Smashing Uranus' Moons

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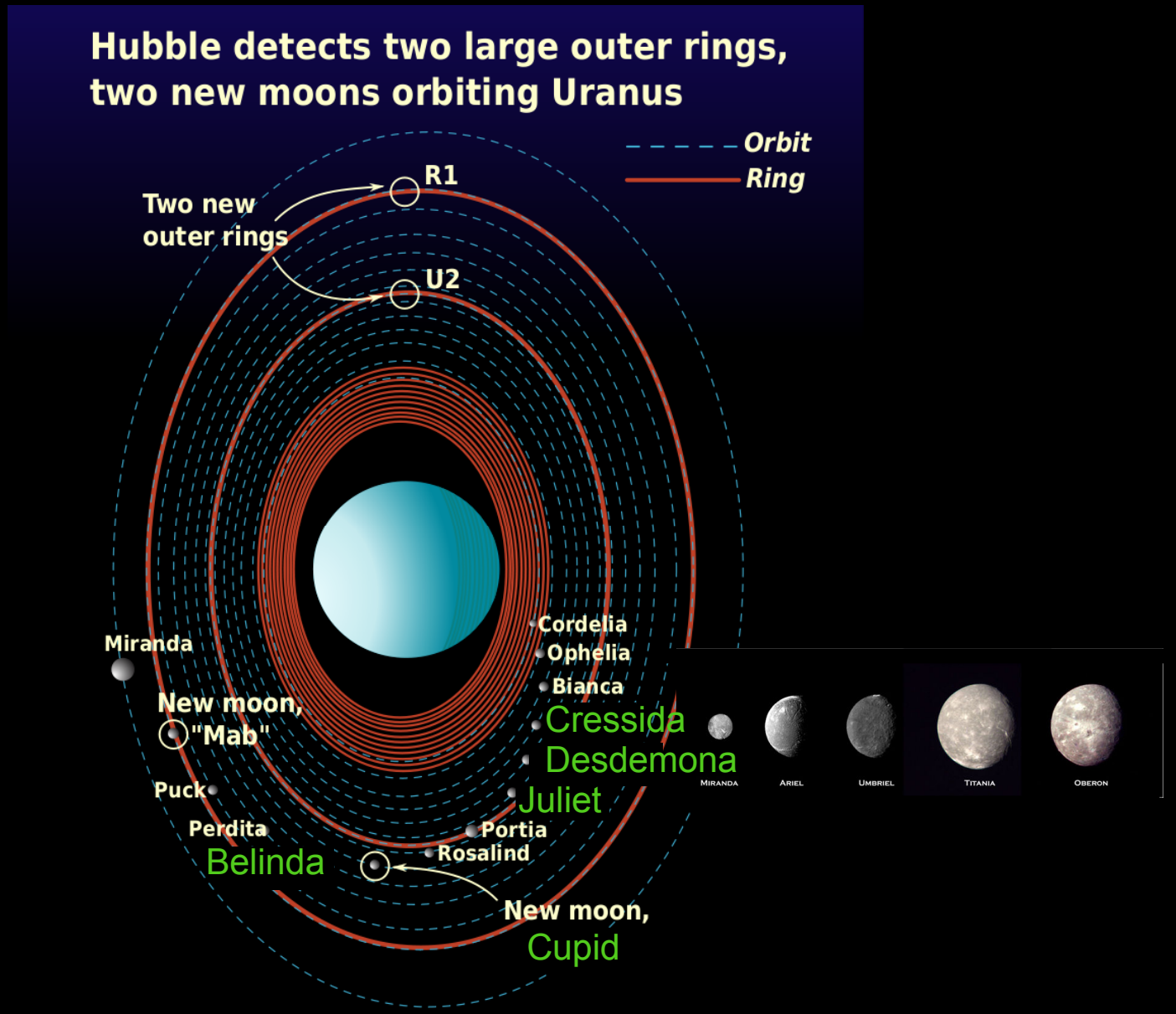
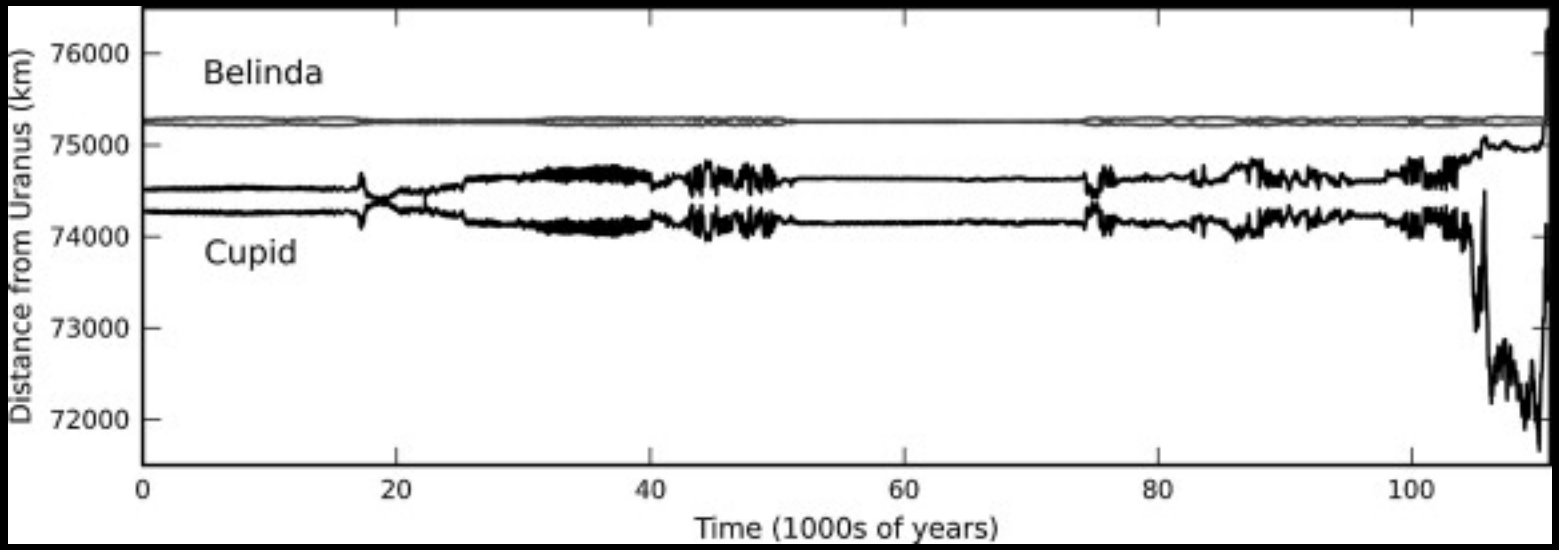
TERPS Conference

Based on French & Showalter Icarus 220 (2012)


Hubble detects two large outer rings, two new moons orbiting Uranus
Orbit
Ring
R1
Two new outer rings
U2
Miranda
New moon, "Mab"
Puck
Perdita
Belinda
Cordelia
Ophelia
Bianca
Cressida
Desdemona
Juliet
Portia
Rosalind
New moon, Cupid
Miranda
Ariel
Umbriel
Titania
Oberon

Motivation

- Duncan and Lissauer 1997
- Crossing ~1-100Myr
- Continual gravitational interactions



- Regularized Mixed Variable Symplectic Integrator
- Dynamical masses unknown

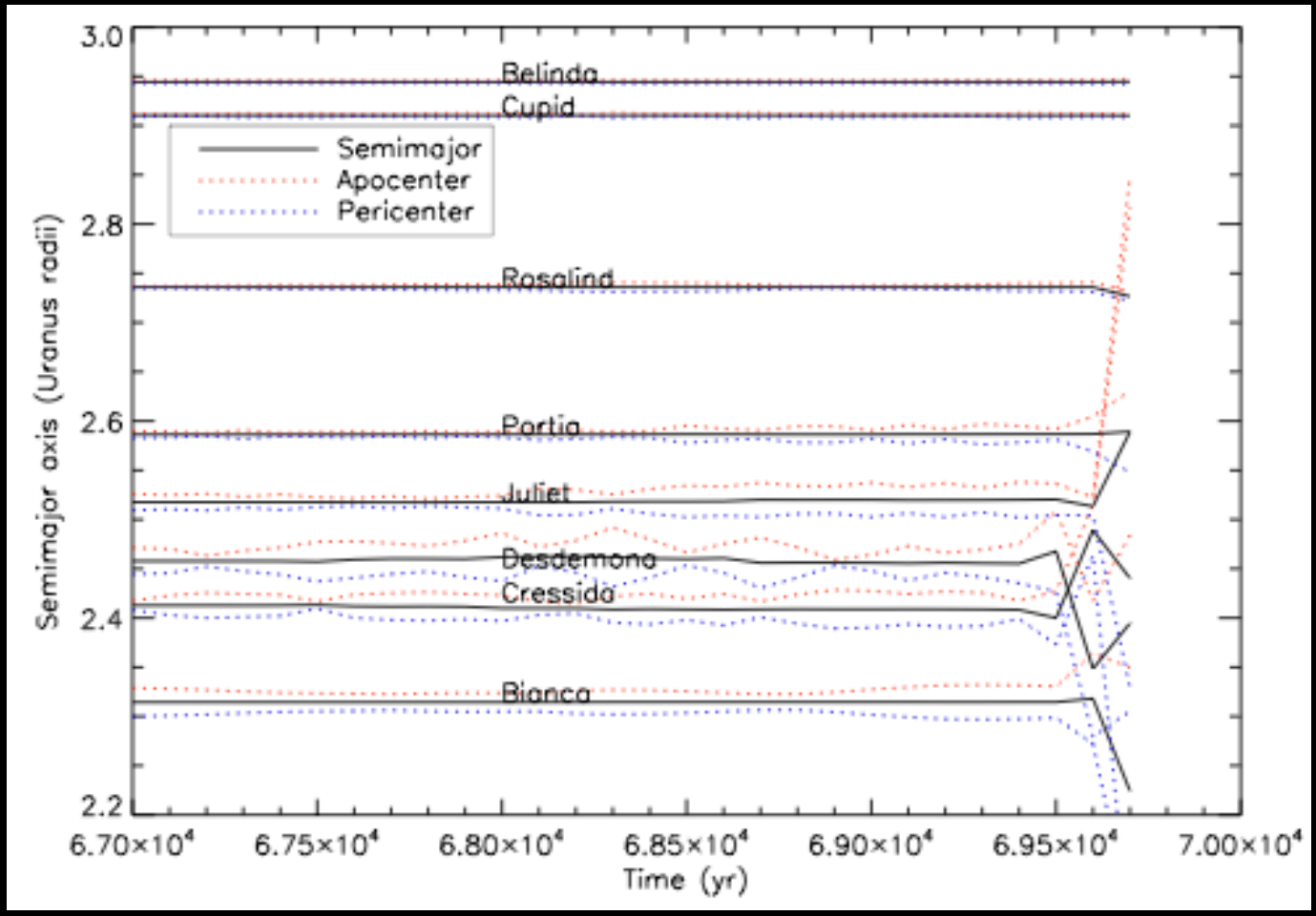
Satellite	Radius (km) [e^-/mV]	GM (km^3s^{-2}) [e^-]
Cordelia	21 ± 3	0.002589112466095
Ophelia	23 ± 3	0.003401547497568
Bianca	27 ± 2	0.005502807544558
Cressida	41 ± 2	0.019268353339353
Desdemona	35 ± 4	0.011986631787478
Juliet	53 ± 4	0.041621779139926
Portia	70 ± 4	0.095893054299822
Rosalind	36 ± 6	0.013043691957471
Cupid	9 ± 2	0.000203807686836
Belinda	45 ± 8	0.025475960854435
Perdita	13 ± 3	0.000614218776375
Puck	81 ± 2	0.148575803703066
Mab	12 ± 3	0.000483099702129
Miranda		4.403988880239192
Ariel		86.48943821066345
Umbriel		81.48337213859010
Titania		228.6406014922988
Oberon		190.9467780172403

- French and Showalter

Model	log t_c	Crossing satellites
Inner($\rho = 0.5$)	6.2	Cupid-Belinda
Inner($\rho = 0.7$)	5.3	Cupid-Belinda
Inner($\rho = 1.0$)	5	Cupid-Belinda
Inner($\rho = 1.5$)	3.4	Cupid-Belinda
Inner($\rho = 2.0$)	3.1	Cupid-Belinda
Inner($\rho = 3.0$)	3.4	Cressida-Desdemona

- Duncan and Lissauer - 4-100 Myr Desdemona with Cressida or Juliet

ρ (gcm^-3)	0.32x Cupid	3.23x Cupid	32.3x Cupid	64.5x Cupid	161x Cupid	323x Cupid
0.0431 Belinda	>1e6	>1e6	>1e6	>1e6	>1e6	>1e6
0.431x Belinda	>1e6	>1e6	>1e6	>1e6	>1e6	>1e6
4.31x Belinda	>1e6	>1e6	>1e6	>1e6	>1e6	>1e6
8.61x Belinda	>1e6	>1e6	>1e6	>1e6	151,500	~69,000
21.6x Belinda	9,384	129,296	46,083	19,546	9,500	>1e6
43.1x Belinda	5.3	2.8	1.6	3.8	17.2	0.8



Significance

- Timescales extremely short
- Statistically unlikely to be in this timeframe
- Possible explanation:

  Continual collisions and re-accretion