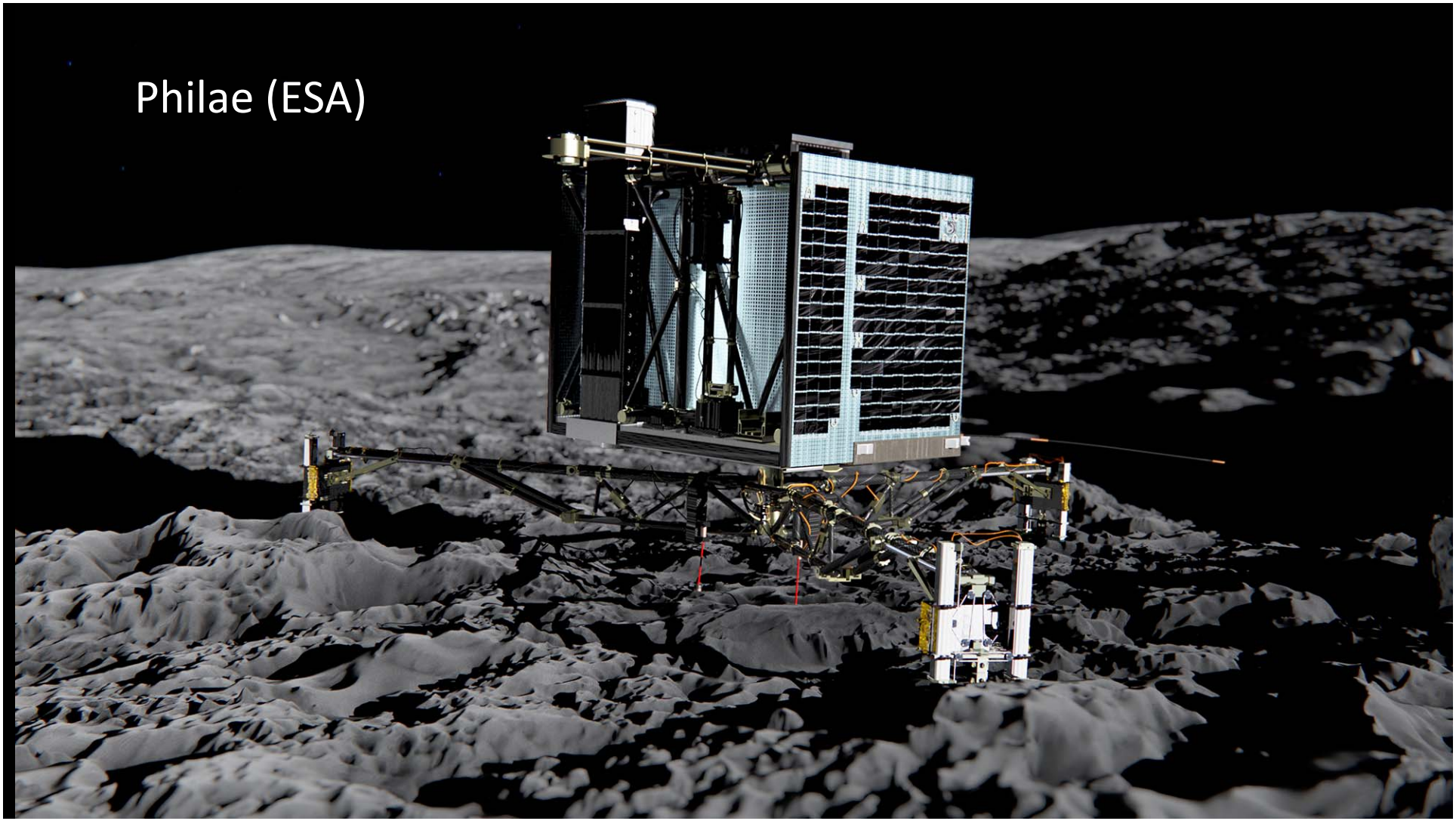


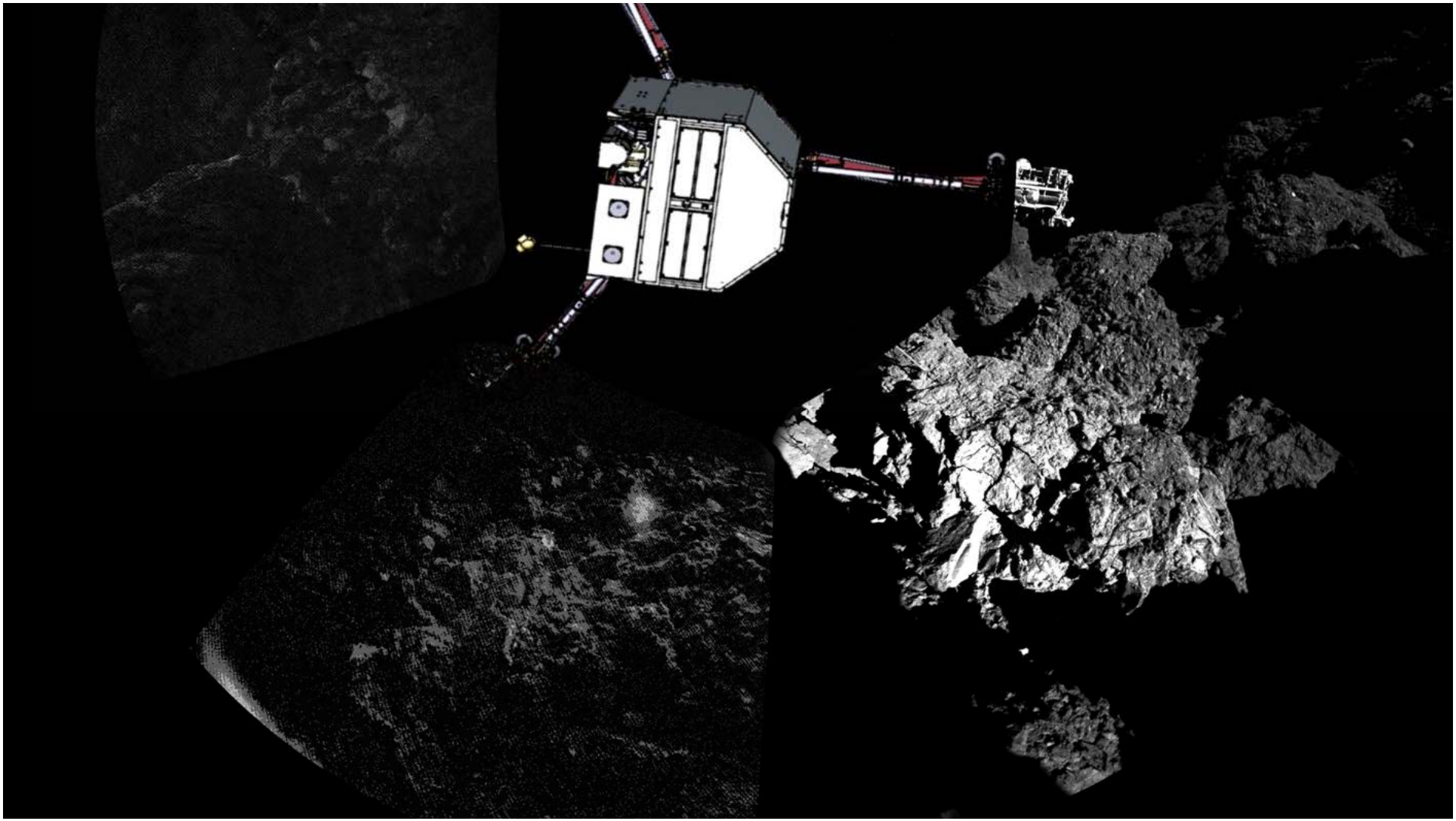


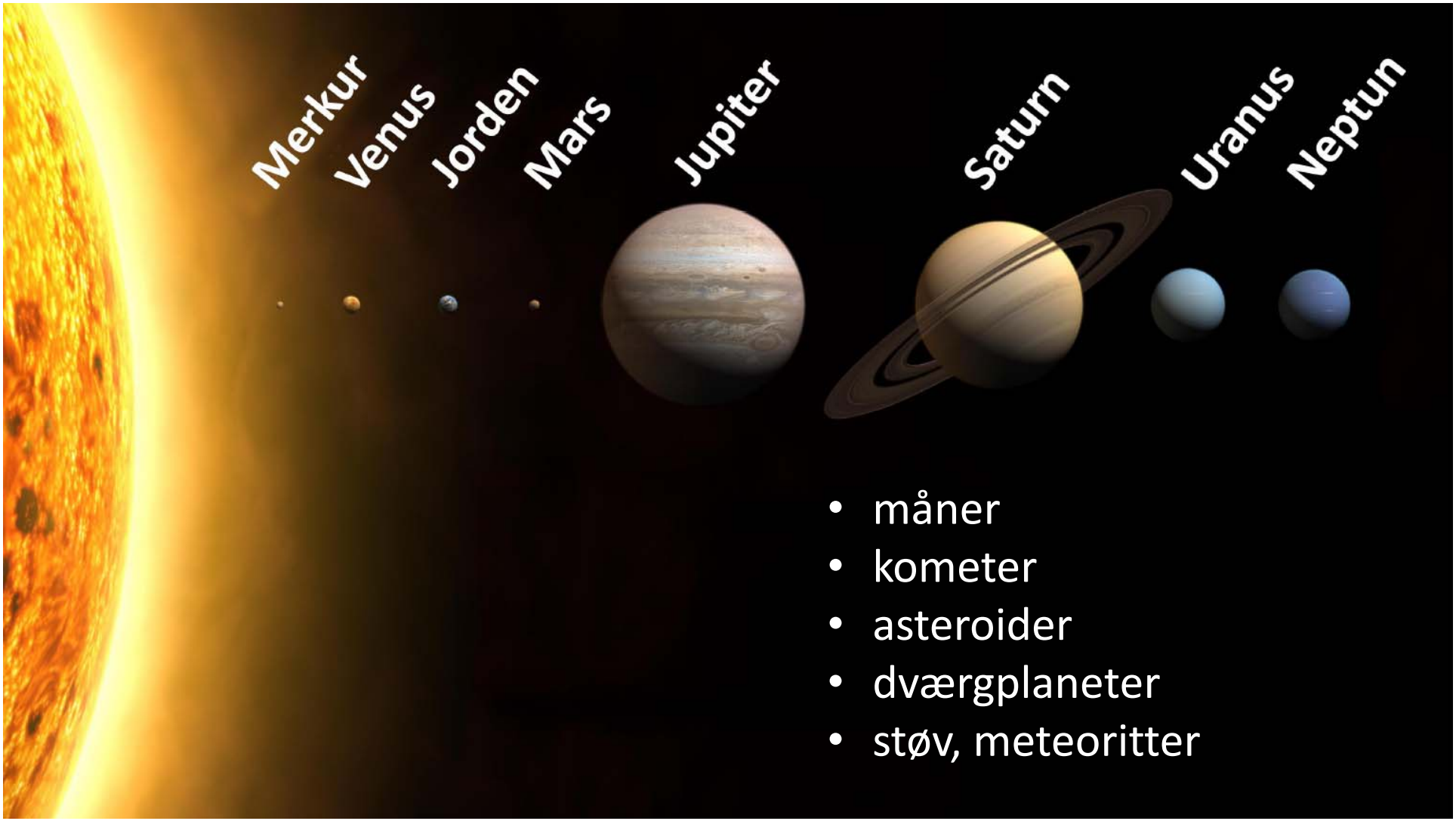







Philae (ESA)




Merkur
Venus
Jorden
Mars
Jupiter
Saturn
Uranus
Neptun
• måner
• kometer
• asteroider
• dværgplaneter
• støv, meteoritter