

# Magnetic (and Other) Observations of Saturn from the Cassini Mission

Cassini Magnetometer Team, Imperial College

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*Principal Investigator : Professor Michele K. Dougherty*

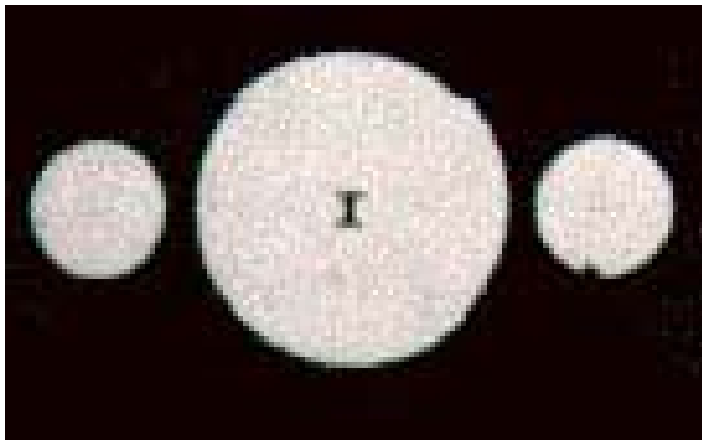
*Operations team Leader : Steve Kellock*

*Operations / Data Processing: Dr. Peter Slootweg, Tim Sears*

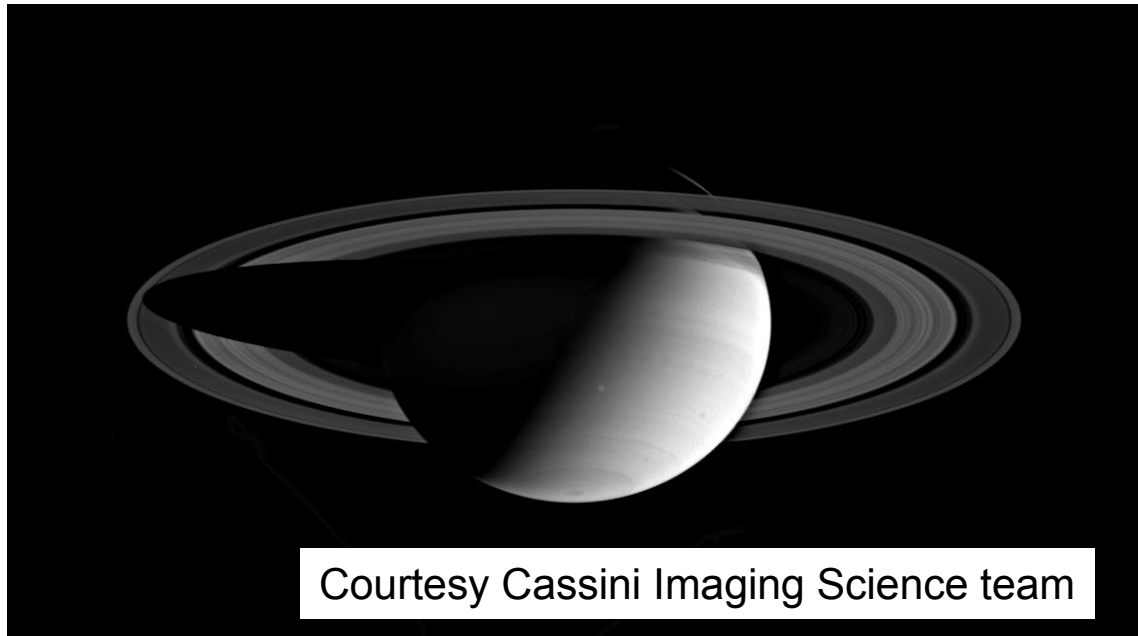
*Science: Dr. Cesar Bertucci, Christopher Arridge*

*plus co-investigators at Leicester University, NASA JPL, UCLA, University of Cologne, CESR Toulouse, University of Braunschweig*

- The Cassini mission – the journey to Saturn
- Images on approach to Saturn (Imaging Science Subsystem)
- Magnetic field measurements from Cassini first orbits
- Images from Huygens probe mission (25 Dec 2004 – 14 Jan 2005) to Titan



Galileo 1610 'Saturn has ears'



Courtesy Cassini Imaging Science team

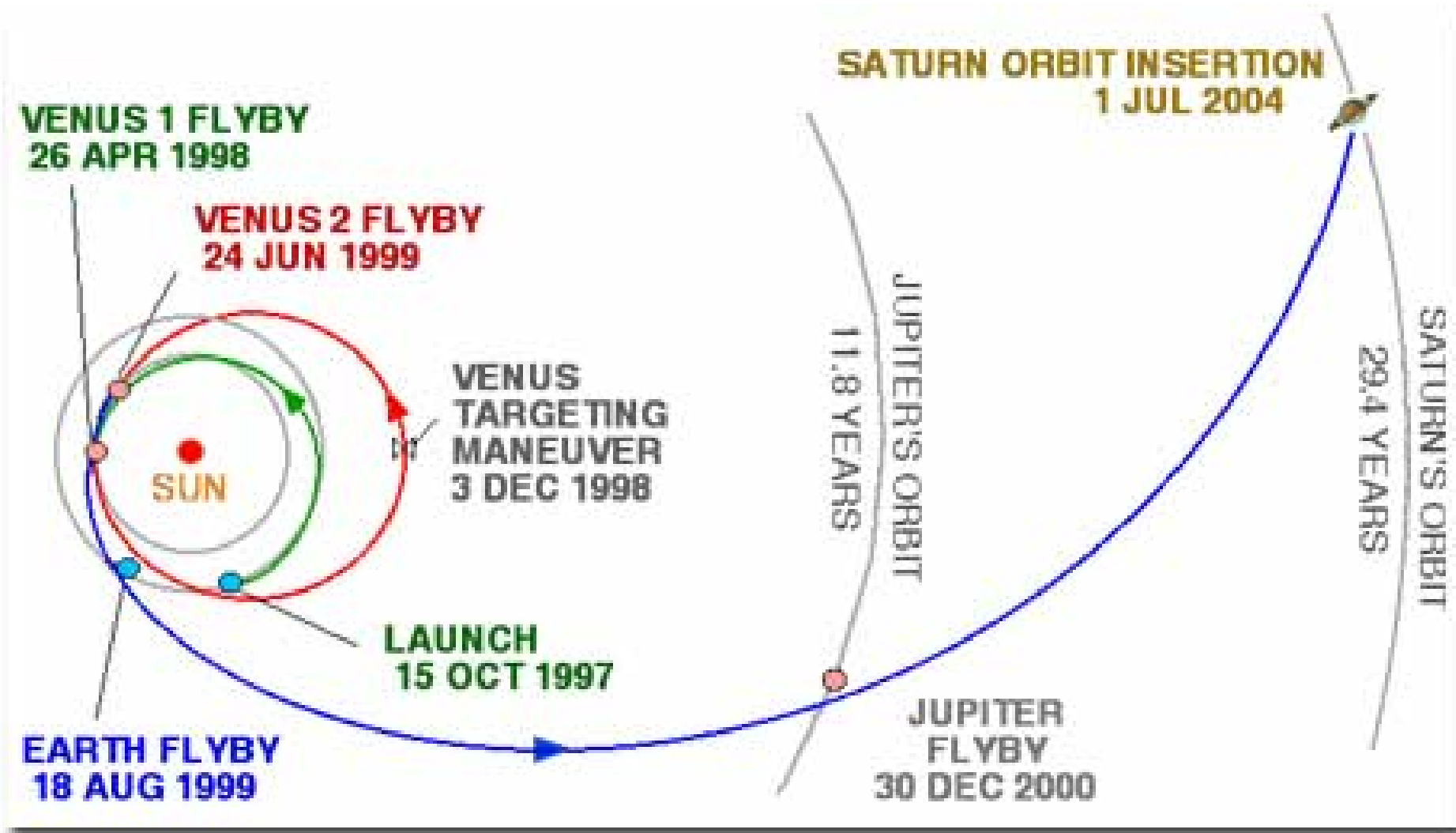


Giovanni Cassini  
1625-1712  
Moons  
'Cassini Division'



Christiaan Huygens  
1629-1695  
Rings and Titan

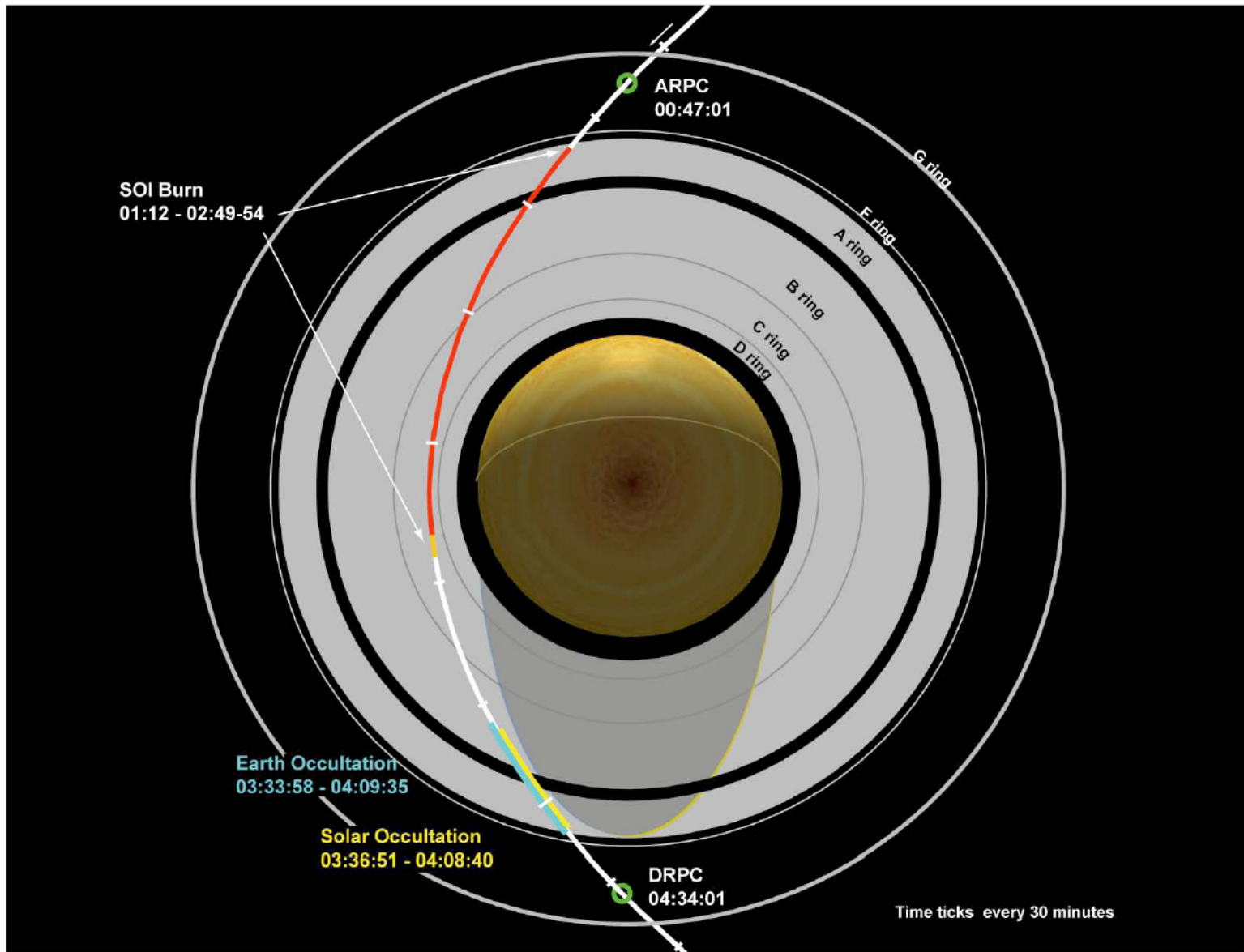
# CASSINI HUYGENS Trajectory

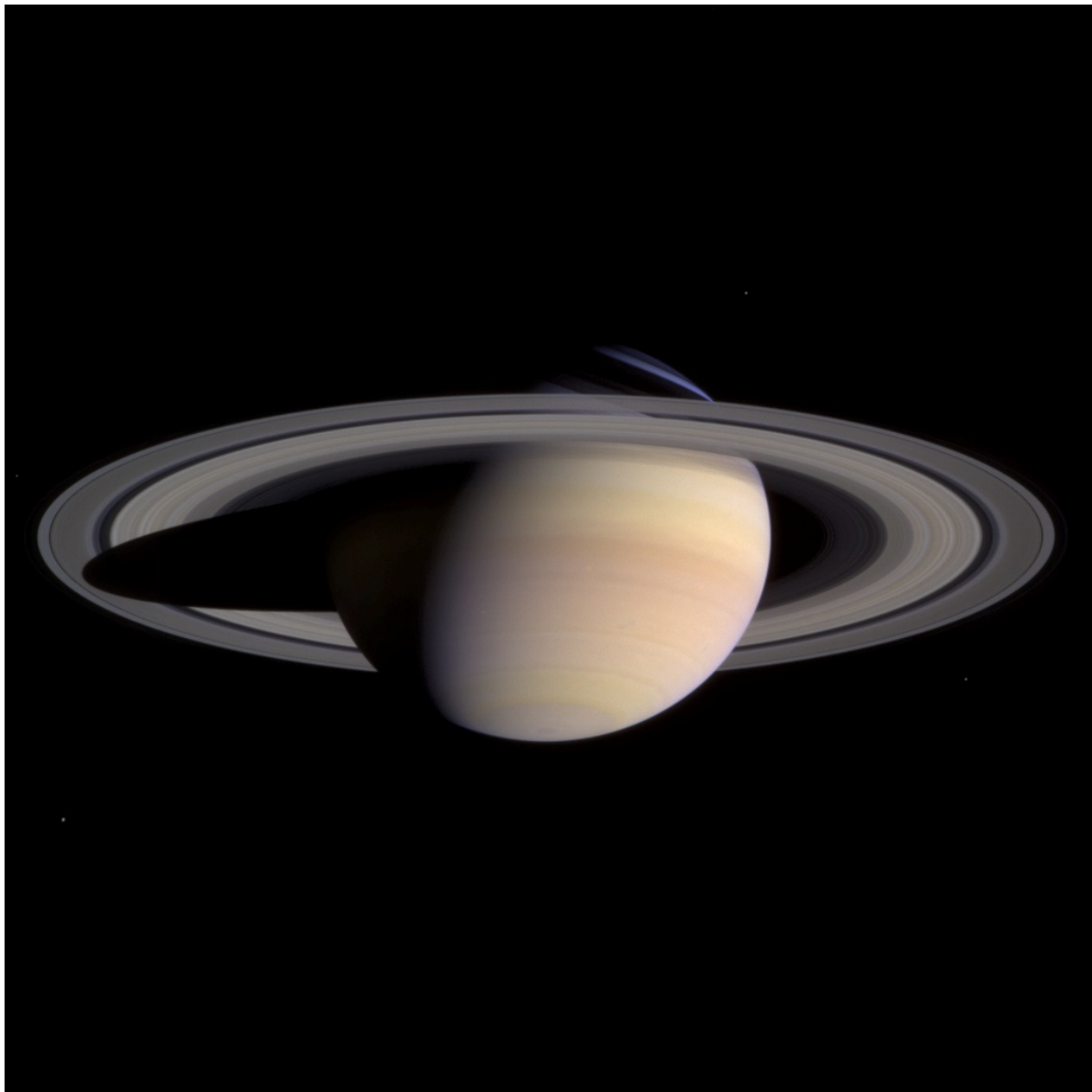


# CASSINI SPACECRAFT

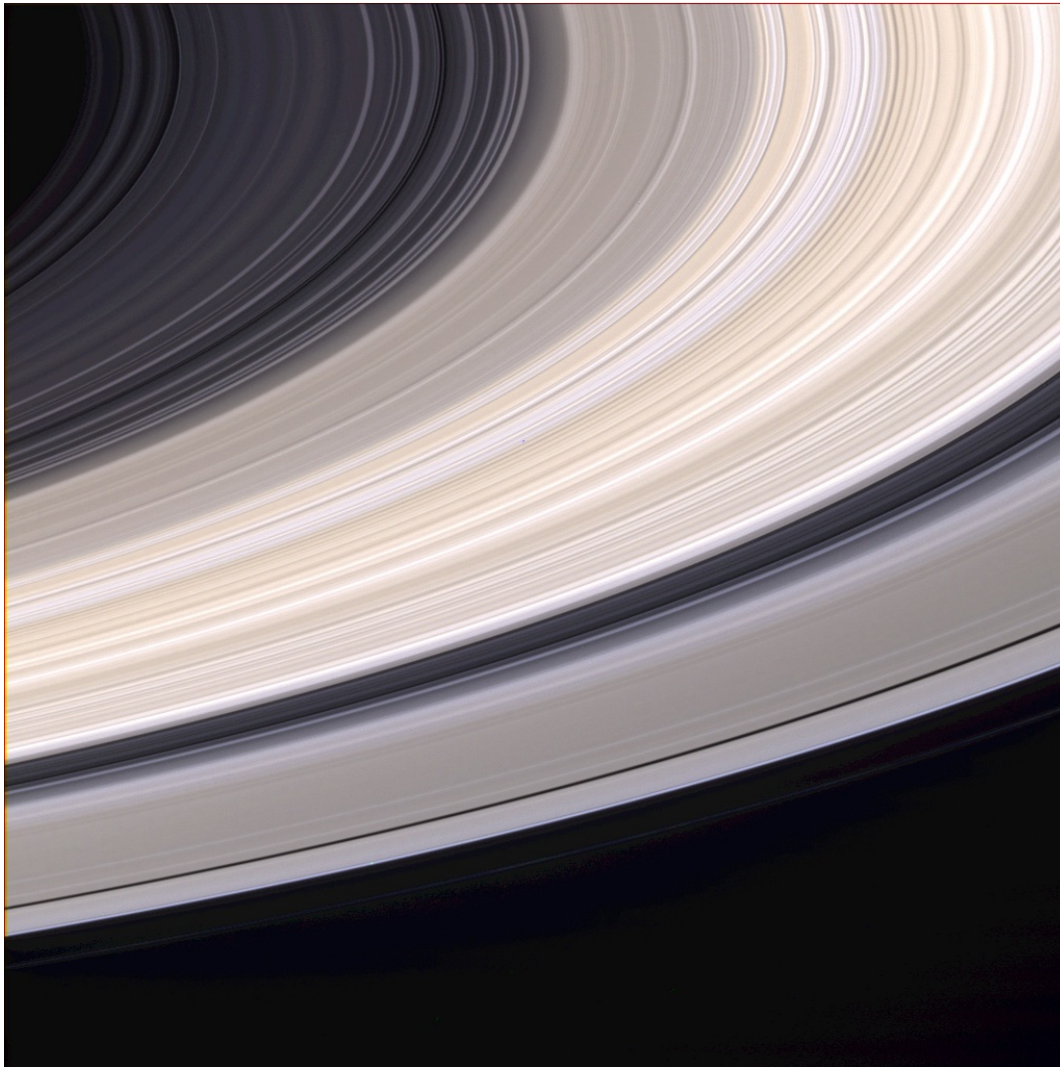








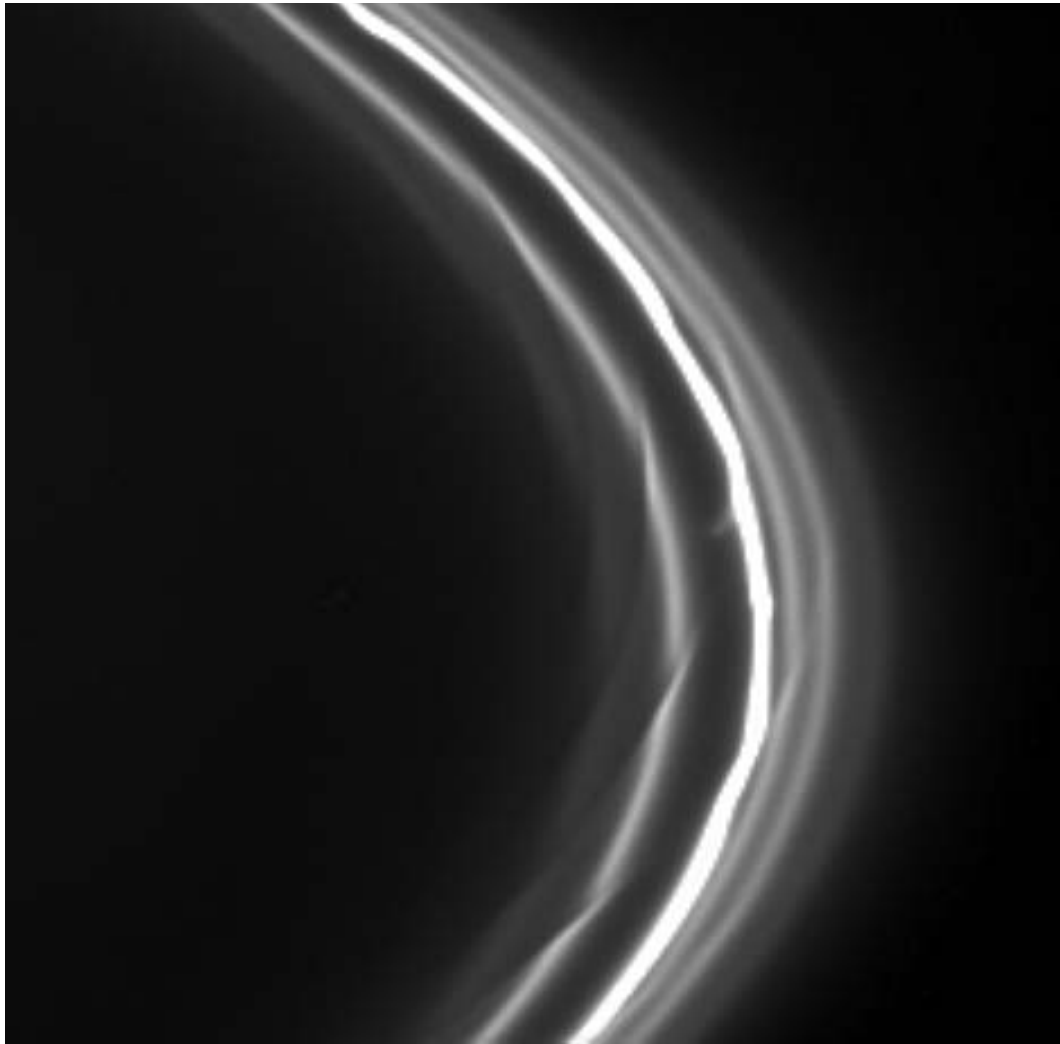
Courtesy Cassini  
Imaging Science team



Courtesy Cassini  
Imaging Science team

Rings are made of ice and 'dirt' (tholin)  
Cassini Division is due to 'orbital resonance' with Mimas

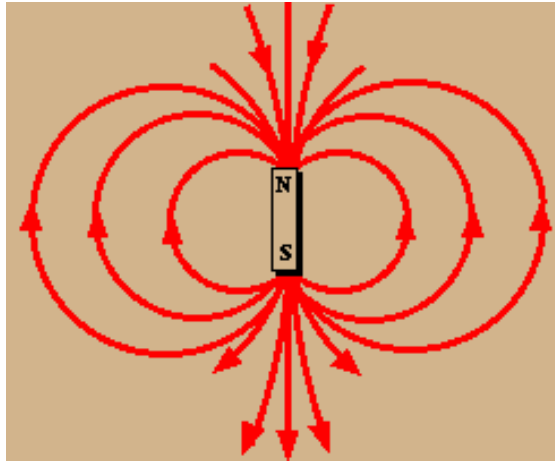




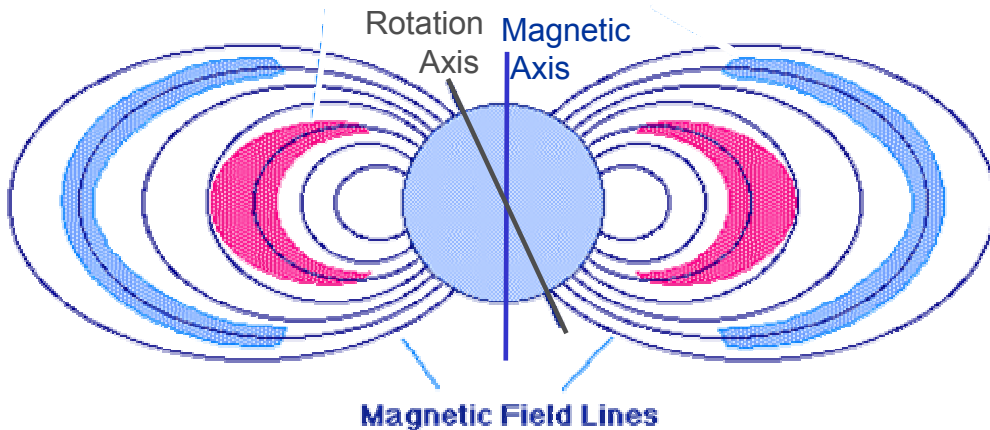
Courtesy Cassini  
Imaging Science team

F Ring features due to Prometheus pulling on ring material

## Planetary Magnetic Fields



Bar magnet – iron filings line up along ‘lines of force’. Two poles, N and S – *magnetic dipole*.

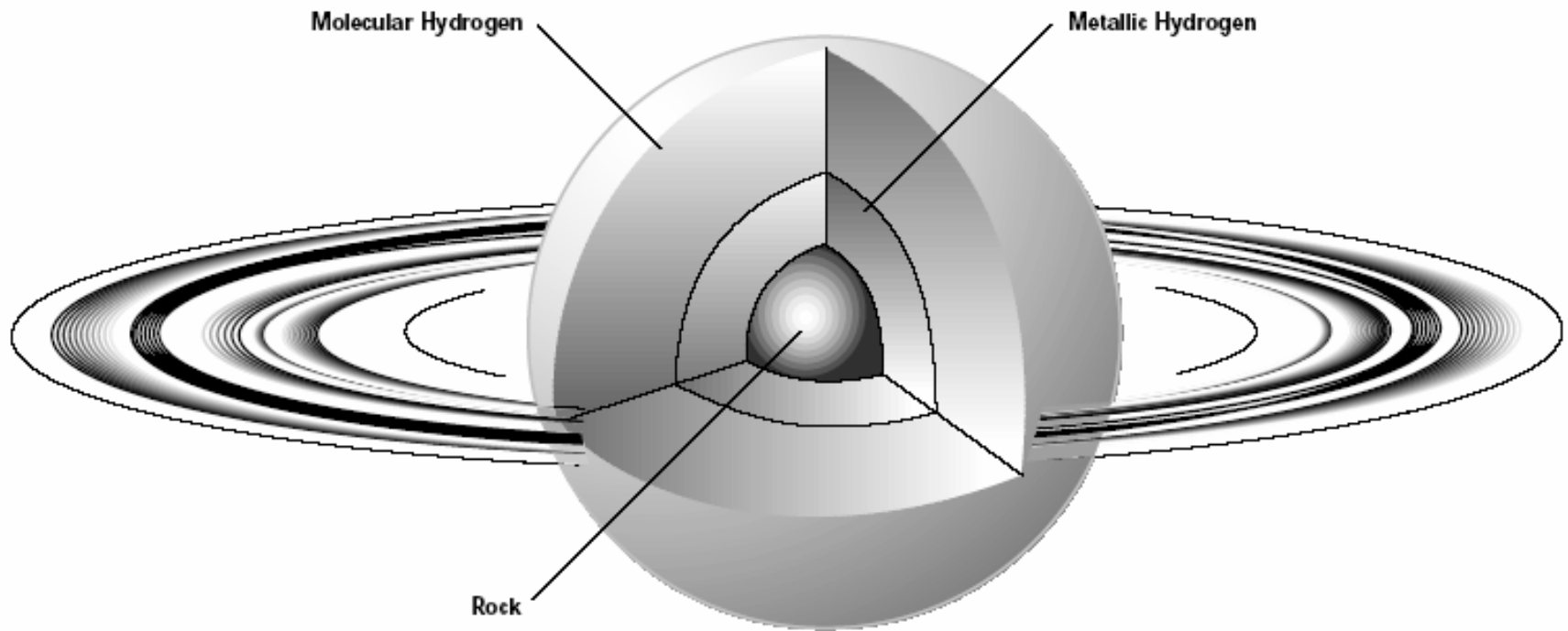


Earth’s magnetic field (and other planets) – looks like giant ‘bar magnet’ near planet centre. At large distances, field looks like dipole. Dipole or magnetic axis usually displaced from planet’s rotation axis (‘dipole tilt’).

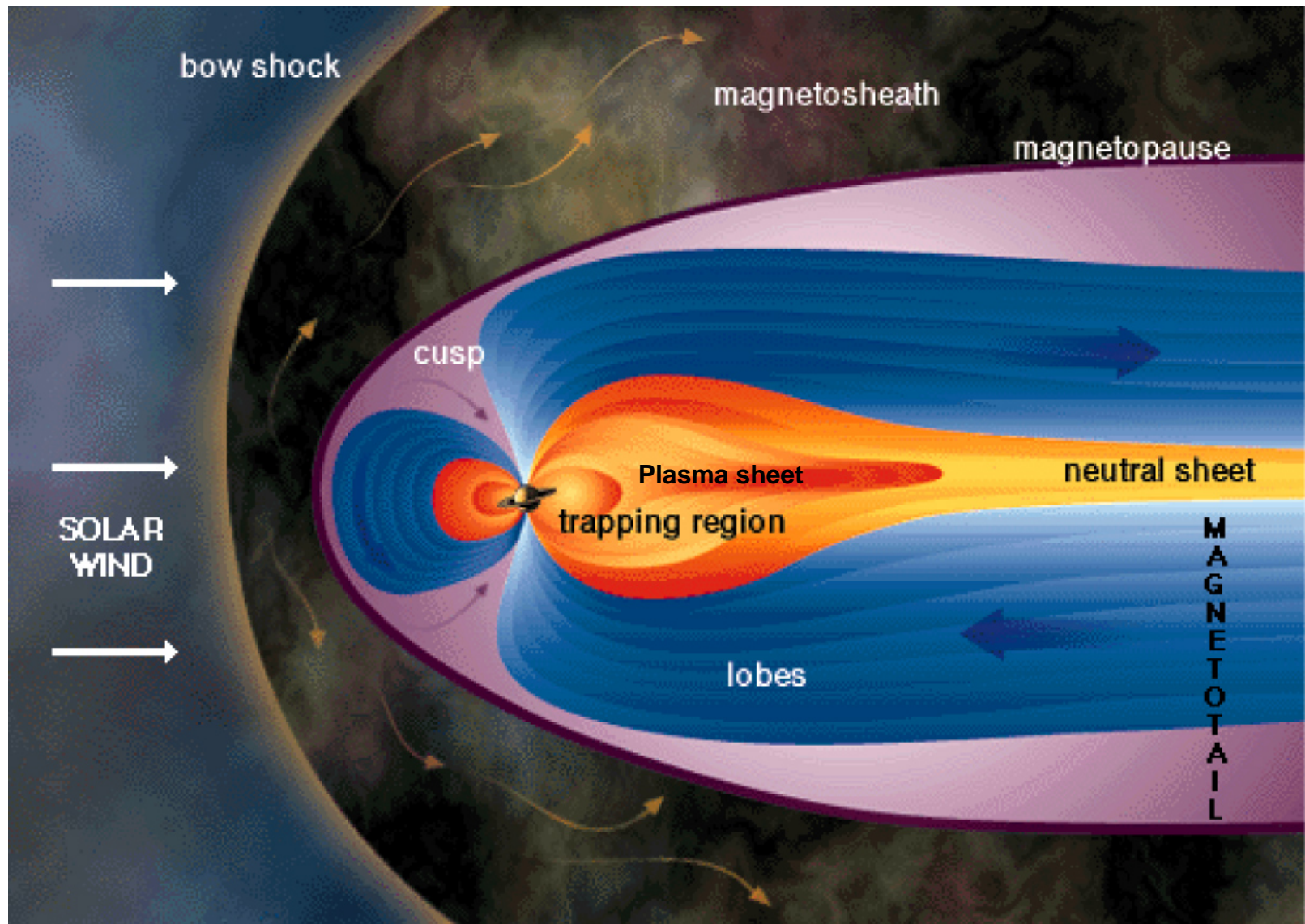
## Magnetism and Rotation

<i>Planet</i>	<i>Mass</i>	<i>Radius</i>	<i>Period of Rotation</i>	<i>Planetary Dipole: Moment (<math>B_{eq} R^3</math>)</i>	<i>Tilt</i>
Earth	1	1 (6400km)	1 day	1 ( $B_{eq} = 32000\text{nT}$ )	10.6 deg
Jupiter	318	11	0.414	18000	9.4
Saturn	95	9.5	0.426	550	< 1

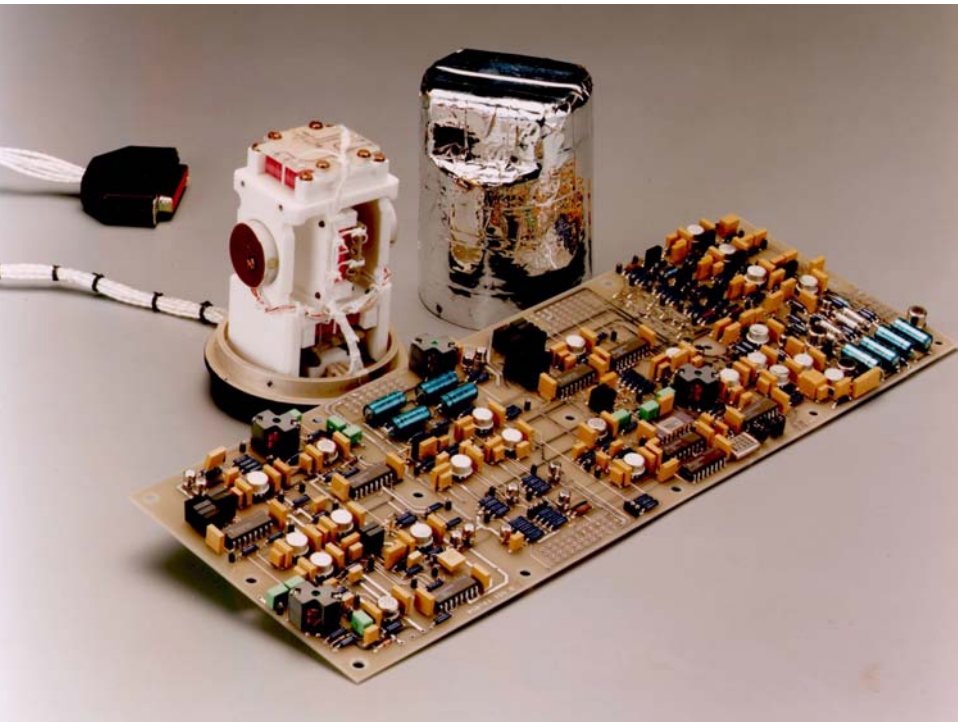
- Giant planets are rapid rotators *for their size*, and thought to have liquid metallic hydrogen above core → excellent conductor → strong magnetic field from dynamo action (planet rotation plus convection in interior)



Metallic hydrogen → perfect electrical conductor → strong planetary magnetic field



# Cassini Magnetometer : Saturn Arrival Science

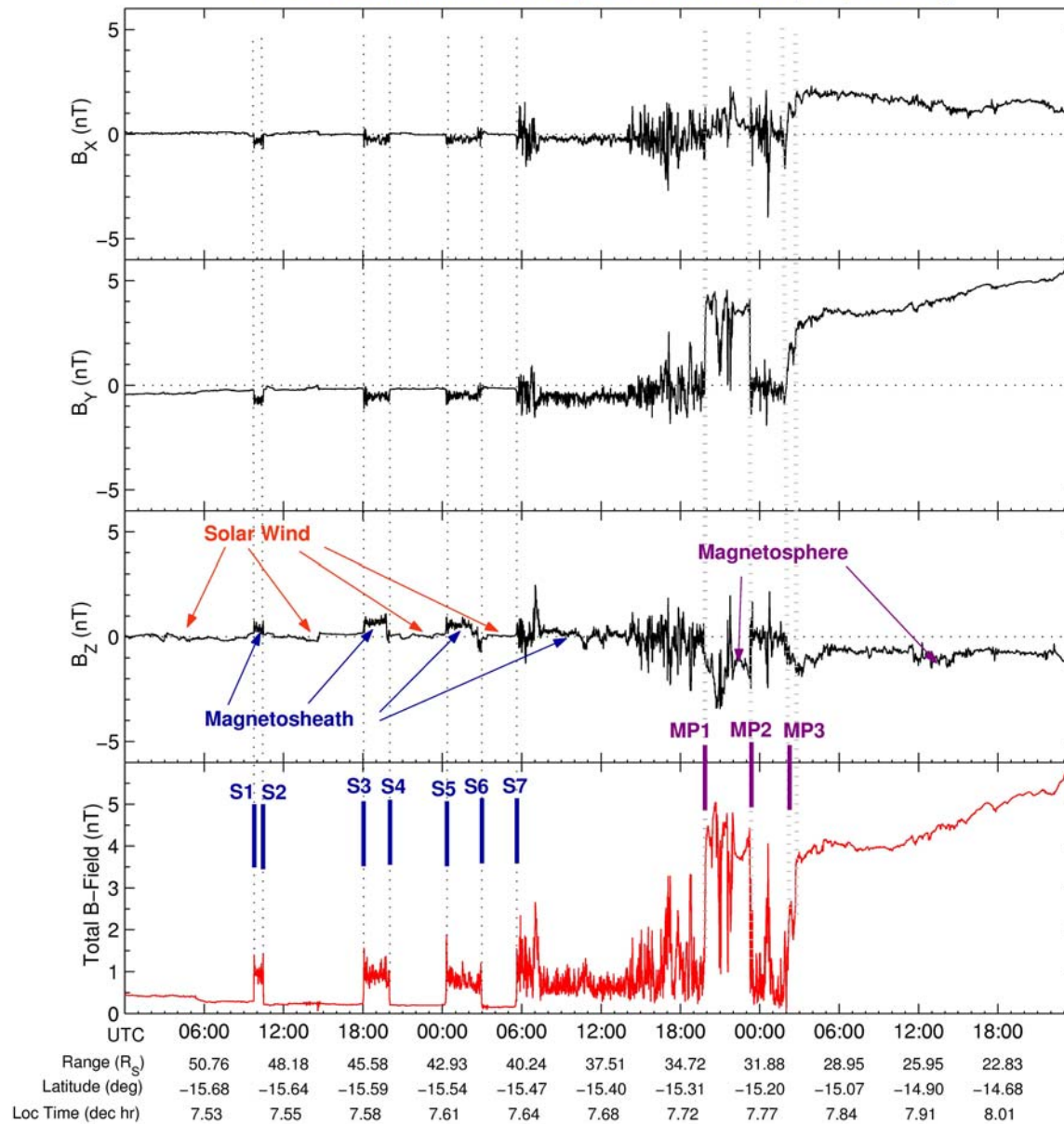


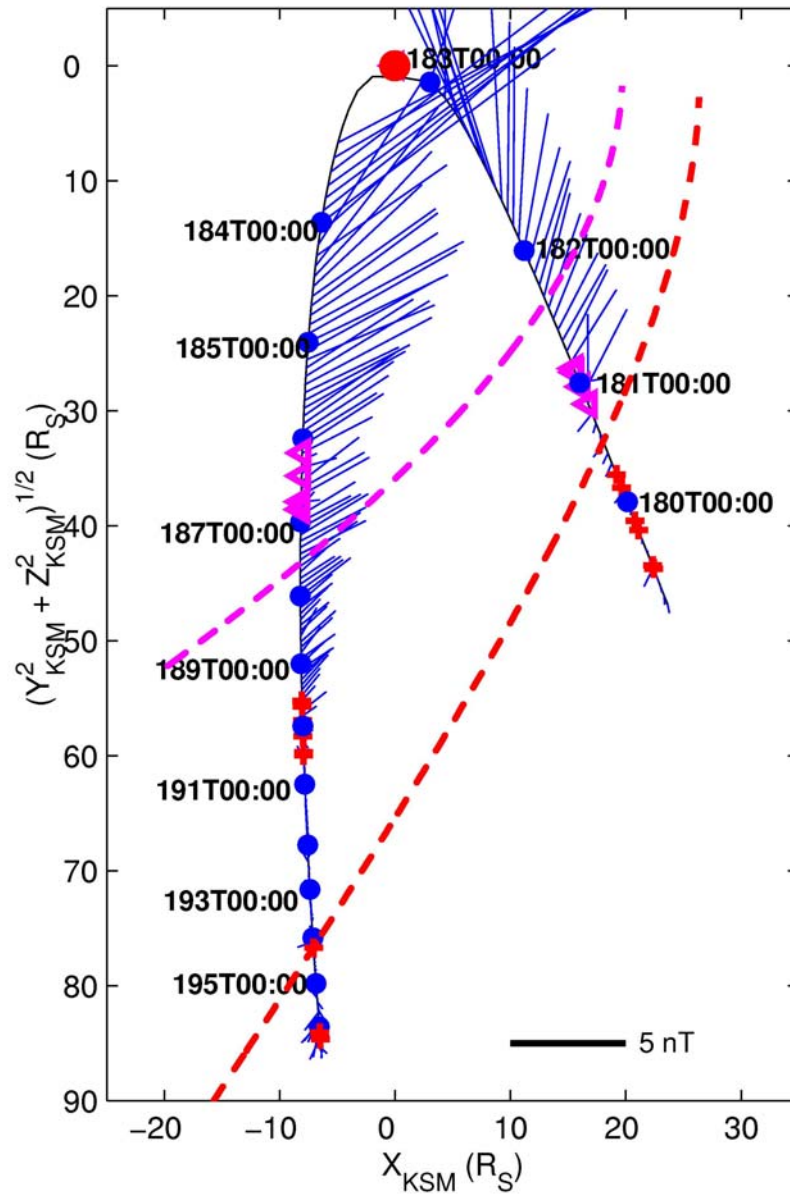
**Flux-gate Magnetometer (FGM)**

## Vector/Scalar Helium Magnetometer (V/SHM)



Cassini Inbound Interval 2004 Days 179–181 VHM Data (KSM, 1 min avg)

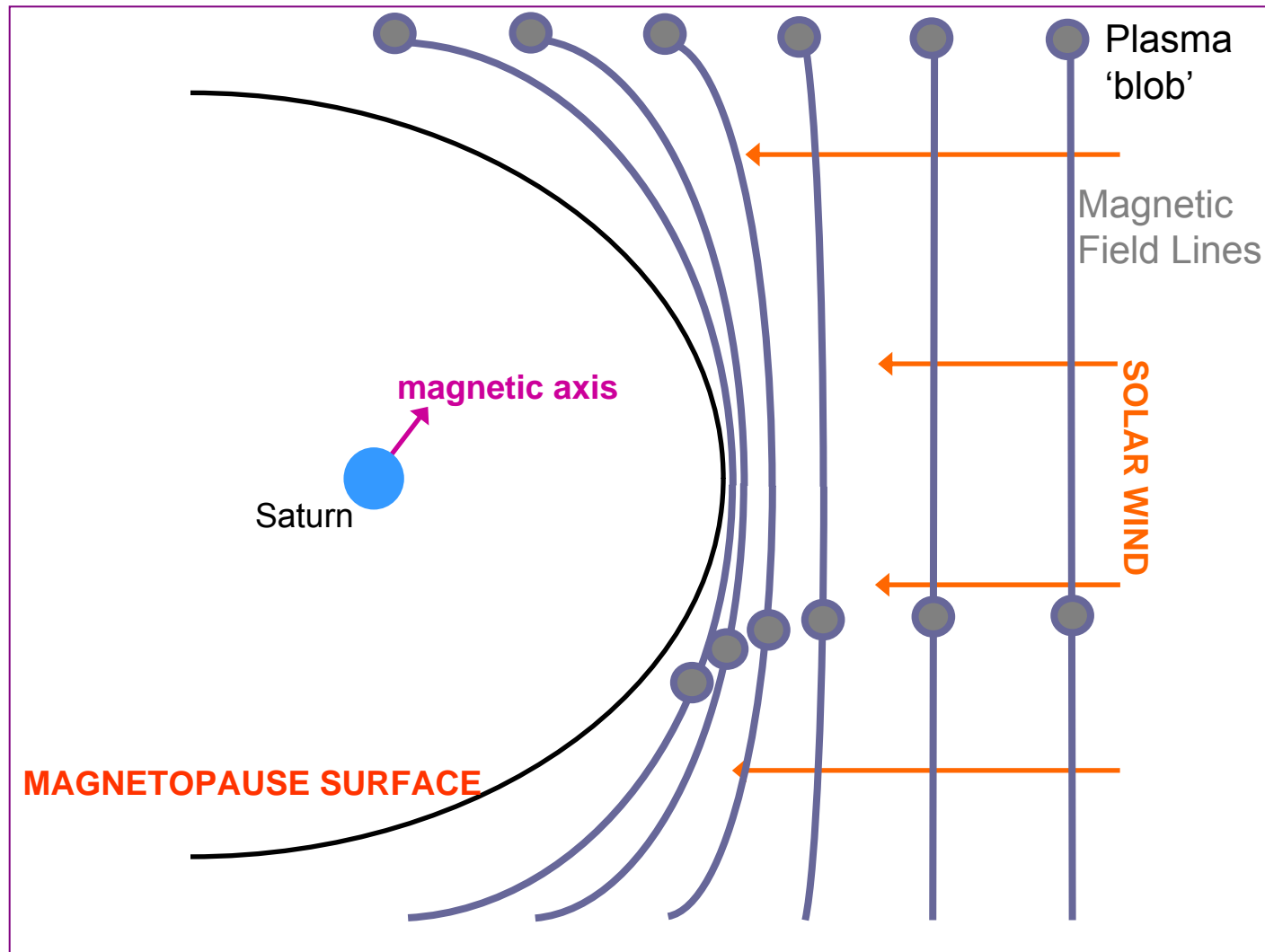




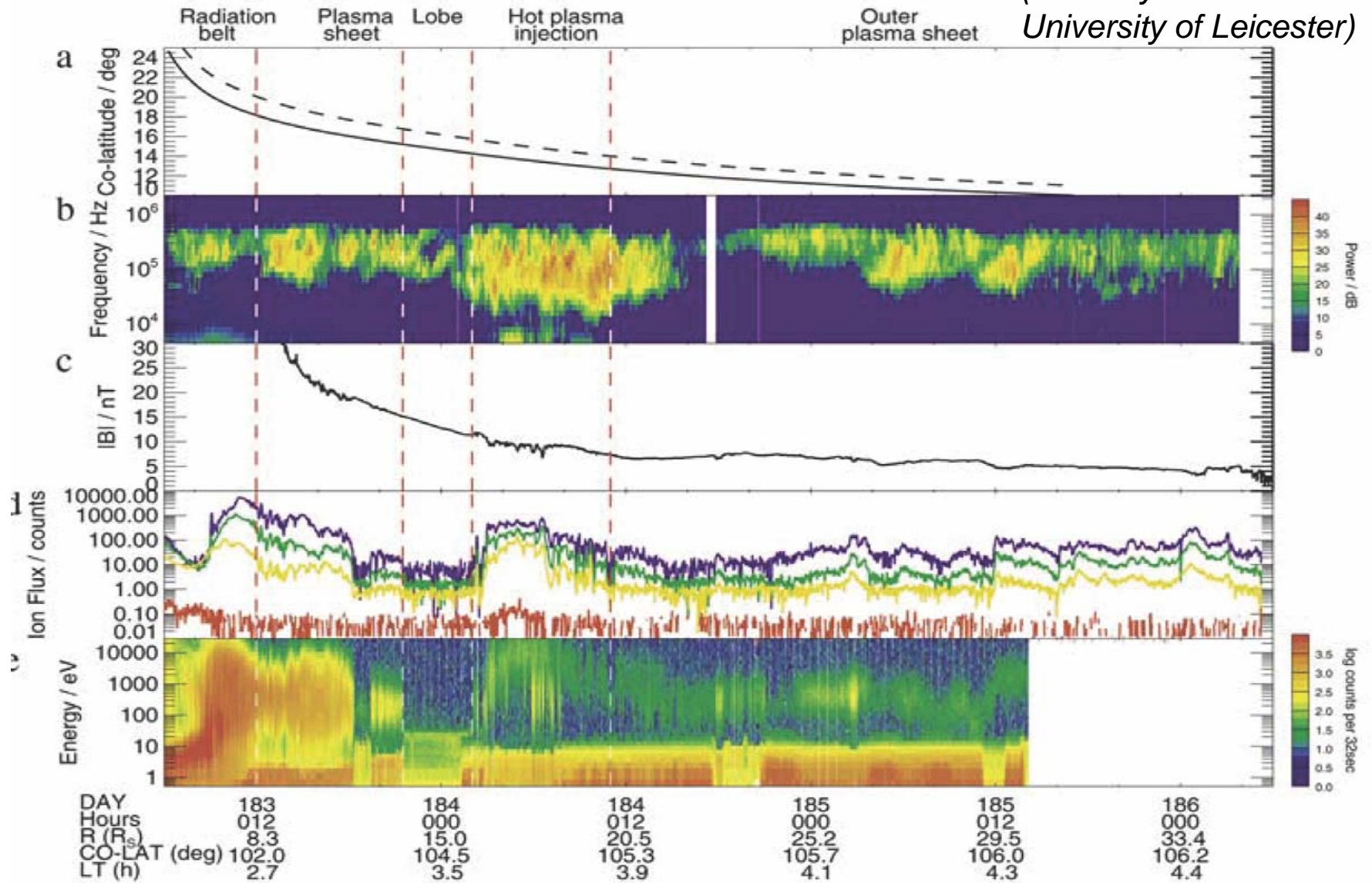
From Dougherty et al, recent issue of Science journal



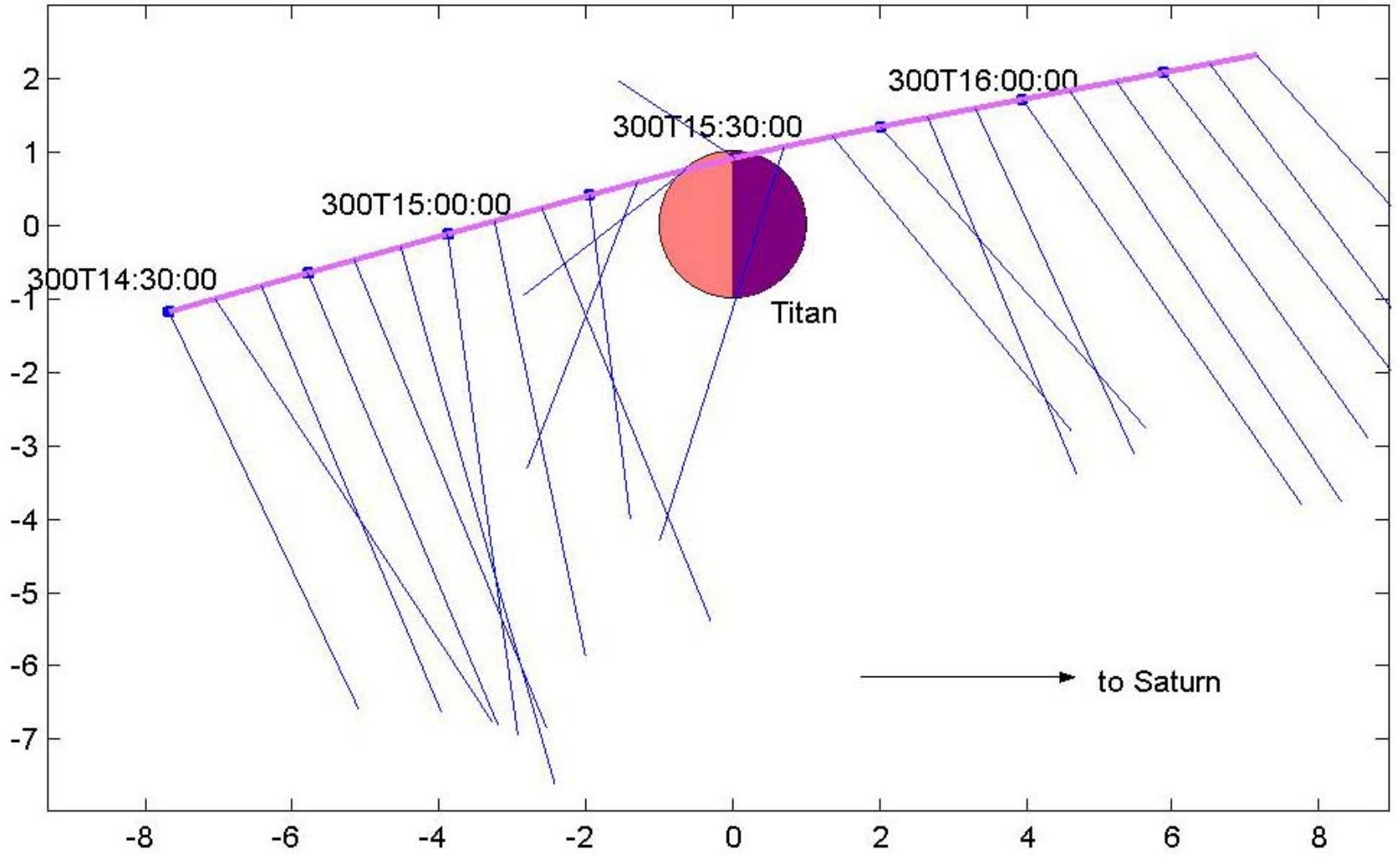
## MAGNETIC 'DRAPING'



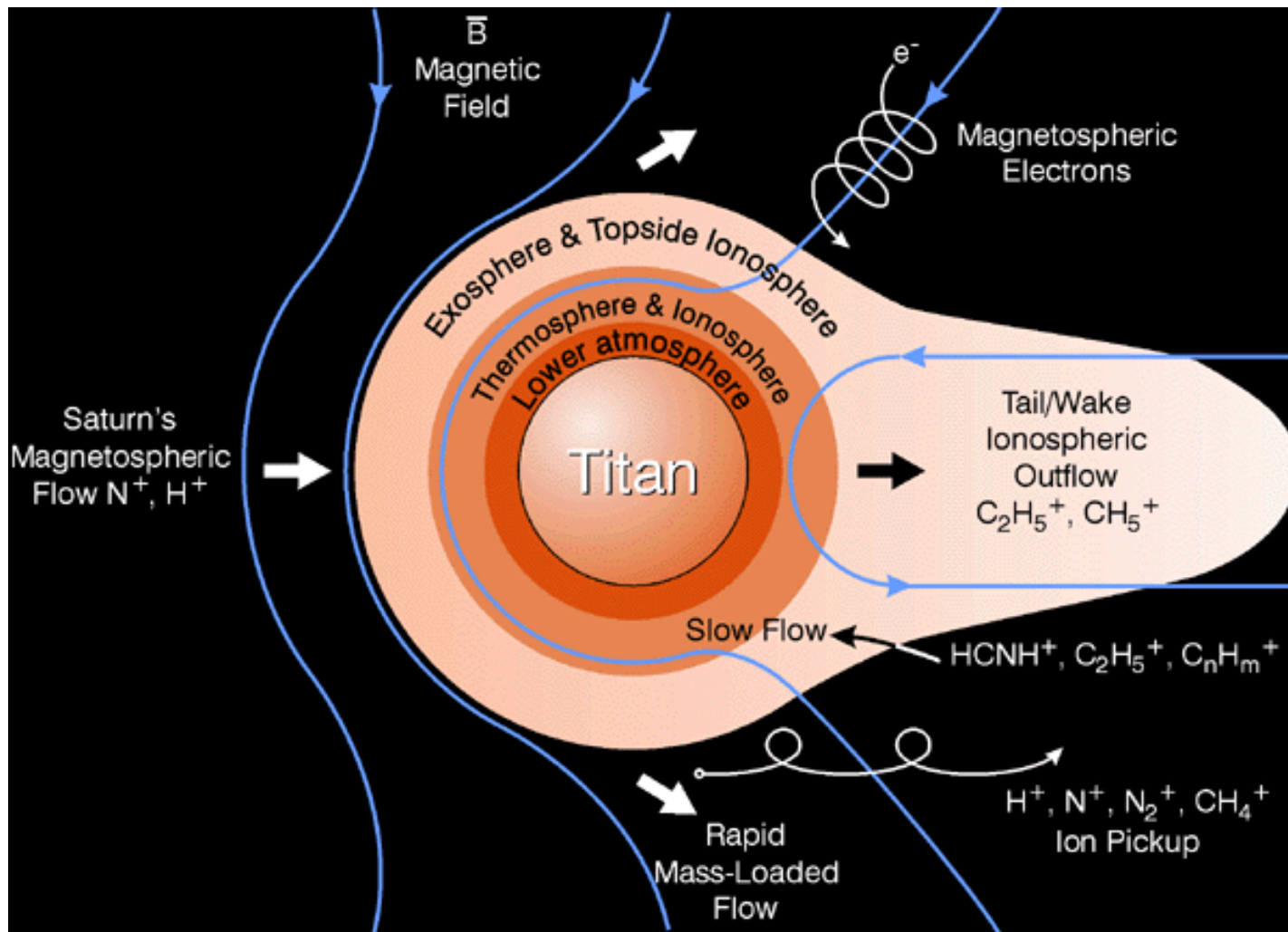
Plasma blobs on the same field line **stay** on that field line → 'Frozen-in' flow



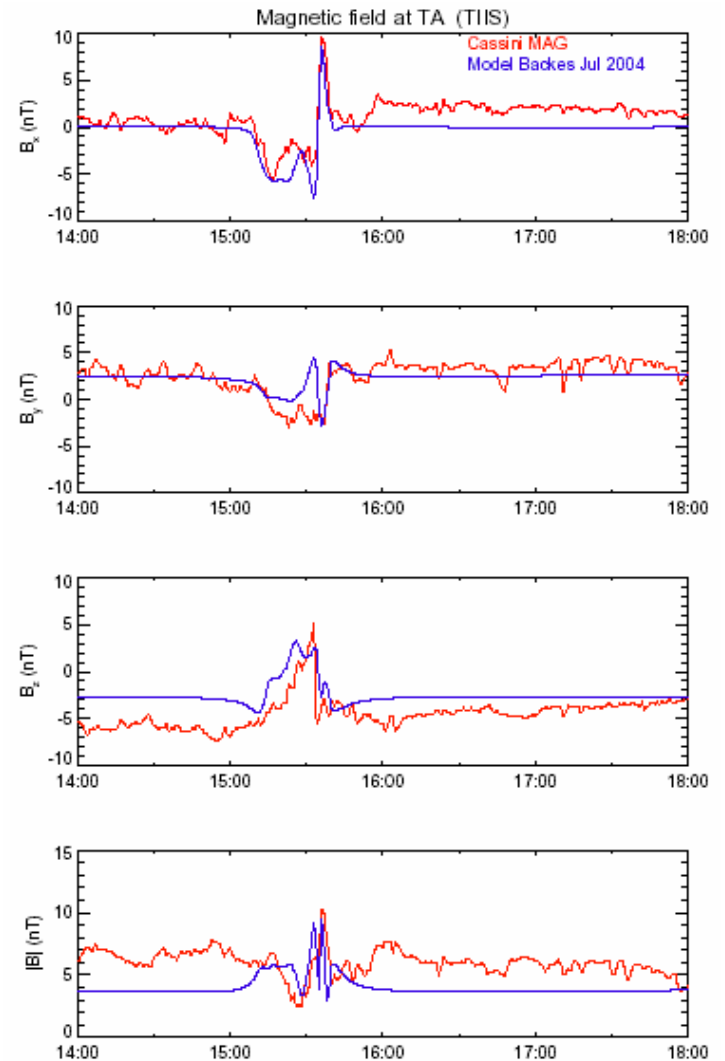
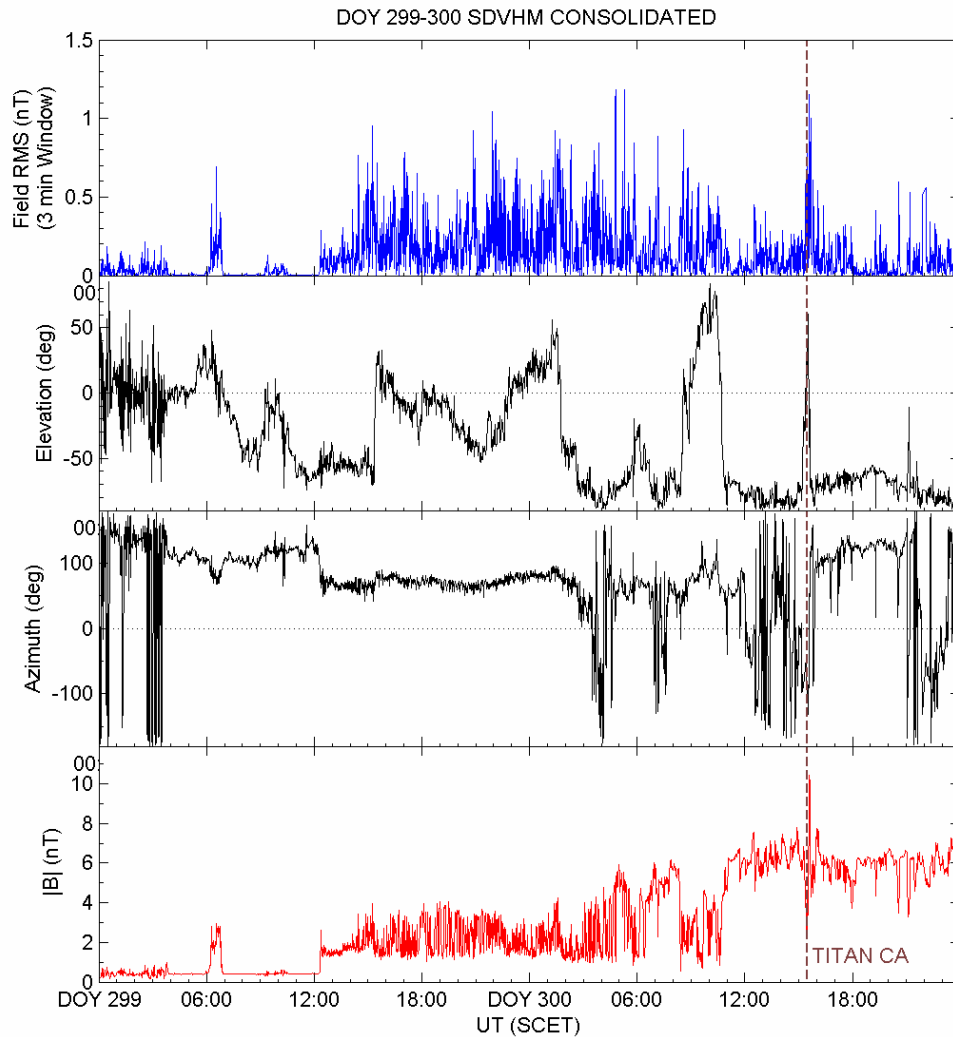
# Magnetic Data from Cassini Titan Flyby A (2004 October 26)

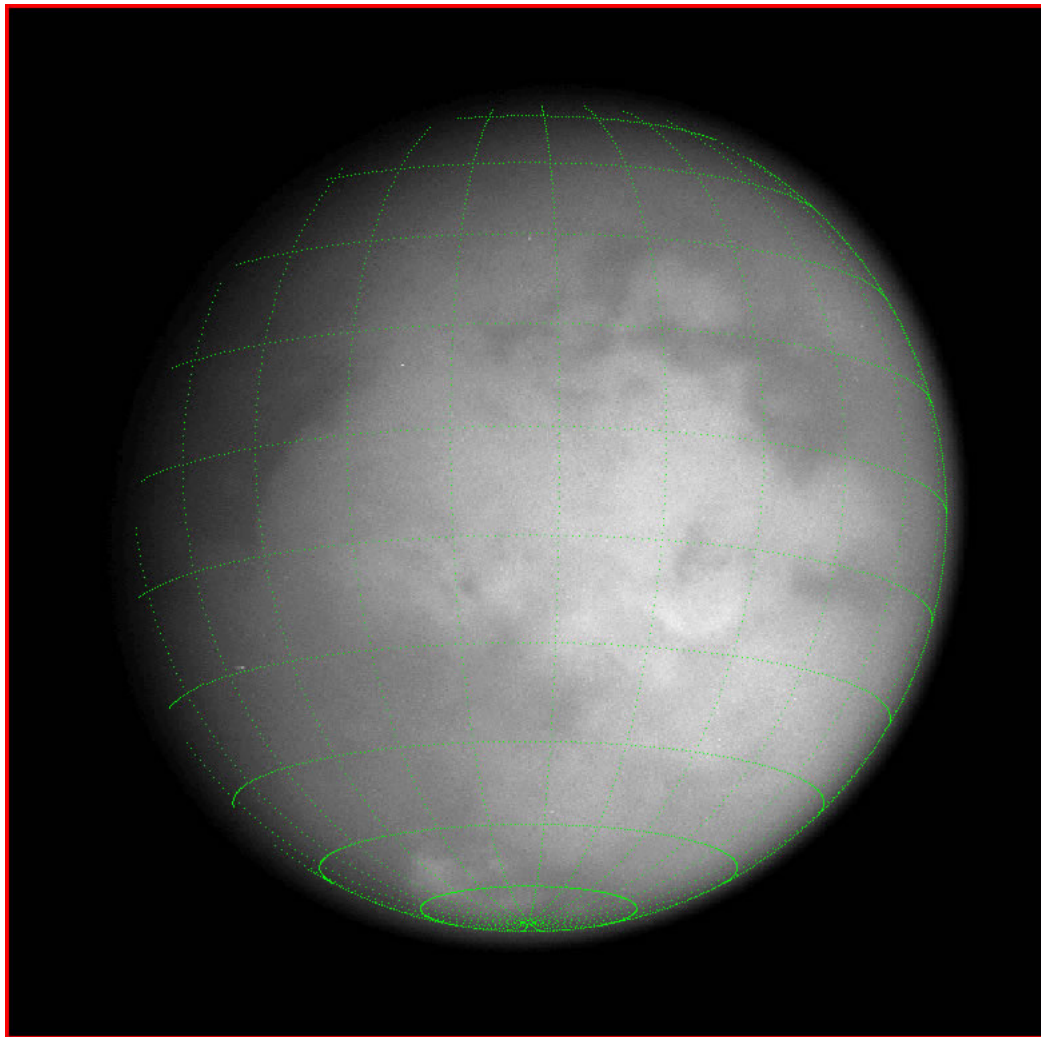


Material in Saturn's magnetosphere flows around Titan (up out of page)



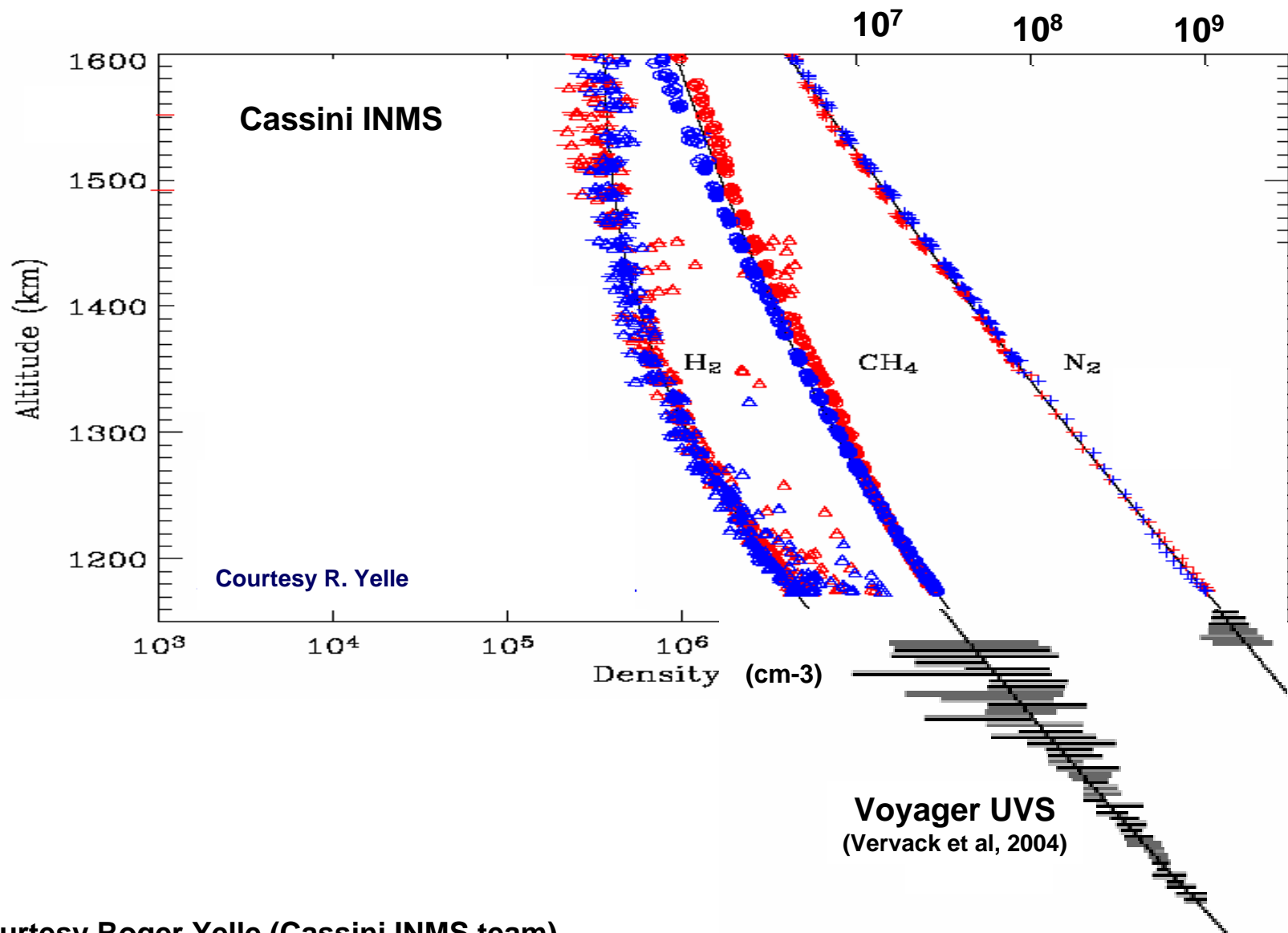
# Magnetometer Overview on TA flyby



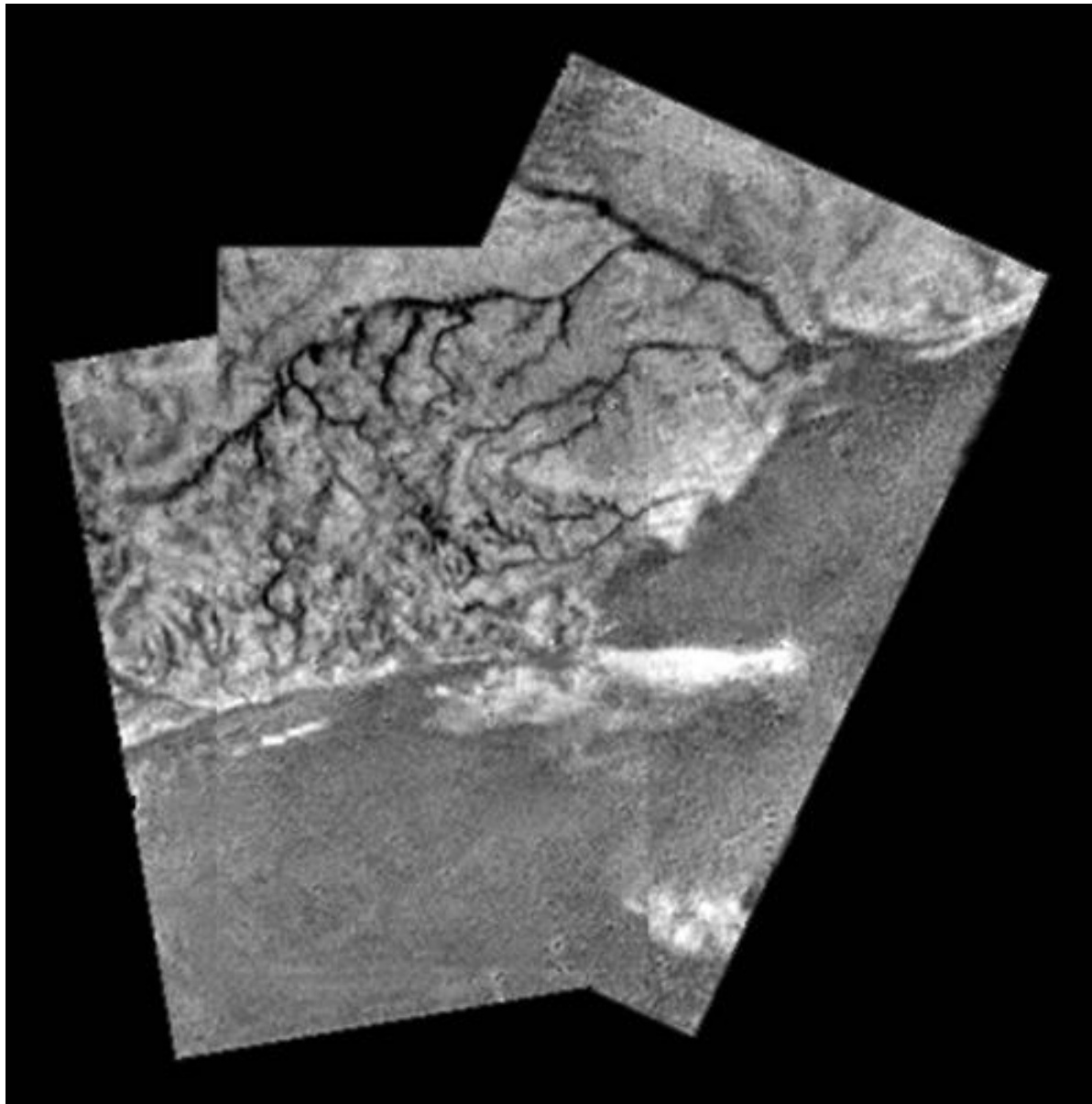


Courtesy Cassini  
Imaging team

Discovered by Huygens 1655  
2575 km radius (2<sup>nd</sup> largest moon in Solar System)



Courtesy Roger Yelle (Cassini INMS team)



Courtesy Huygens  
imaging team

'Channels' fed by  
liquid methane  
'rain' on Titan

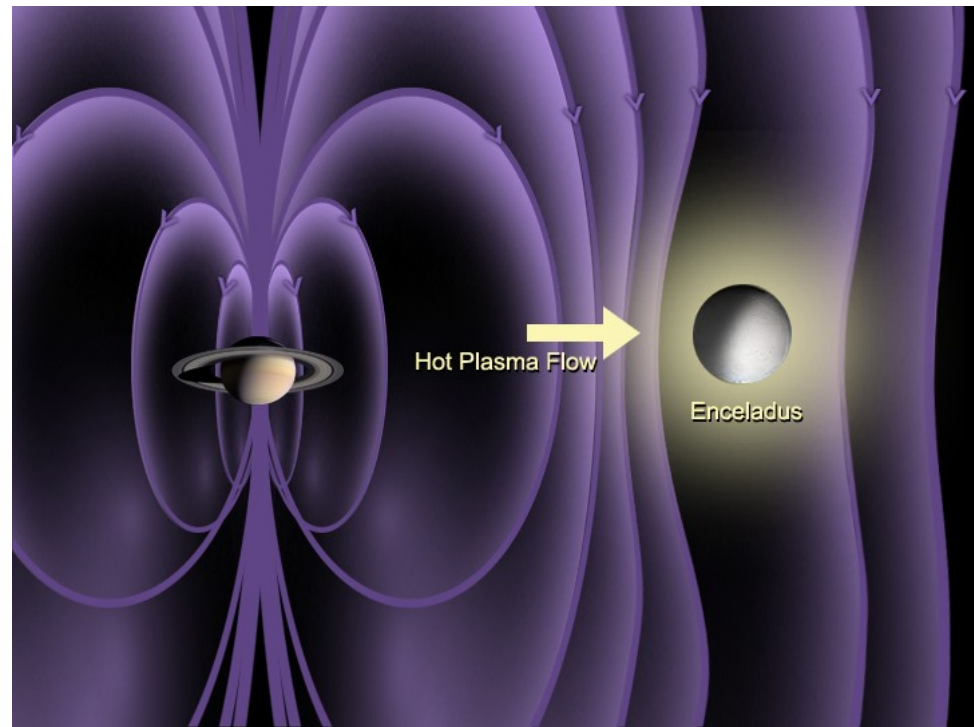
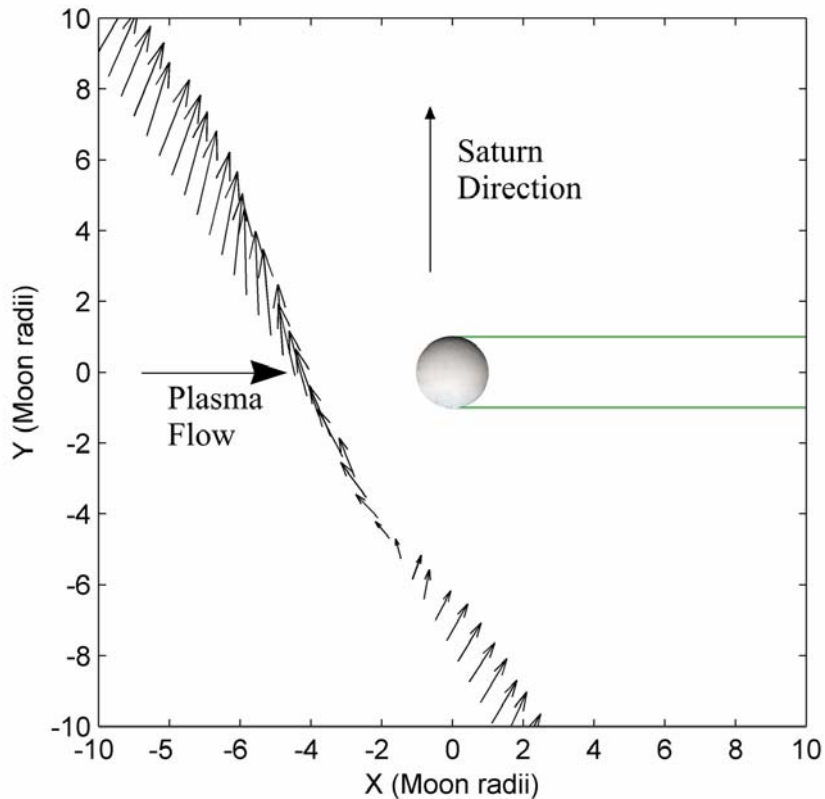




Courtesy Cassini RADAR team

Radar penetrates 'haze' of Titan  
Large crater 440 km wide – not seen  
before on Titan (surface 'reshaping')

Preliminary results from 17<sup>th</sup> February and 9<sup>th</sup> March flybys, confirmed more recently by July 14 flyby (Khurana et al) → Interaction seems similar to Io



Saturn magnetic field is being bent around the moon. Enceladus is adding plasma/mass to the E ring and plasma torus. Tenuous atmosphere / higher production of ions than expected?

Exploration of Saturn – ongoing and a long-term activity !!

