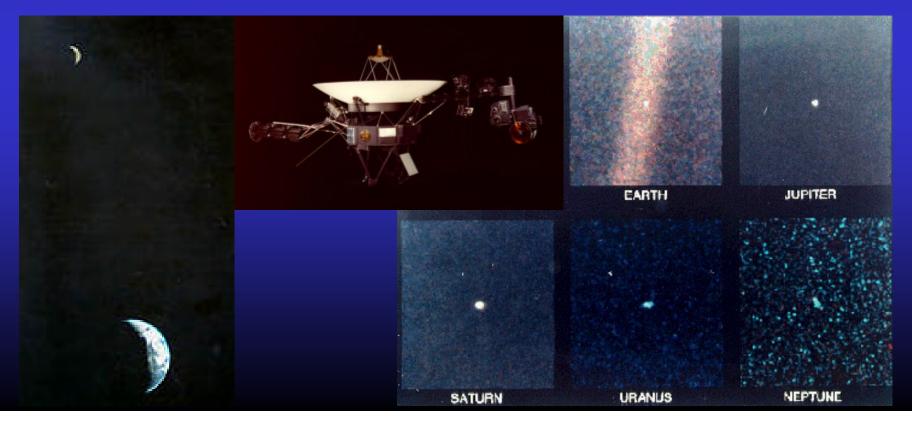
# The Voyager Odyssey 375th Birthday of Christiaan Huygens Titan: From Discovery to Encounter ESTEC - Noordwijk - April, 13, 2004







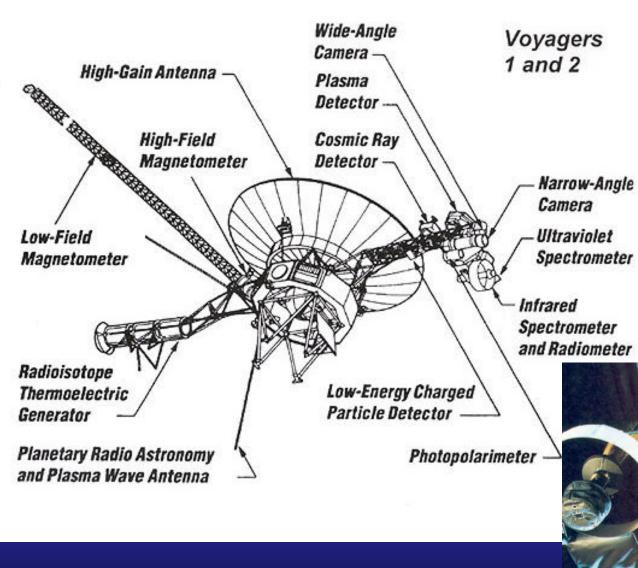


## **Before Voyager**



### Outer Planets Grand Tour (1969)

- Rare geometric arrangement of outer planets
   (~ 175 years)
- « Gravity assist » technique: Neptune: 30 🔰 12 years
- Dual launches: Jupiter, Saturn, Pluto (1976 77)
- Dual launches: Jupiter, Uranus, Neptune (1979)
- ~ 750 M \$
- 1972: budget **¥** ⊗
- © Mariner Jupiter Saturn ~ 250 M \$

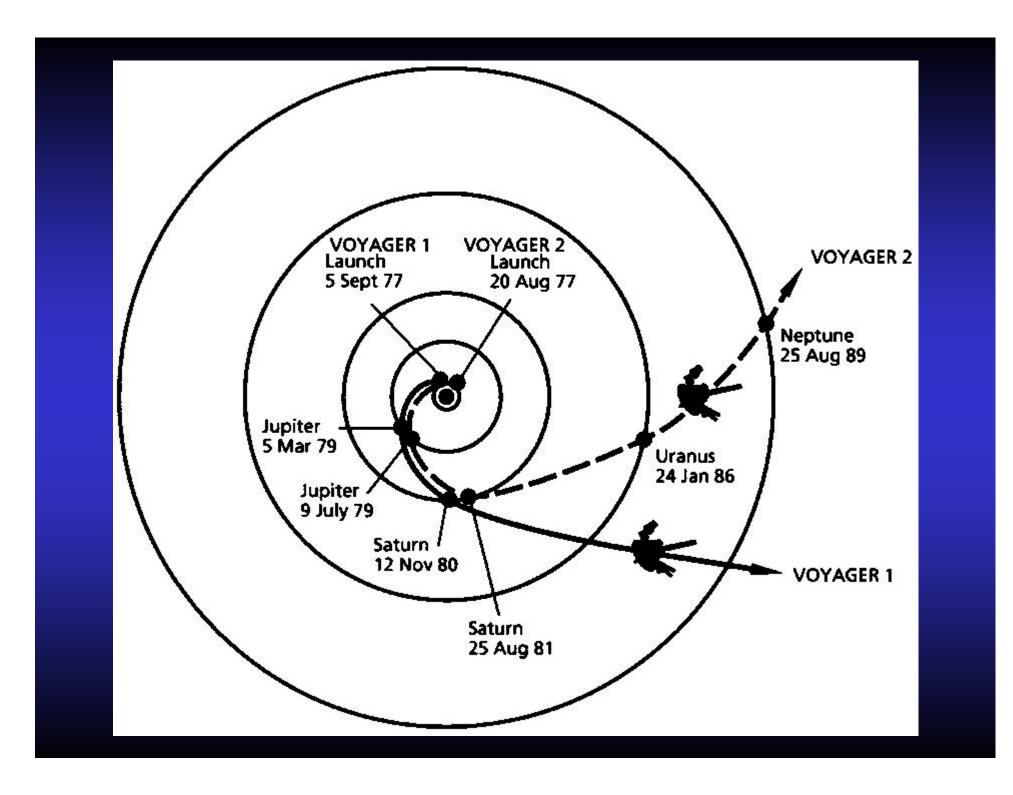


### DSN ? 23 w transmitting power





815 kg





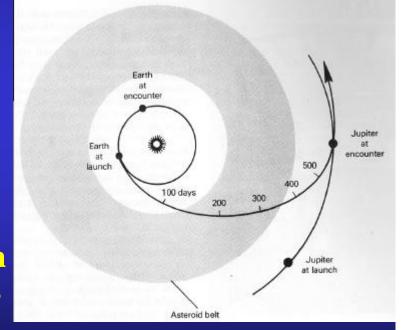


#### First step to the Grand Tour:

- Pioneer flyby of Jupiter
- 10 times farther Venus or Mars
- Economy and reliability
- Spinning design



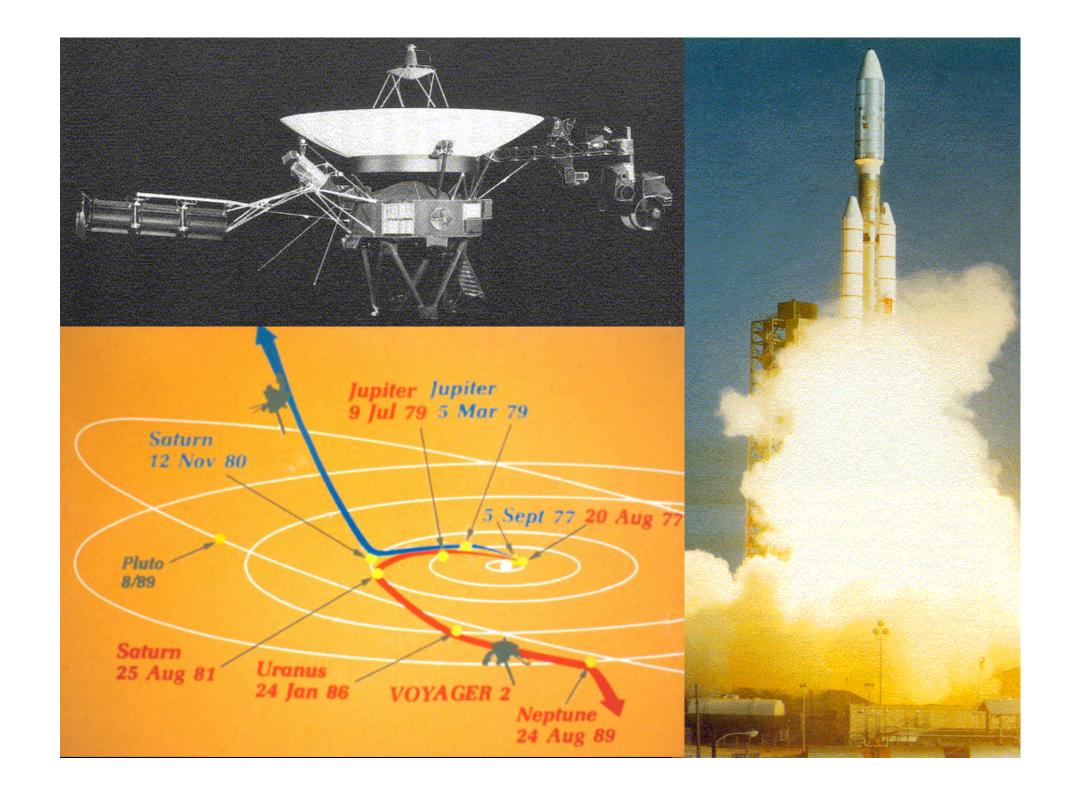
- Asteroid belt: large amounts of debris?
- Jovian magnetosphere: electronic brain damaged by energetic charged particles?



March 2, 1972: Pioneer 10? December 3, 1973: 1.3 10<sup>5</sup> km Jupiter Pioneer 11: April 5, 1973? Jupiter? Saturn (August 1979)

« Inside » or « outside » flyby? 21 000 km above the clouds.







6 encounters, but more than 20 y. of designing, building, planning, analysing

More new information that had been collected in 370 years Earth obs.

# DIVERSITY RICHNESS

### Never before observed:

- Atmospheric motions (in details) of a giant spinning sphere of H and He
- Planet-sized objects such as Ganymede, Callisto, .
- Volcanic activity on a Moon-sized satel.: Io
- Magnetospheres of giant planets in situ
- Unexplored electric and magnetic fields
- Detailed structures in ring systems
- Text books have to be rewritten
- Like to be at the crow's nest of a ship, landfall, passage? stange new islands

# WE ALWAYS EXPECTED THE UNEXPECTED:

# WE WERE NEVER DISAPPOINTED

(bets)

# Risky venture

- Immense distances of cold, dark, airless space
- Unexplored fields of parti. and magnetic forces
- Spacecraft not designed for Uranus and Neptune
- Reliability: 5? more than 12 years
- 1st year: « psychotic behaviour of computers on board
- Voyager 2: Failures radio receiver, scan platform
- Voyager 2: slightly deaf and rhumatisms
- Programs rewritten: More « intelligent » at the end (techno. end 60s)
- « Repaired » between Saturn and Uranus
- Young lady? Experienced old lady







#### La sonde américaine Voyager-2 passe près de Saturne

La comple appailint anterironine Veyrogere d. agains cut veyrogere de quatire son, se man moche municipatante de la planette lighteres elle au sone deltamante de annis de 100 de Allamantes. Errottis-elle a Veingarege vere Unpatte el Septimus, clera cità e l'apparegiate della annis de 100 de Allamantes. Errottis-elle a Veingarege vere Unpatte el Septimus, clera cità e l'apparegiate que della a soli internationale del soni internationale della complete della colori della complete della colori del

Veryage.

Les niuntifiques attendent dans de Verager à fe, uniférantien, mais auné de bouveau et du congéneraliste.

Verager 2 verre les anneux éclaire en homère aunée resulte que Verager 1, et le unique aunée de linage, informets set que l'organisme des insage, informets set

Pour cas deraiera, la sonde les verra sons en autre angle, en paux excitaira. — Telleya, Encelude, Apper — de hescitaira plus pere Elle carrimente Huiste des hait nouveaux entellibres décurrent Las formies depuis la Terre su lees de passage.

Allo personale de derenno deputa la Terro di her de passago de Verangeri.

de Verangeria, disservatione cerisal directoració continuación, deservationes cerisal directoración continuación de la continuación de la continuación de la continuación de la continuación de Satinus, por los desa sunden peut fonnese una pressión side de la constauración satientalmen.

Verqueria va sessa perellar d'una contextuara qui se perdun tens les trates ano. Canada del passarra pris de Betterna, la fielda, l'applier o de Satinus besus procedencieras algués.

L'efficia de manaquio de Jugitire suit la fina de passarra pris de Satinus de percentación de passarra personal de la della continuación de percentación de personal de la della dell

Dablimbiospest. Le survei de la sematare grochation not mose un primi d'organi danze l'exploration plantichire primative missait un authorit plan d'organi danze l'exploration plantichire primative matelier disconsistent autrorite la constitute de Mallie, es l'organic d'expertit autrorite la constitute de Mallie, au roussa qu'este sur l'organic d'expertit attorite le colorate de Mallie, au roussa qu'este sur l'organic d'expertit des des l'este de l'autorité de l'autorité de l'este d



Portfolio

Un bouleversement des connaissances



### **LE FIGARO** L'AURORE

NIVARD, FLORNOY

La fusillade

Police:

le malaise

grandit

Polimique entre commissaire

et impecteurs après l'inculpation

de la rue du Docteur-Bland

EDITION OF PARTS - PROX : 42

A S S BARRIO 25 - DIMANCHE DI JAMPEN TRES (N. S. STILL

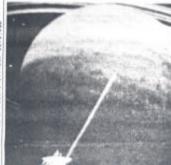
La fabuleuse mission de Voyager II

#### Rencontre avec la planète verte

Suprématie américaine

P. Other Span-Cure in Proceedings of Strapes of Strapes

Hier, à 19 heures, la sonde américaine a feillé L'eures Deux mille images consyées vers la Terre.



L'affaire Westland

#### Thatcher: crise de confiance

Après le ministre de la Défense. r ministre du Commerce britannique déminione.

d'un policier pour hold-up.

# total trapmoternia studies

WITER A DROITE CEST REVENUE A AWART MELL

Aden: la rébellion semble l'emporter

NELLE SERIEN' 1457

Dix jours de combats entre factions rivales ont fait dix mille morts à Aden L'ambassadeur de France arrivé hier à Diibouti apporte son témoignage sur la violence des combats.

(Lire page 26)

La sonde Voyager II s'approche aujourd'hui pour la première fois de la planète verte

Rendez-vous historique, ce soir à 19 h. Pour la première fois, une sonde spatiale, Voyager 2, va rencontrer la planète Uranus. Elle s'approchera à quelque 80 000 kilomètres de la planète

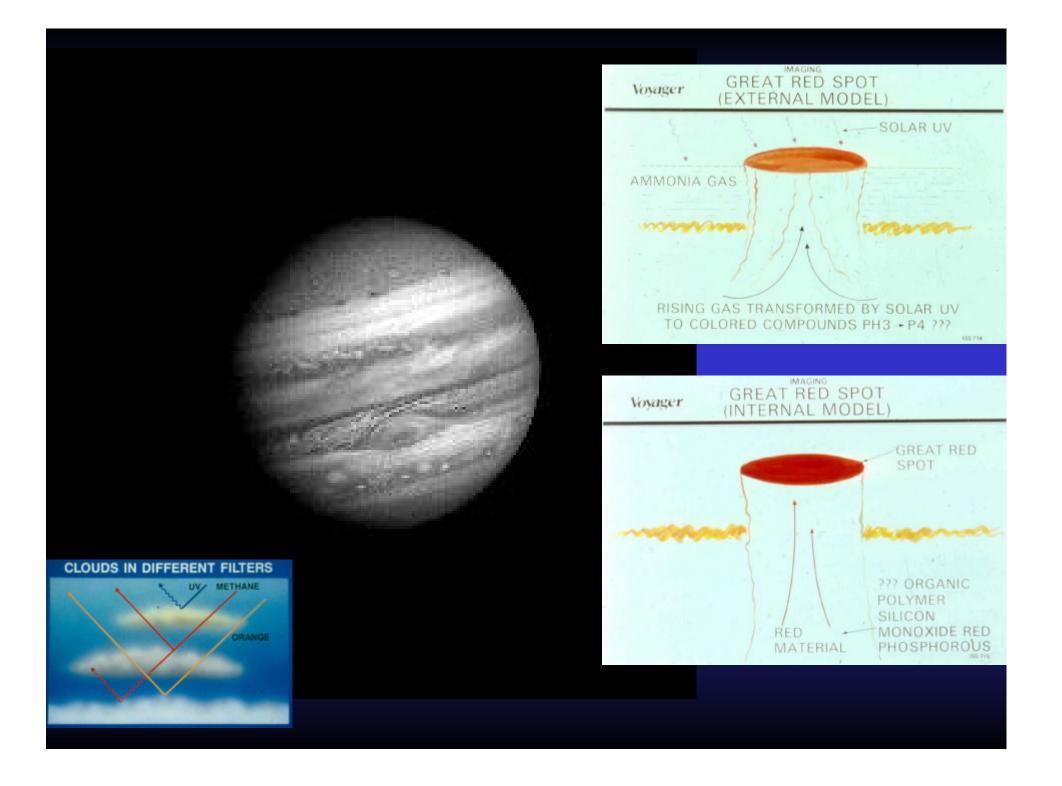
verte. Un enjeu purement scientifique pour un voyage qui a commencé il y a plus de huit ans. Uranus a peut-être quelques clefs à fournir concernant l'origine de l'Univers. En attendant qu'on en sache plus, aux Etats-Unis Voyager 2 est devenue en quelques jours la star des chaines de télé. (lire pages 2 à 4)

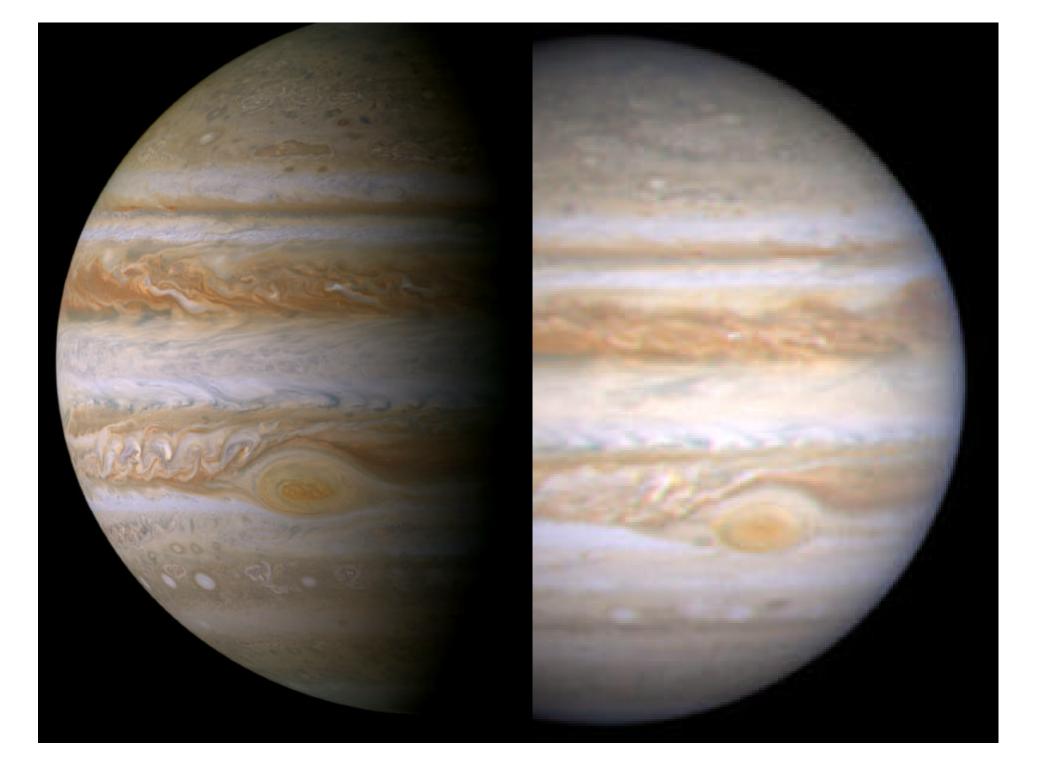
#### D'Auxerre à Tottenham. le foot-business

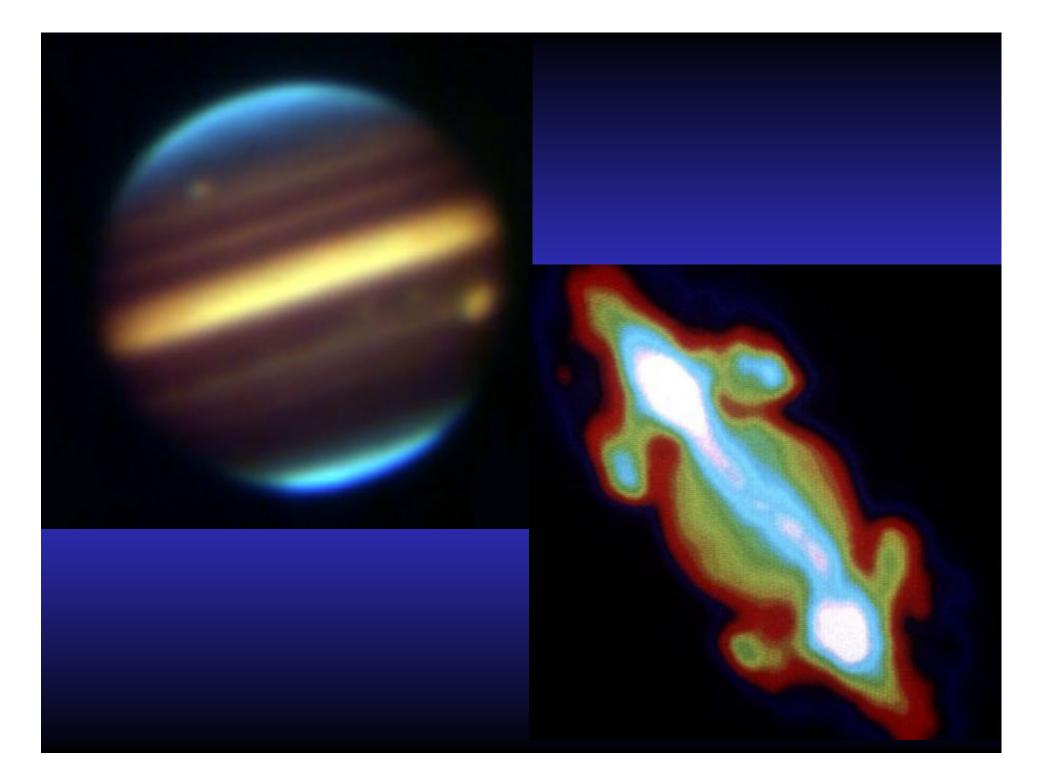
Comment les patrons du foot ont accueilli ceux de l'industrie dans un monde où la monnaie de base, c'est le but. Lire pages 24 et 25.

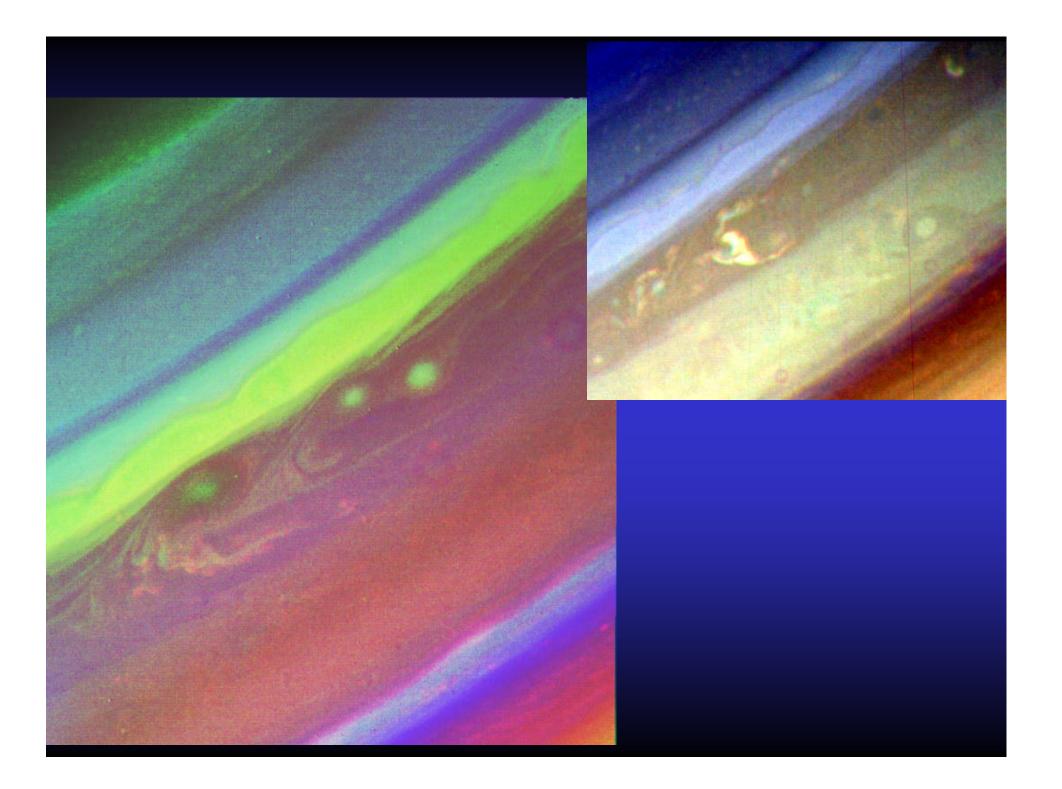
GINGER. FRED ET FELLIN

**Conferences** 

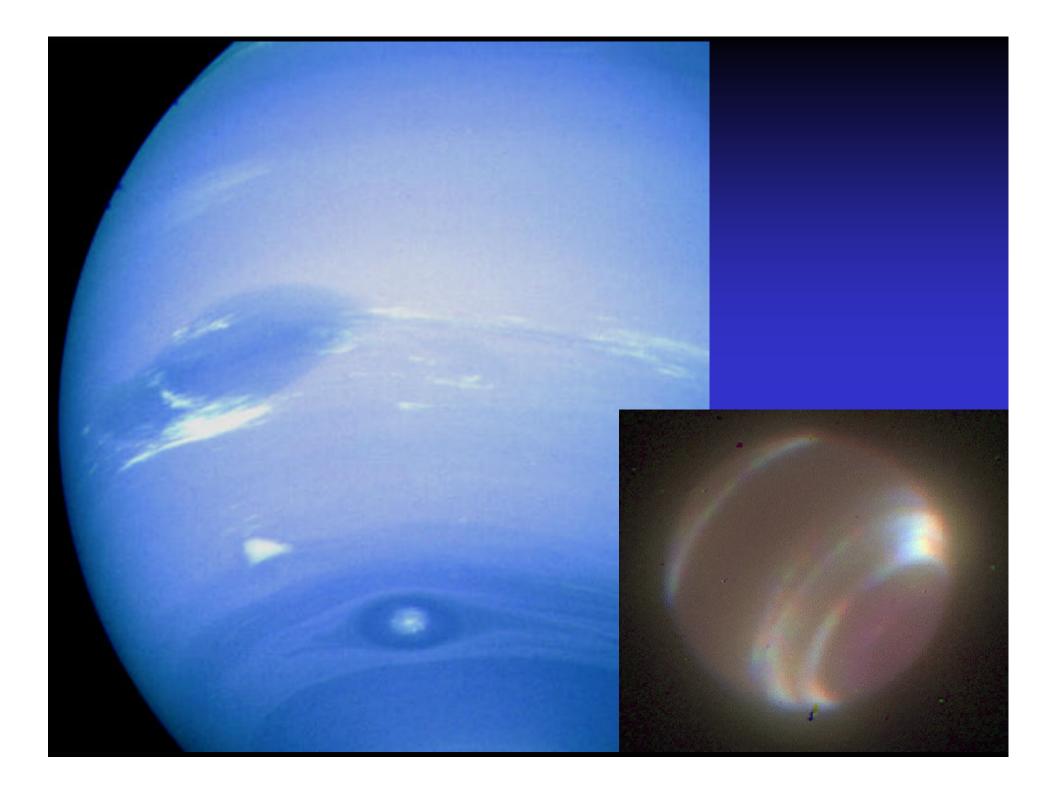


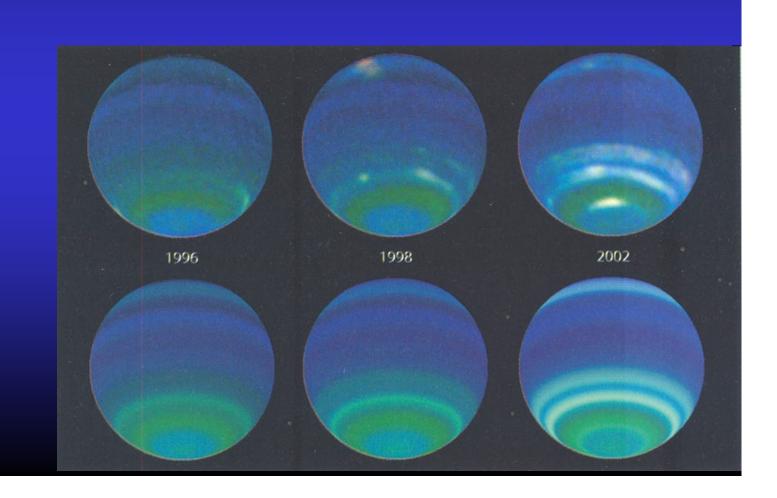


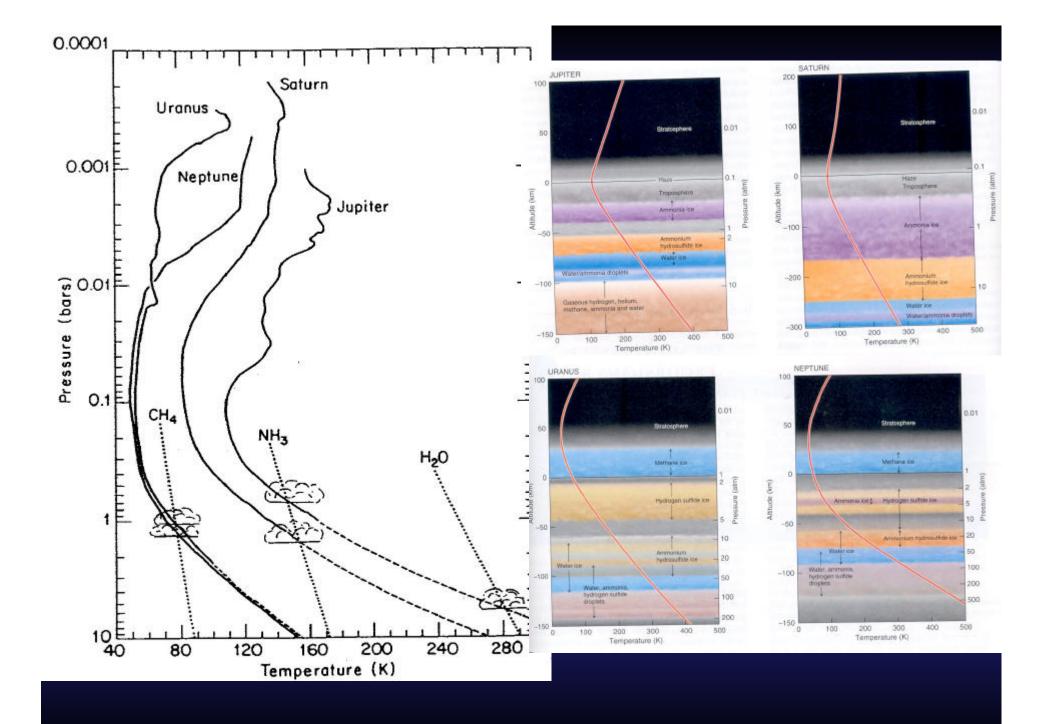


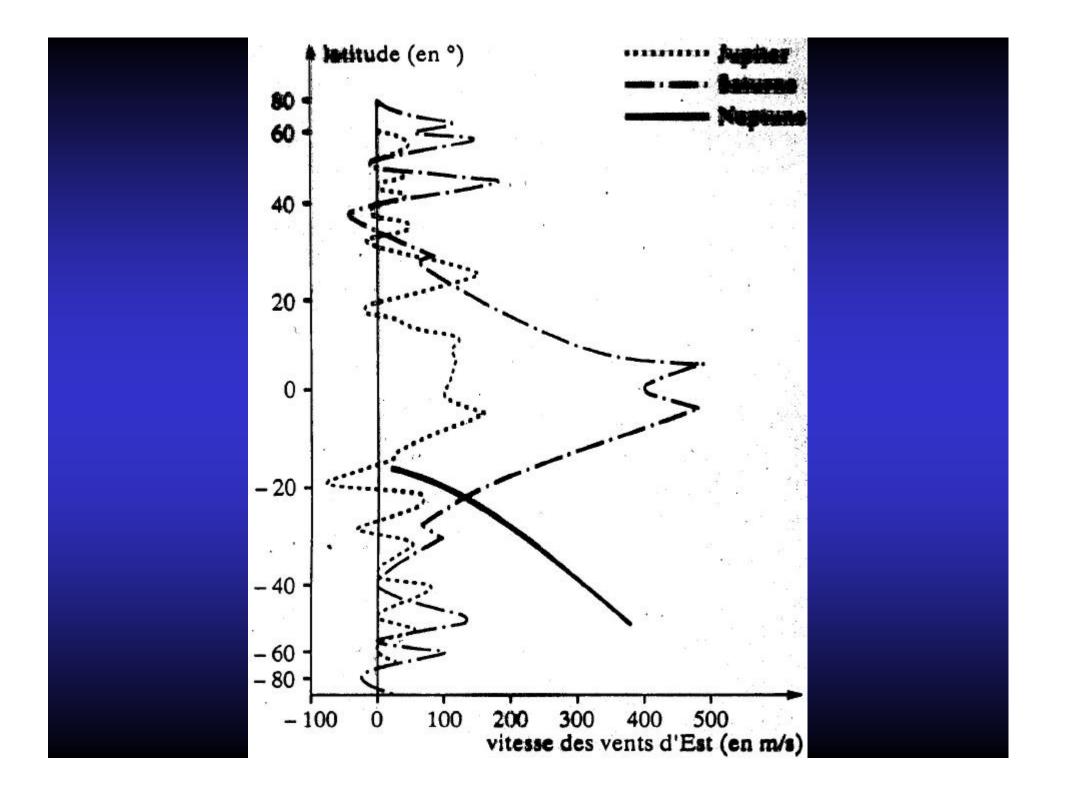


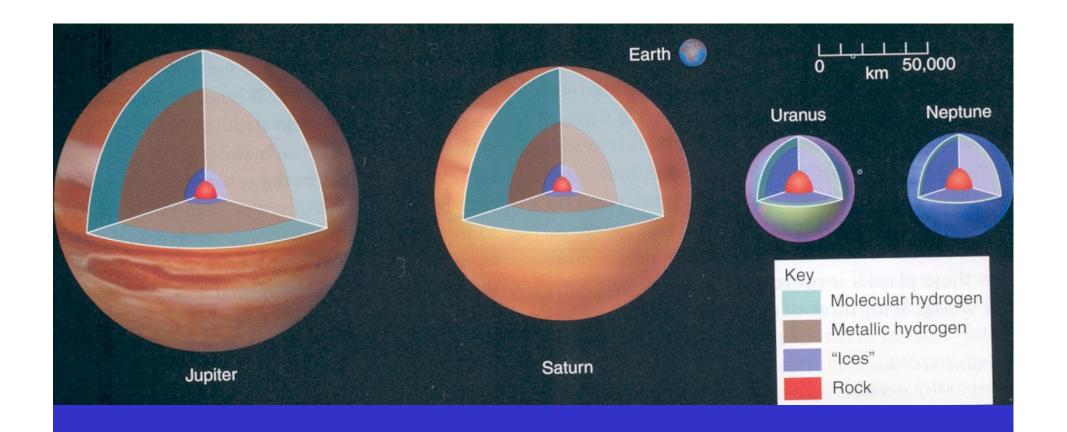






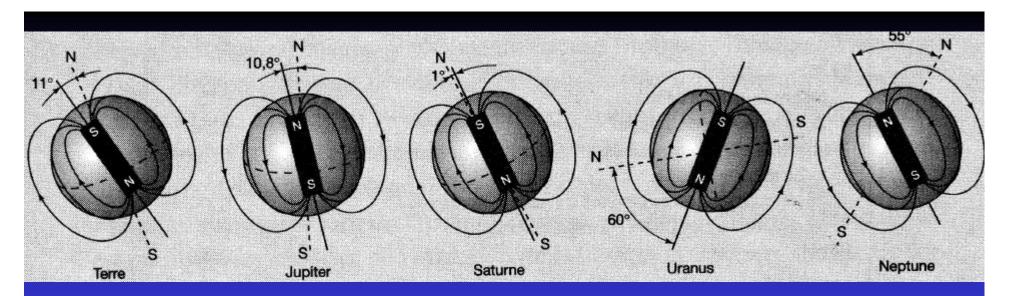






# Jupiter, Saturn and Neptune internal heat 2 gas giant planets 2 ice giant planets

# JUPITER SATURN URANUS EARTH JUPITER SATURN URANUS **EARTH** CLIPTIC

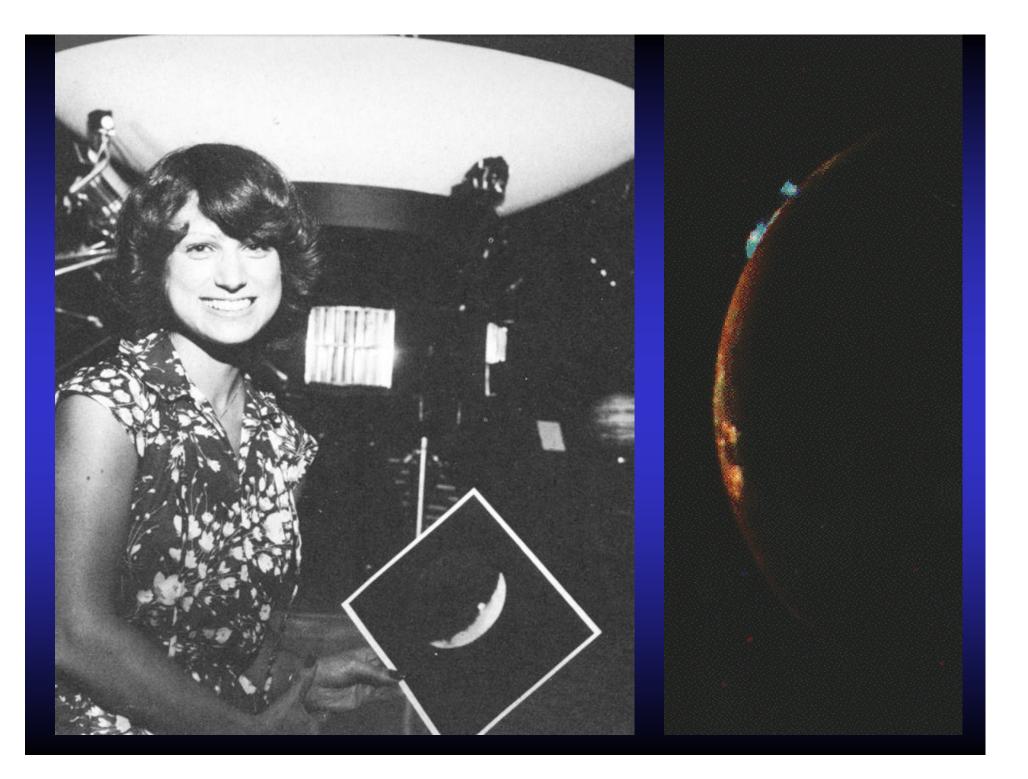


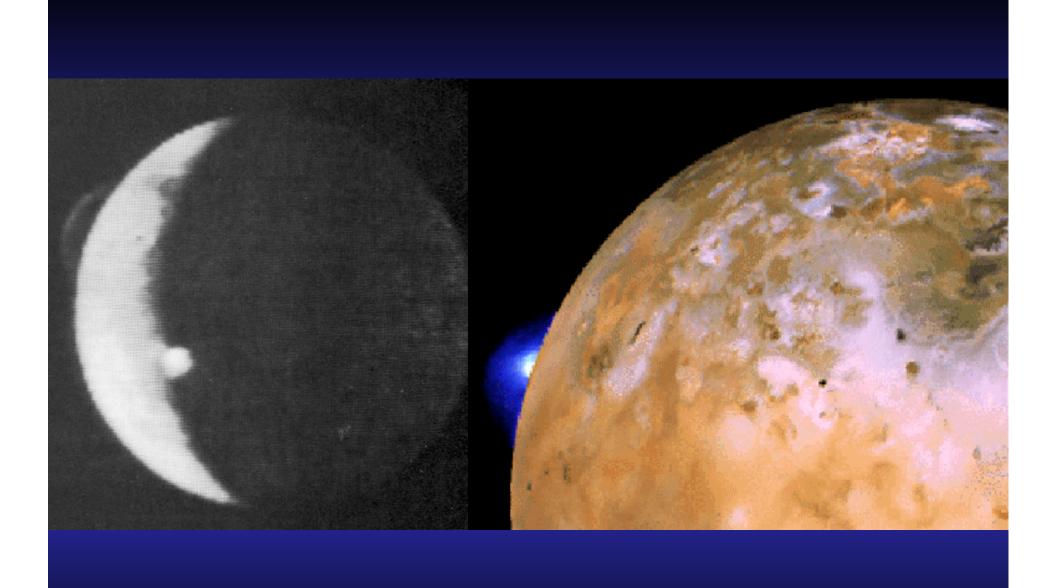
Io's plasma torus in Jupiter magnetosphere

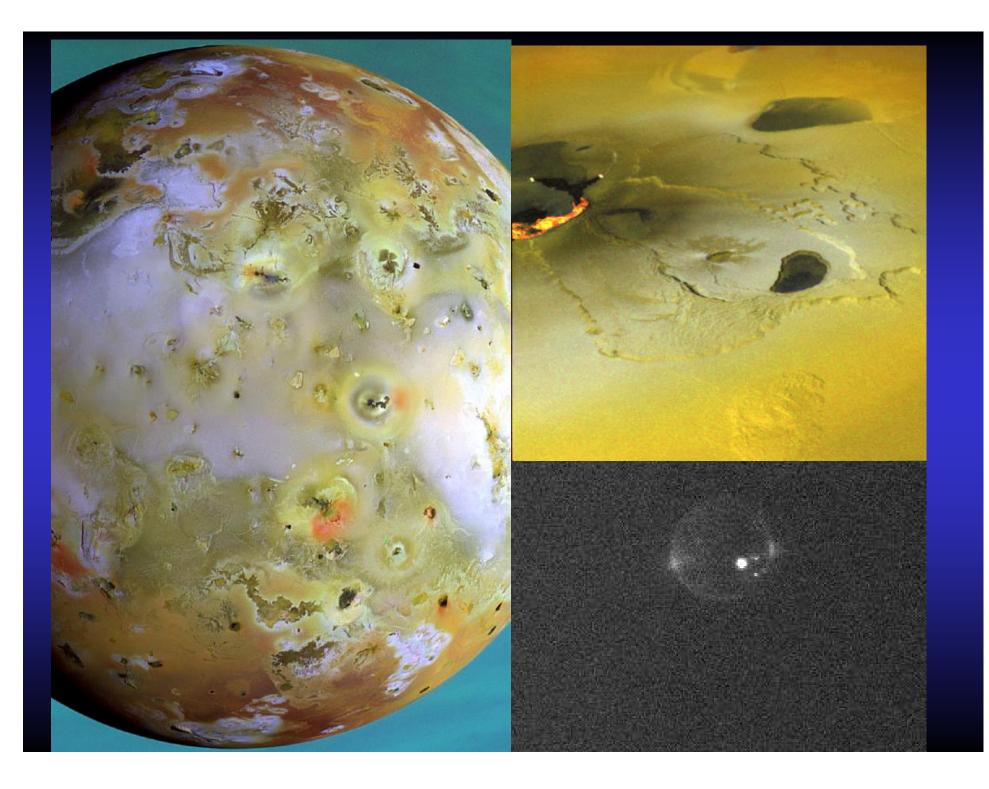


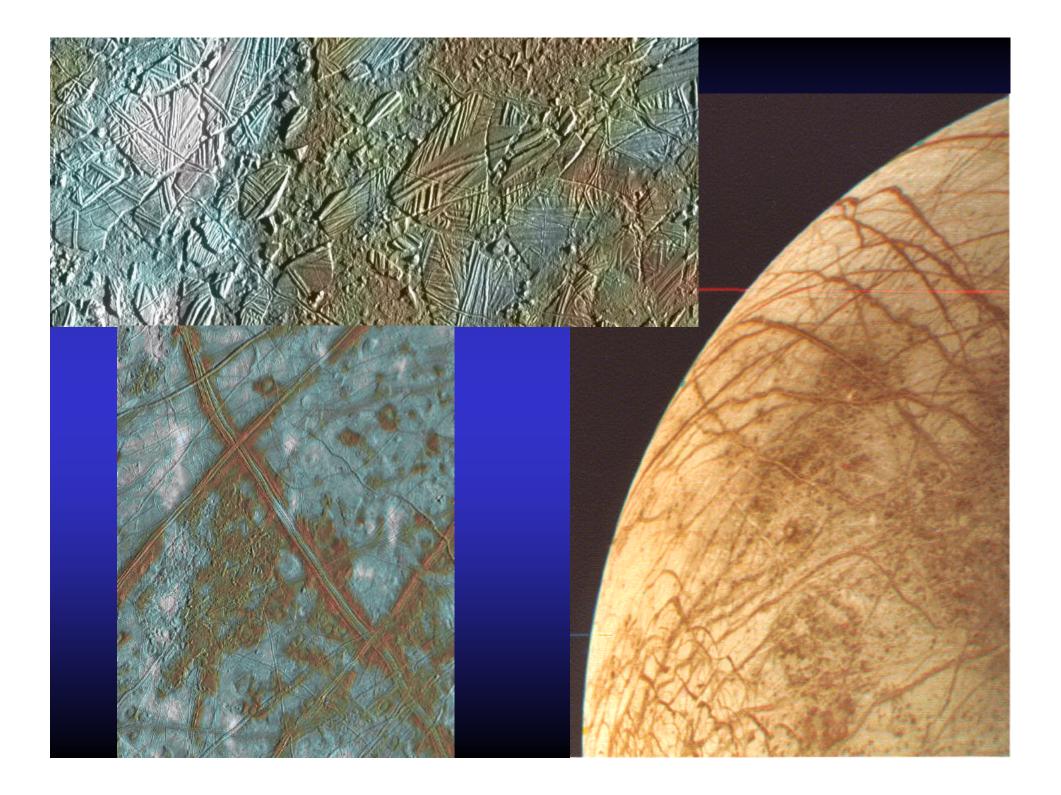


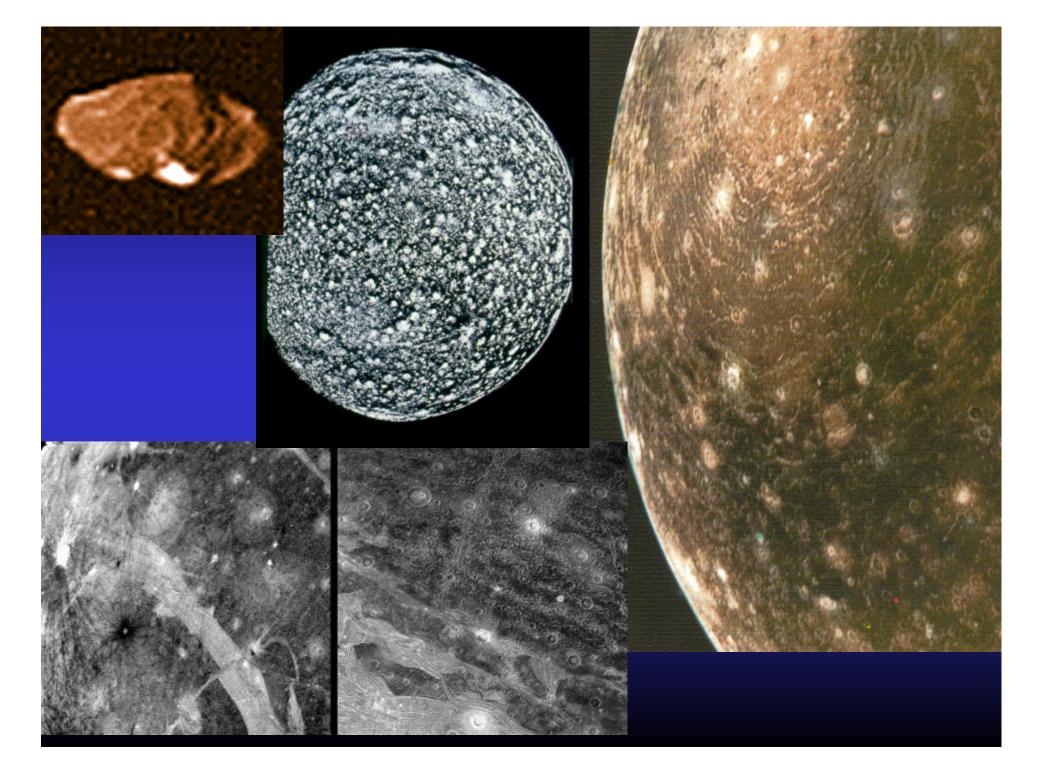
Saturn Aurora HST • STIS PRC98-05 • ST ScI OPO • January 7, 1998 • J. Trauger (JPL) and NASA

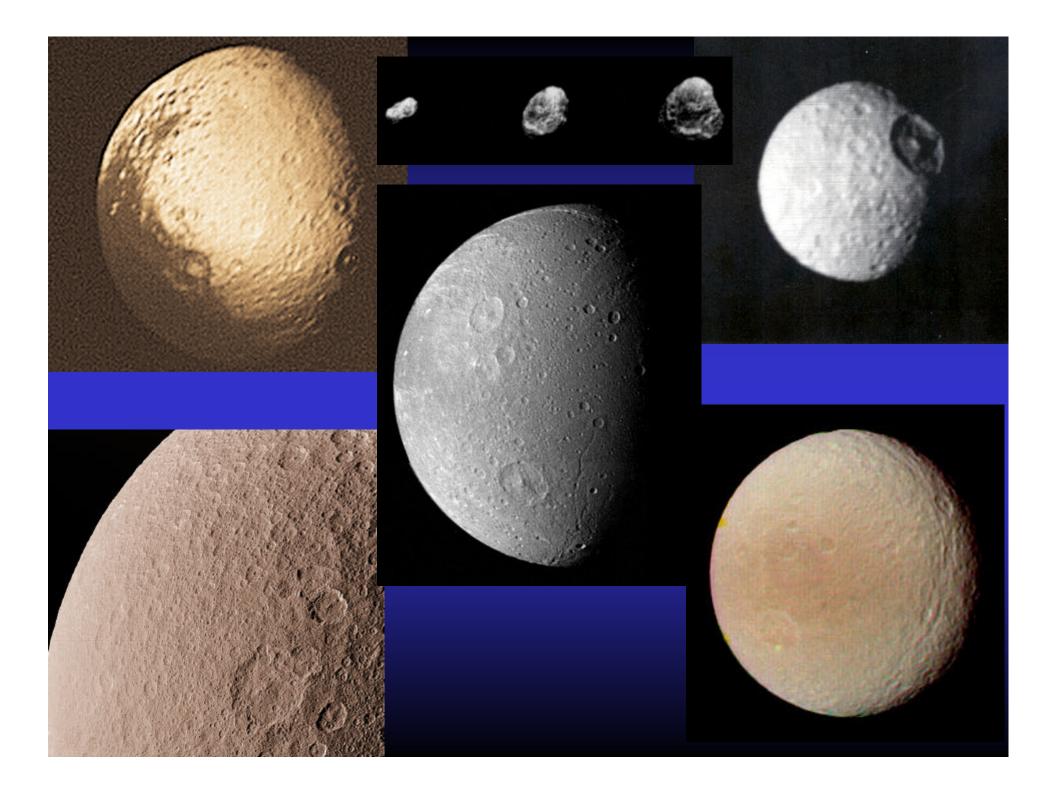






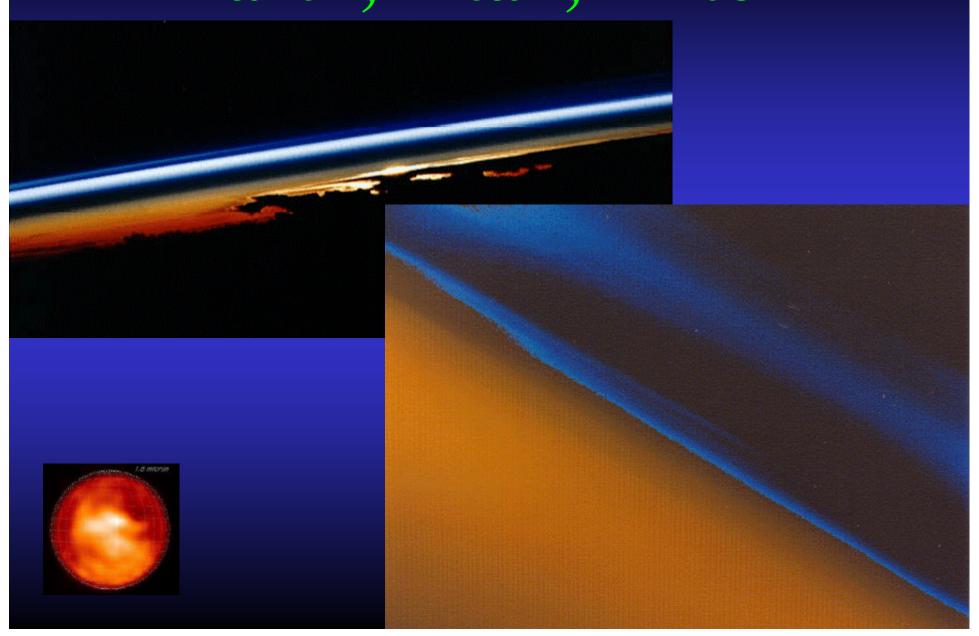


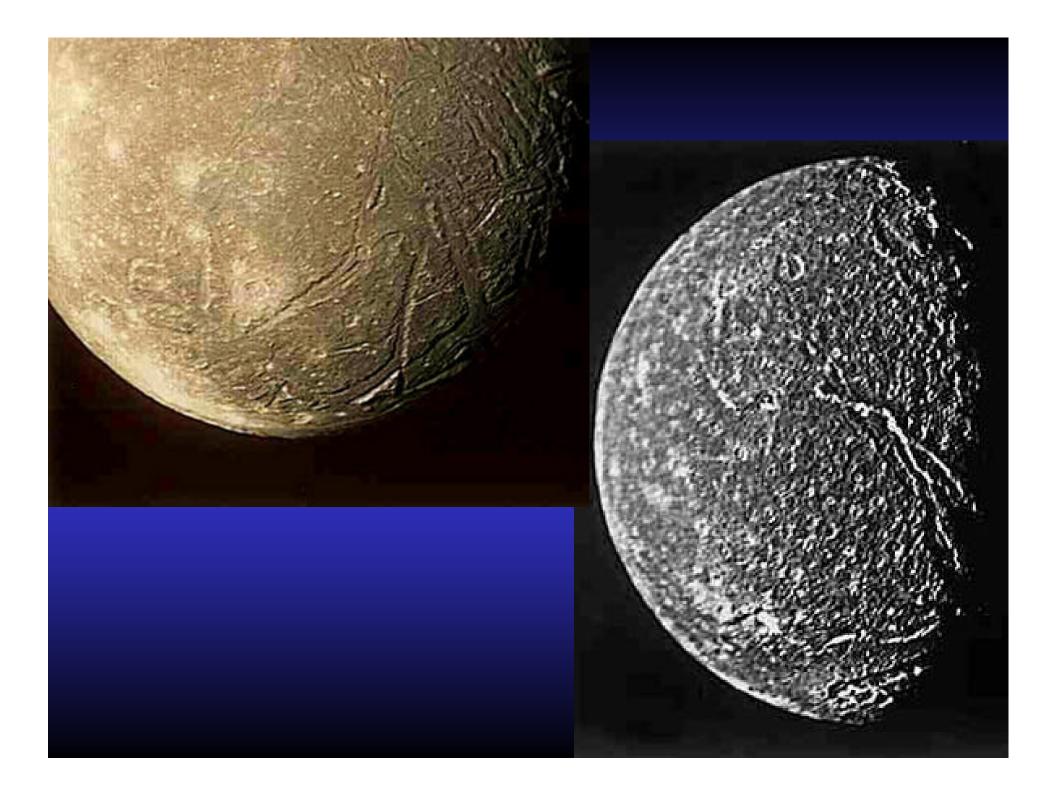




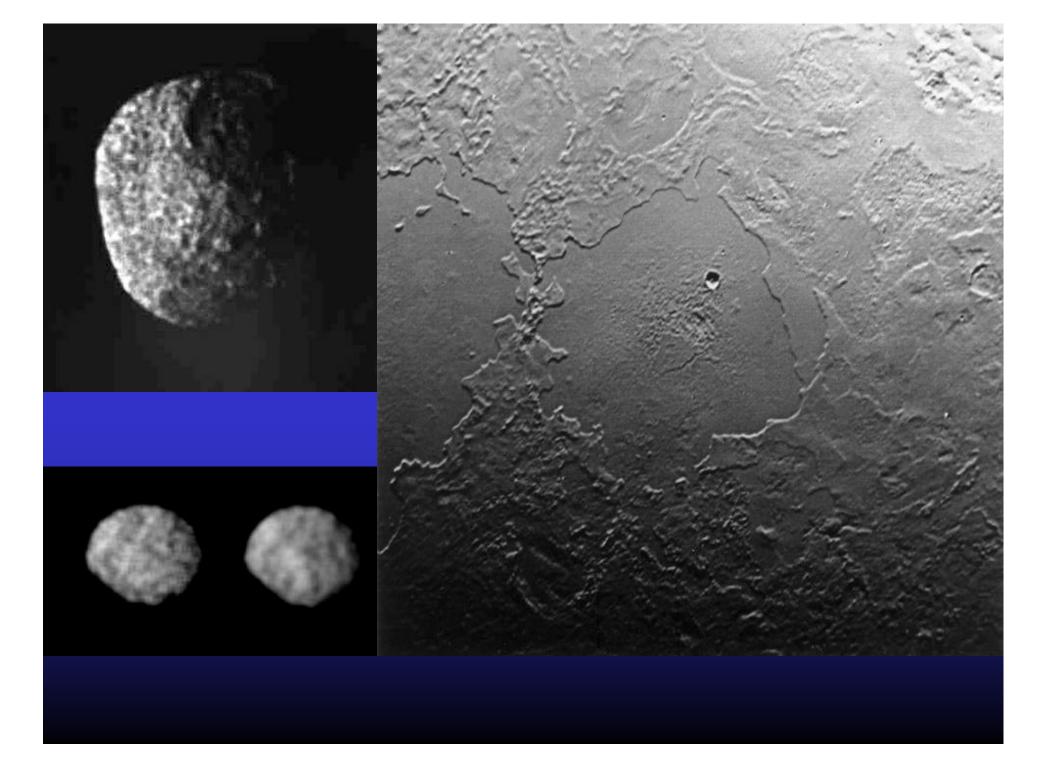


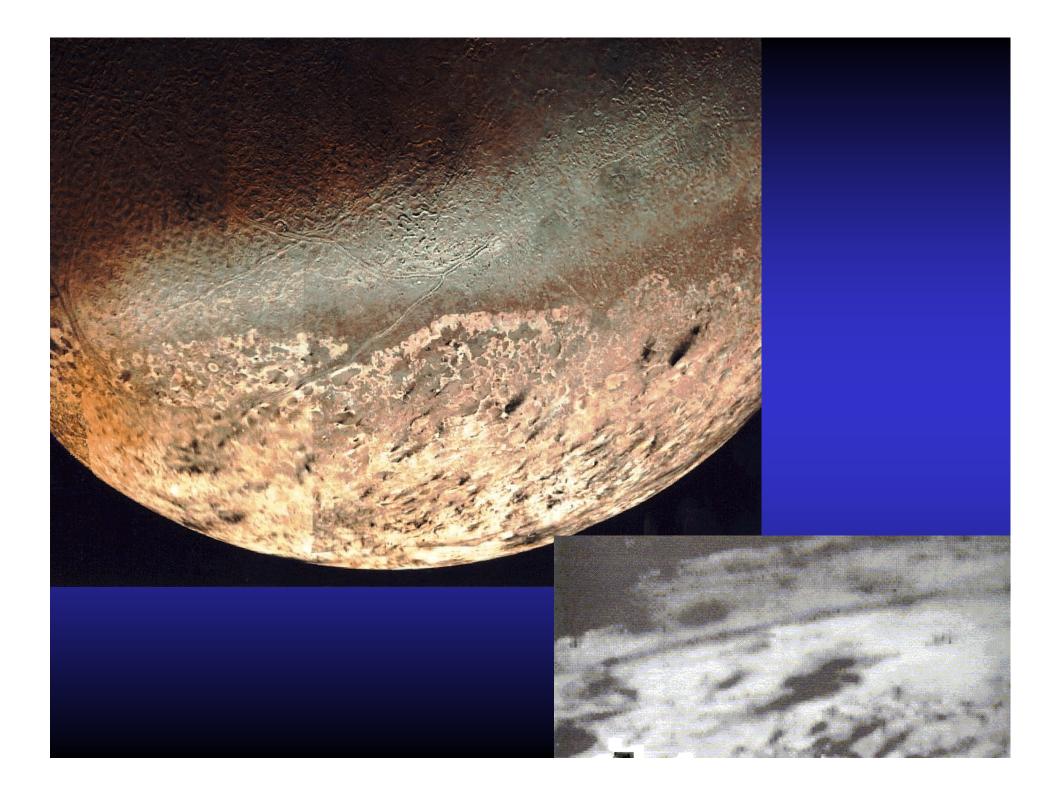






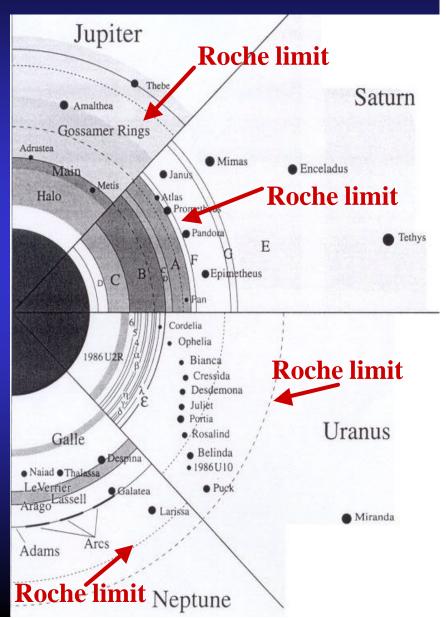


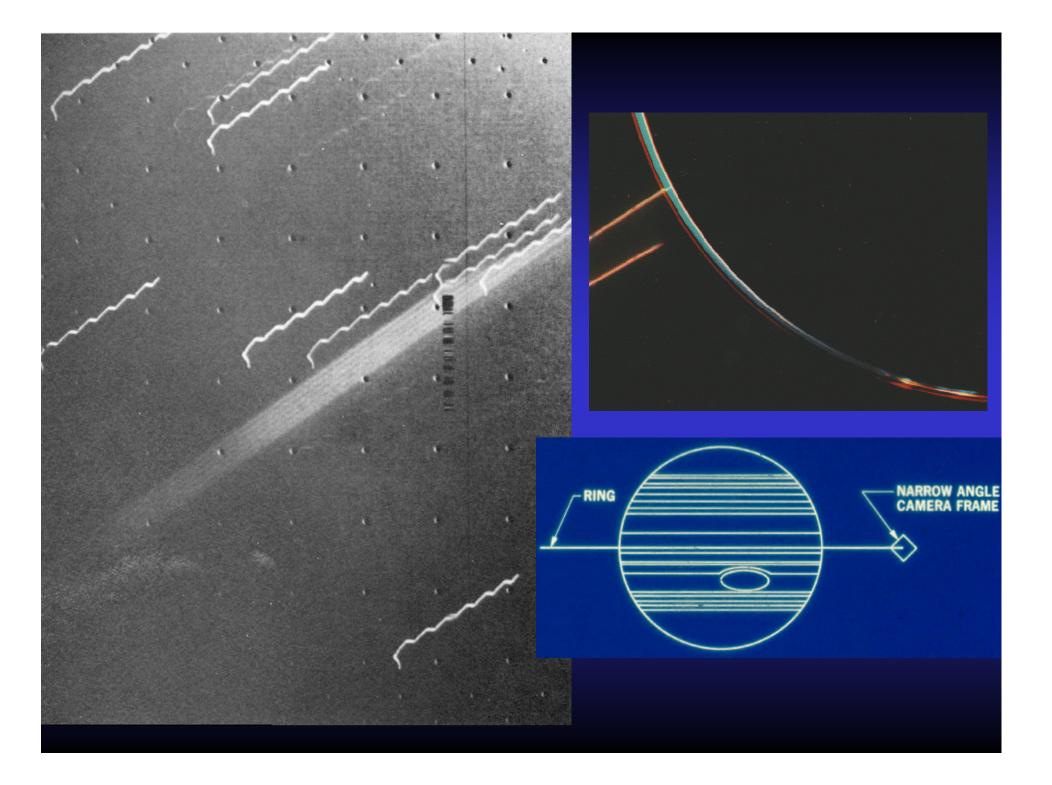


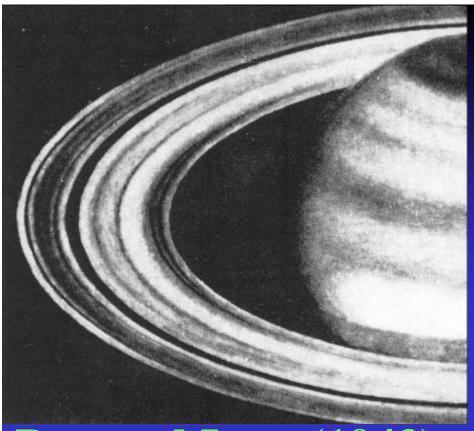


## Planetary rings: diversity (perfume)

- < 1977: homogeneous rings with smooth edges
- Since 1977:
  - Heterogeneous rings with sharp edges
  - Discovery of Uranus',Jupiter's and Neptune's rings
  - Discovery of Neptune's arcs
  - More questions than replies

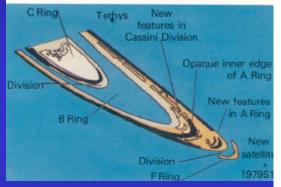






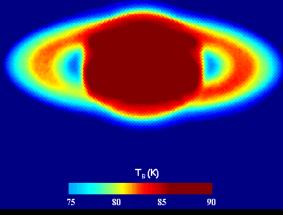
Pioneer 1979



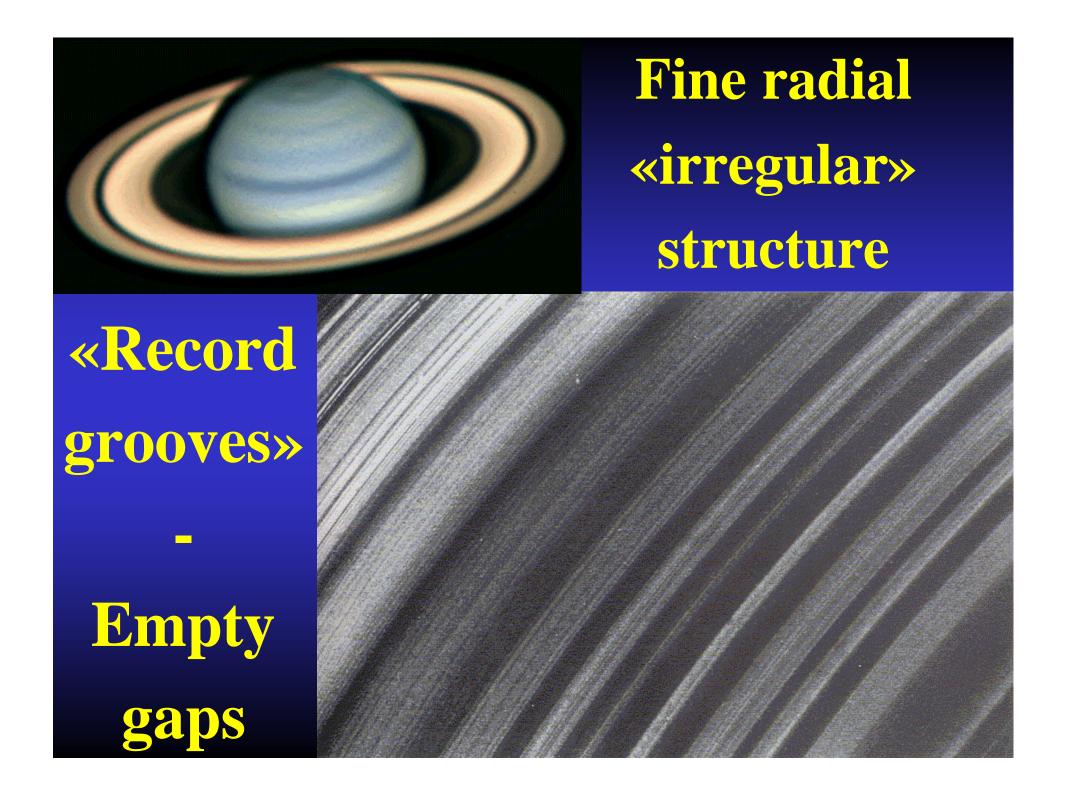


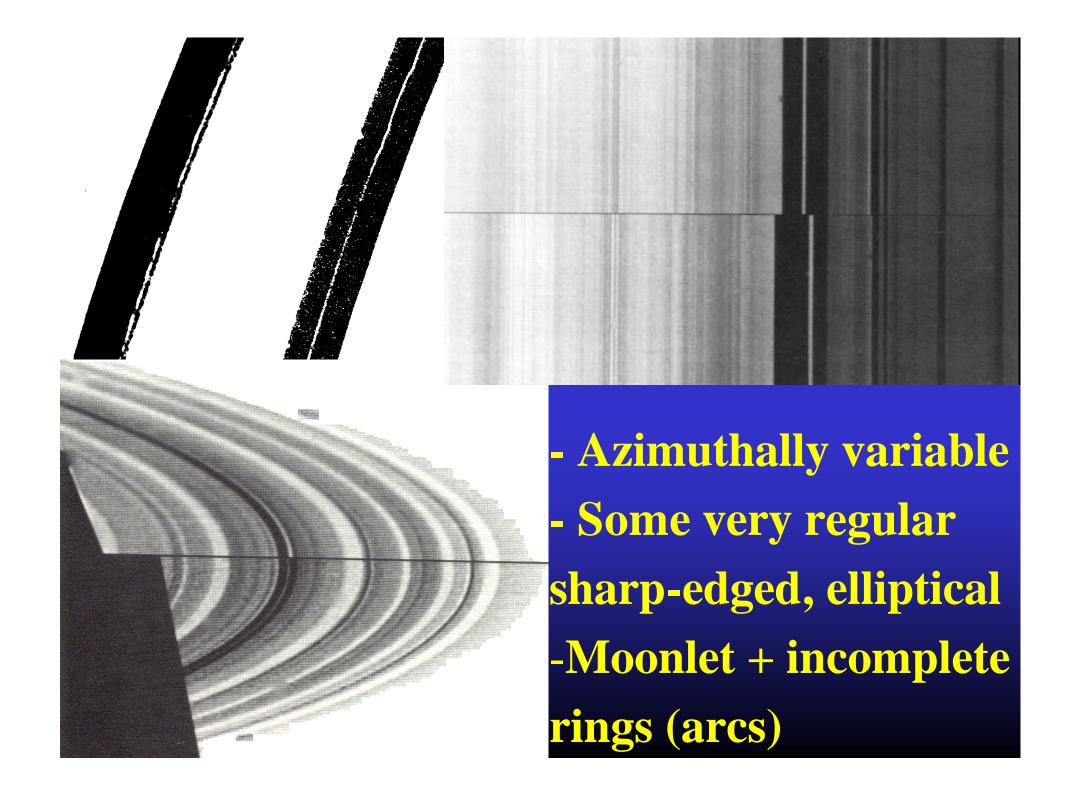
Bernard Lyot (1943)

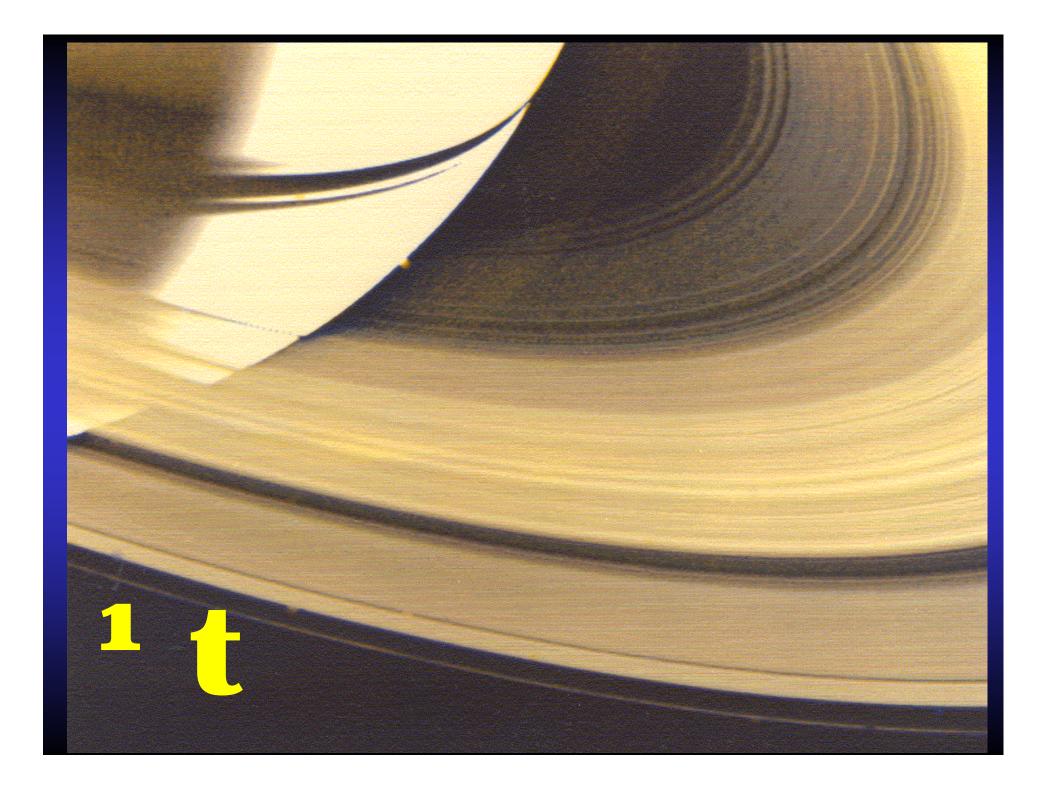




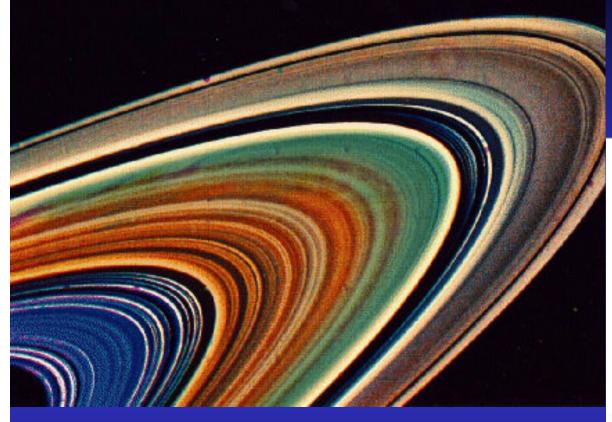






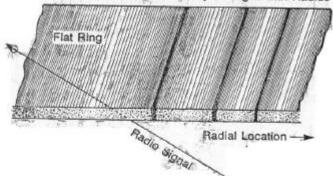


## Regional and local variations in particle colors

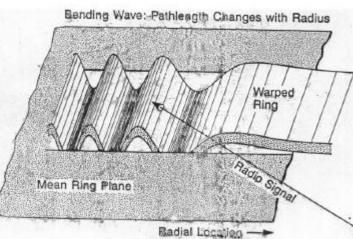


Radio Occultation as a Probe of Density & Bending Wayes

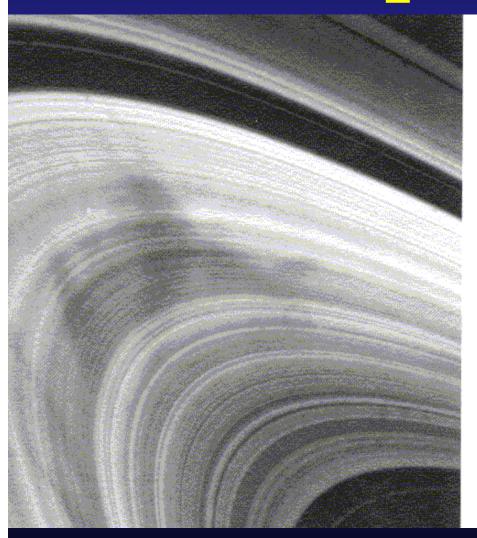
Density Wave: Number Density Changes with Radius

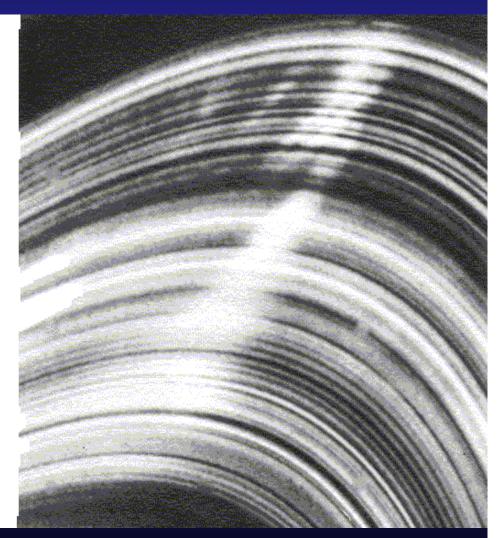


Spiral density waves and bending waves



## «spokes»

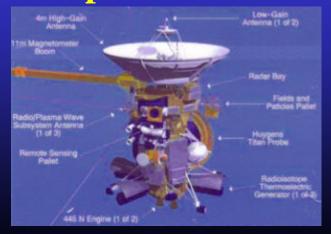


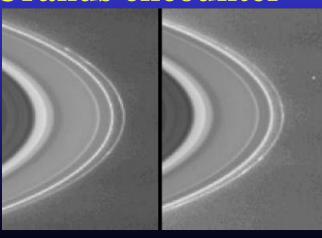


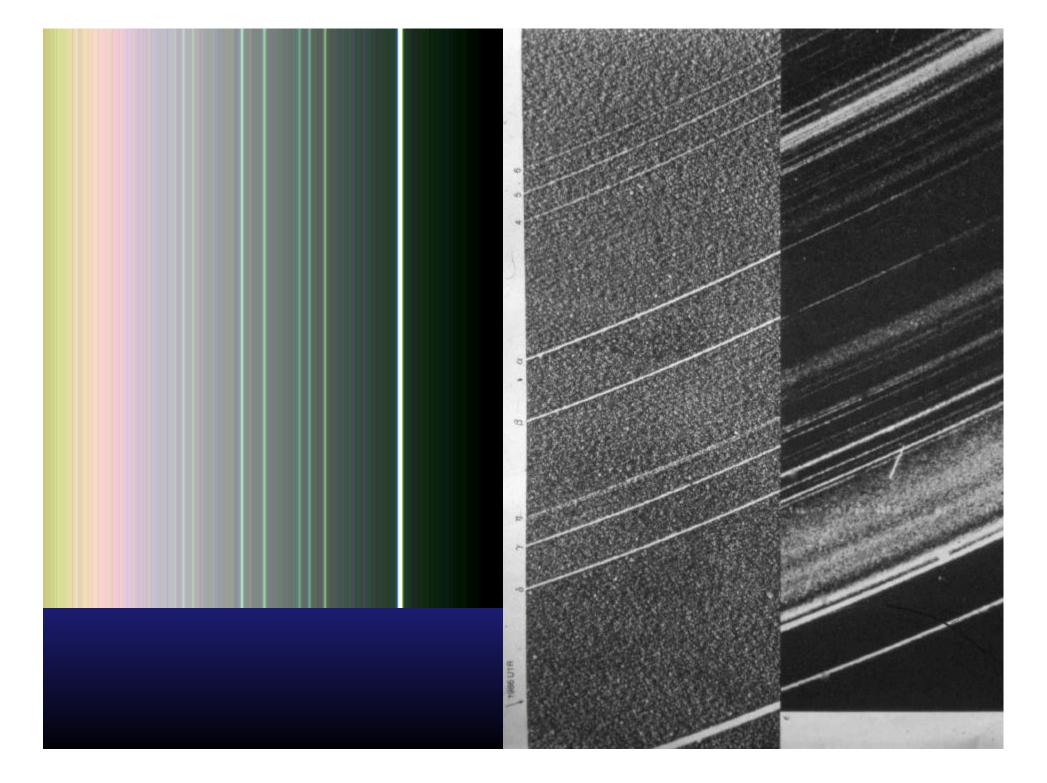


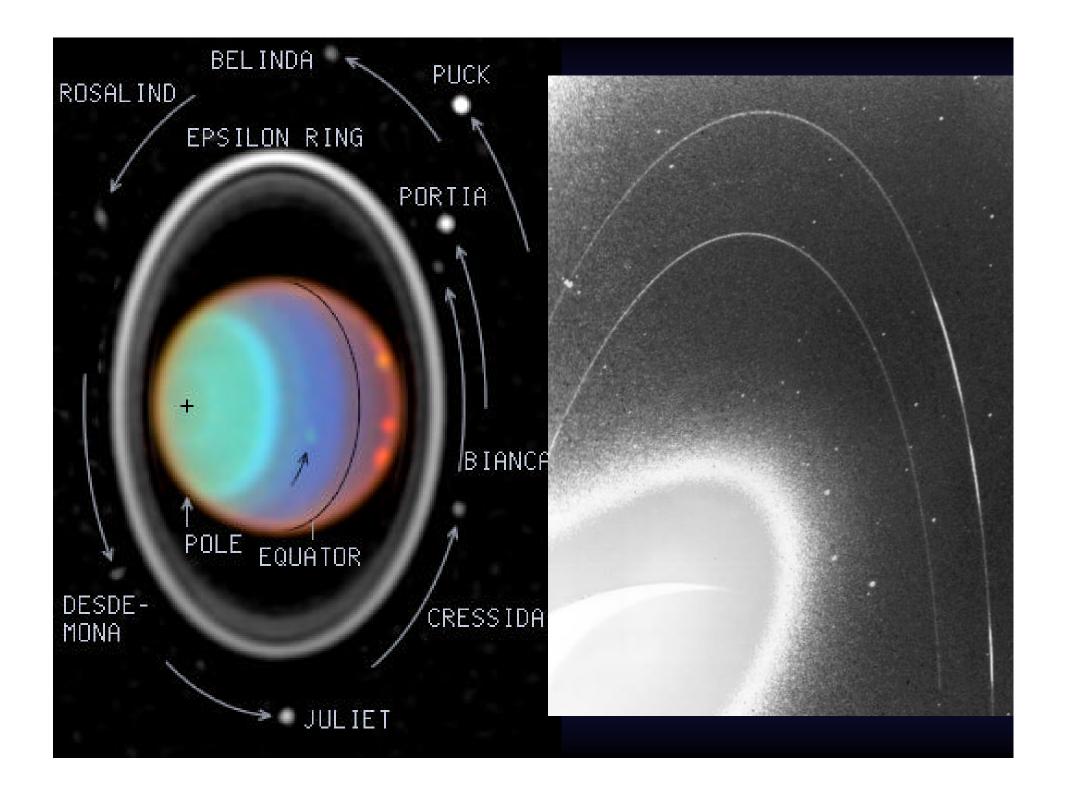
Failure of the scan platform on August 26, 1981: loss of data, but « repaired » before Uranus encounter

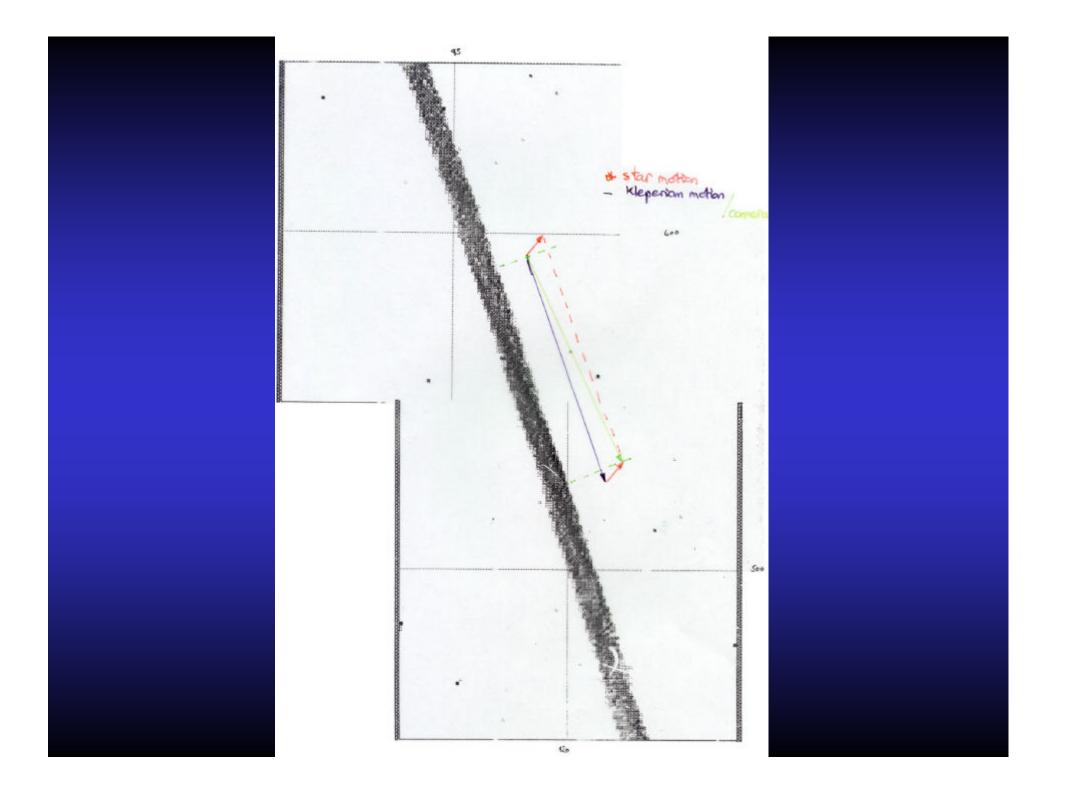
... and Cassini

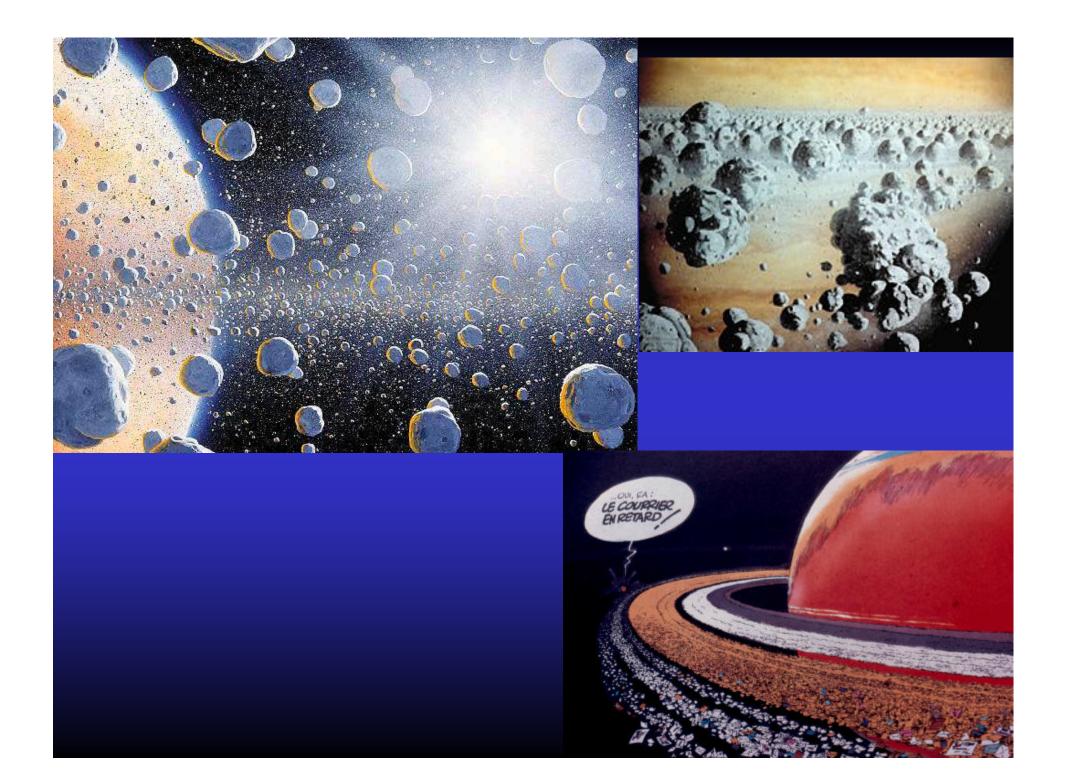




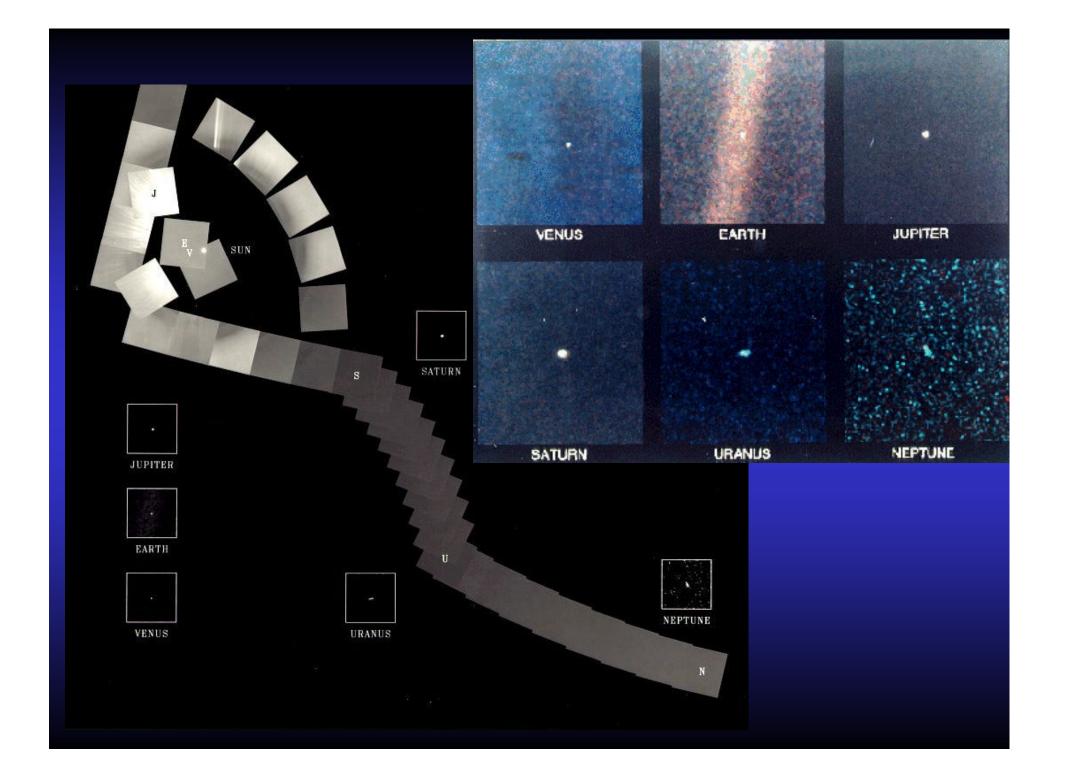


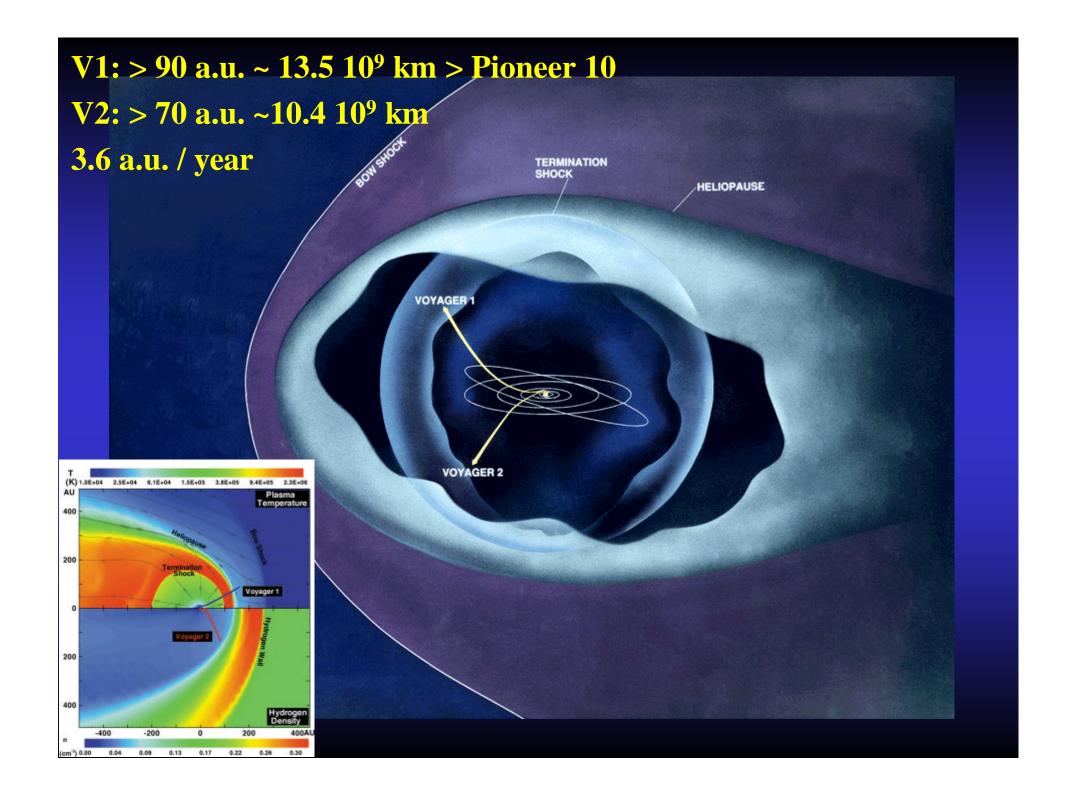


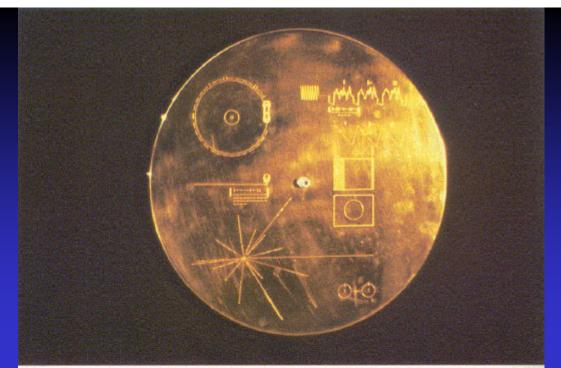


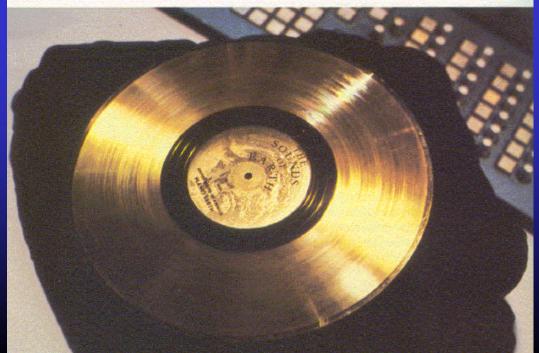


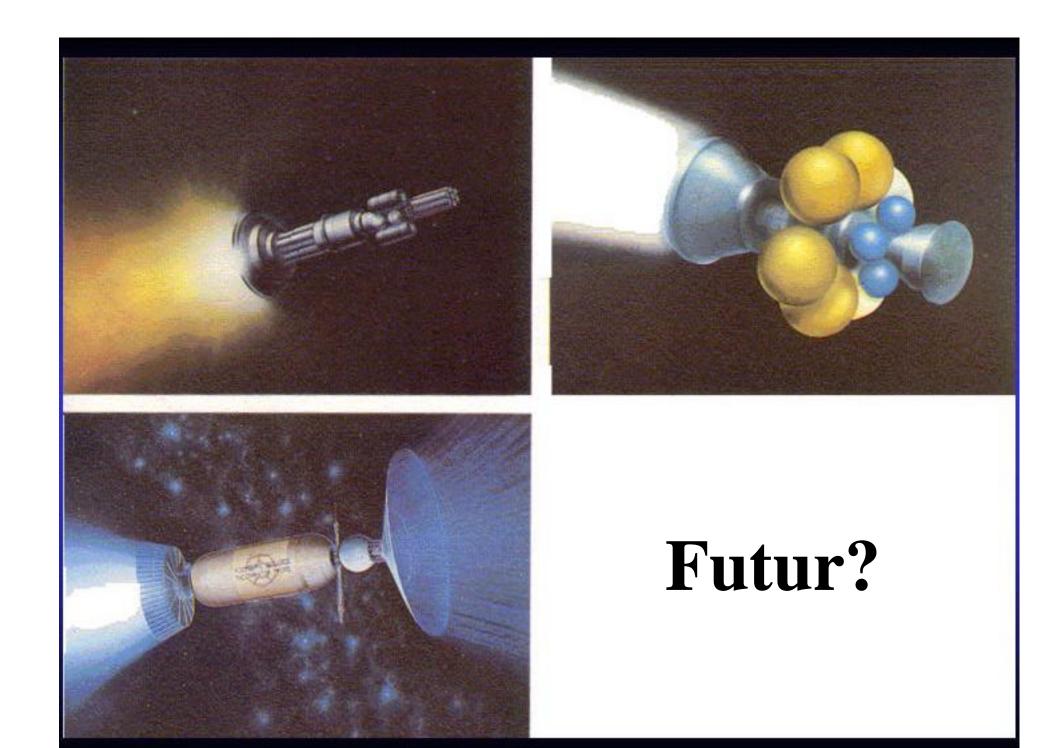












## 3.9 millions years .. or 2 hours?

