

Objekti u blizini Zemlje: nastanak, evolucija, značaj



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Comet C/2011 L4 (Pan-STARRS) 2013, March 16.8
Stacking of 4x10second exposures at Iso 800
Canon Eos50D + Orion 80 Ed
From Mount Faito (Naples - Italy)
Antonio Catapano & Ernesto Guido



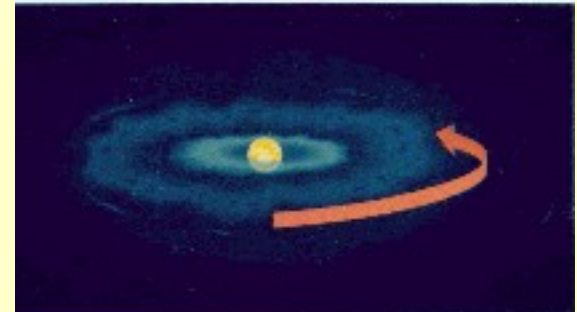
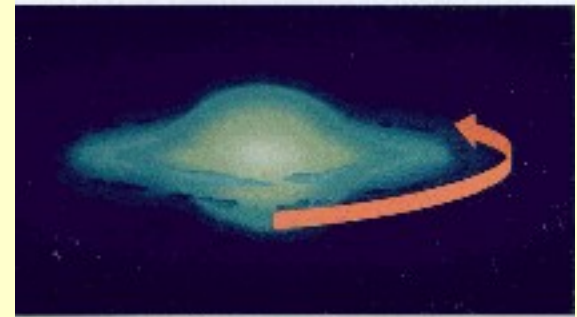
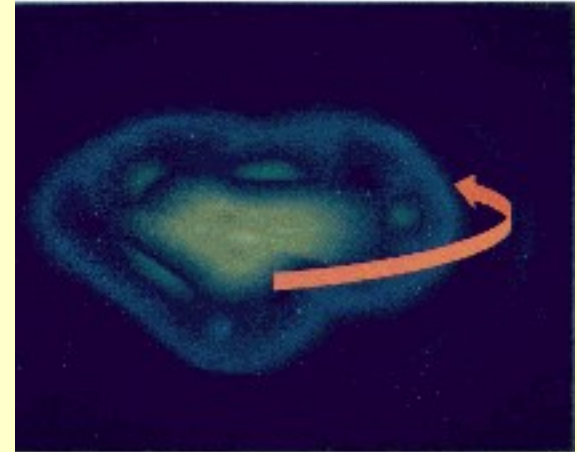
Аннотация Марат

O čemu će biti reči

- Formiranje Sunčevog sistema
- Asteroidi i komete: ostaci tog formiranja
 - Gde se sve nalaze asteroidi i komete
 - Objekti bliski Zemlji (OBZ)
 - Dinamička evolucija OBZ
 - Izvori OBZ-a
 - Značaj OBZ-a

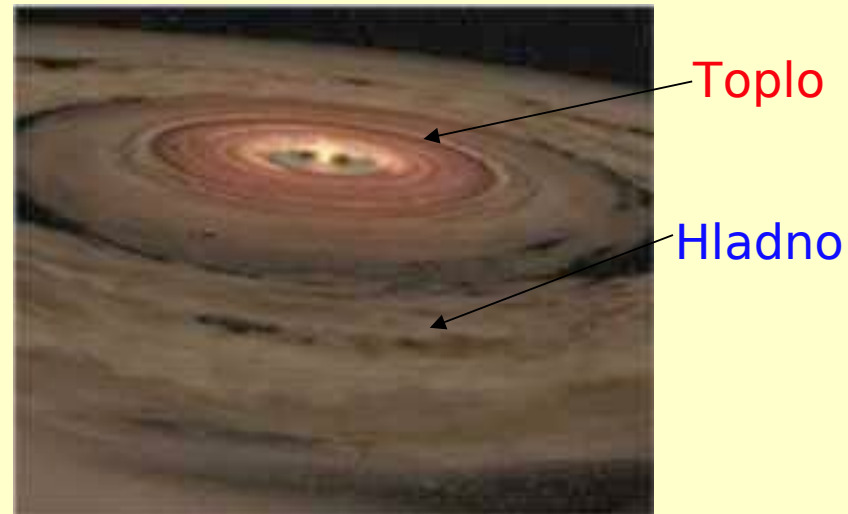
Kako je (možda) nastao Sunčev sistem

- Gravitacioni kolaps dovodi do sažimanja međuzvezdanog oblaka
- Oblak se transformiše u disk
- U centru se formira proto-Sunce
- Od ostatka materijala iz diska formiraju se planetezimali čijim spajanjem (akrecijom) nastaju planete

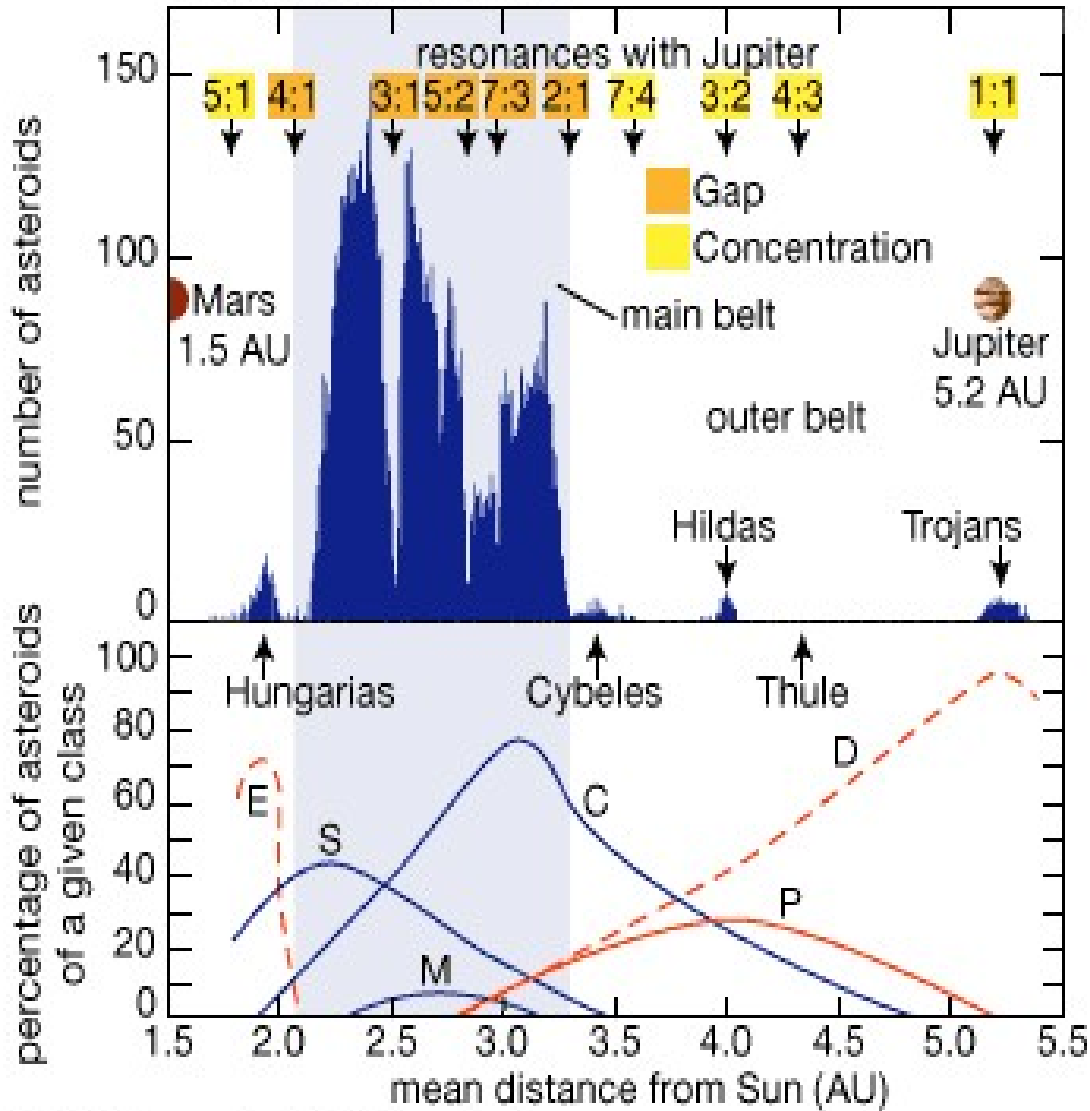


Asteroidi + komete = preostali planetezimali

- U unutrašnjoj oblasti Sunčevog sistema (jer je bila toplija) planetezimali su formirani od minerala i metala
- U spoljašnjoj oblasti, gde je temperatura manja, planetezimali sadrže i vodu
- Asteroidi i komete su planetezimali preostali iz procesa formiranja planeta



Asteroid distribution



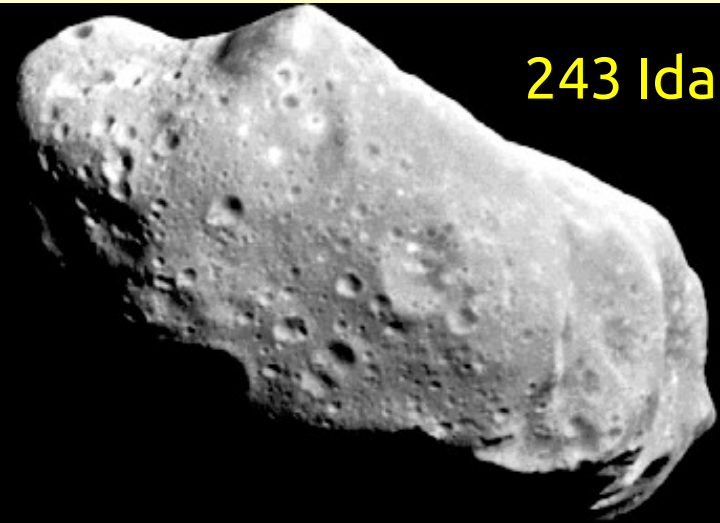
E-tip: dominantan u populaciji Hungarija asteroida

S-tip: dominantan u unutrašnjem delu GAP-na

C-tip: dominantan u središnjem i spoljašnjem delu GAP-na

D-tip: dominantan među Jupiterovim trojancima i Hilda grupi

Oblik asteroida



243 Ida



25143
Itokawa

Dactul

Asteroidi mogu biti različitih, uglavnom **nepravilnih** oblika!

To je posledica njihovih čestih međusobnih sudara!



21 Lutetia

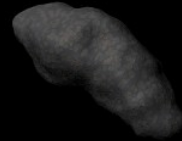
433 Eros



216 Kleopatra



1620 Geographos



6489 Golevka



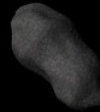
1998 Ky26



4179 Toutatis



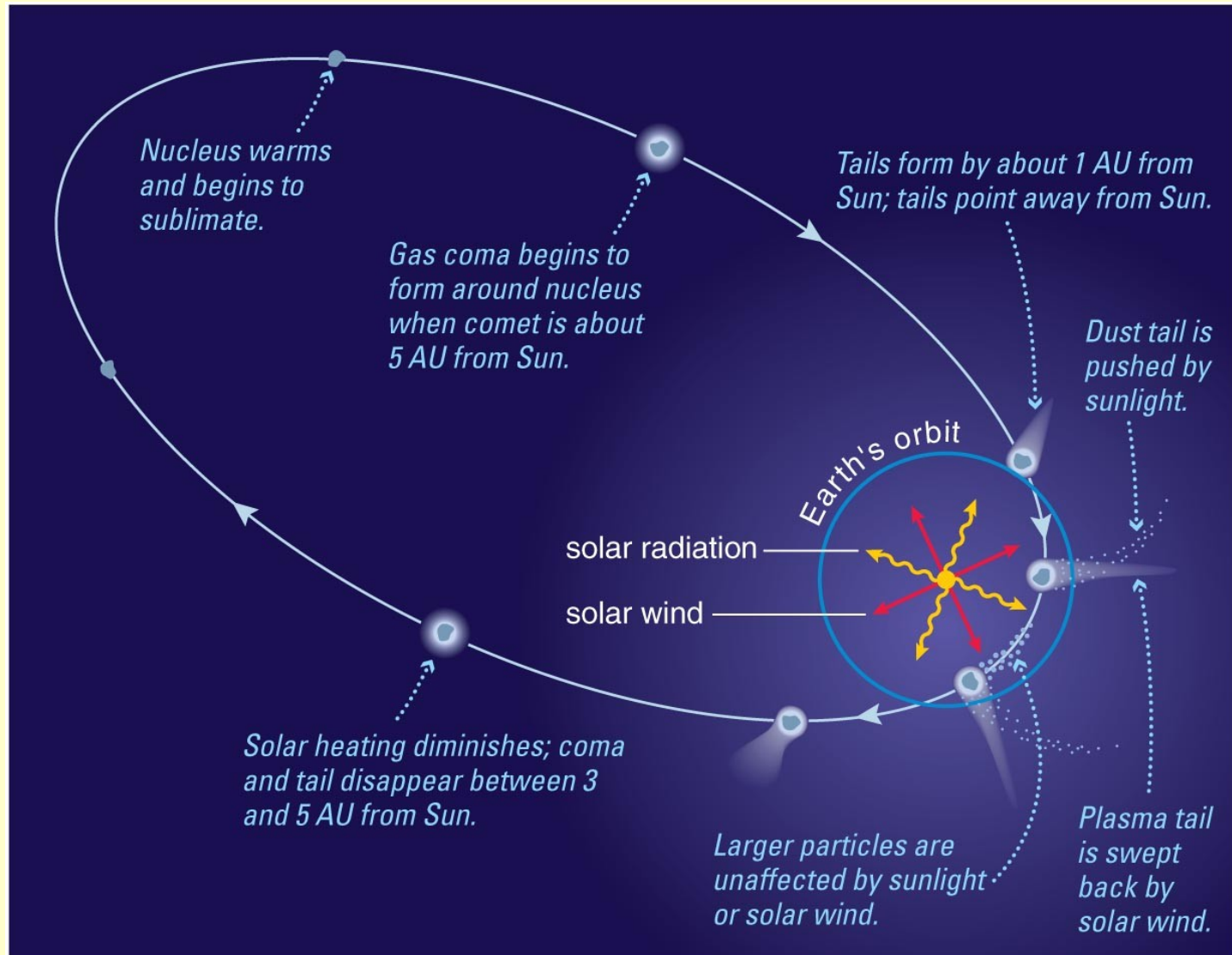
2063 Bacchus



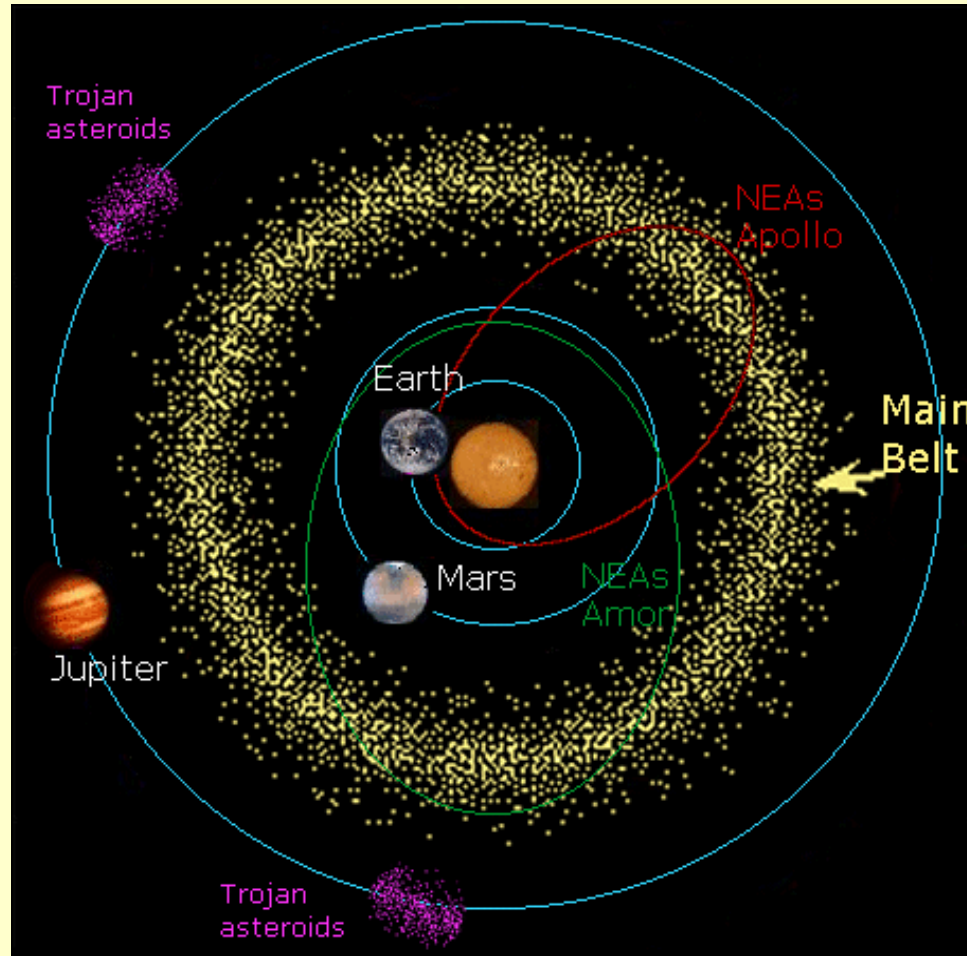
4769 Castalia



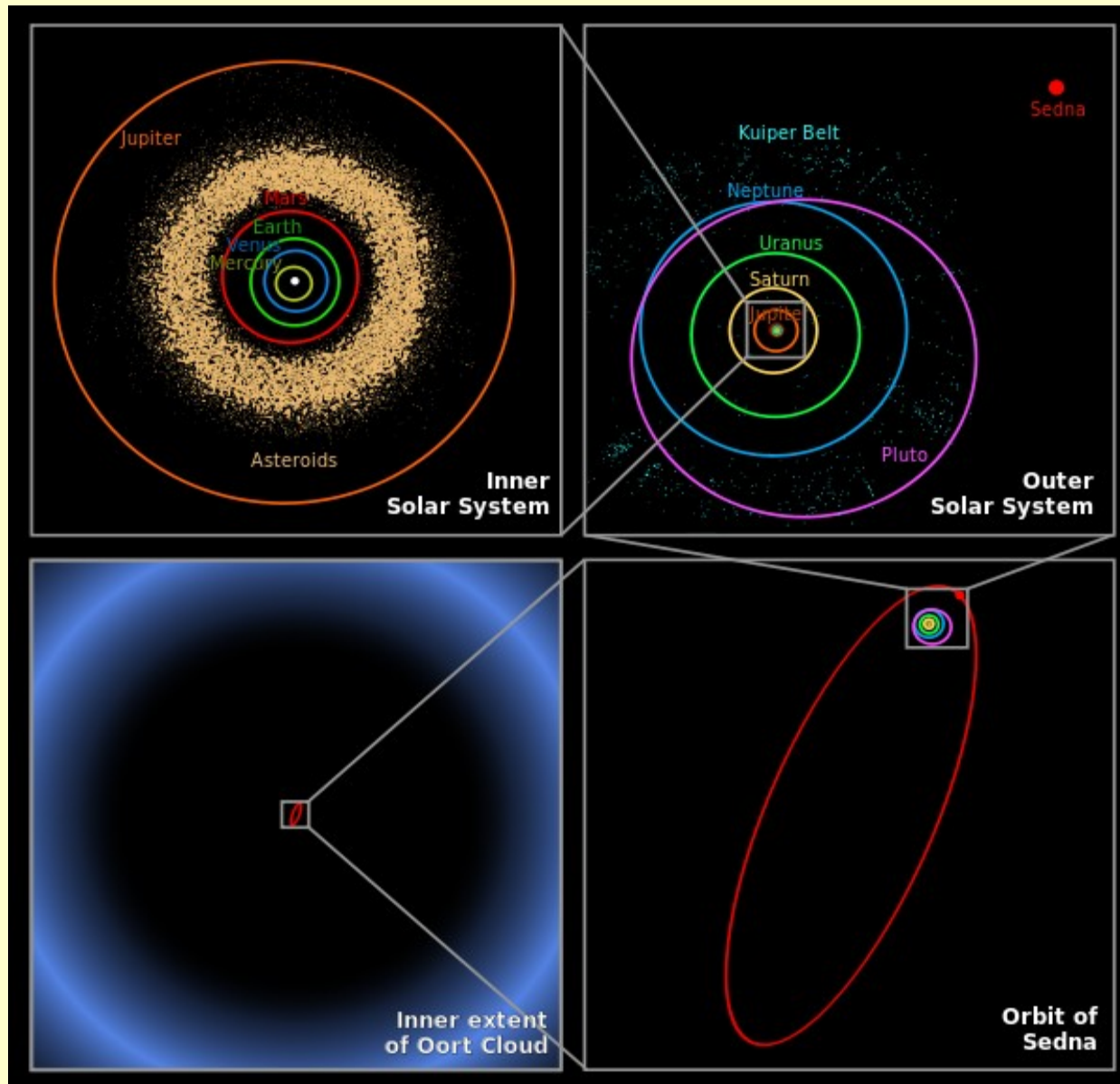
Komete: aktivnost, tj. pojava glave i repa



Gde sve možemo naći asteroide?



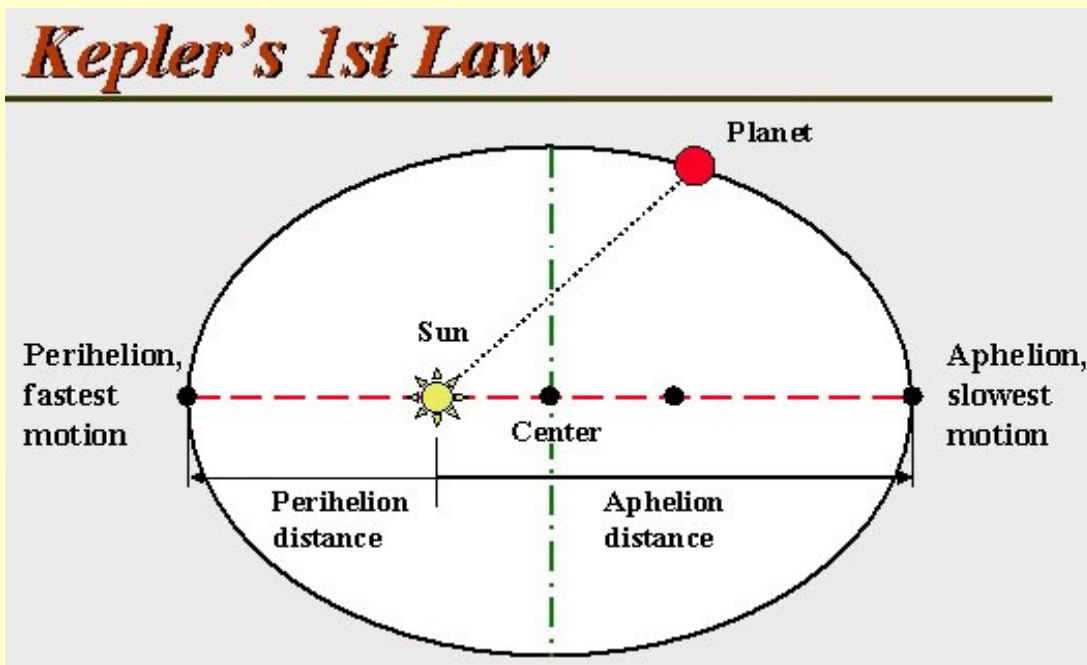
Mala tela u Sunčevom sistemu





1. Keplerov zakon

Planete se kreću oko Sunca po eliptičnim putanjama u čijoj zajedničkoj žiži se nalazi Sunce.



$$r = \frac{a(1-e^2)}{(1+e \cos \theta)}$$

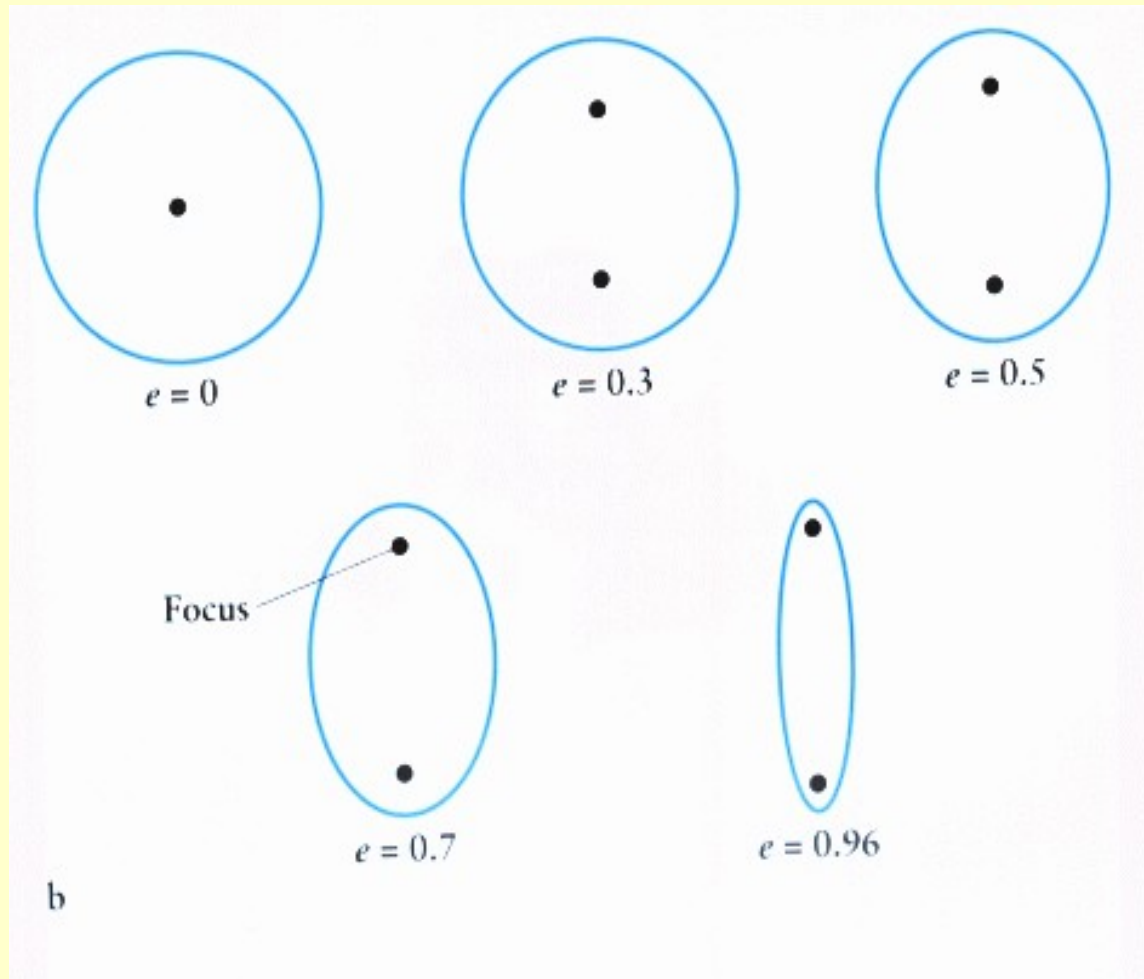
$$\text{for } 0 \leq e < 1$$

$$\text{Perihel: } q = a(1-e)$$

$$\text{Afel: } Q = a(1+e)$$

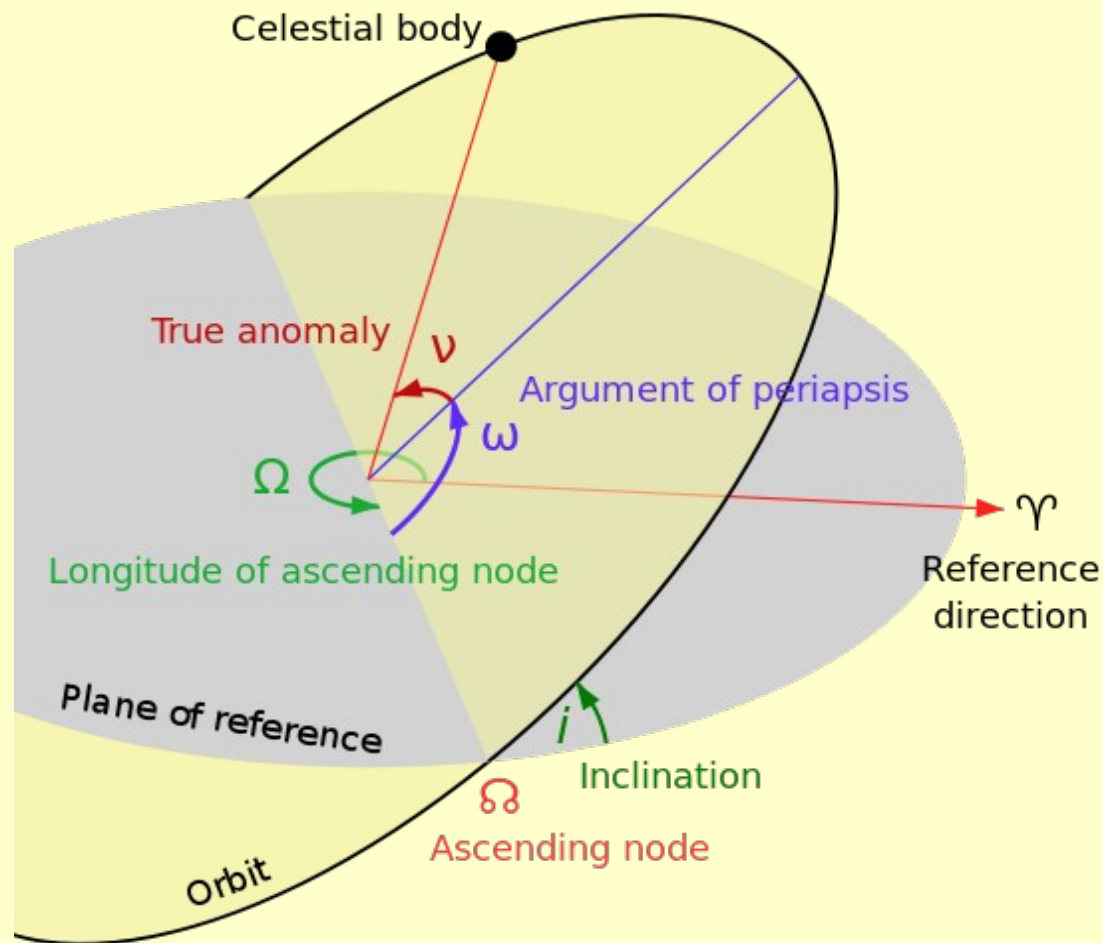
Neke karakteristike elipse

Ekscentričnost (e): $0 \leq e < 1$



Eliptički orbitalni elementi

$(a, e, i, \Omega, \omega, M)$

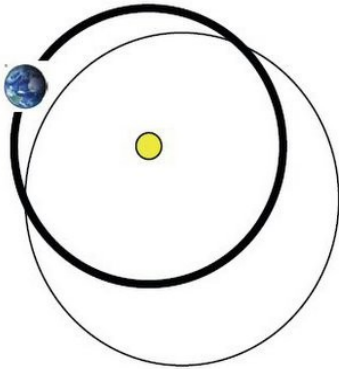


Srednja anomalija: $M = n(t - t_0)$

Asteroidi u blizini Zemlje

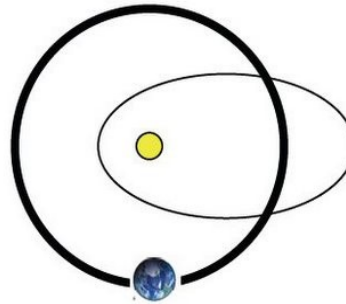
Apollo

Semimajor Axis ≥ 1.0 AU
Perihelion ≤ 1.02 AU
Earth Crossing



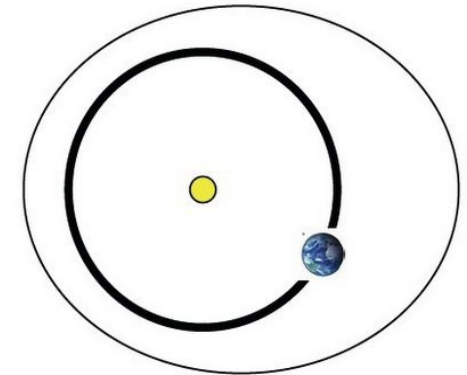
Aten

Semimajor Axis < 1.0 AU
Aphelion ≤ 1.0167 AU
Earth Crossing



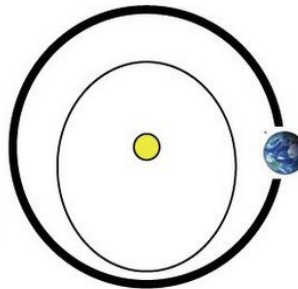
Amor

1.02 AU $<$ Perihelion ≤ 1.3 AU



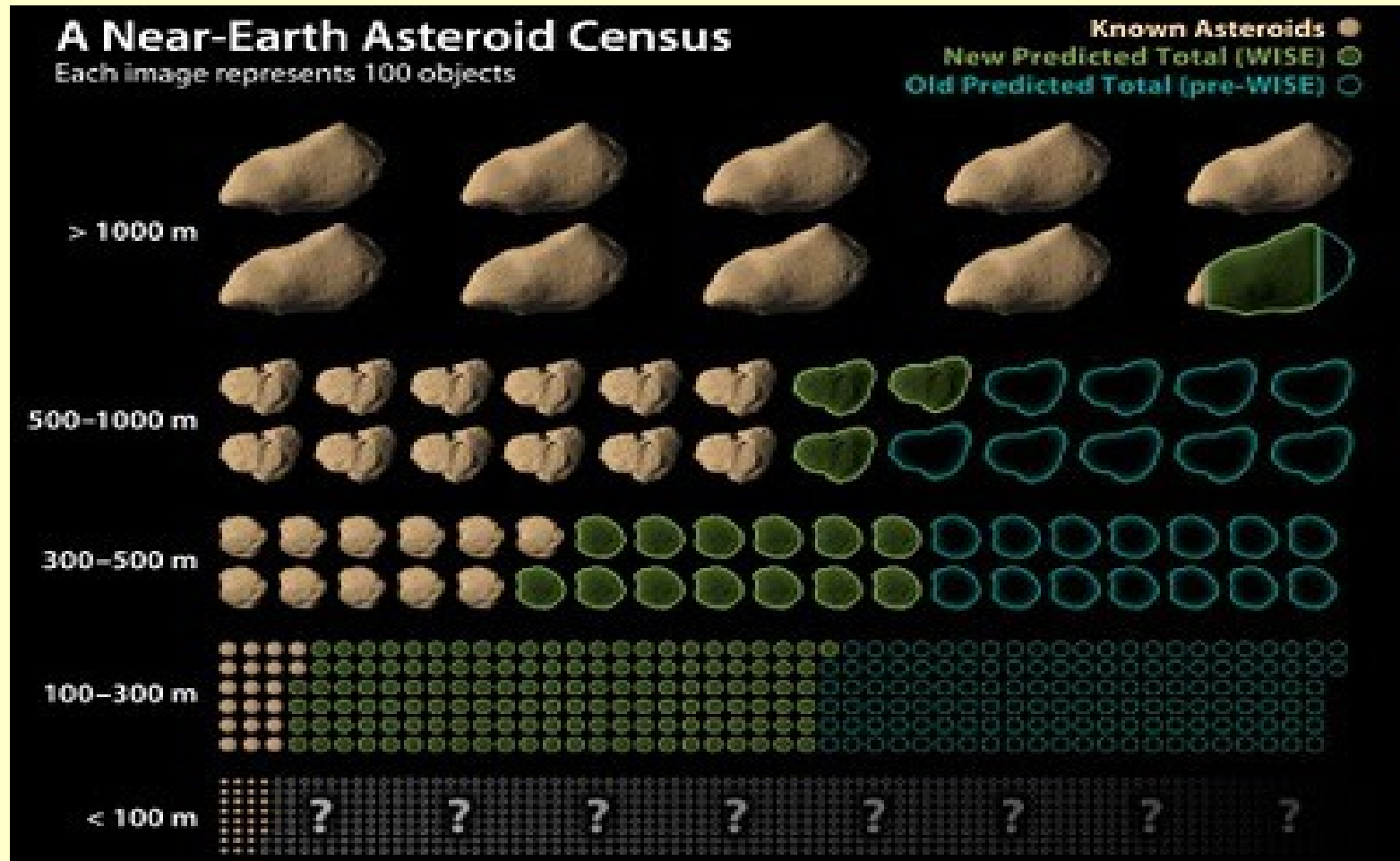
Inner Earth Objects (IEOs)

Aphelion < 0.983 AU
Always inside Earth's orbit
(aka Apohele)

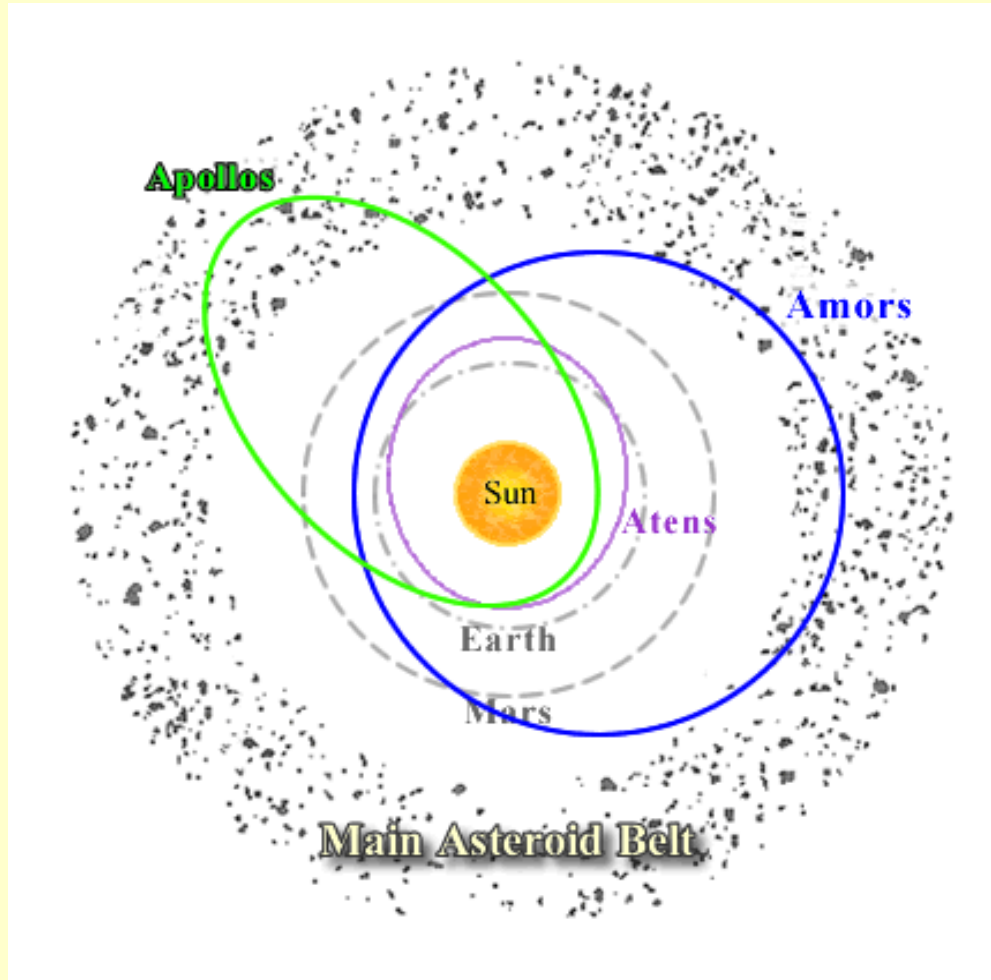


Type	Near-Earth Population
Apollo	62% of known asteroids
Aten	6% of known asteroids
Amor	32% of known asteroids
IEO	6 known asteroids

Asteroidi u blizini Zemlje: koliko ih (trenutno) ima?



Asteroidi u blizini Zemlje: dinamička (ne)stabilnost



Životni vek (dinamički) 10-20 miliona godina !!!

Asteroidi u blizini Zemlje: uzroci dinamičke nestabilnost

- Uzroci nestabilnosti kretanja:
 - Rezonance
 - Bliski prilazi sa planetama
 - Negravitacioni efekti (Efekat Jarkovskog)

Asteroidi u blizini Zemlje: uzroci dinamičke nestabilnost

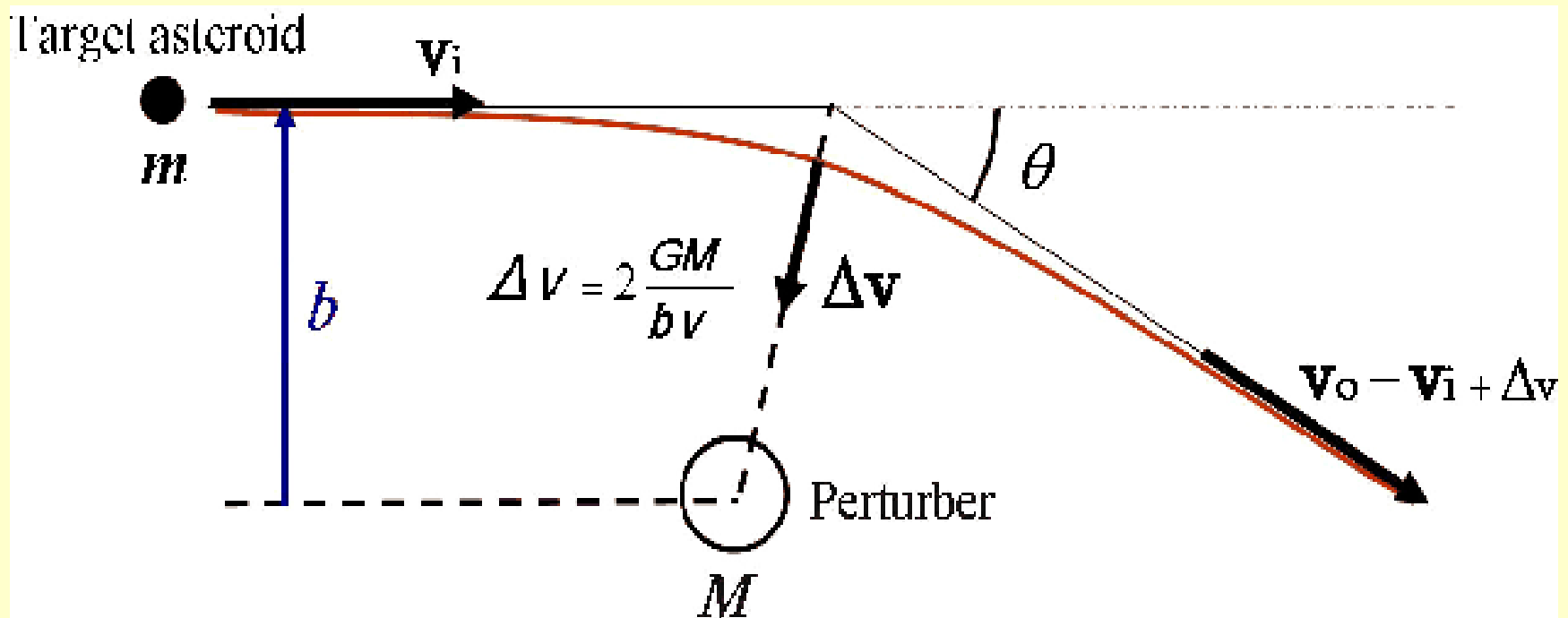
Rezonance:

- Rezonance u srednjem kretanju
- Sekularne rezonance
- Spin-orbit rezonance



Asteroidi u blizini Zemlje: uzroci dinamičke nestabilnost

Bliski prilazi sa planetama ili masivnijim asteroidima:



Asteroidi u blizini Zemlje: uzroci dinamičke nestabilnost

Ovaj efekat dovodi do konstantne promene velike poluose orbite asteroida

Dve tipa:

Dnevni – usled obrtanja oko svoje ose

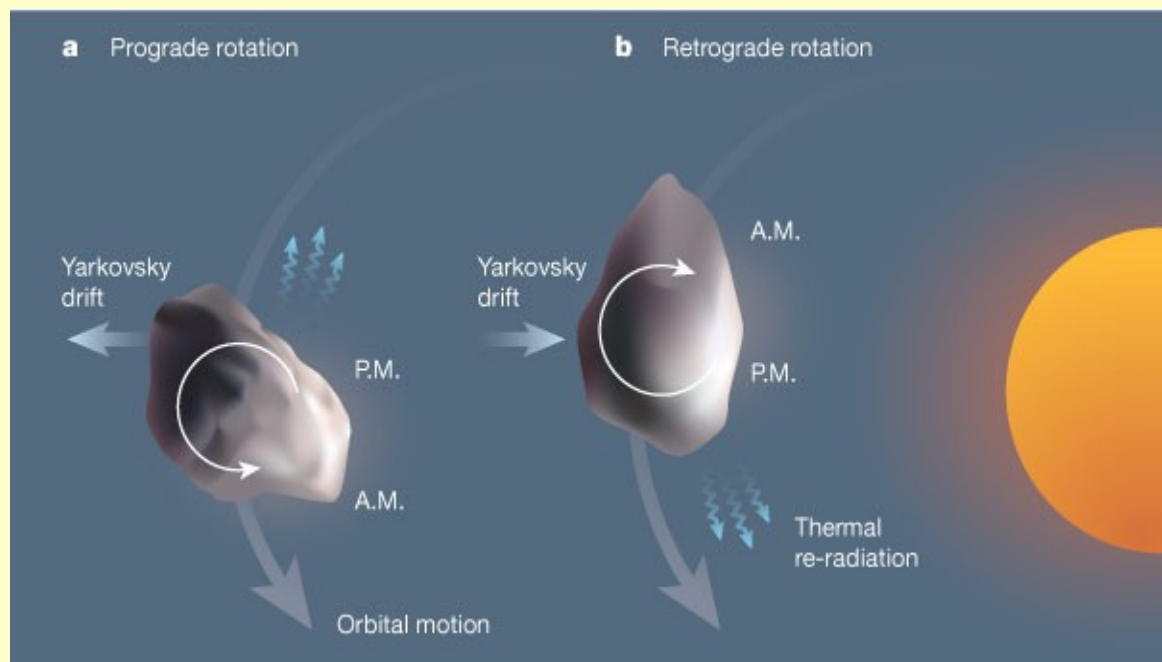
Sezonski – usled kretanja oko Sunca

Dnevni efekat:

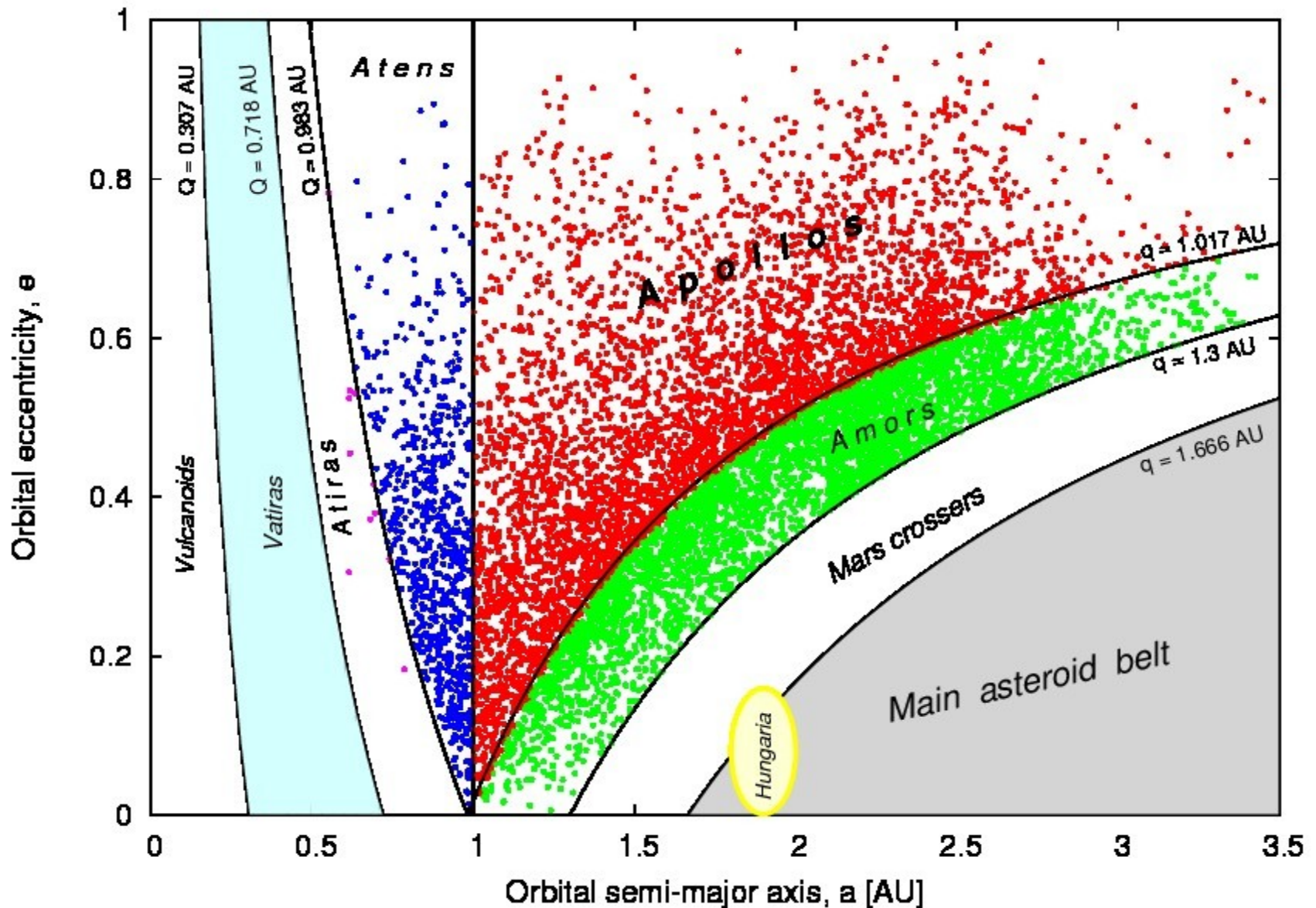
rotacija u direktnom smeru ==> **povećava** veliku poluosu

rotacija u retrogradnom smeru ==> **smanjuje** veliku poluosu

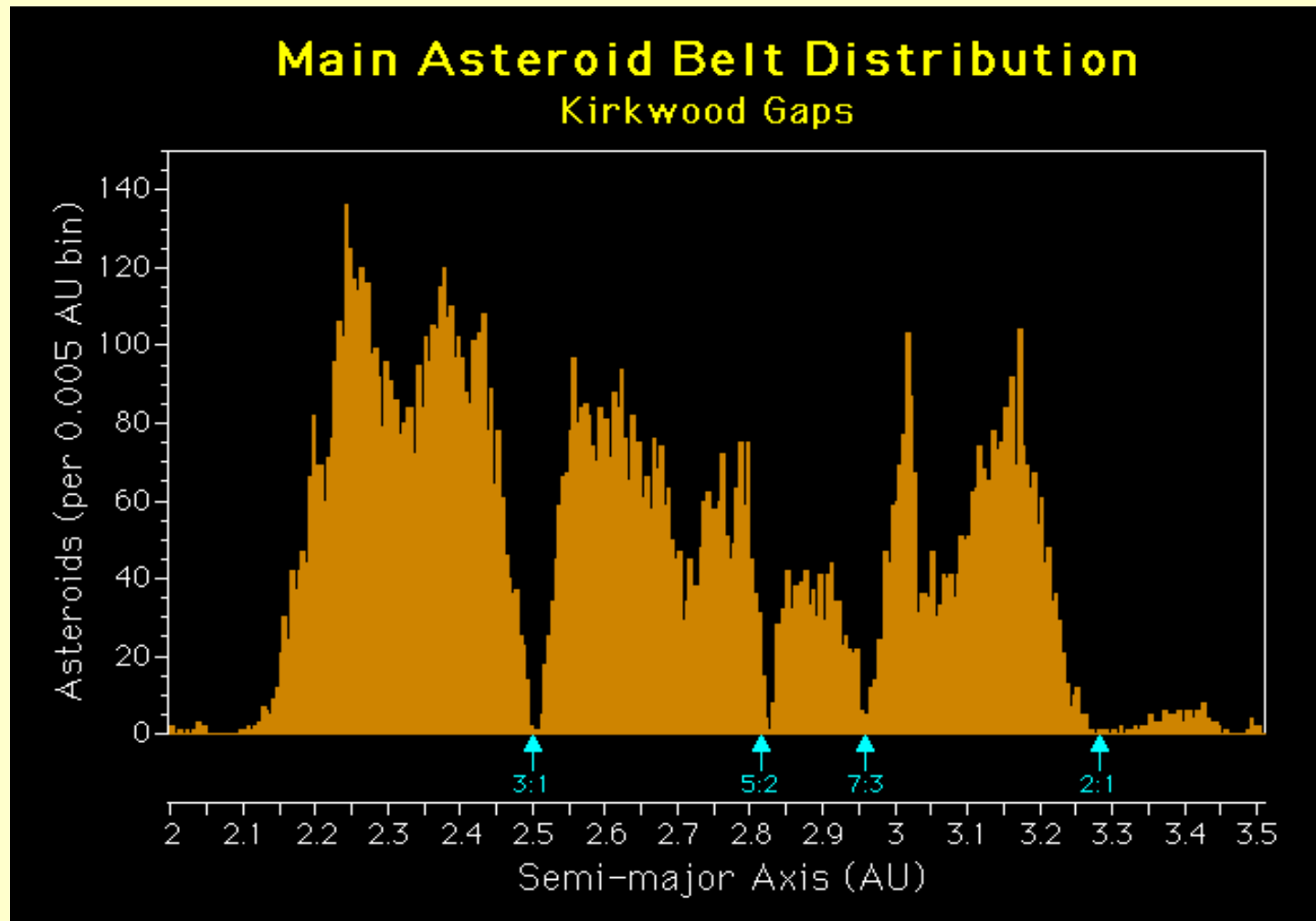
Efekat Jarkovskog



Asteroidi u blizini Zemlje: uzroci dinamičke nestabilnosti



Kirkvudove praznine



Značaj OBZ-a

- Mogućnost sudara sa Zemljom
 - Naučna istraživanja
 - Resursi

Sudari: gde, kada, koliko?

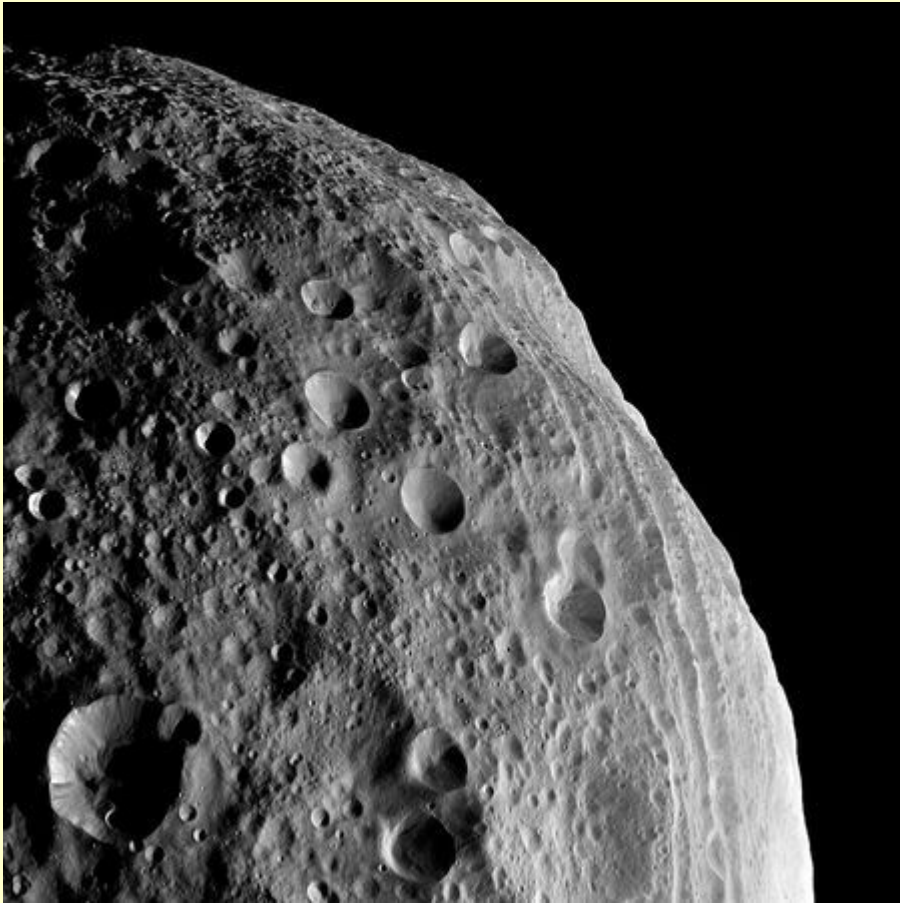
Mars



Mesec



Krateri na asteroidima

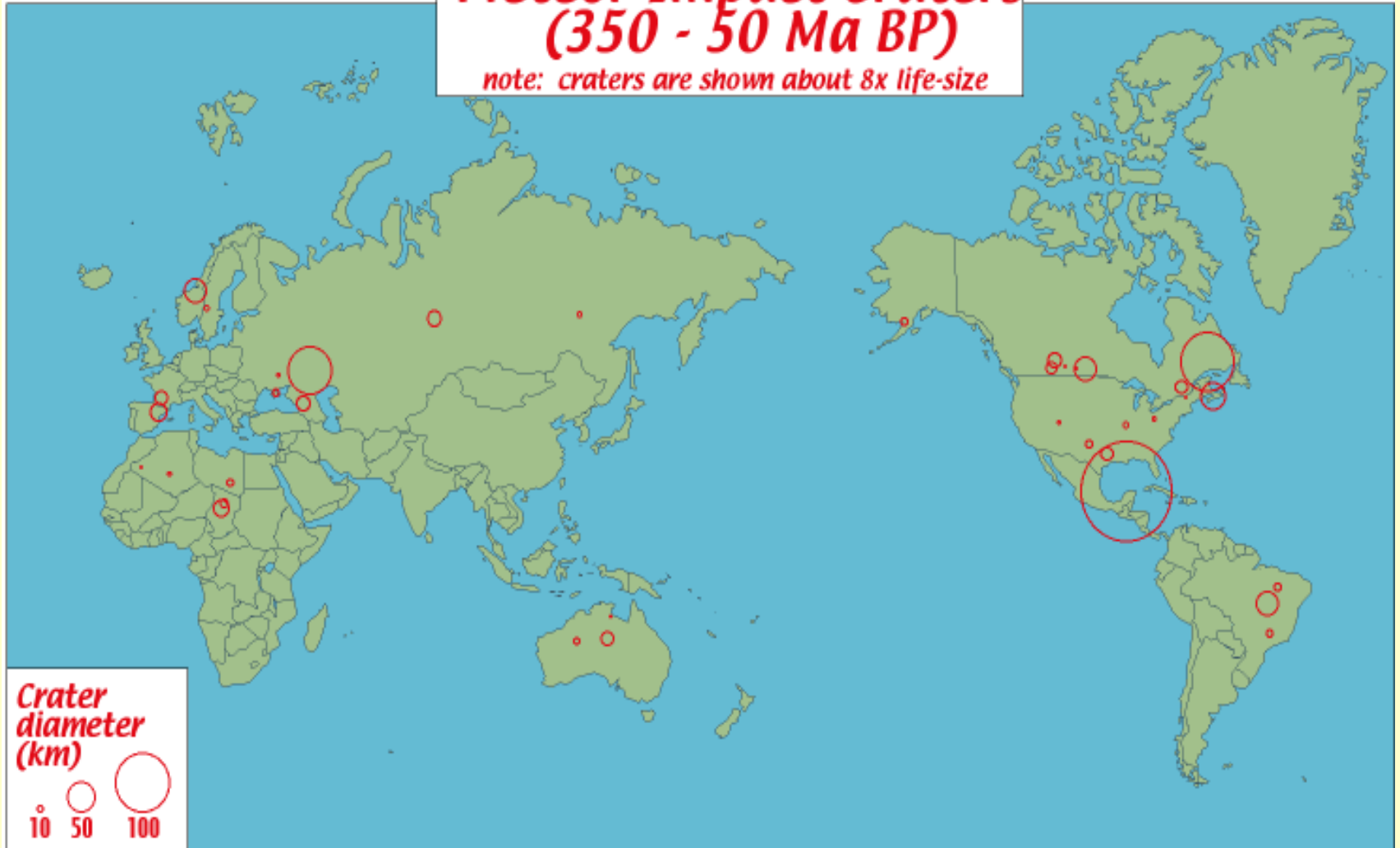


Vesta

Eros

Meteor Impact Craters (350 - 50 Ma BP)

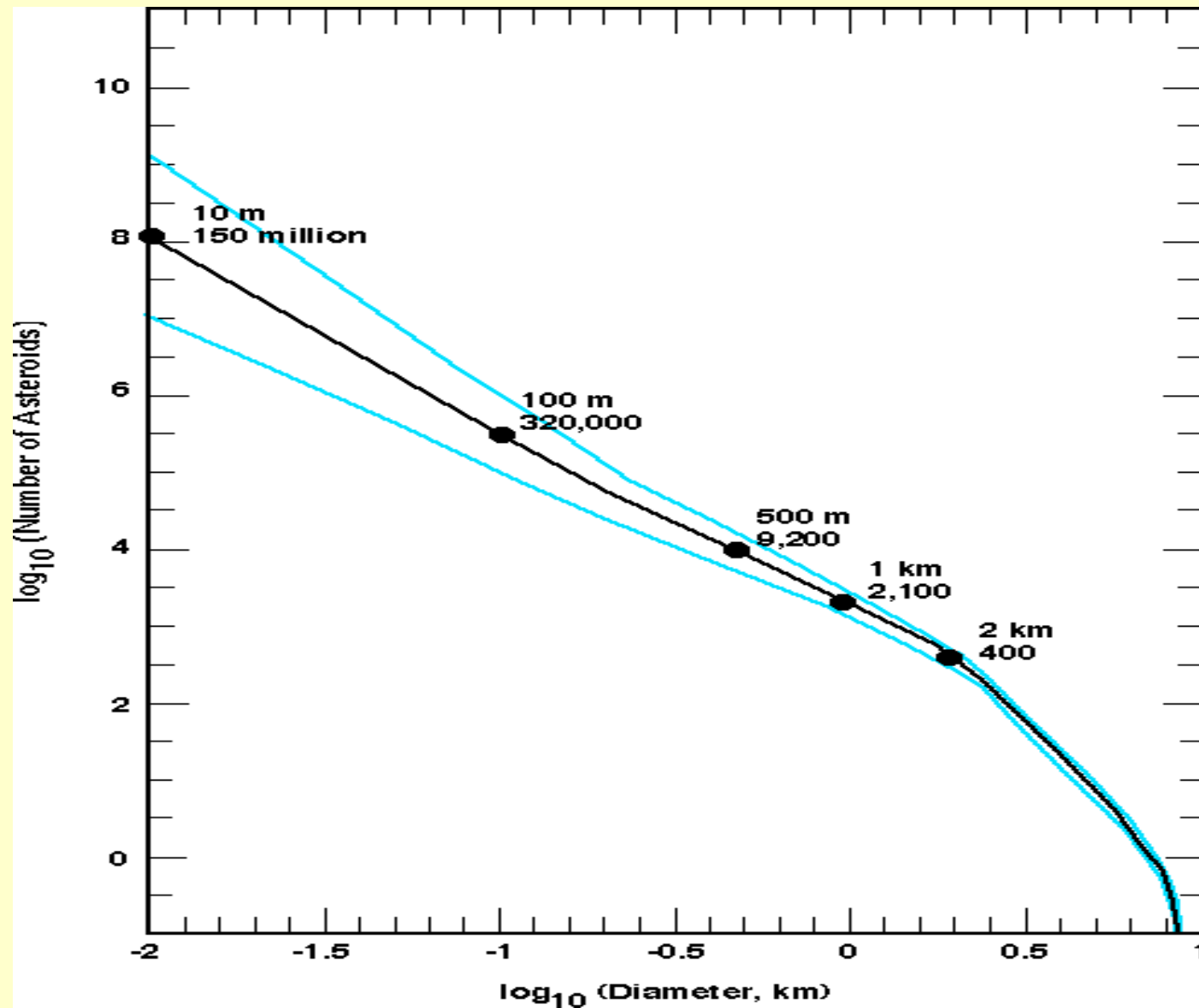
note: craters are shown about 8x life-size





Izumiranje dinosaurusu pre oko 65 miliona godina

Koliko su česti udari asteroida?



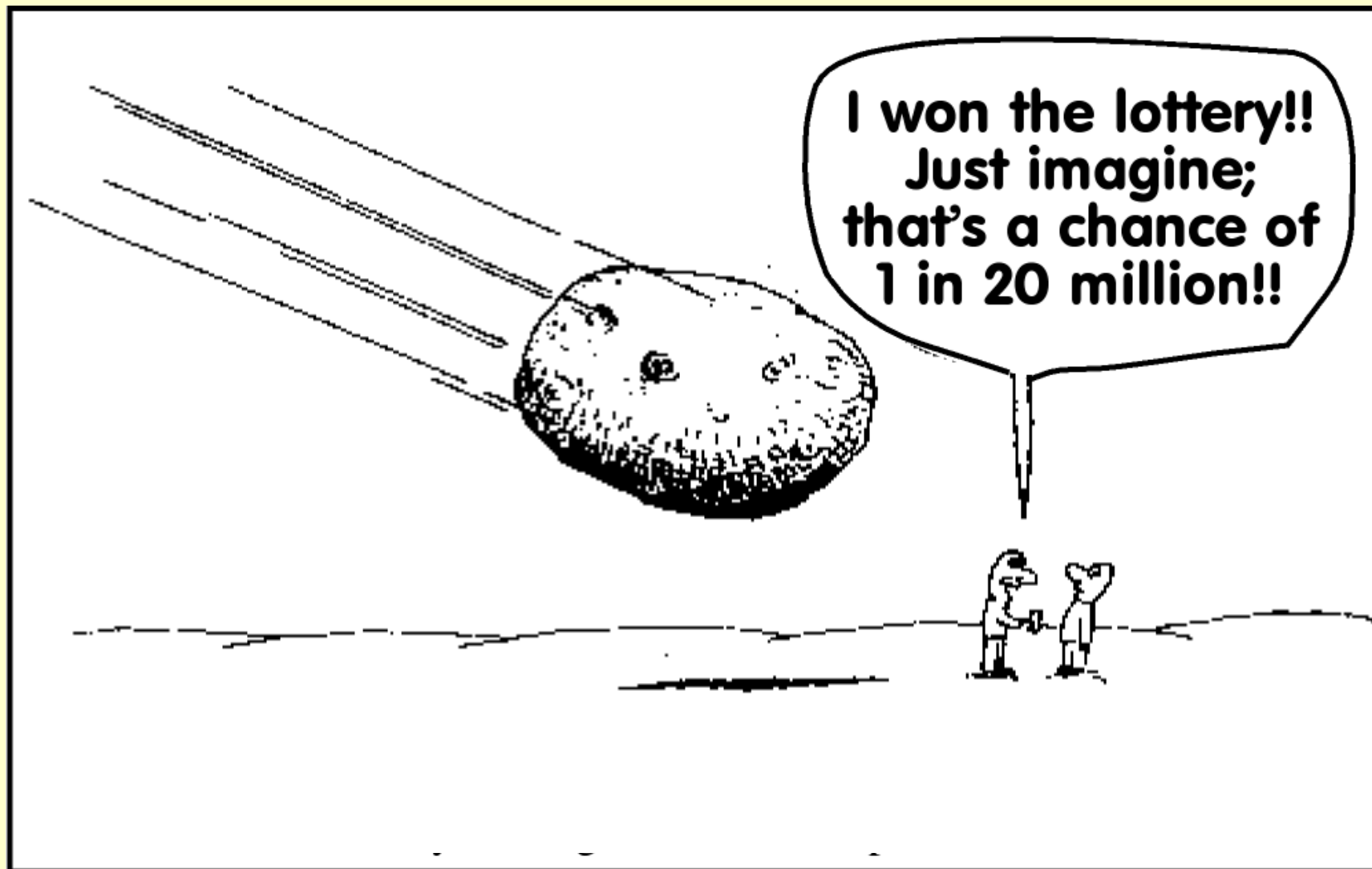
I malo poređenja...

Prosečan broj nastradalih u toku godine na milion stanovnika (verovatnoća)

300	Saobraćajni udesi
200	Ubistva i samoubistva
160	Udesi na motorima
10	Požari
5	Strujni udari
1	Avionske nesreće
0.5	UDAR ASTEROIDA (ukupno)
0.3	Vremenske neprilike
0.1	LOKALNI / REGIONALI UDAR
0.1	Zemljotresi
0.01	TUNGUSKA

Nama bliski asteroidi... budućnost?

- Sirovine 2040
 - Baze 2070
- Kolonizacija 2100



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ASTEROIDS

GAME OVER

PRESS ENTER to restart