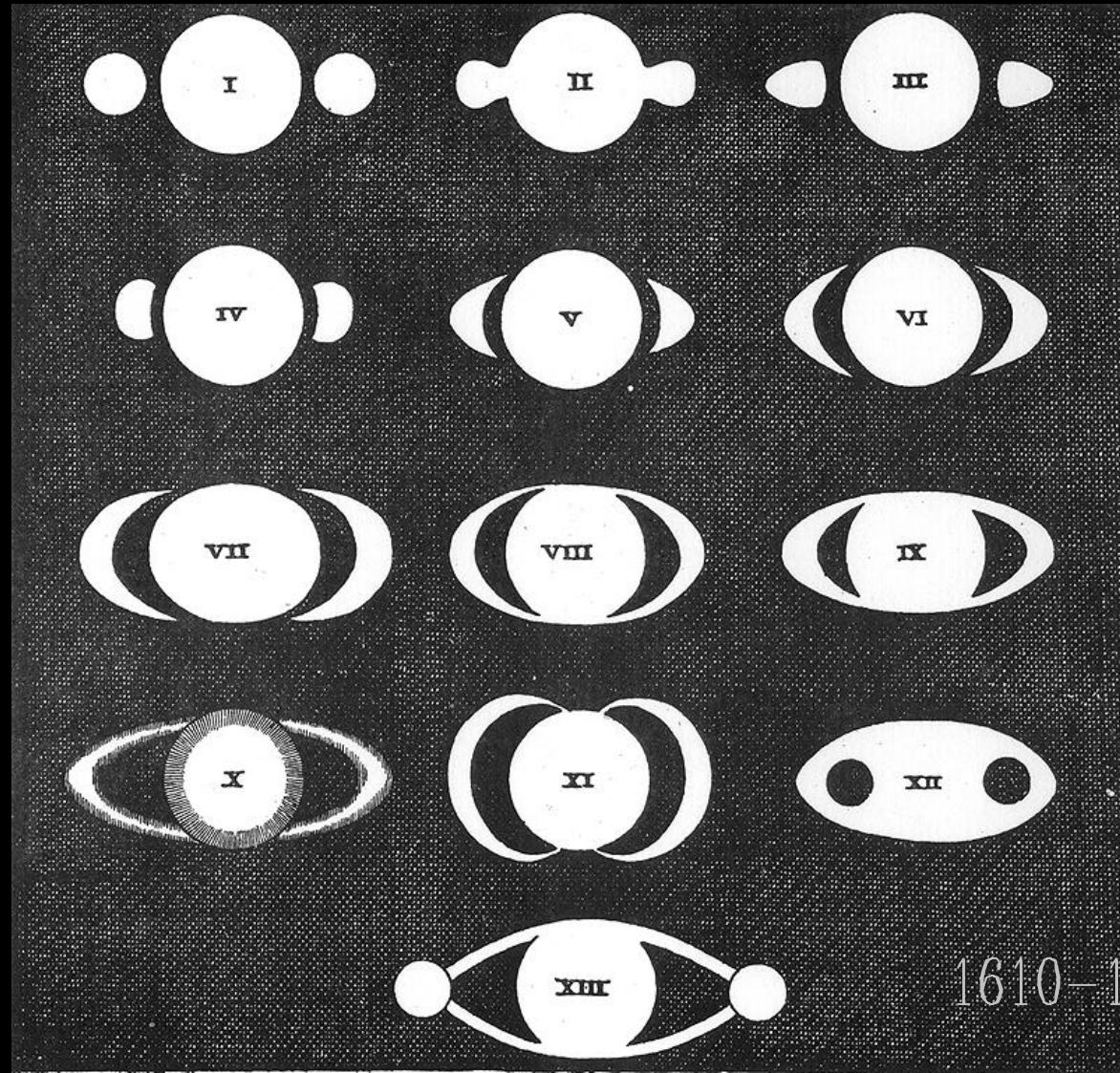


Satellites and rings: Huygens heritage

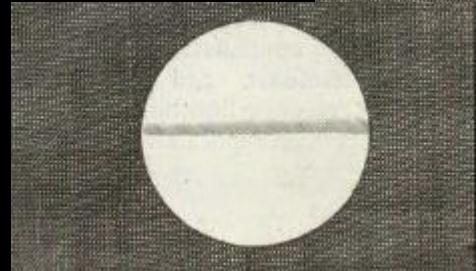
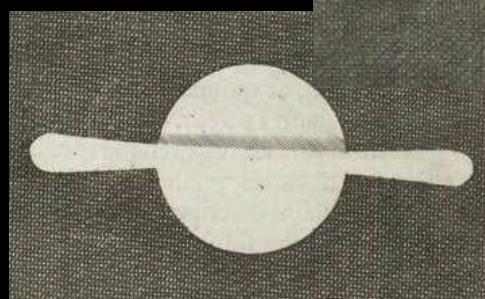
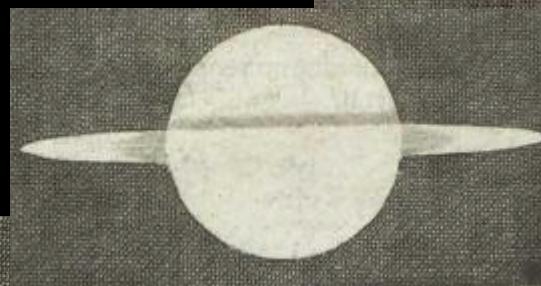
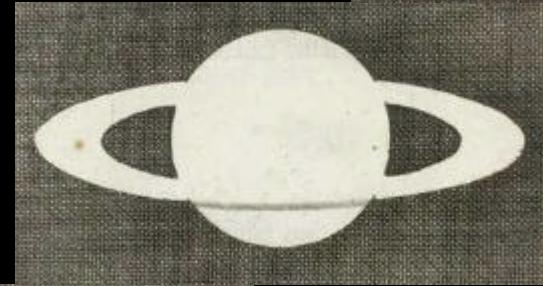
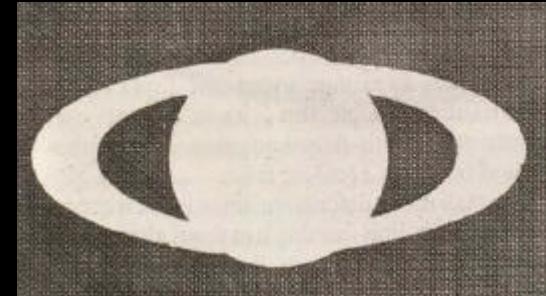
C. Ferrari

University Paris 7 – Denis Diderot

Saturn before Huygens

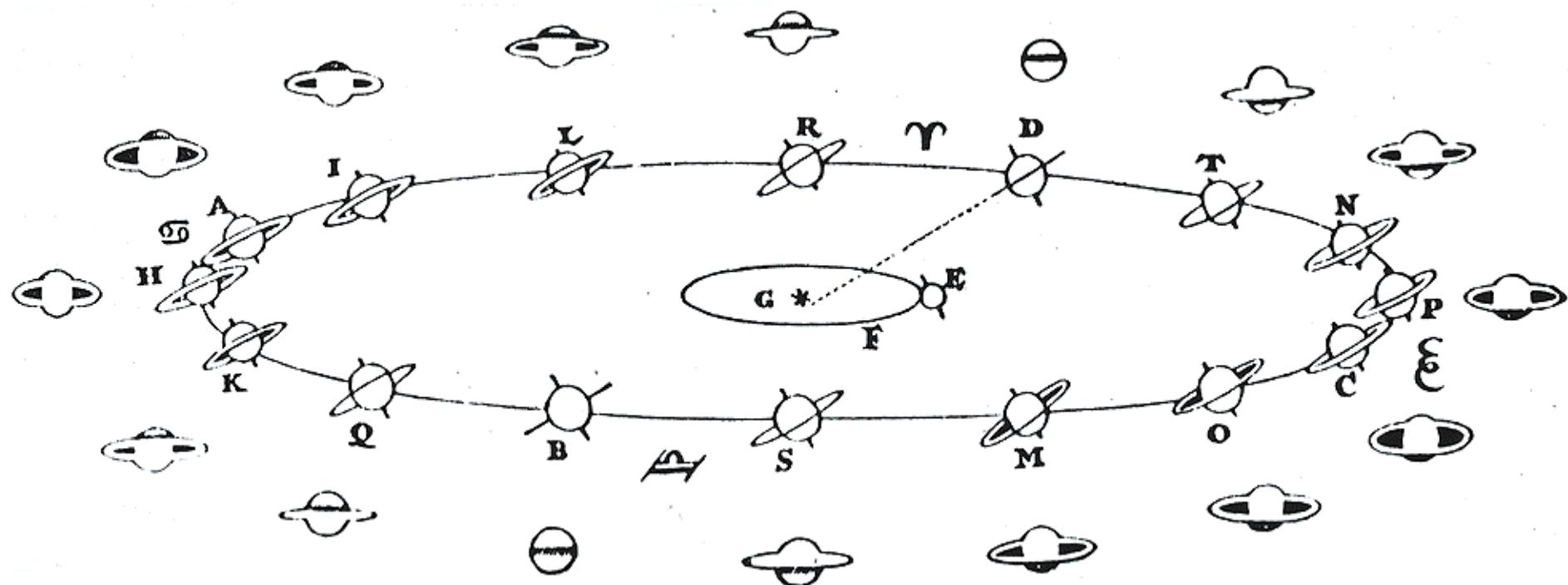


Huygens: a ring around Saturn

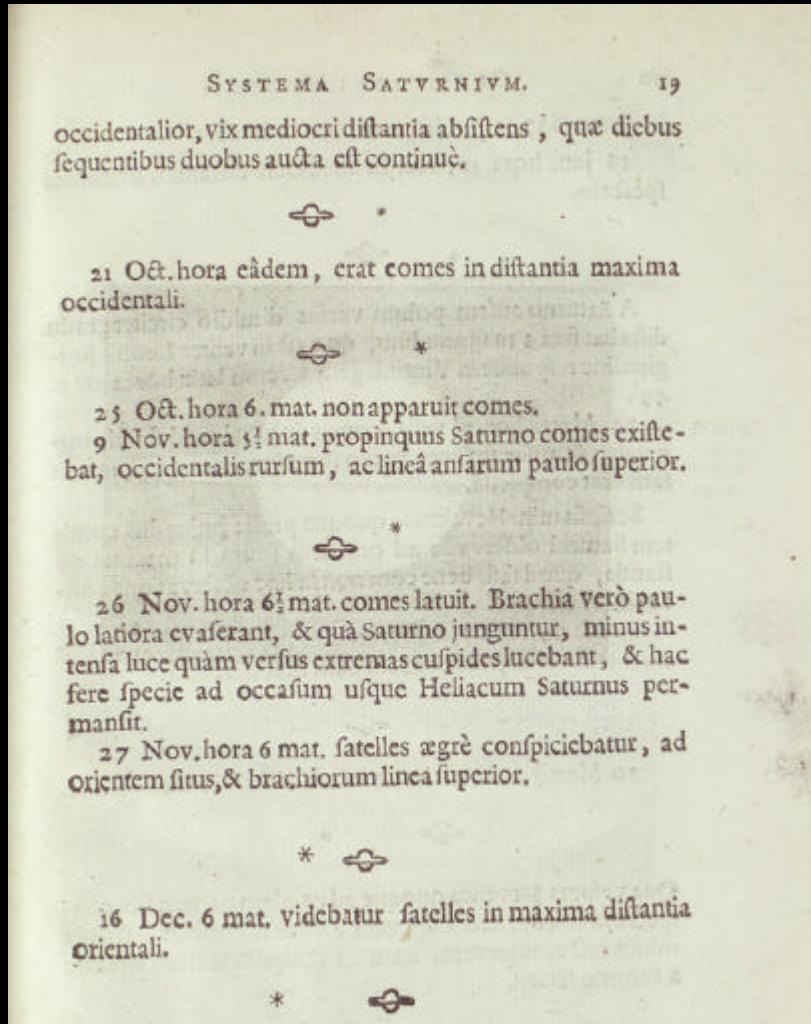


CHRISTIANI HVGENII
SYSTEMA SATURNIUM.

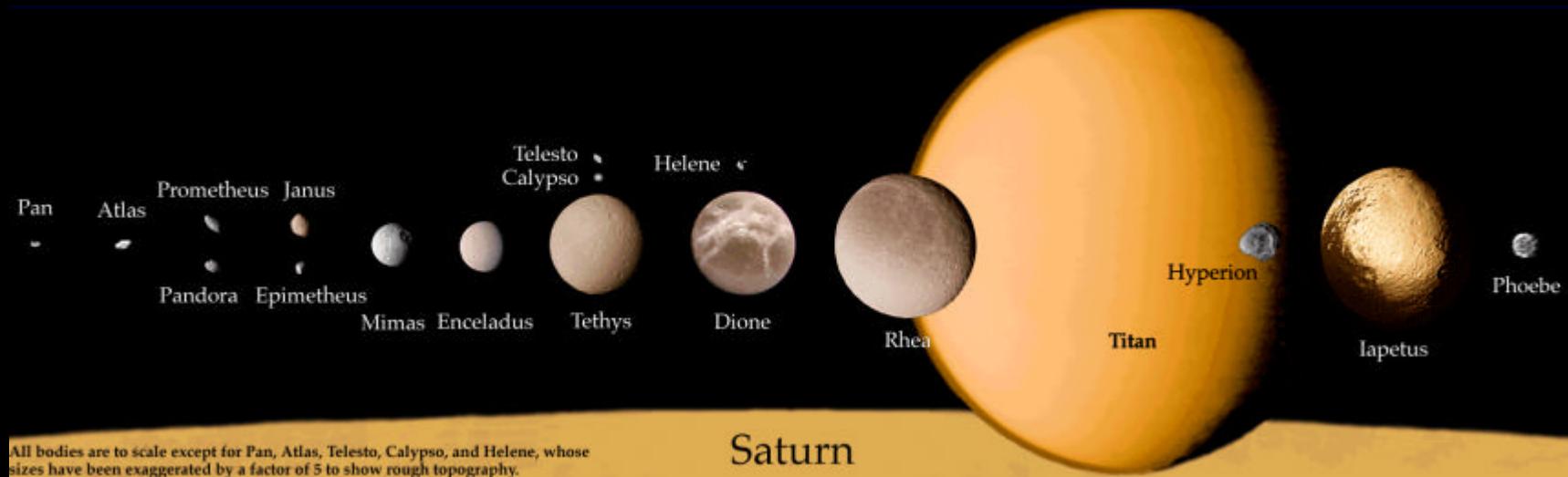
Saturn's seasons



Titan's discovery near RPX



Crops around RPXs



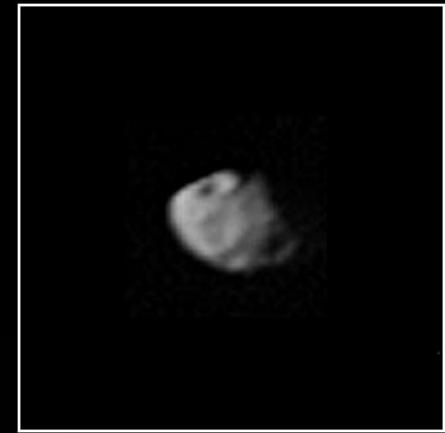
>1000 km		1684	1684	1671-72	1655	1671-72
300-500 km	1789-90				1848	1898
30-180 km	1966	1979-80				
1980-81 (30-90 km)						

But not too close...



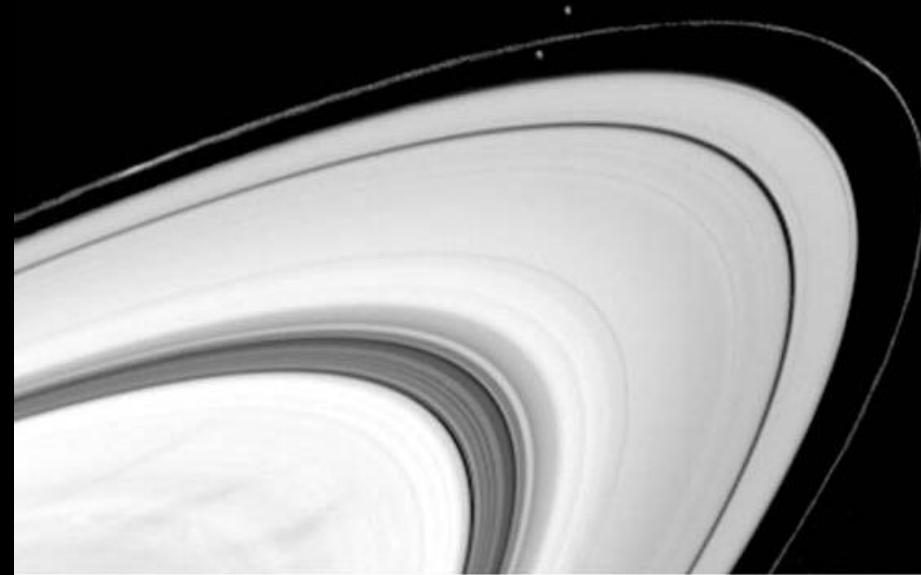
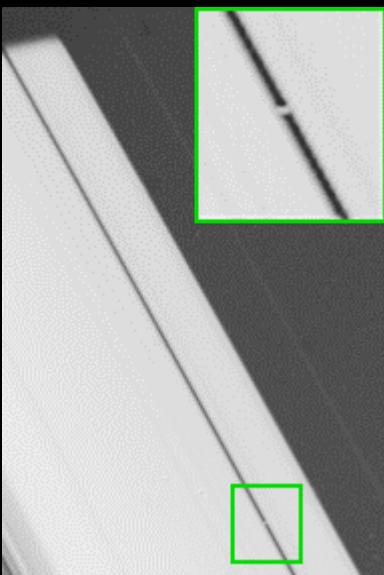
Prometheus

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Pandora

© 1999 by Calvin J. Hamilton



F-Ring Shepherd Satellites Prometheus & Pandora

© Copyright Calvin J. Hamilton

Heritage

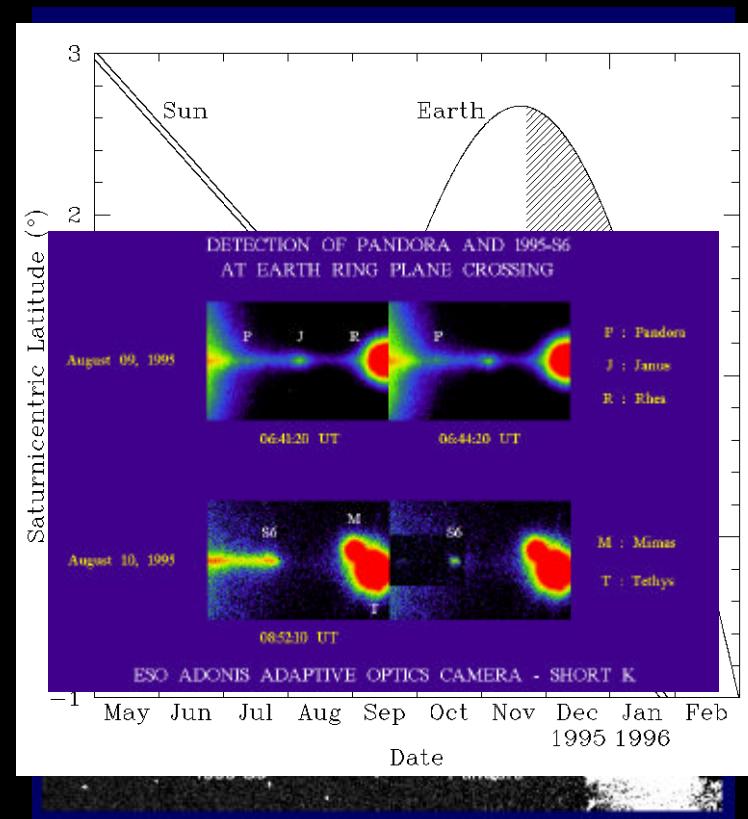


Hubble
Heritage

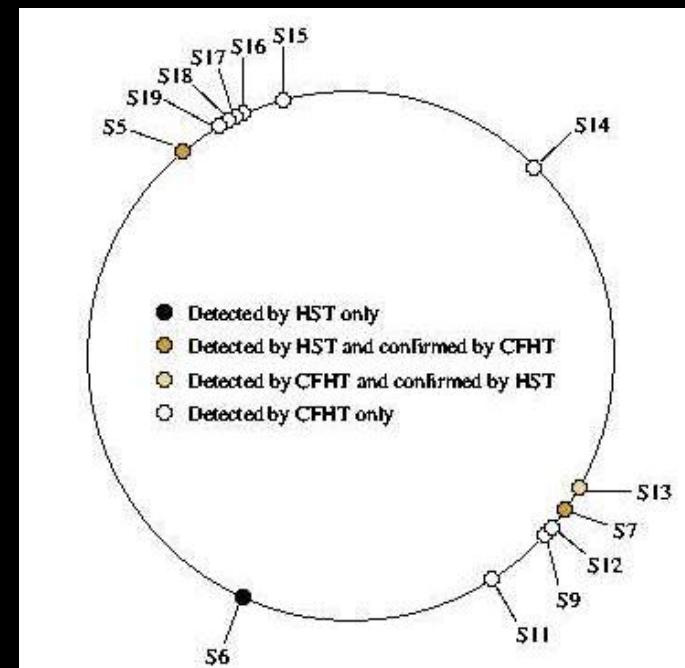
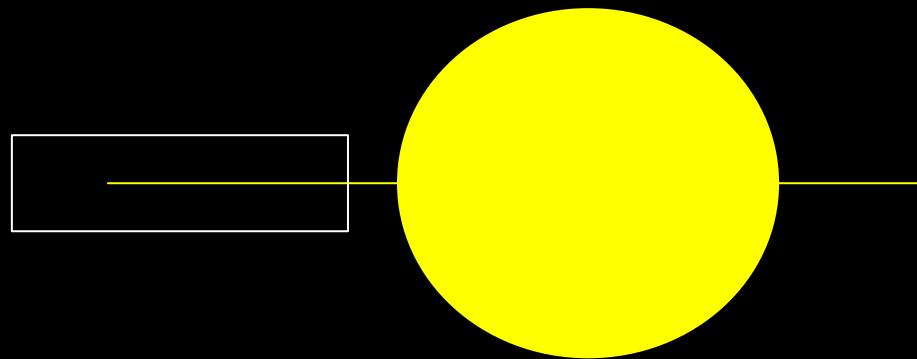
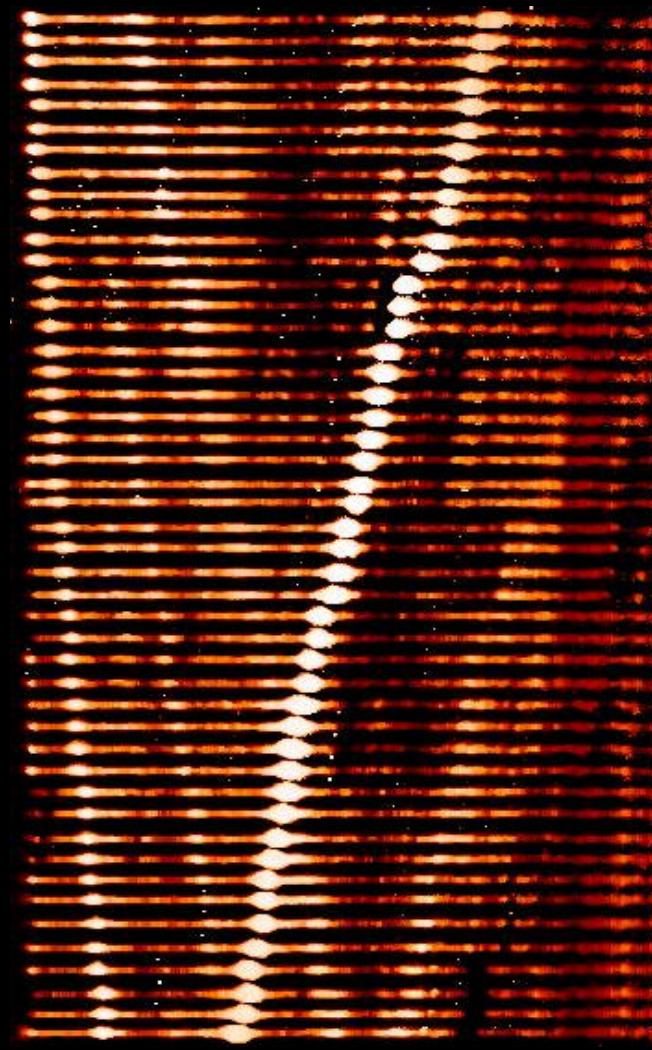
NASA and The Hubble Heritage Team (STScI/AURA) • Hubble Space Telescope WFPC2 • STScI-PRC01-15

$$1995 = 1656 + 23 * 14.74$$

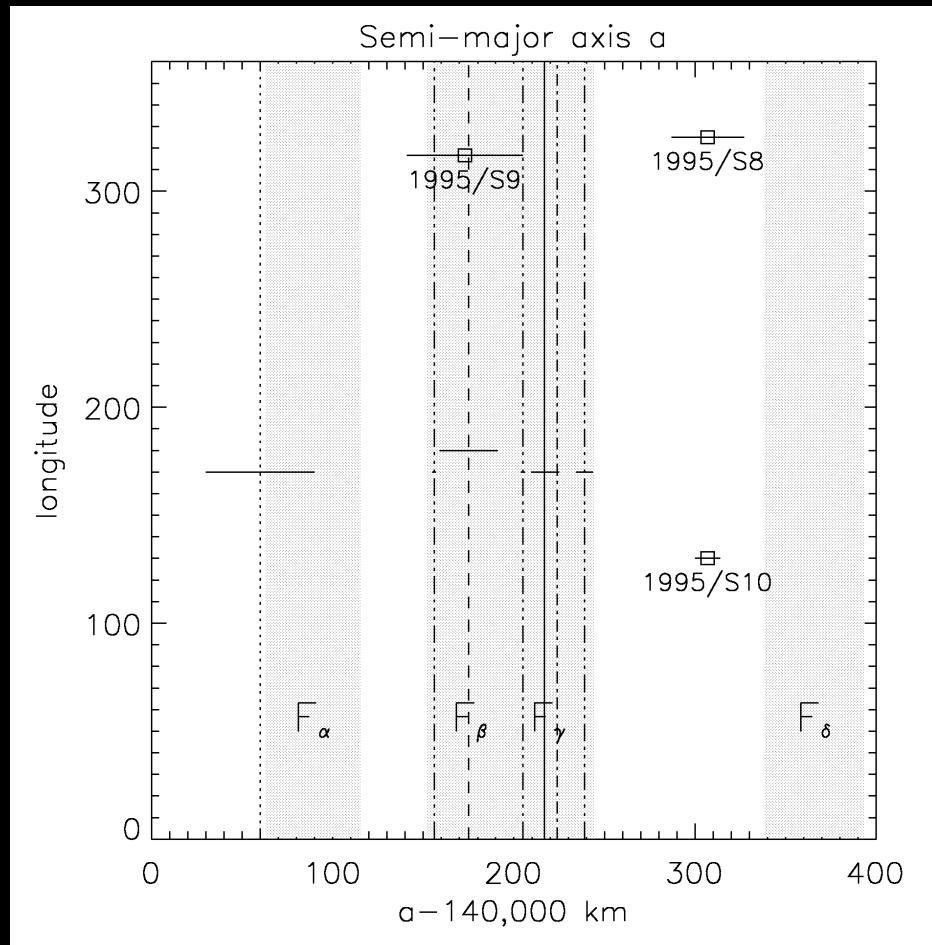
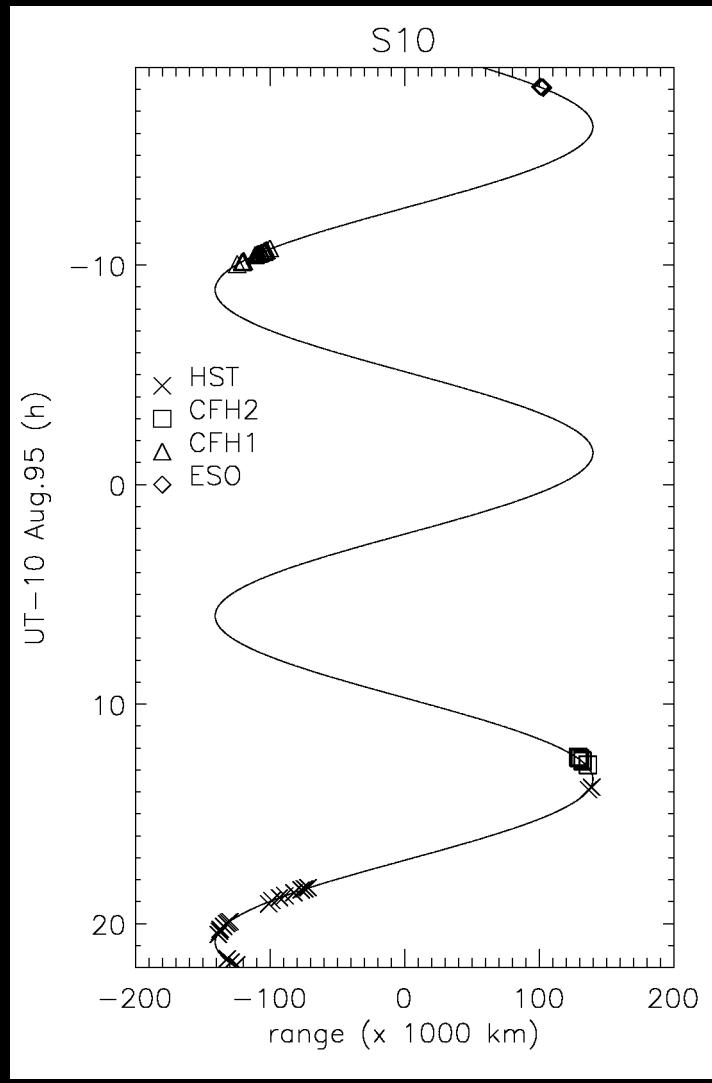
- 3 crossings (RPX)
- HST (Nicholson et al. 1996, McGhee et al. 2001, Bosh and Rivkin 1996)
- ESO-AO (Poulet et al. 2000, Sicardy et al. 1995)
- CFHT (Roddier et al. 1996,)



Big summer crop in the F ring

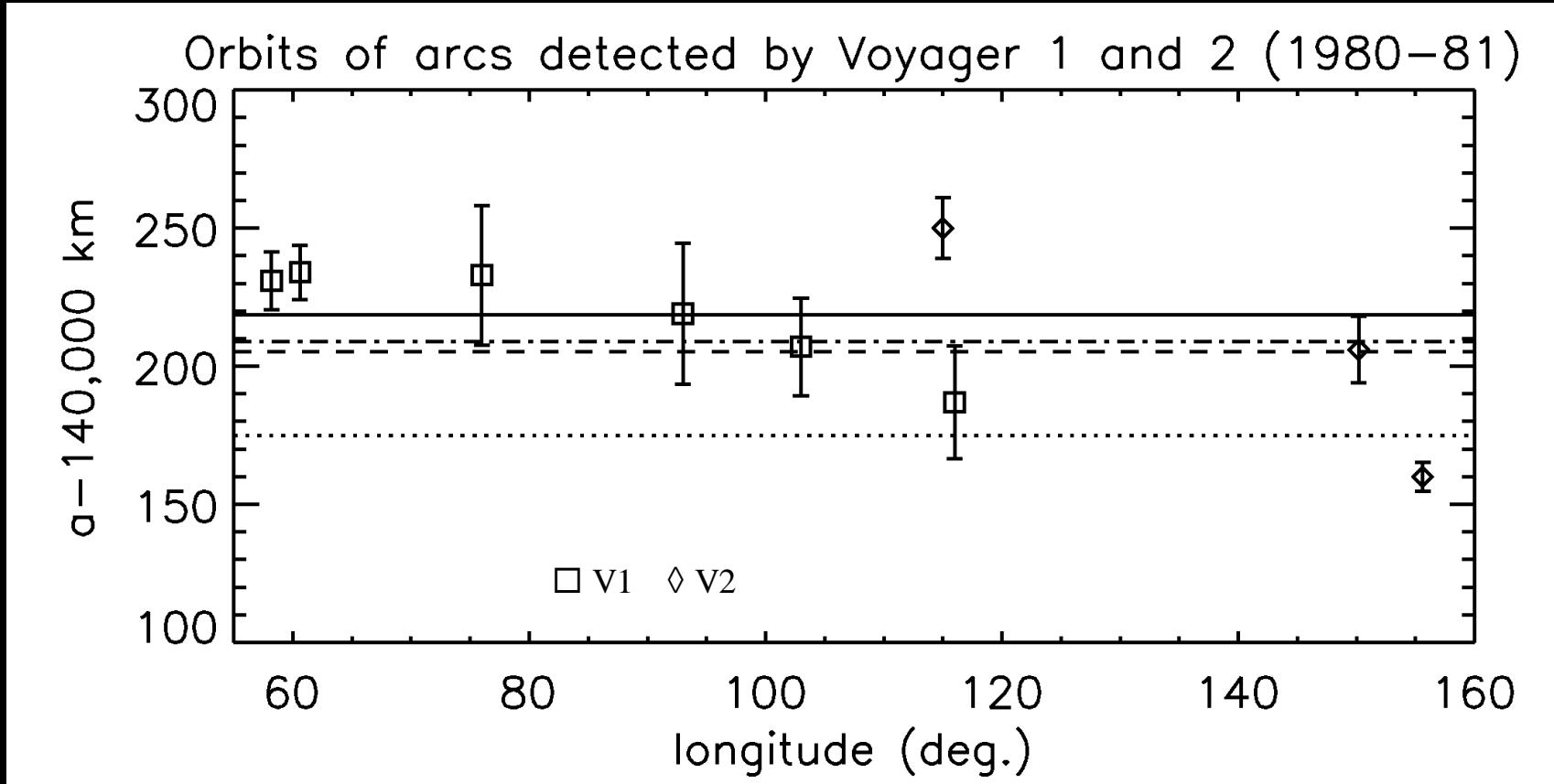


Arcs and clumps in the F ring



$\Delta a = 134 \pm 50 \text{ km}$, $\Delta \Omega \approx 1.44^\circ/\text{d}$

(Ferrari et al. 2004)



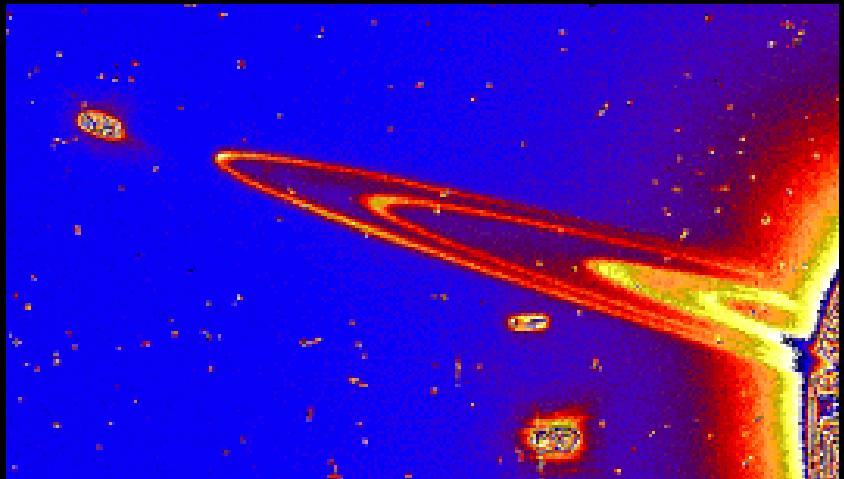
Voyager 1 (8d): $a=140219 \pm 19$ km

Voyager 2 (15d): $a=140205 \pm 10$ km (Ferrari et al. 1999)

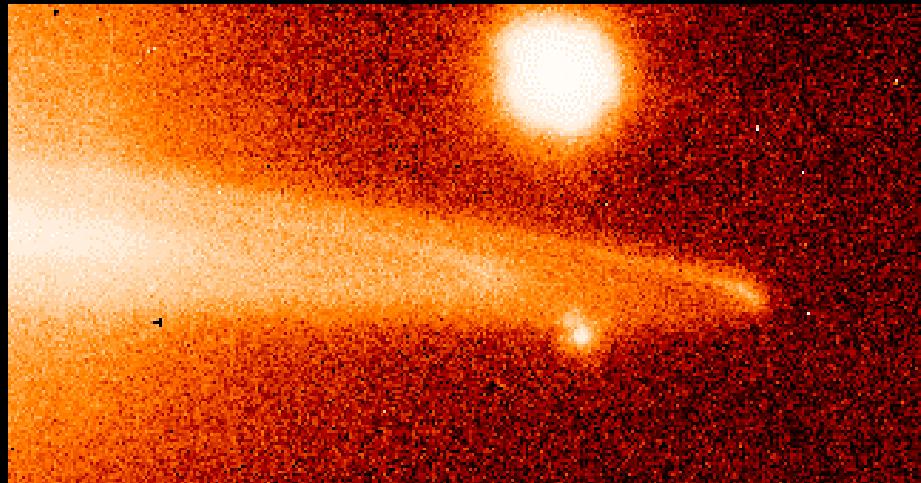
$$\Delta a = 89 \pm 6 \text{ km}, \Delta \Omega \approx 0.6^\circ/\text{d}$$

Lifetime : $\geq 15\text{d}$, $\geq 30\text{-}60\text{d}$ pour 95% (Showalter 1999)

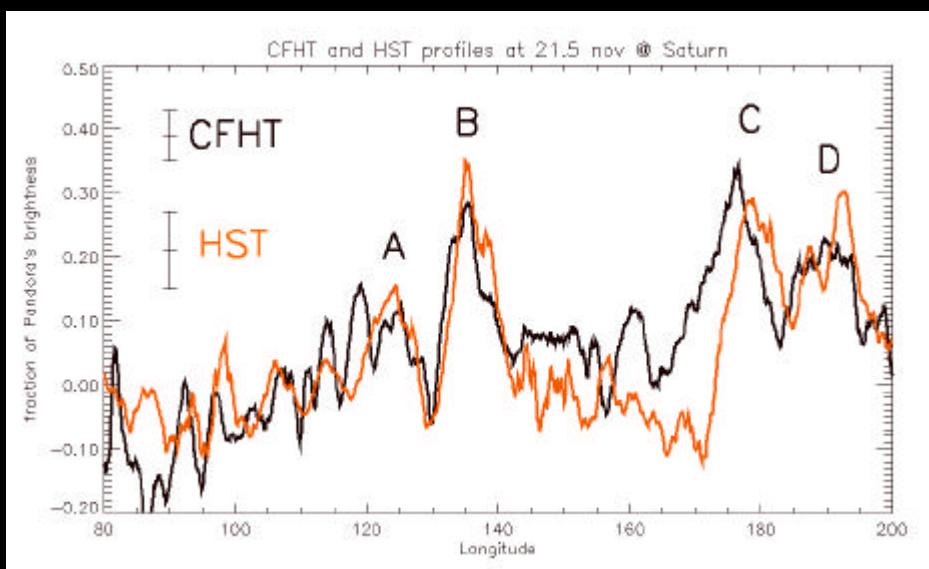
Sun RPX (Nov. 95): more arcs



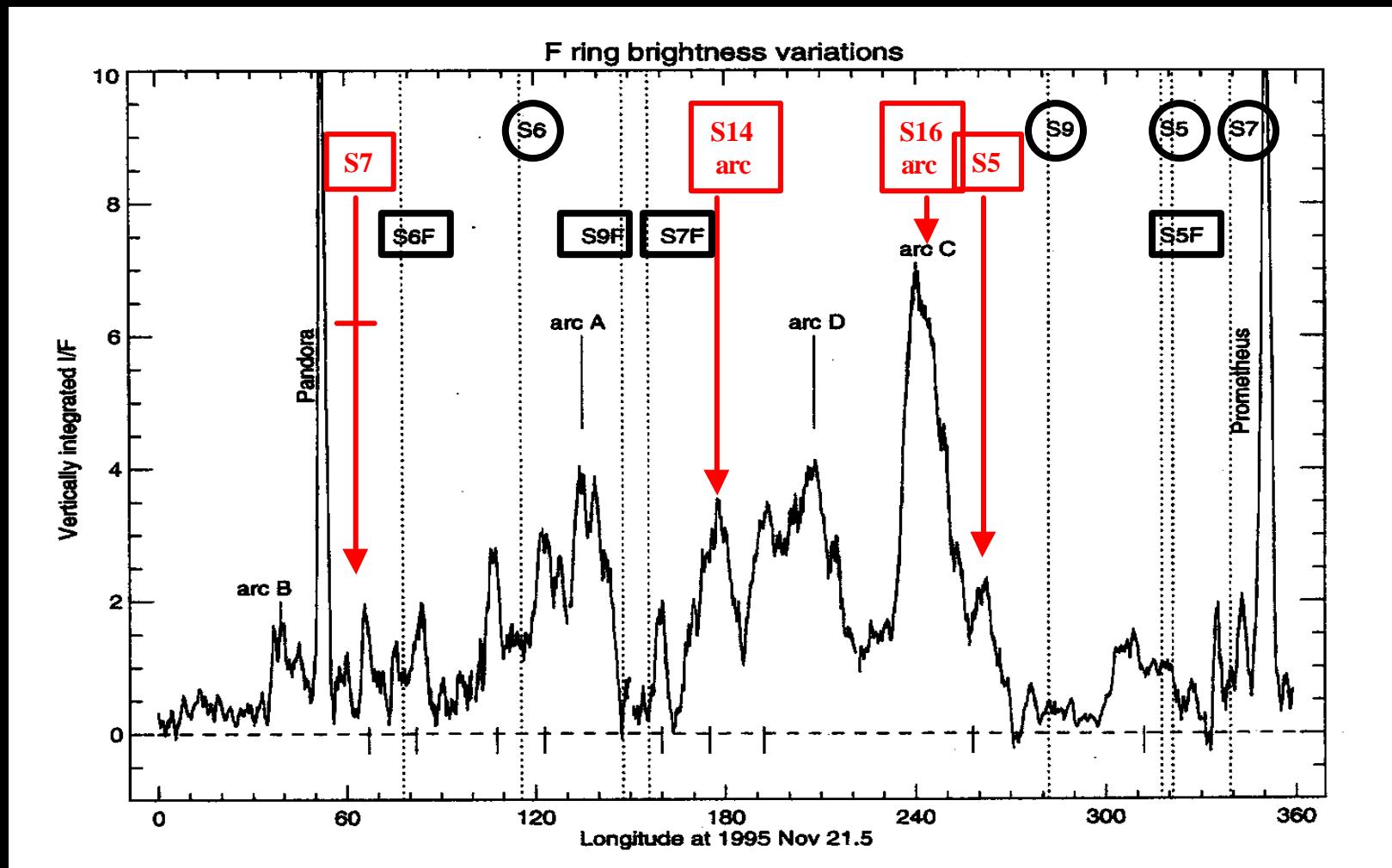
HST



CFHT-UHAO

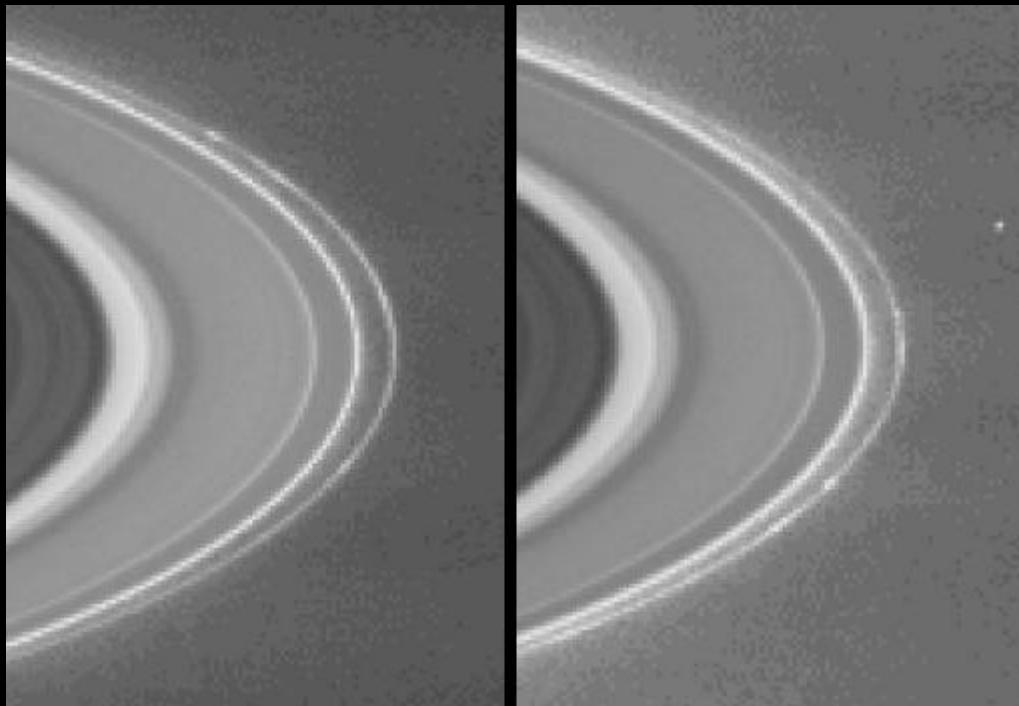


$$a_{\text{CFH-HST}} = 140060 \pm 60 \text{ km}$$
$$a_{\text{HST}} = 140074 \pm 30 \text{ km}$$



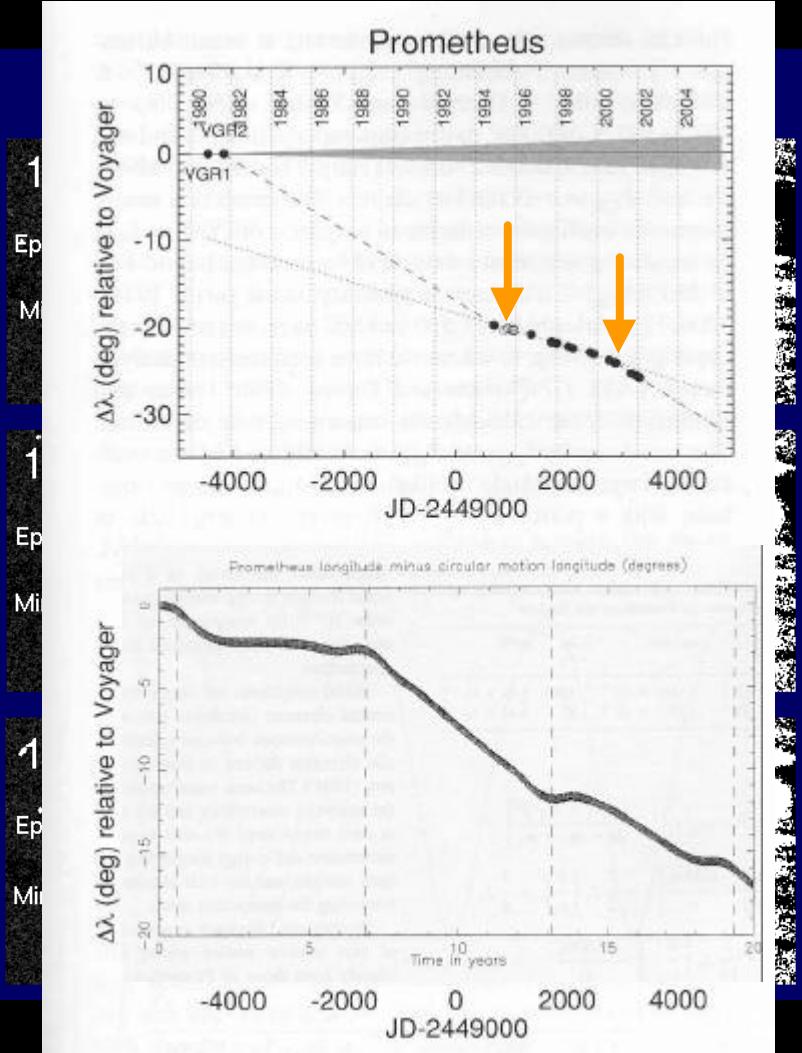
Evolution of arcs and clumps: differential rotation or finite lifetime ?

Dynamics and lifetime : Cassini



(Porco et al. 2004)

RPX: Chaos in the suburbs



- Prometheus late, by $\sim 20^\circ$
(Bosh and Rivkin 1996, Nicholson et al. 1996)
Offset rate $\sim -0.71^\circ/\text{yr}$ in 1995, $\Delta a = +0.31 \text{ km}$
- Pandora in advance, by $\sim 20^\circ$ (McGhee 2000)
Offset rate $\sim +0.44^\circ/\text{yr}$ in 1995, $\Delta a = -0.20 \text{ km}$
- Another jump in 2000-2001
Prometheus : $\sim -0.77^\circ/\text{yr}$, $\Delta a = +0.33 \text{ km}$
Pandora : $\sim +0.92^\circ/\text{yr}$, $\Delta a = -0.42 \text{ km}$
(French et al. 2003)
- Angular momentum exchange when apoapses antialigned
- Chaos in mean motion reson. 121:118
(Goldreich and Rappaport 2003)

Far away from RPX, in the lost suburbs

The collage includes:

- A large grayscale image of the night sky with a white outline of the solar system showing the Sun, planets, and their rings.
- A small inset image of Phoebe, a satellite of Saturn, appearing as a bright, slightly irregular white shape against a dark background.
- A text label "Phoebe (220 km)" positioned next to the inset.
- A wide-angle grayscale image of the night sky containing several bright, white, irregular shapes representing newly discovered satellites.
- Two specific satellite images labeled "S2000/S2 (20 km)" and "S2000/S4 (14 km)".
- A list of bullet points describing the discoveries.
- A final text label "(Gladman et al. 2001)" at the bottom right.

• Large CCD, large telescopes, huge data

• 12 new irregular satellites

• **6-32 km-sized**

• $a=11$ to $23 \cdot 10^6$ km ($T=1.2$ to 3.6 yr)

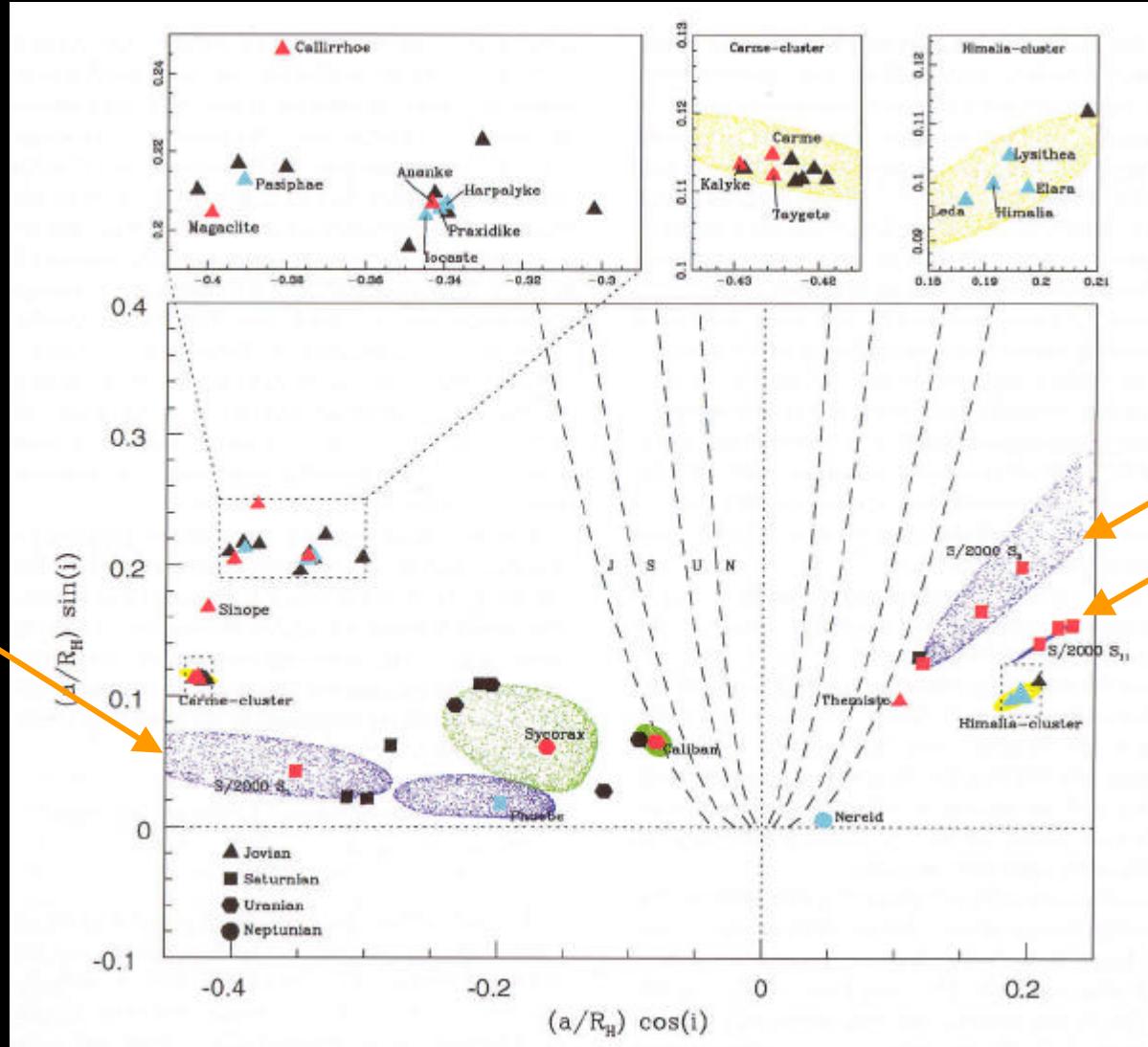
• Large e , 3 groups of i

(Gladman et al. 2001)

New Satellites of Saturn

Irregular but grouped

$i=170^\circ$,
Phoebe's group



Huygens... « un visionnaire »

