TO HERE FROM ETERNITY

The story of the Bovedy, Crumlin and Leighlinbridge meteorites

Mike Simms, Ulster Museum

Friday 25th April 1969
9.25 p.m.

A fireball streaks
across the night sky

Friday 25th April 1969
9.25 p.m.

A fireball streaks
across the night sky


It takes less than a minute to cross the UK!
Bovedy
Sprucefield
fireball
photo


…and barely 15 seconds to cross Northern Ireland
Bovedy
Sprucefield
Portstewart
Portrush
Coleraine
Ballymoney
Limavady
Eglinton
Culmore
Londonderry / Derry
Strabane
Maghera
Ballymena
Larne
Magherafelt
Randalstown
Ballyclare
Whitehead
Antrim
Carrickfergus
Newtownabbey
Greenisland
Bangor
Donaghadee
Holywood
Belfast
Newtownards
Castlereagh
Comber
Carryduff
Lisburn
Moira
Hillsborough
Craigavon
Portadown
Banbridge
Armagh
Downpatrick
Cookstown
Omagh
Coalisland
Dromore
Dungannon
Monaghan
Newry
Warrenpoint
Kilkeel

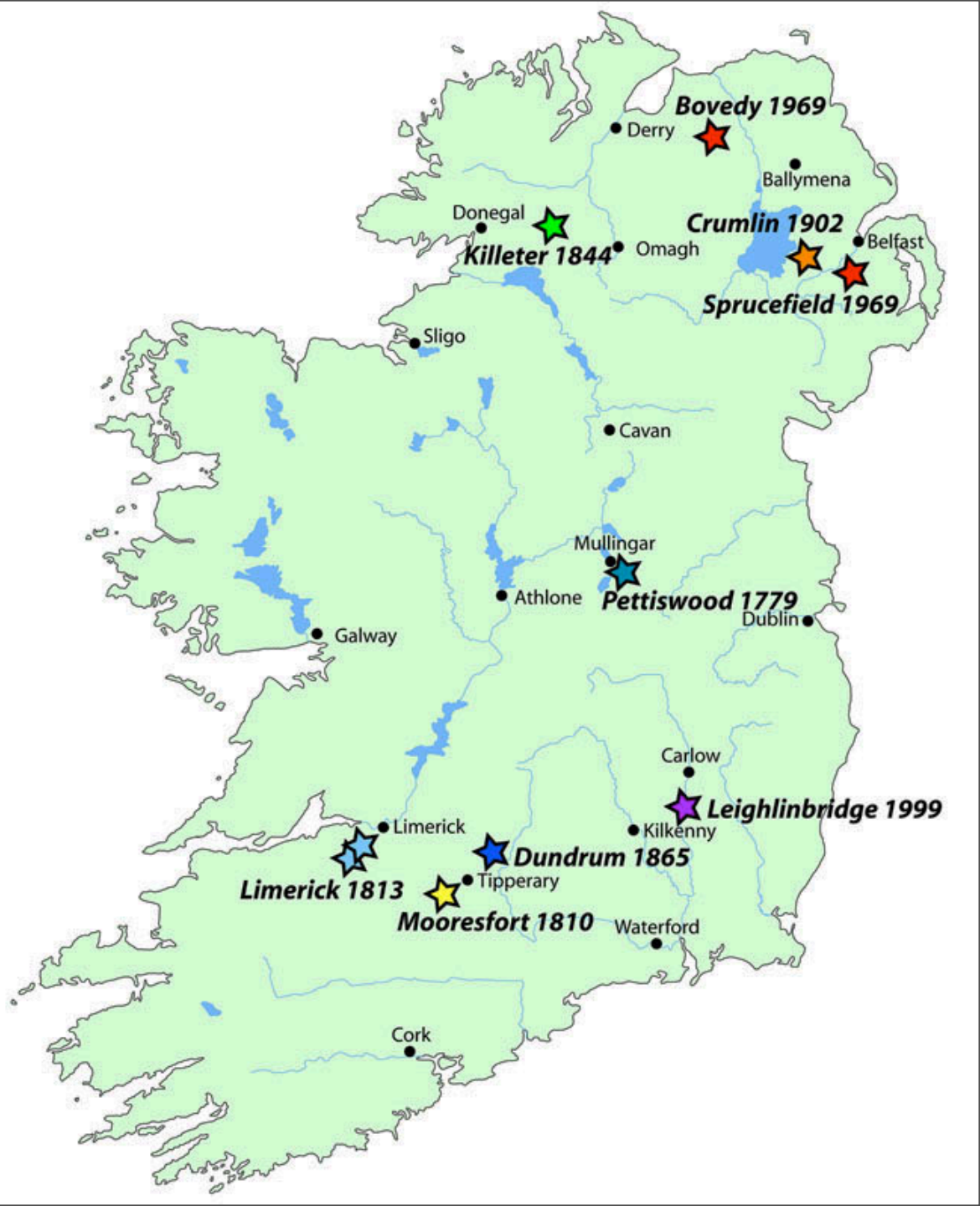
A small rock smashes a roof near Lisburn

A bigger one lands in a field near Garvagh.

These are meteorites - the first found in Ireland since 1902, and the last for another 30 years.

Where else have they fallen in Ireland?

Only 8 meteorite falls in 230 years!



The Bovedy, Crumlin and Leighlinbridge meteorites

all fell in the 20th Century

all are

Type L Ordinary Chondrites

(these are slices)

Types of meteorites and their abundance (%)

Stony Meteorites	**Falls**	**Finds**
Ordinary Chondrites	*76.9%*	*50.9%*
Carbonaceous Chondrites	3.7%	
Other chondrite types	1.7%	
Achondrites	7.7%	
Ungrouped	4.3%	
Irons	4.2%	20.8%
Stony-irons	1.3%	

…which is why they are called *Ordinary* Chondrites.

Types of Ordinary Chondrite

(each comes from its own parent planet)

Type H (**H**igh in iron)

Mooresfort	*1810*
Limerick	*1813*
Killeter	*1844*
Dundrum	*1865*

Crumlin	*1902*
Bovedy	*1969*
Leighlinbridge	*1999*

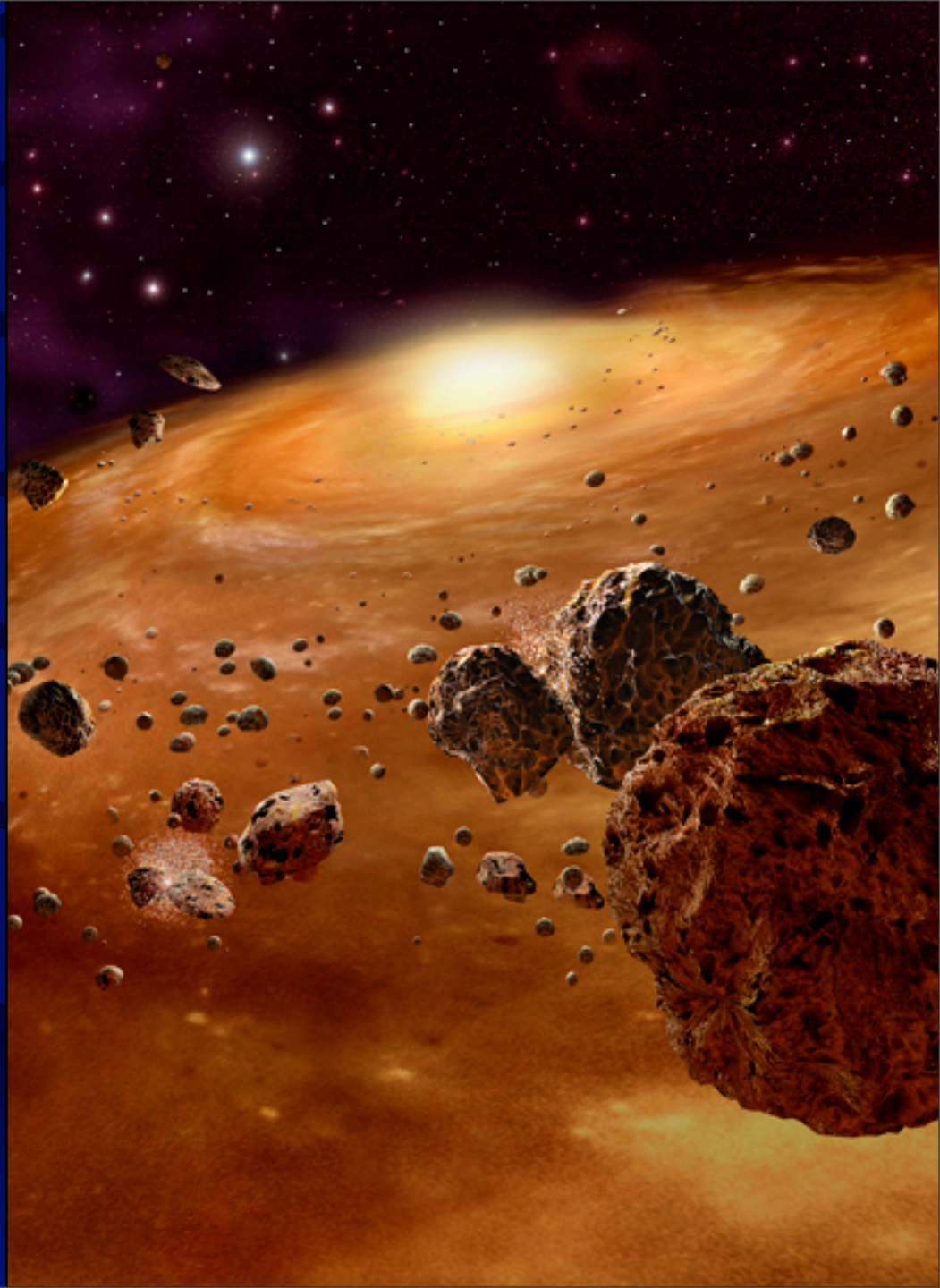
Type L (**L**ow in iron)

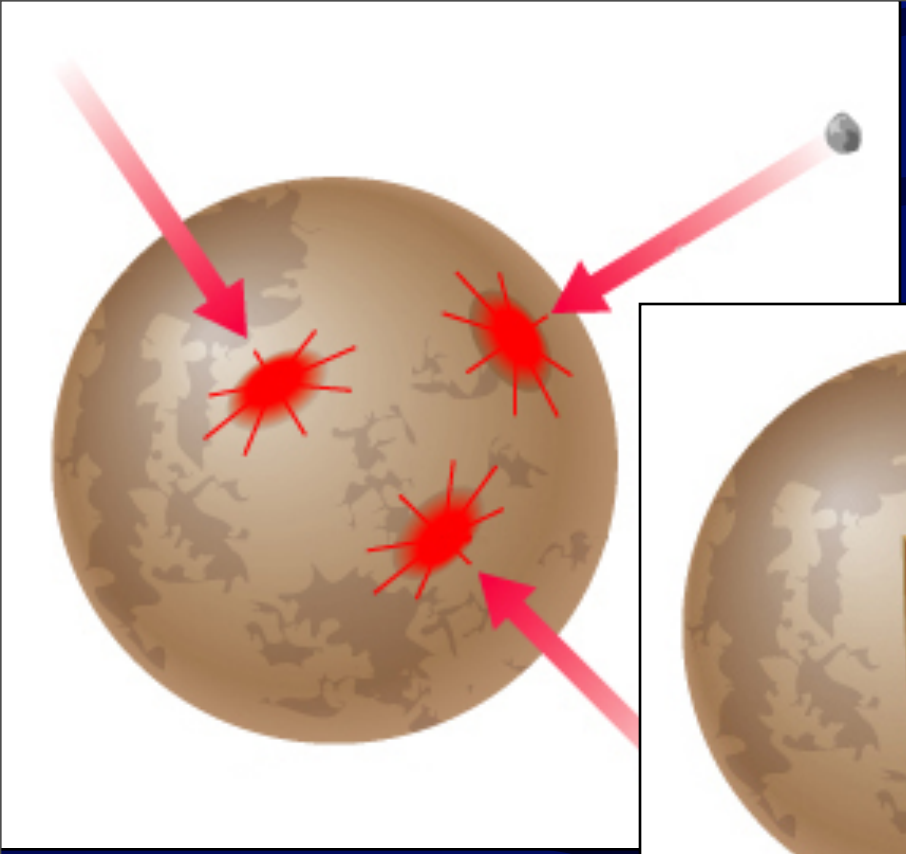
In the beginning, >4568 million years ago…

Star formation triggered by a supernova

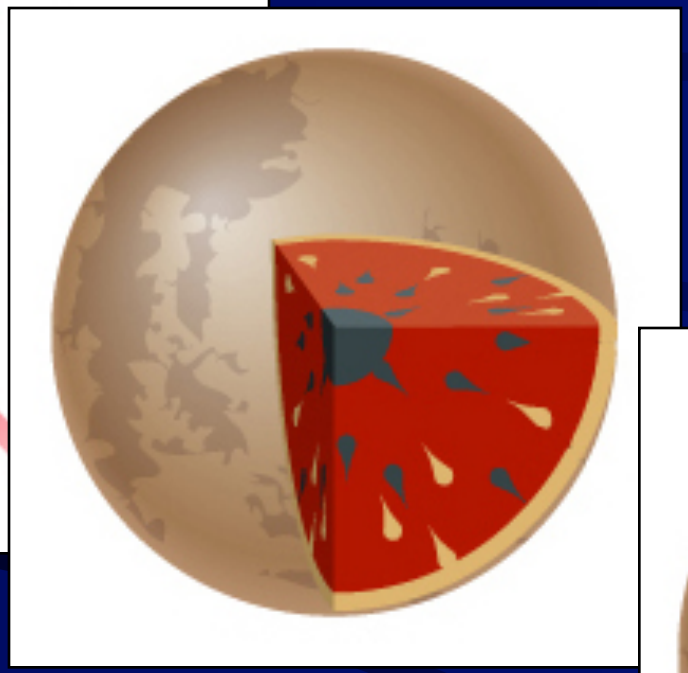
The Sun forms.

Planets accrete and melt.

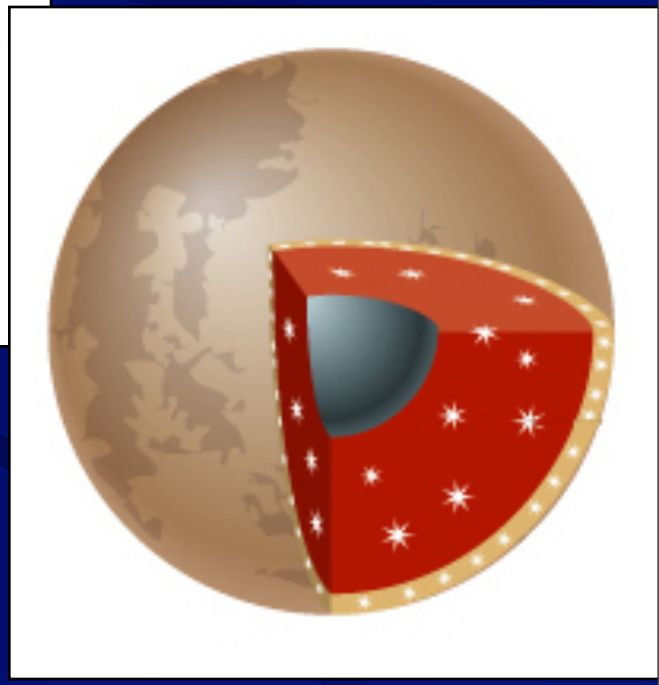




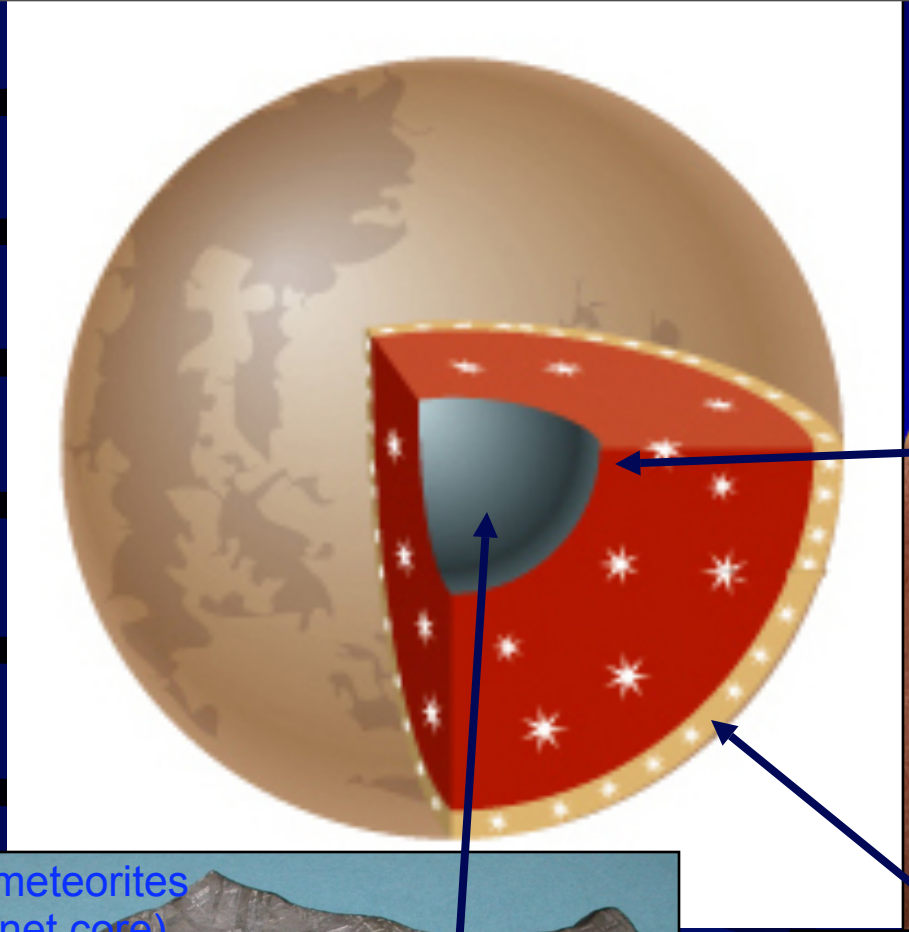
Planetismal accretion



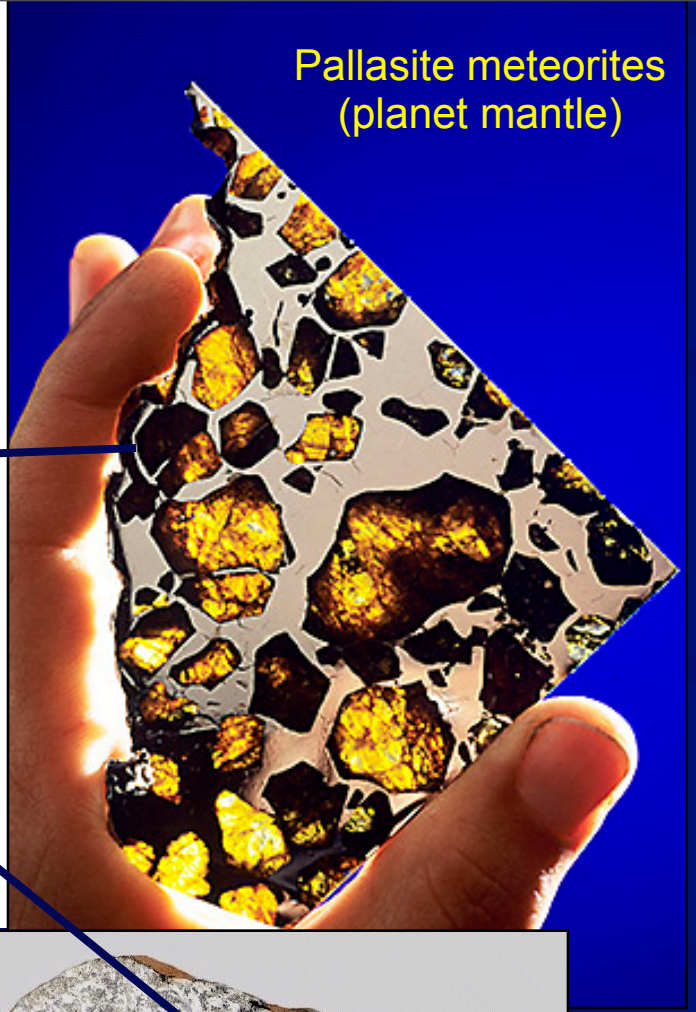
Melting
(due to Al_{26} and Fe_{60})



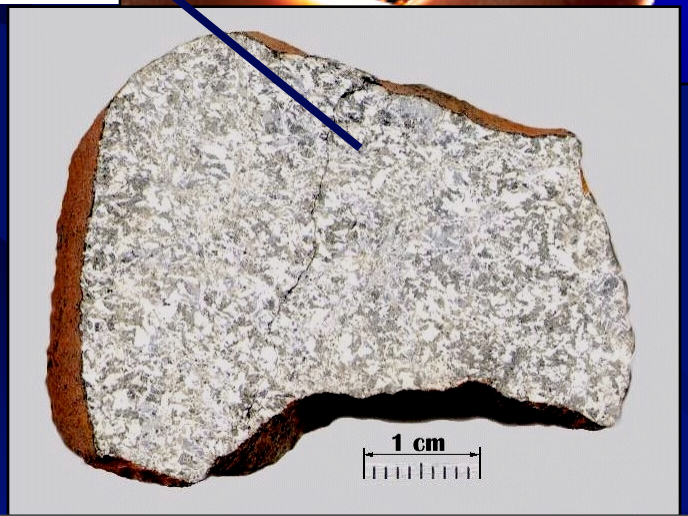
Differentiation



Pallasite meteorites
(planet mantle)



Iron meteorites
(planet core)

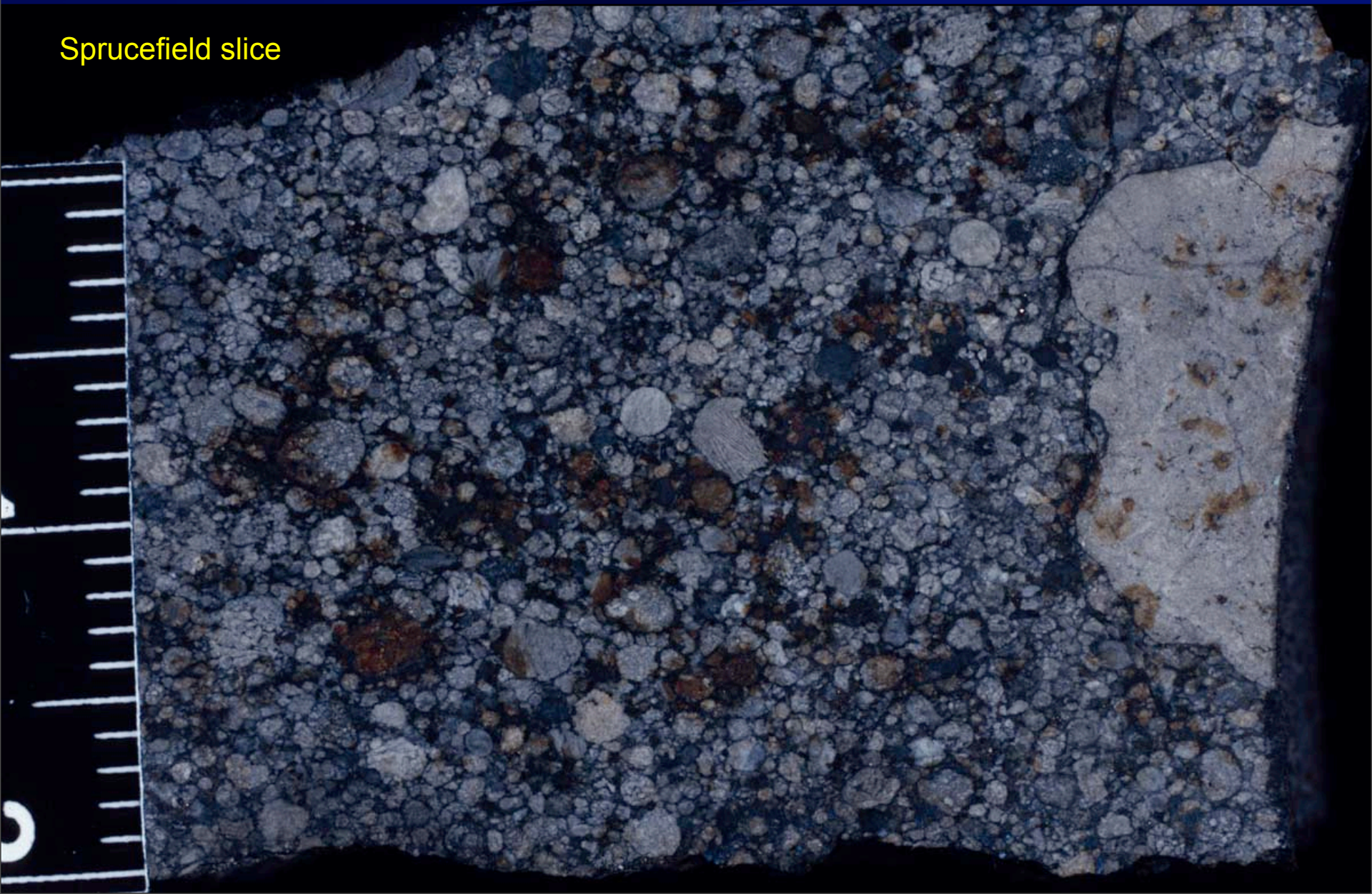


Achondrite
meteorites
(planet crust)

But none of these are chondrite meteorites…

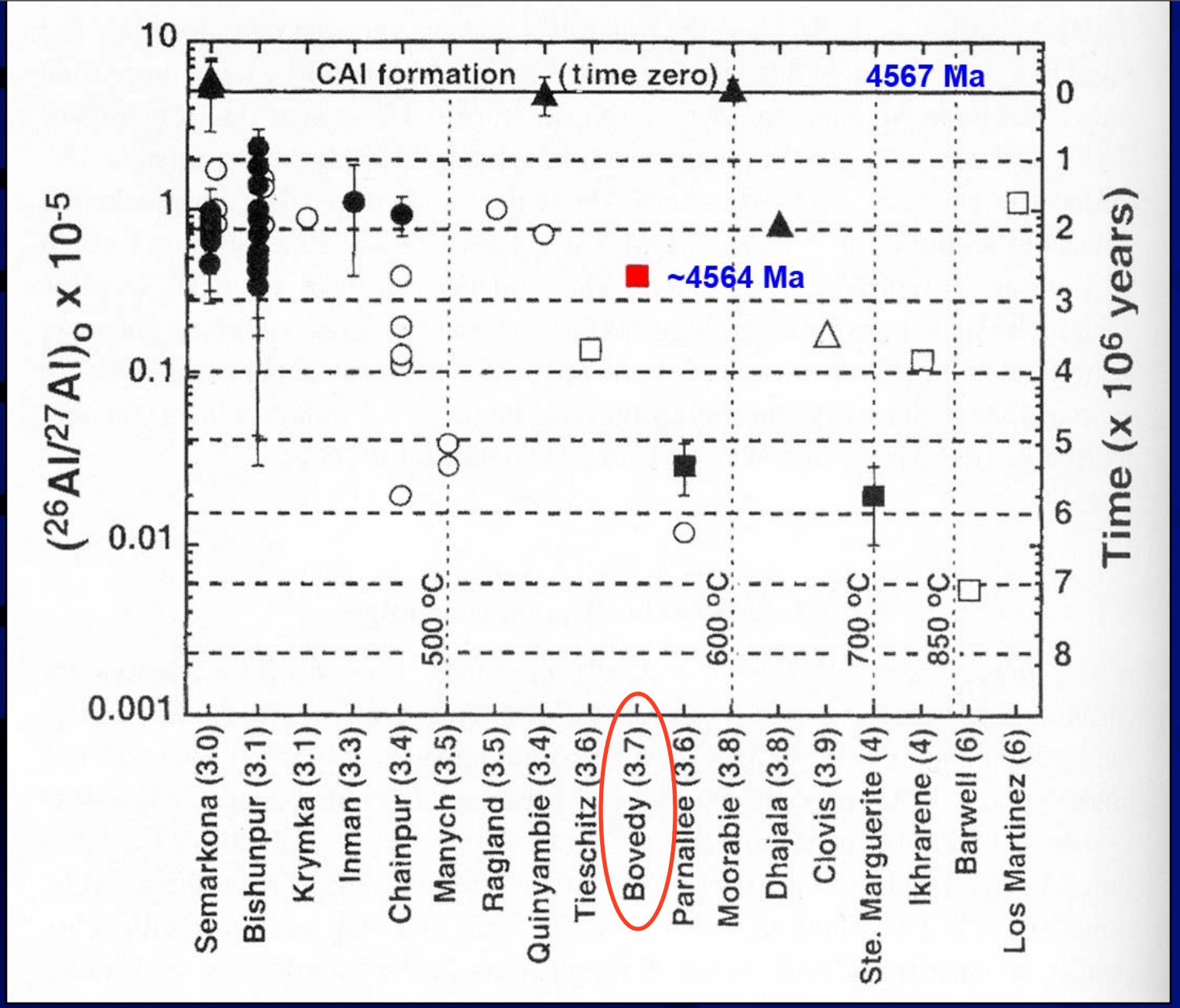
Achondrite meteorites (planet crust)

How and when did the chondrules form?



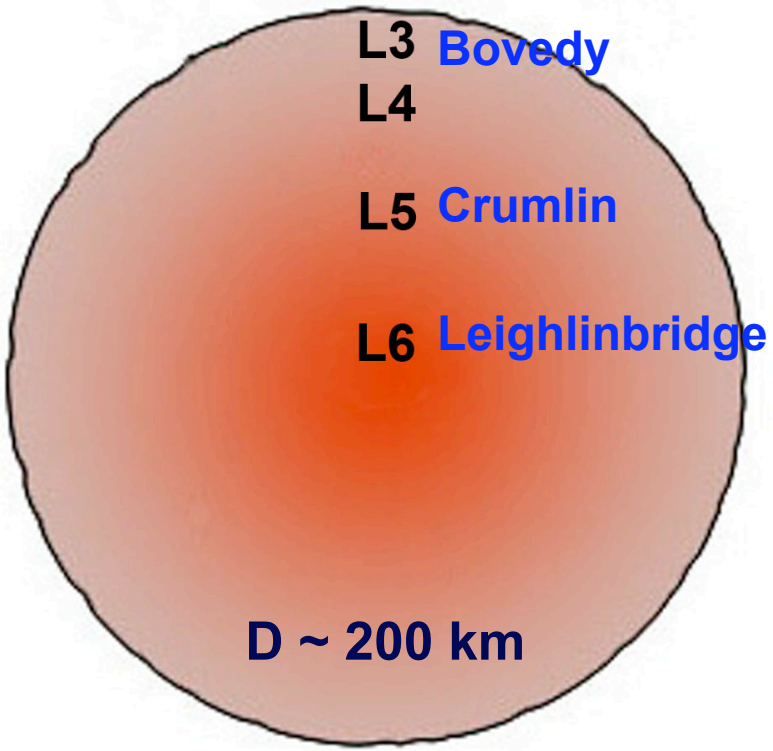
Splashes from the collision of molten planetismals.

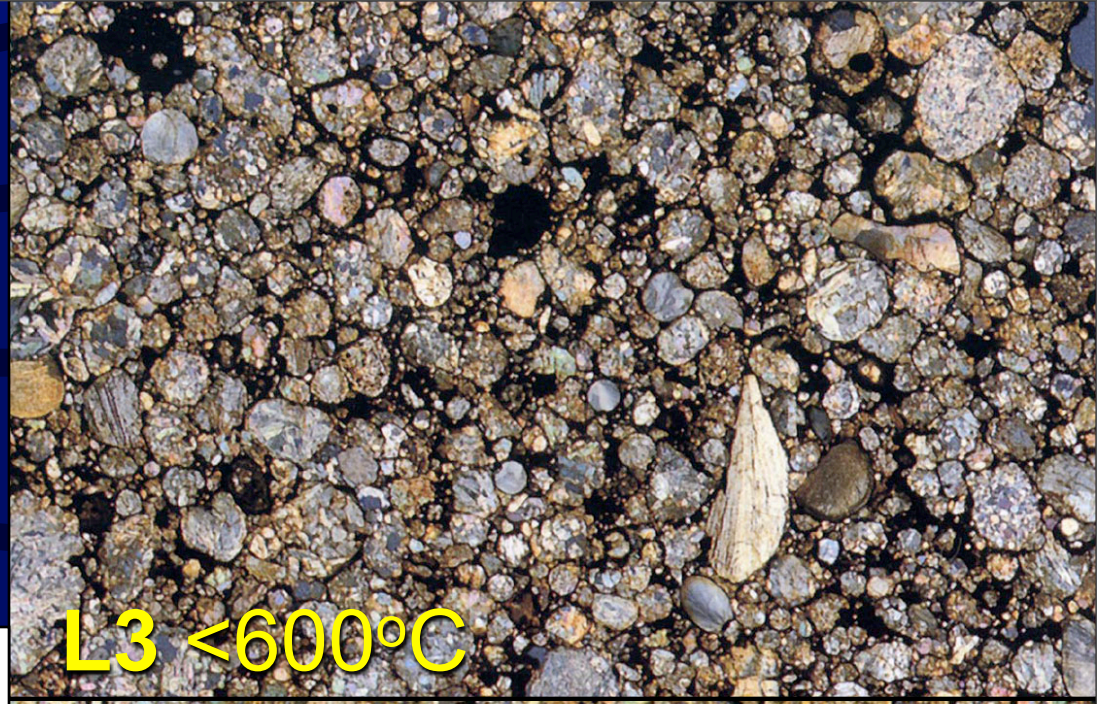
“Drops of fiery rain.” (H.C.Sorby, 1877)

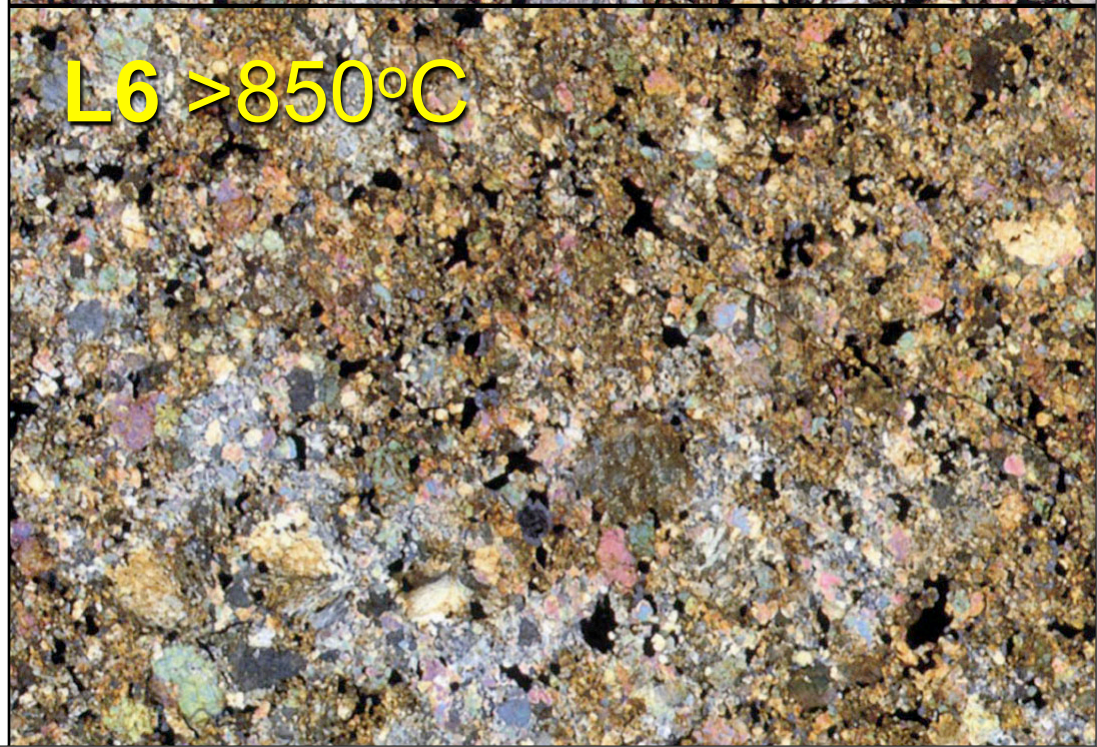


How old are the L Chondrite meteorites? Radiogenic dating

Followed by slow cooking of the L Chondrite planet for tens of millions of years

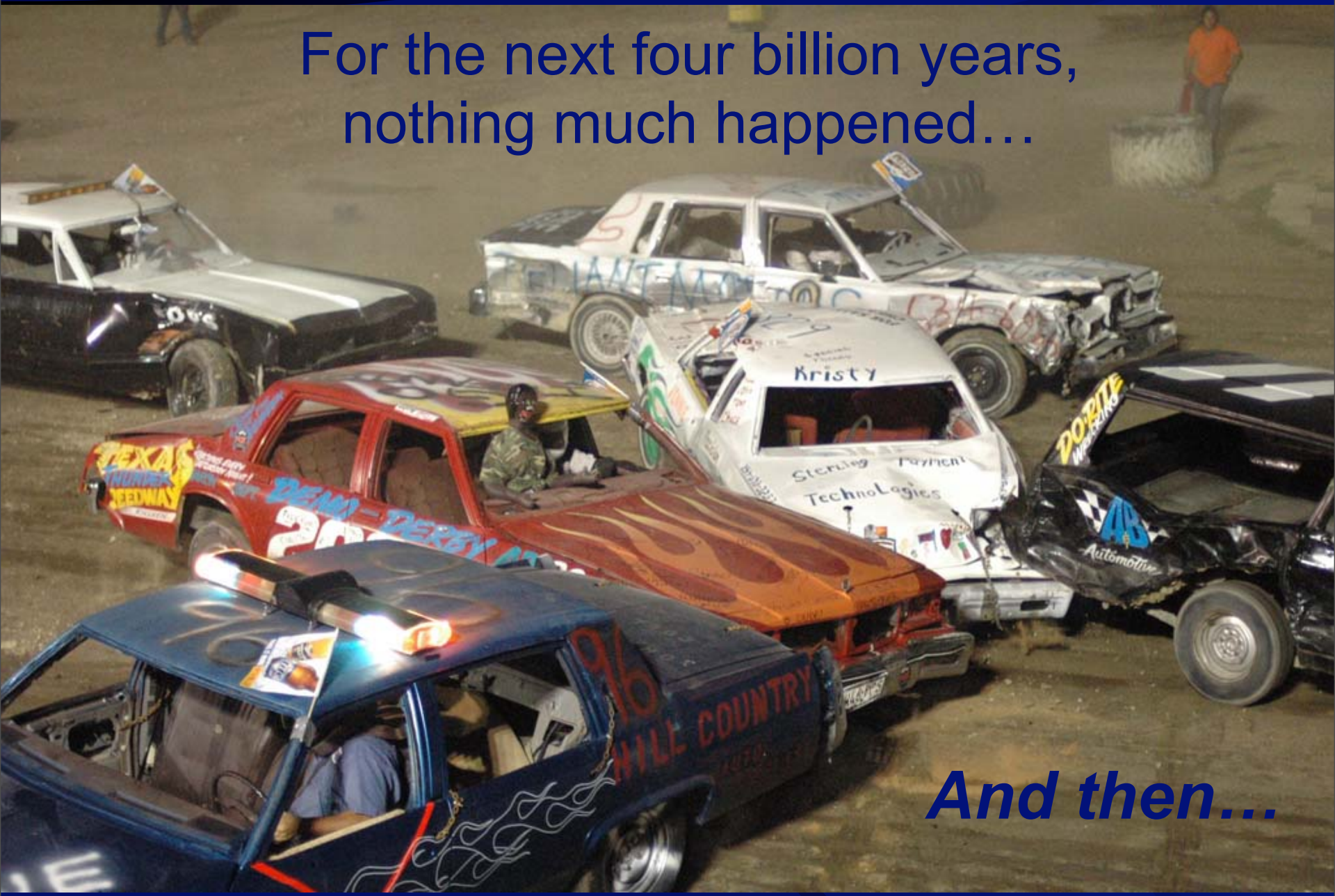






For the next four billion years, nothing much happened…

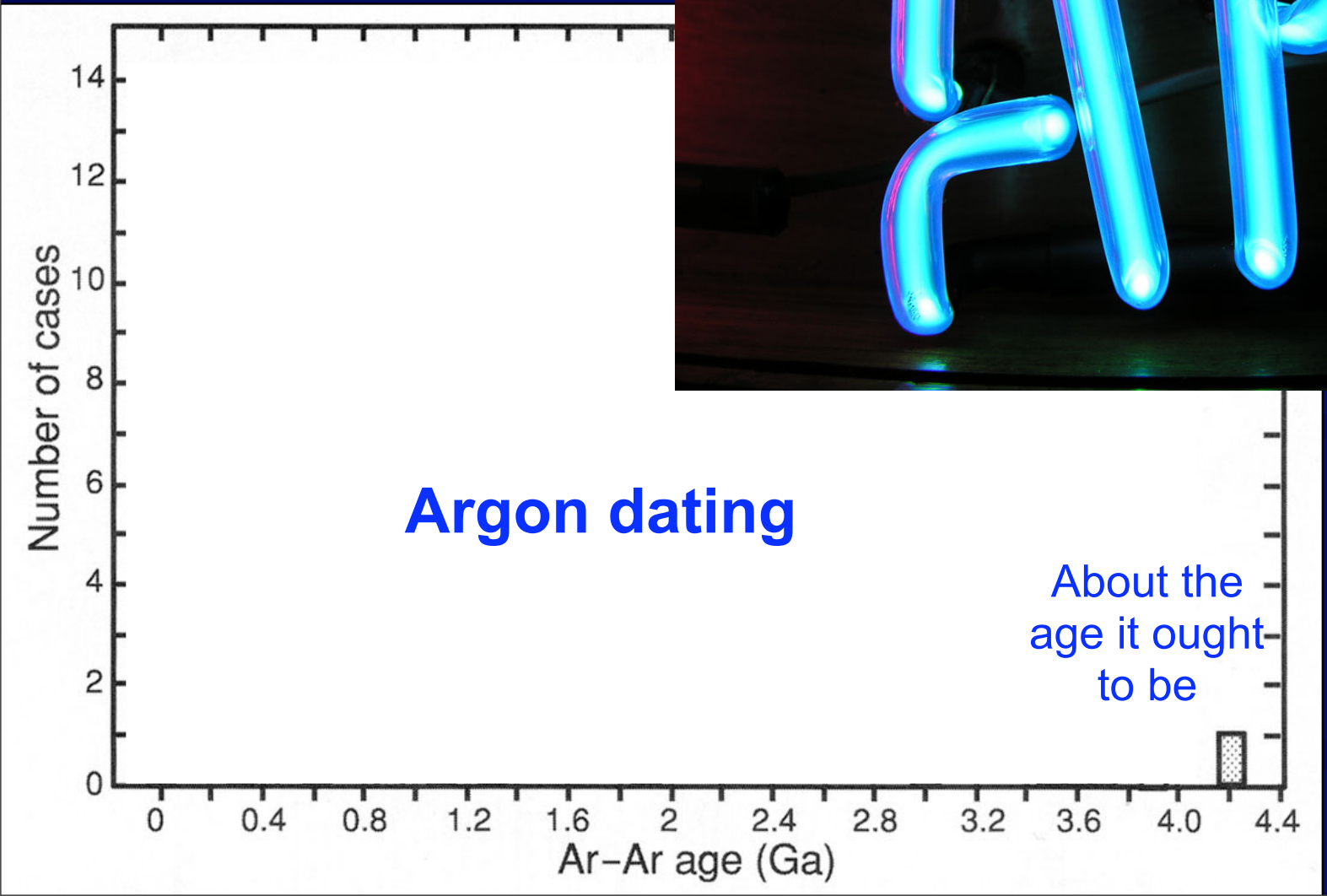
For the next four billion years,
nothing much happened…



And then…

…something shocking…

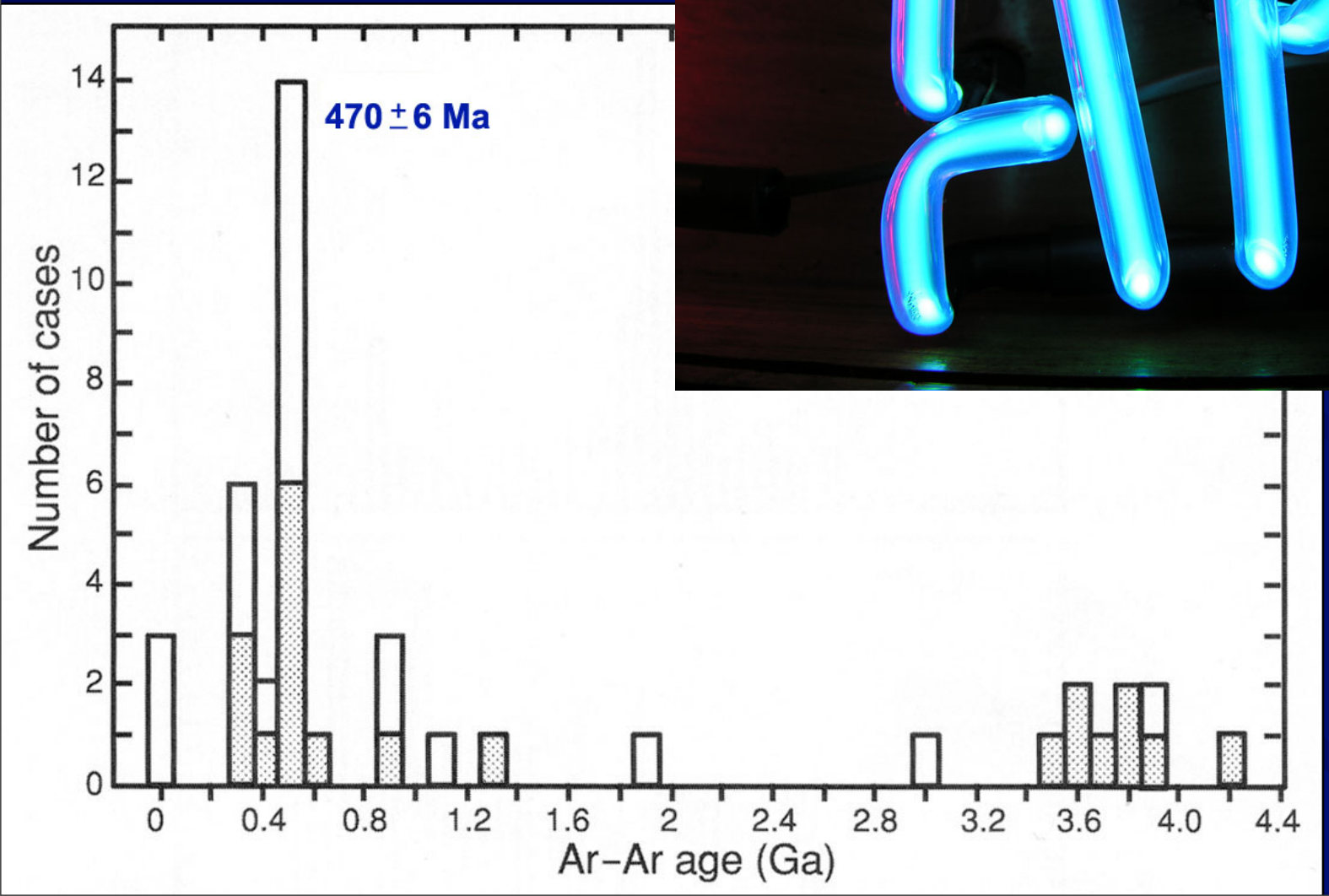
…which knocked the ~~wind~~ argon out of it…



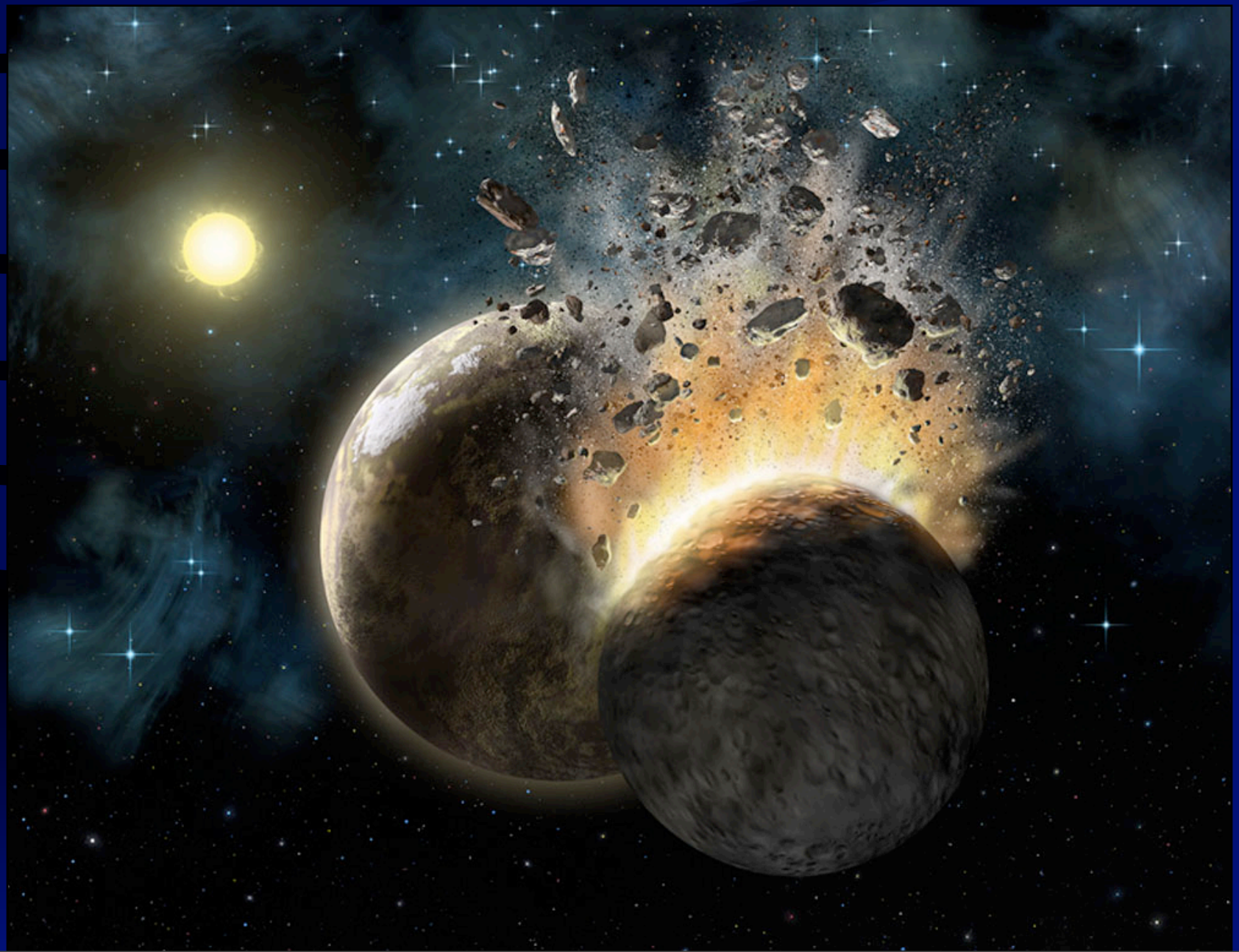
Argon dating

About the age it ought to be

Most L chondrites lie about their age



Catastrophic destruction of the L Chondrite parent planet



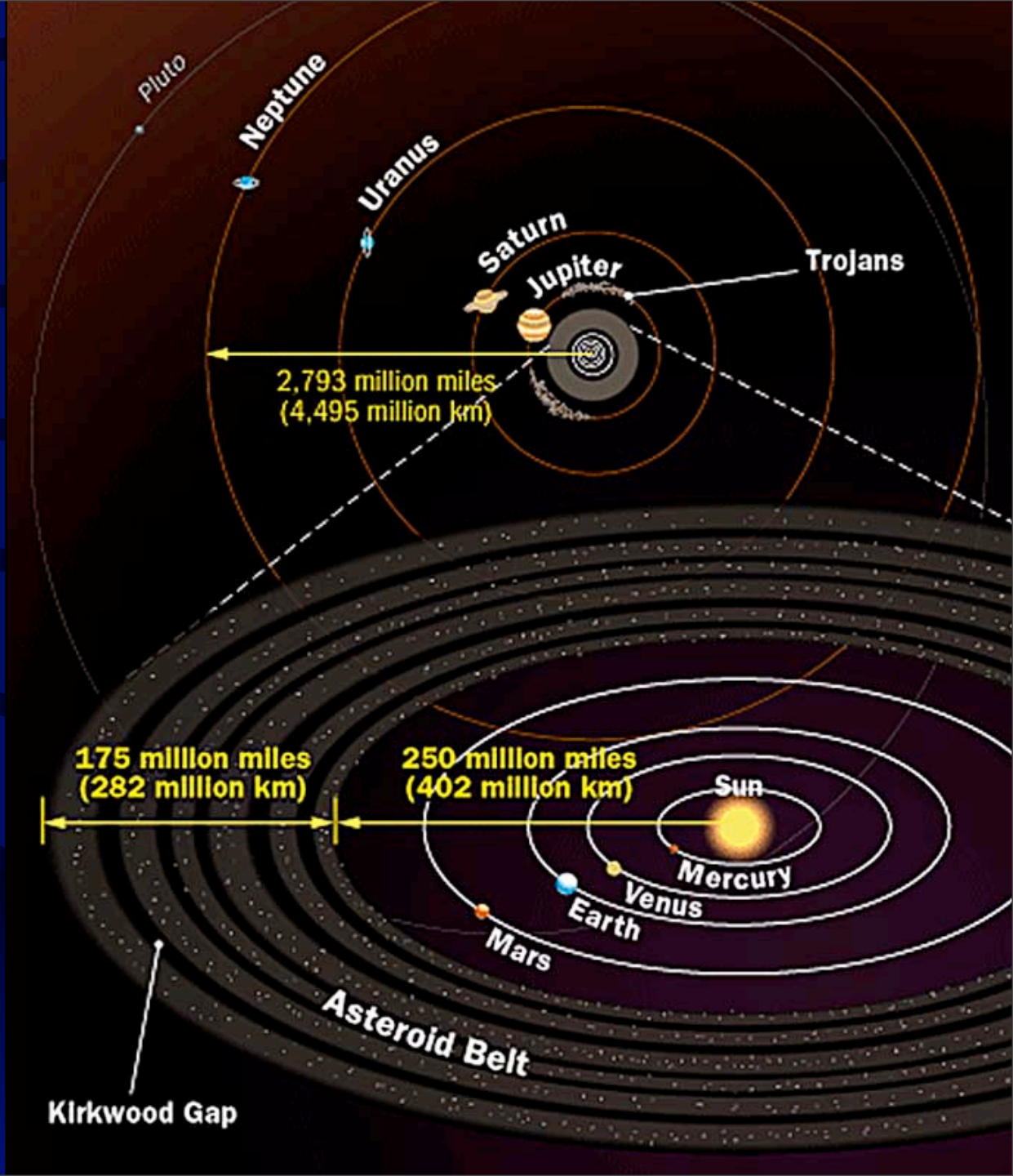
Many fossil meteorites have been found in 470 million year old rocks. All are L Chondrites.

467.3 ± 1.6 Ma ago

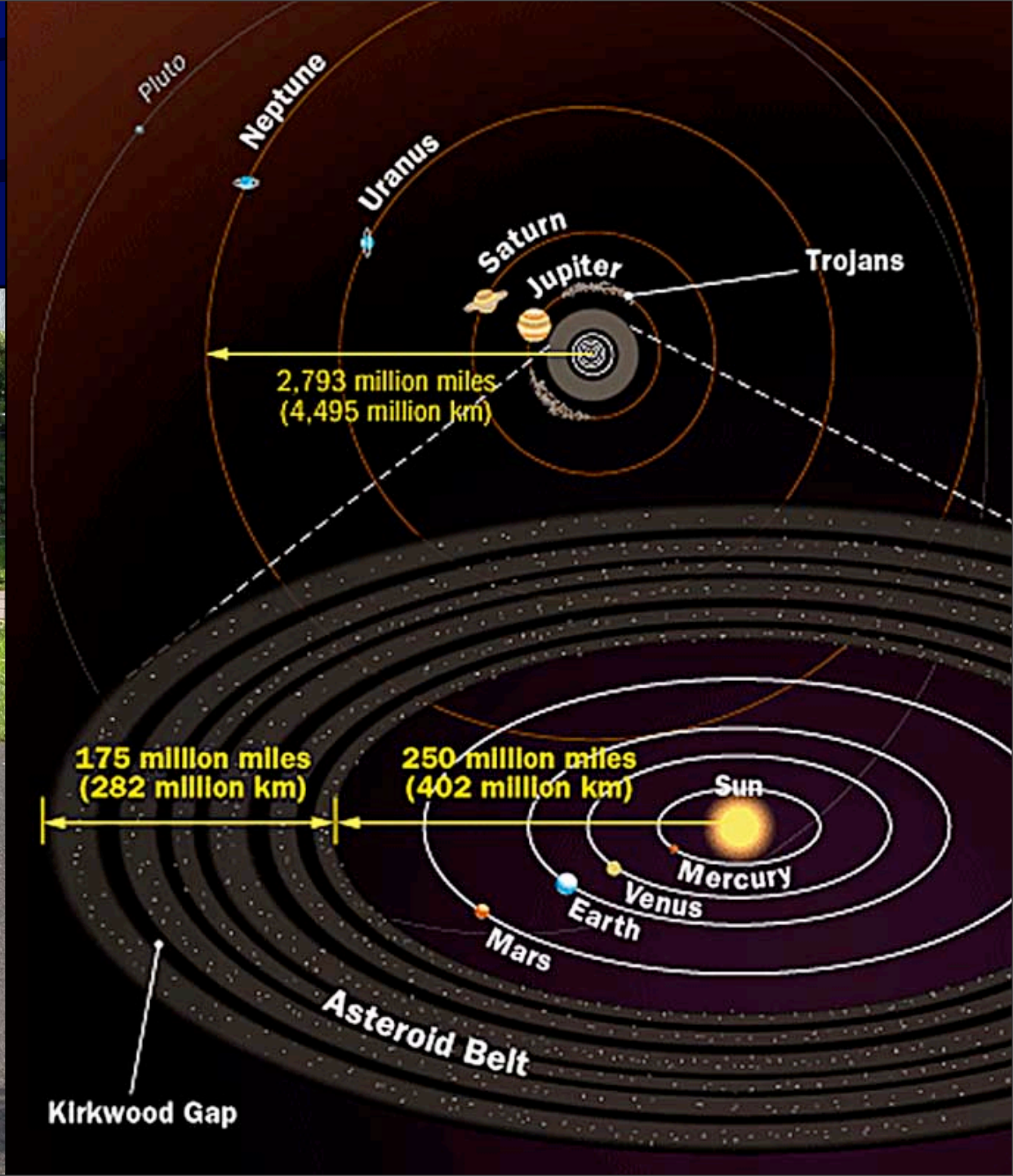
B. Schmitz and M. Tassinari
Photographs appeared in Science, v. 294 (Oct. 5, 2001), p.39.

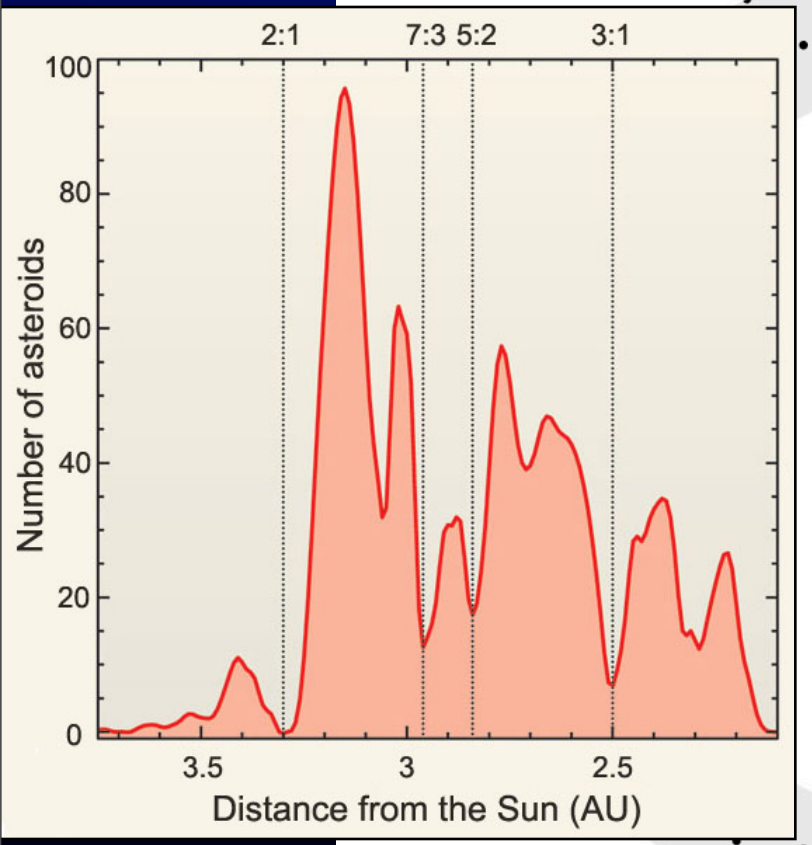
How do they get to Earth?

Mr. Kirkwood's Cosmic Catapult

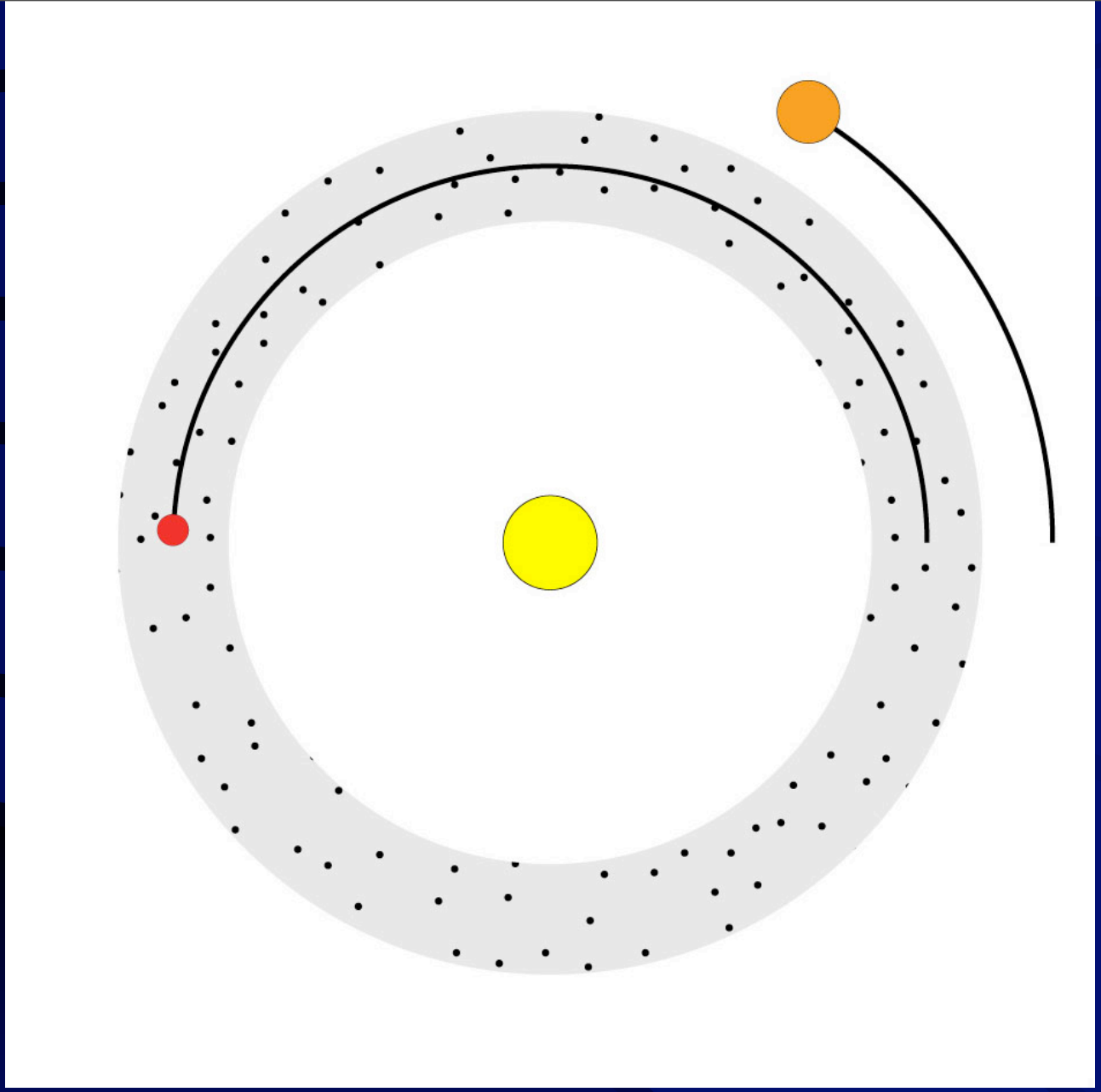


…more like a swing actually

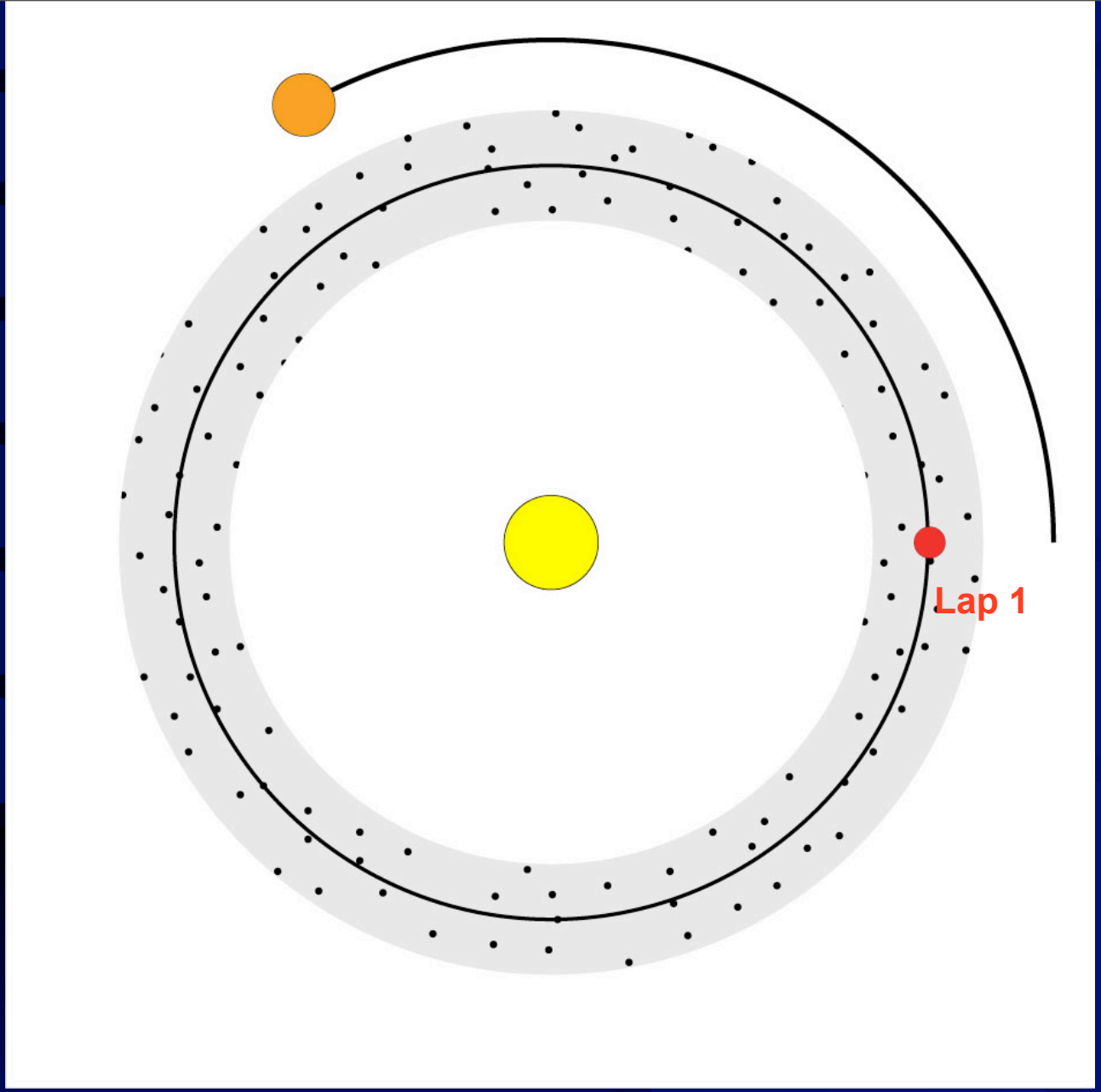


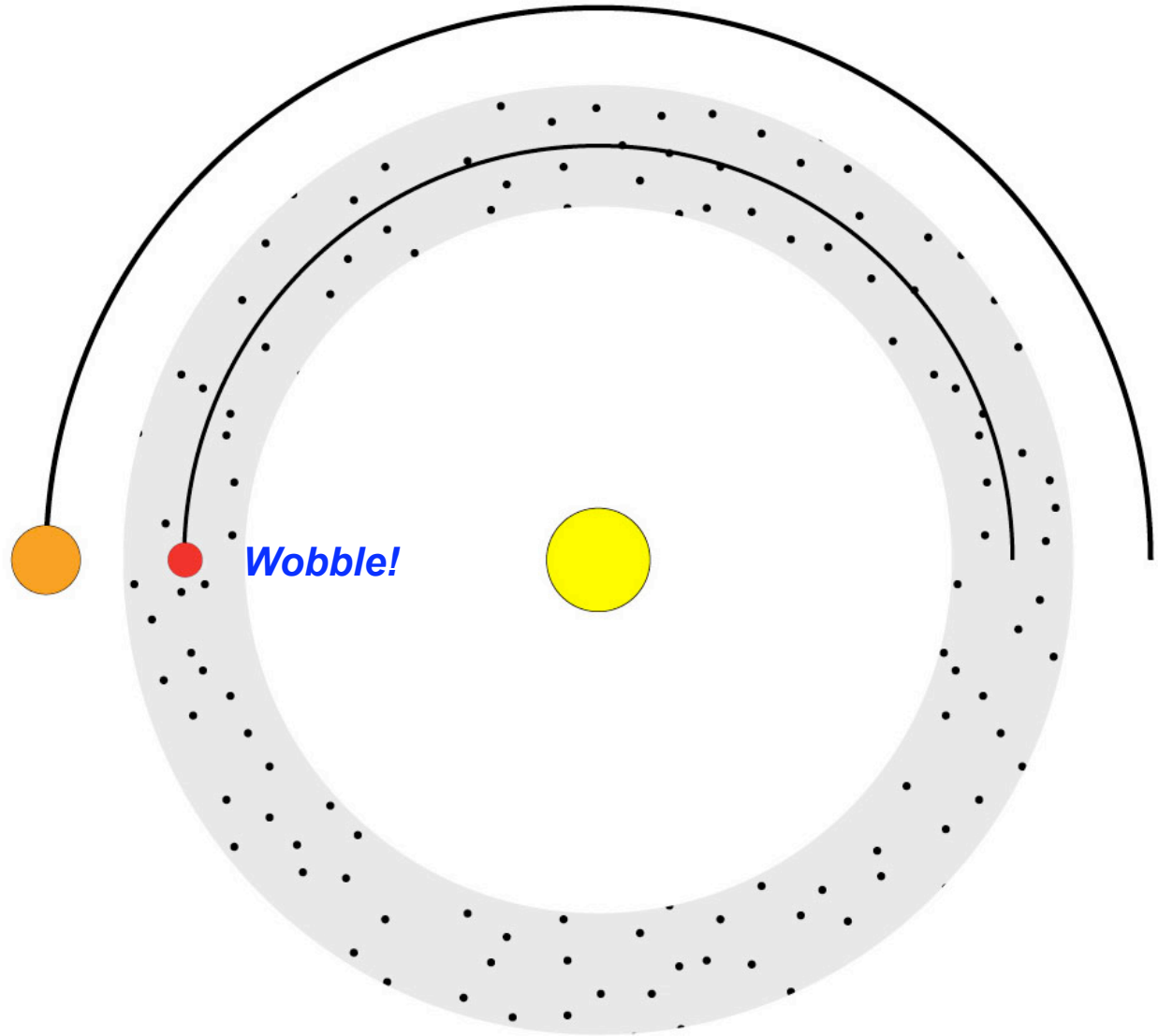


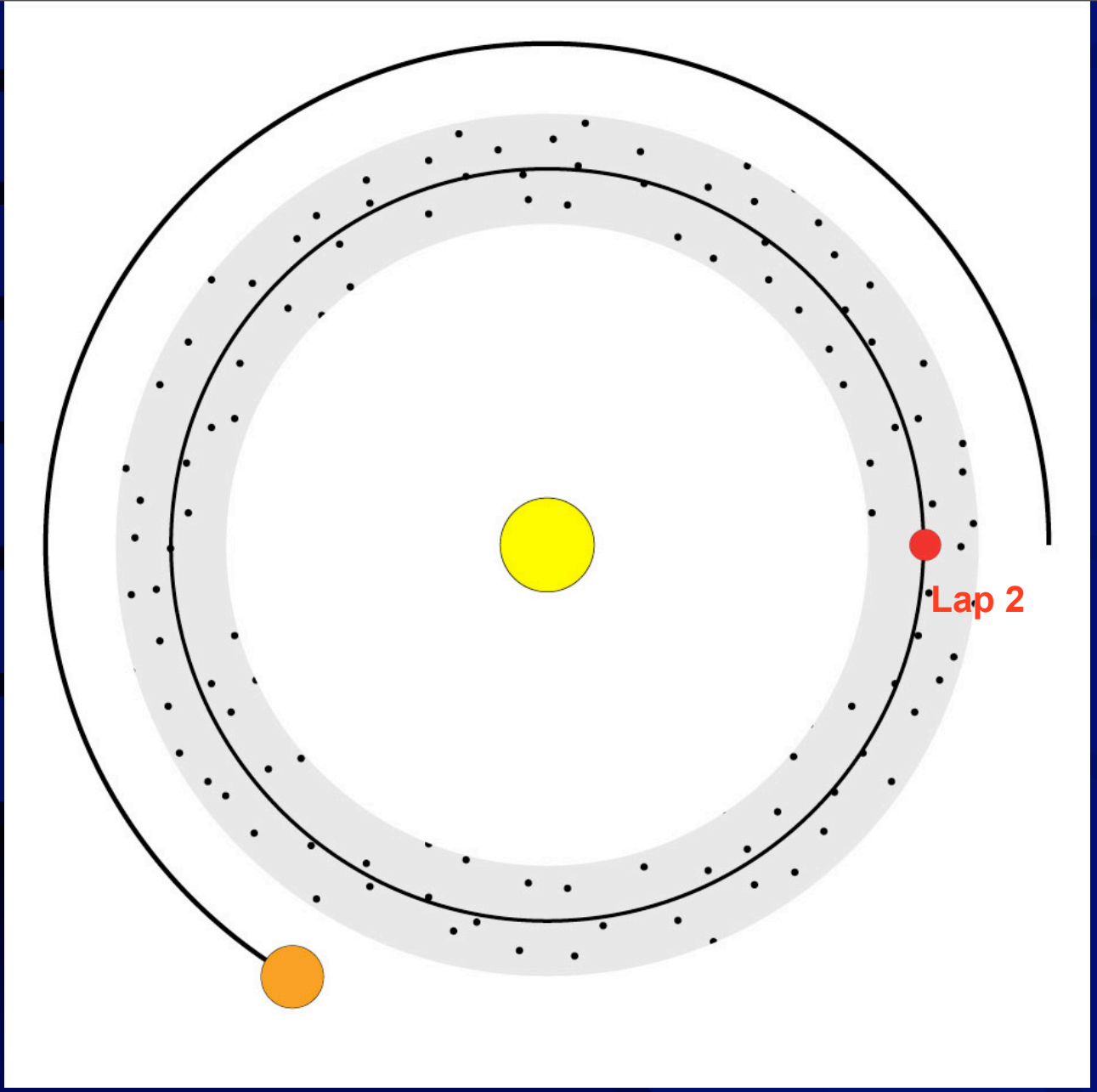
What happens to anything that strays into the 3:1 Kirkwood Gap?

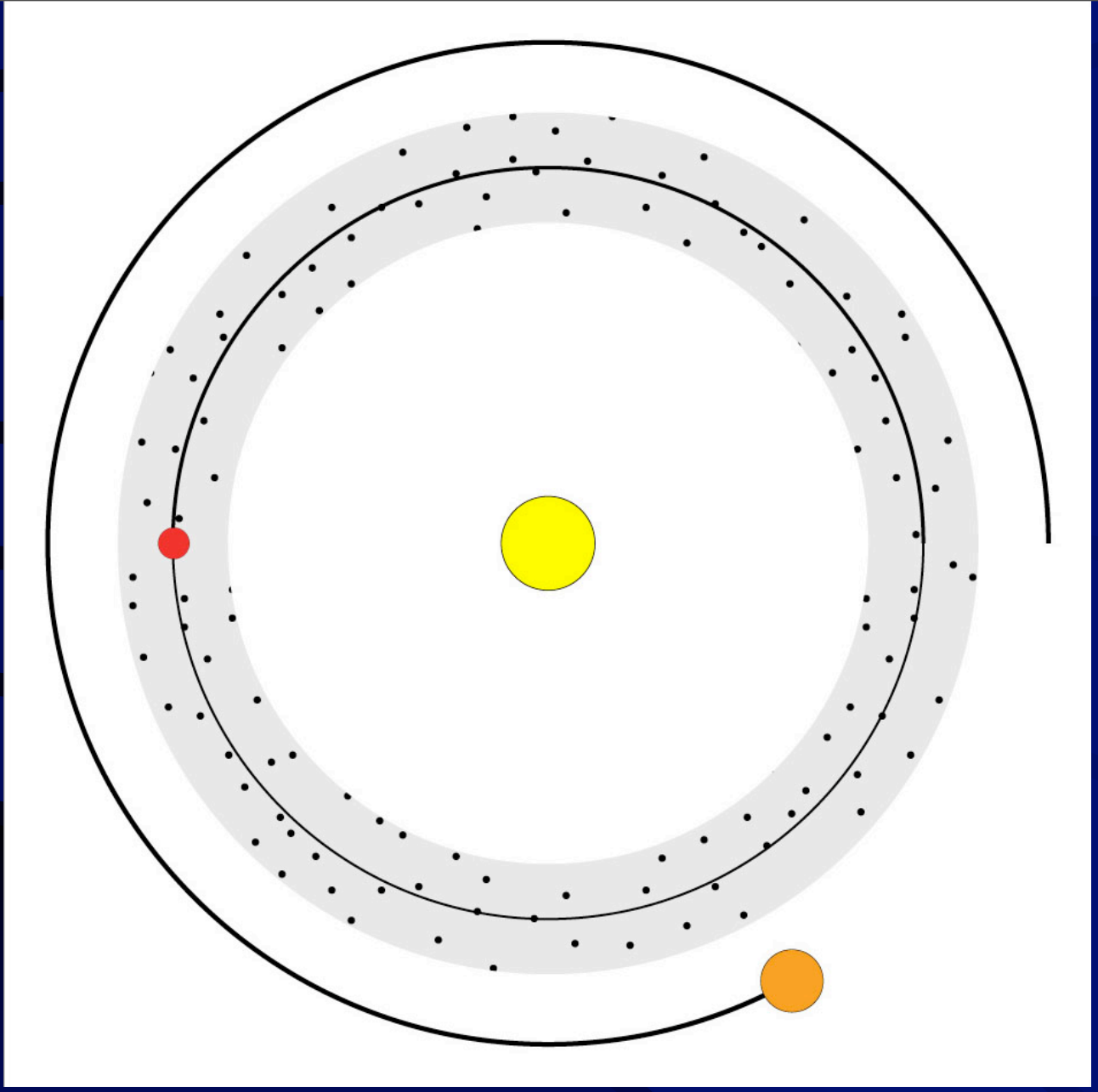


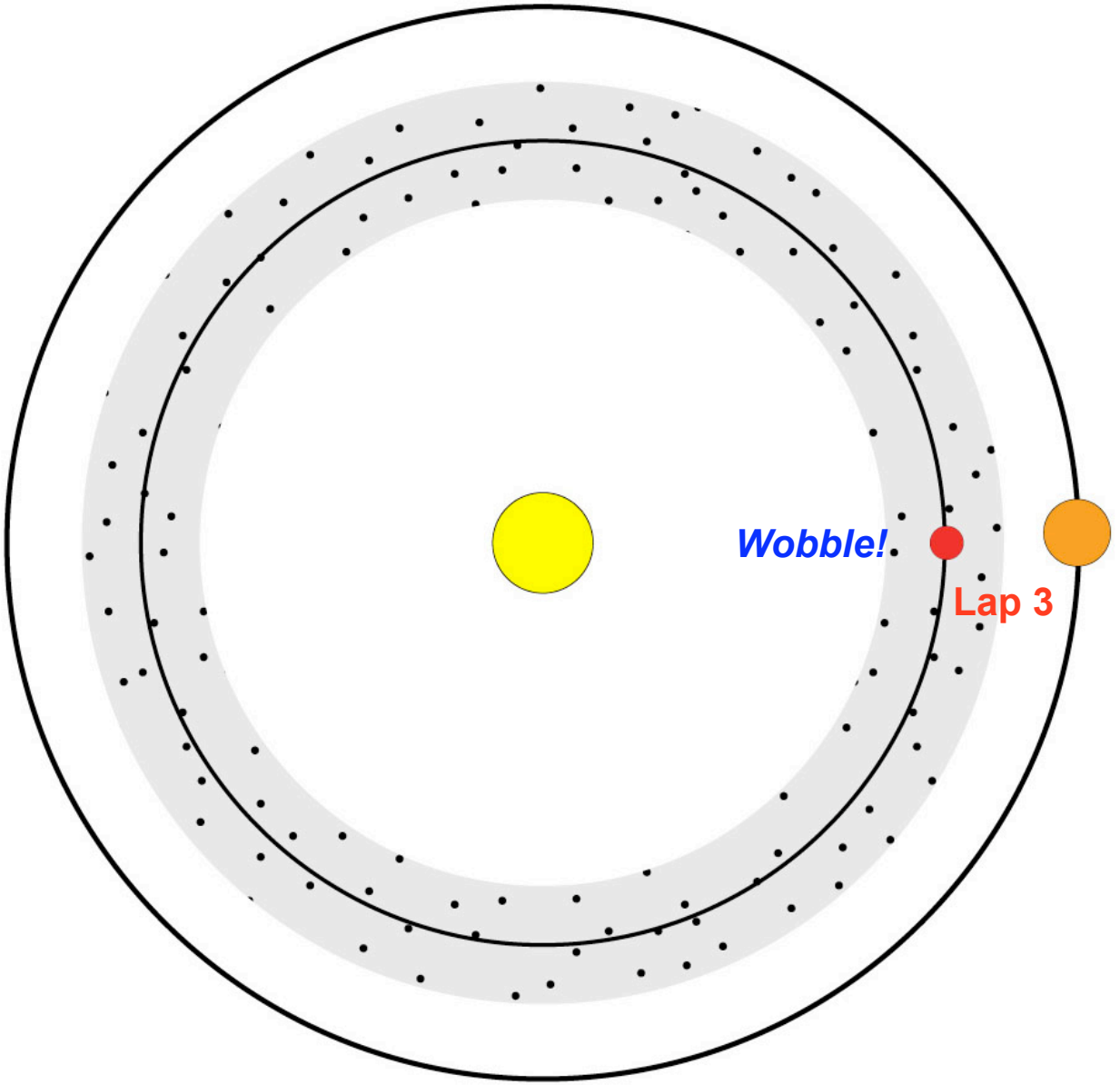
For every one orbit of Jupiter, our rock makes 3 orbits.

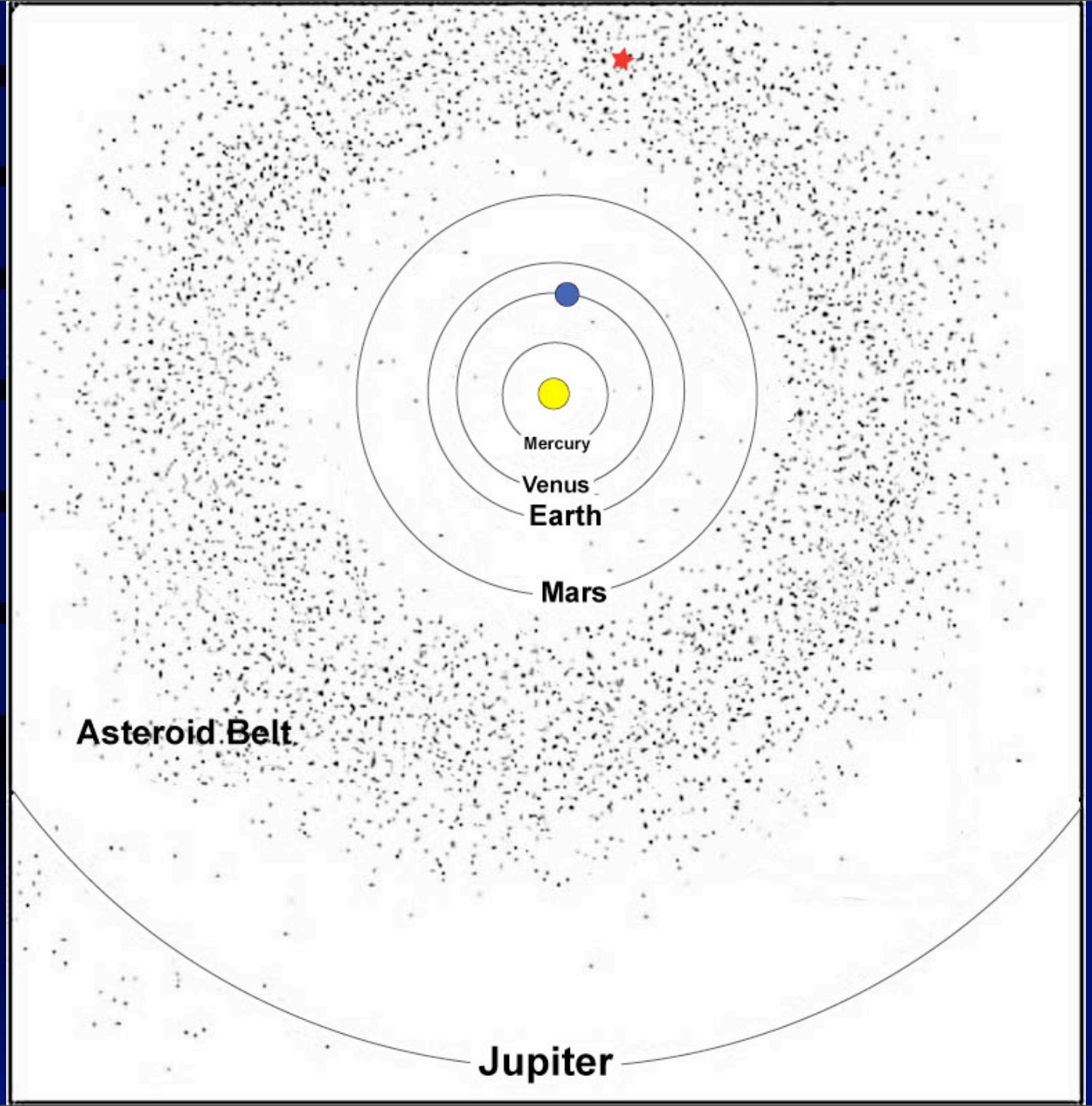

Lap 1

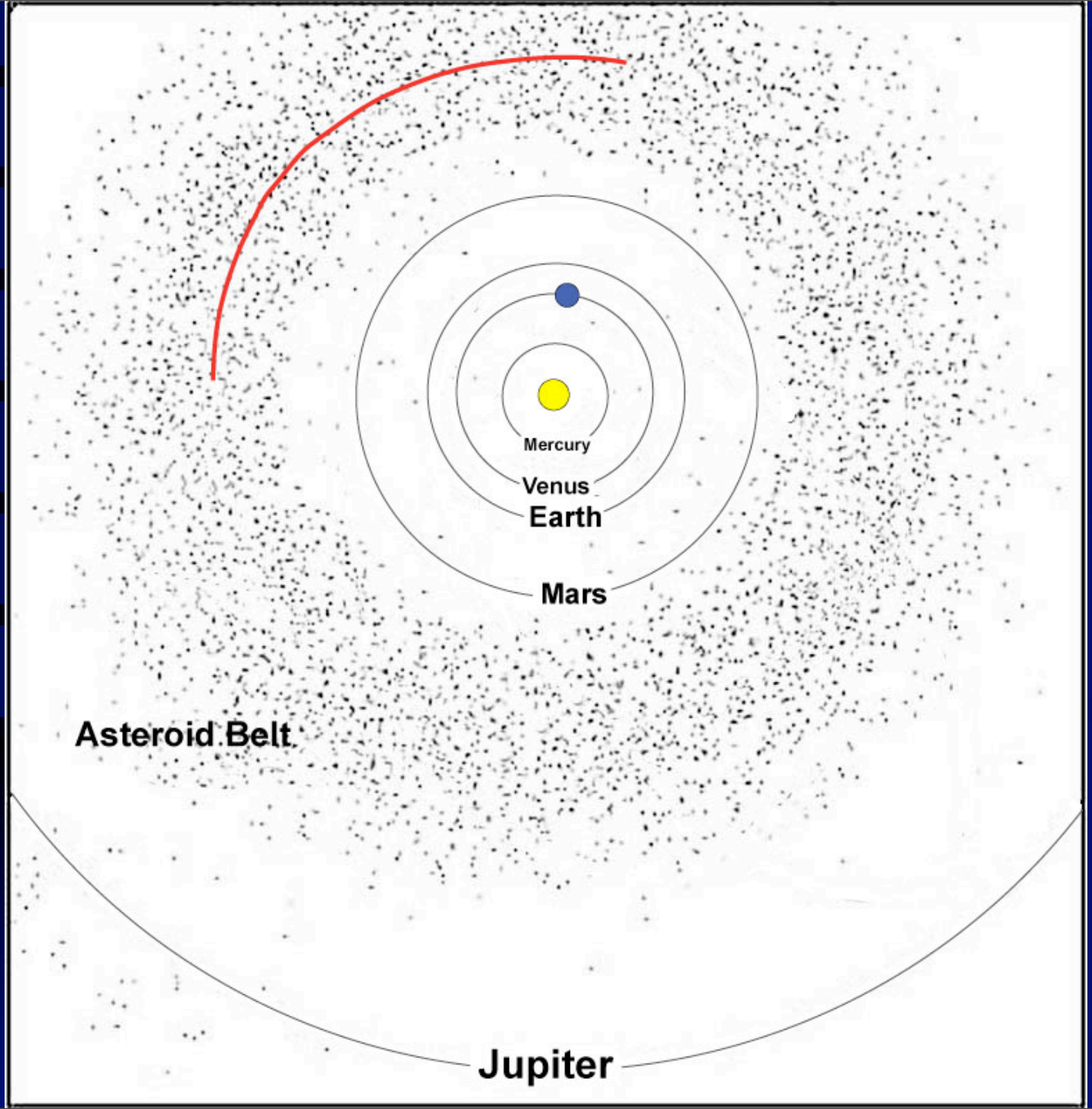

Wobble!


Lap 2




Wobble!
Lap 3


Mercury
Venus
Earth
Mars
Asteroid Belt
Jupiter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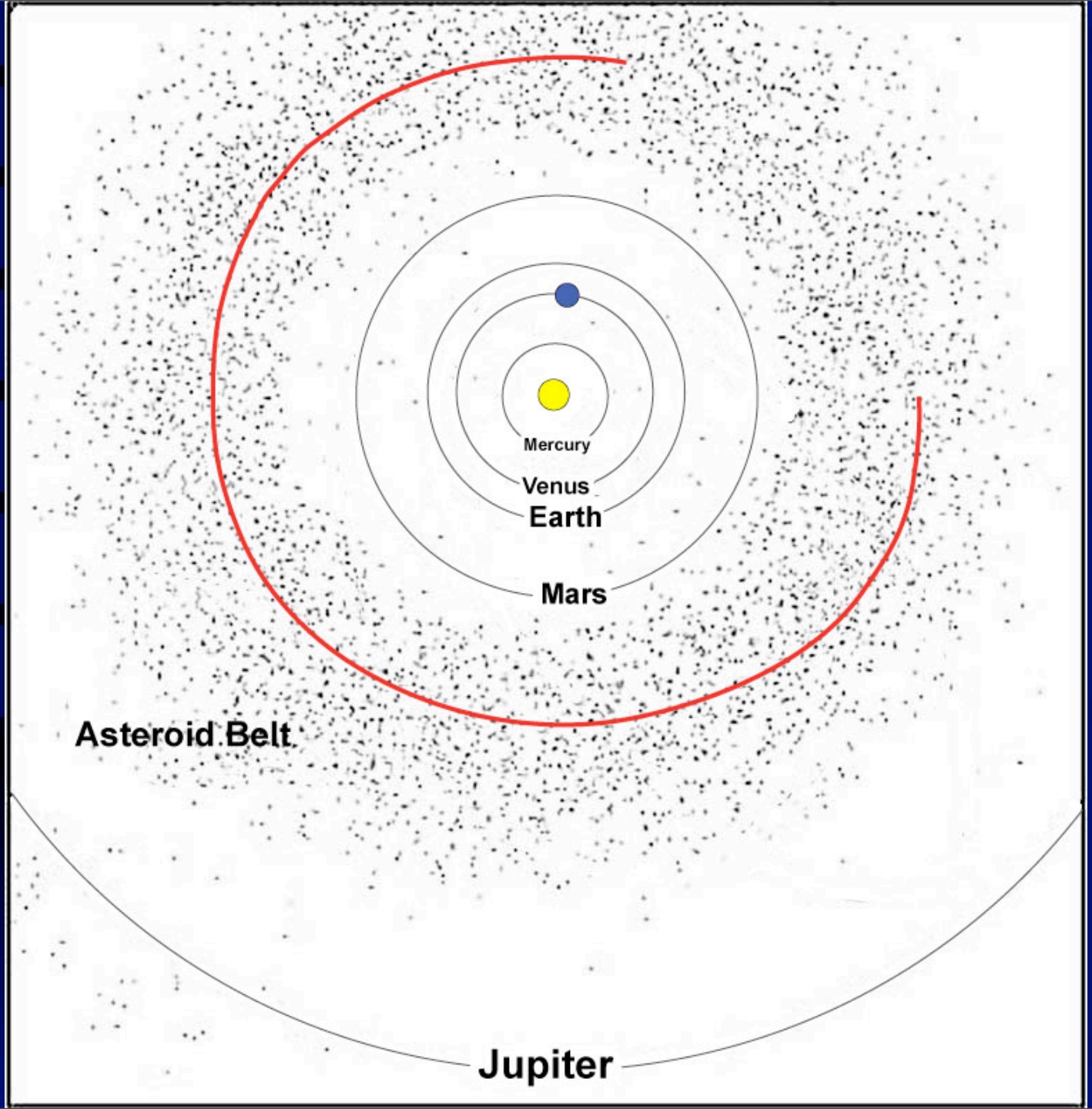
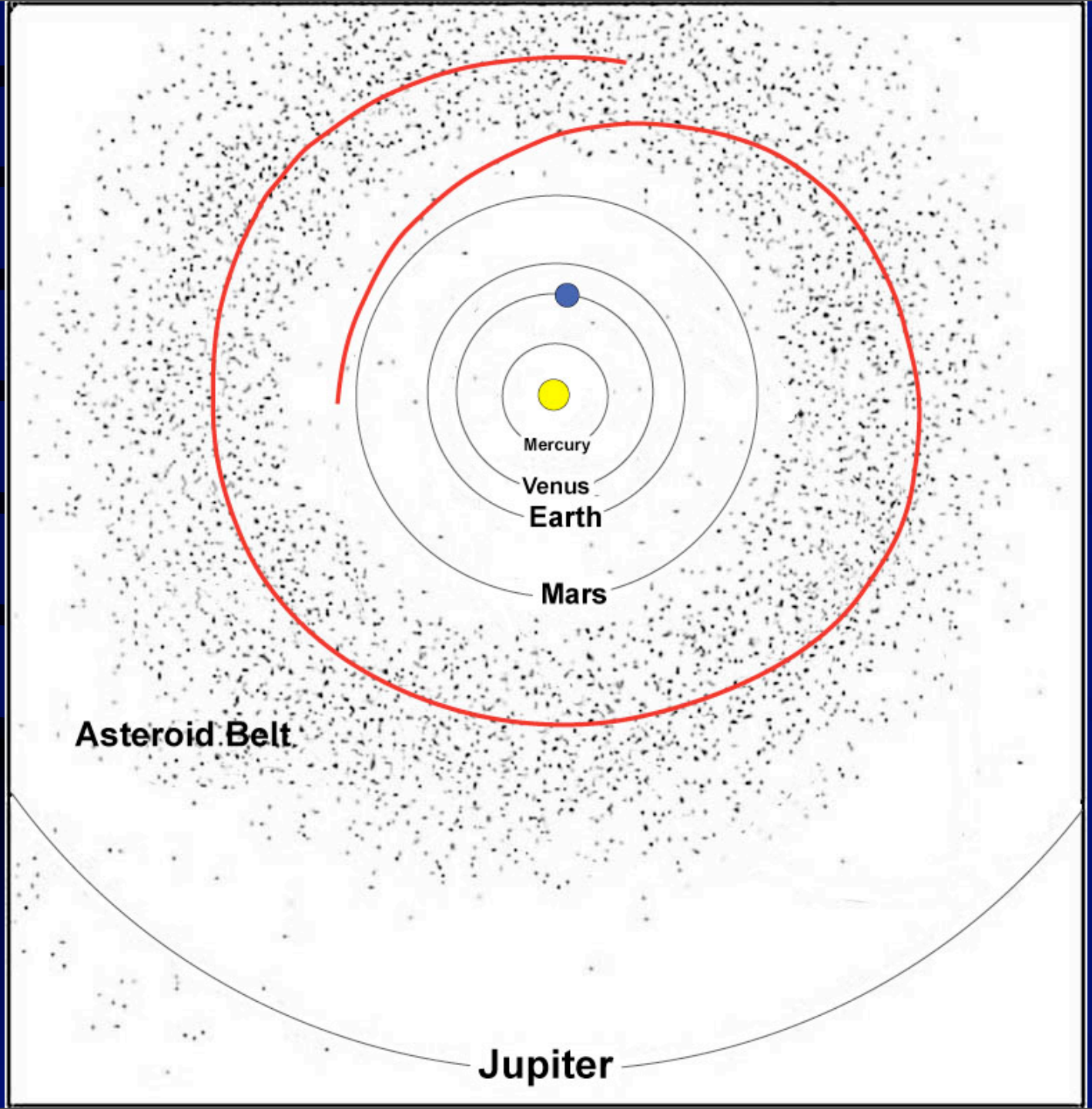
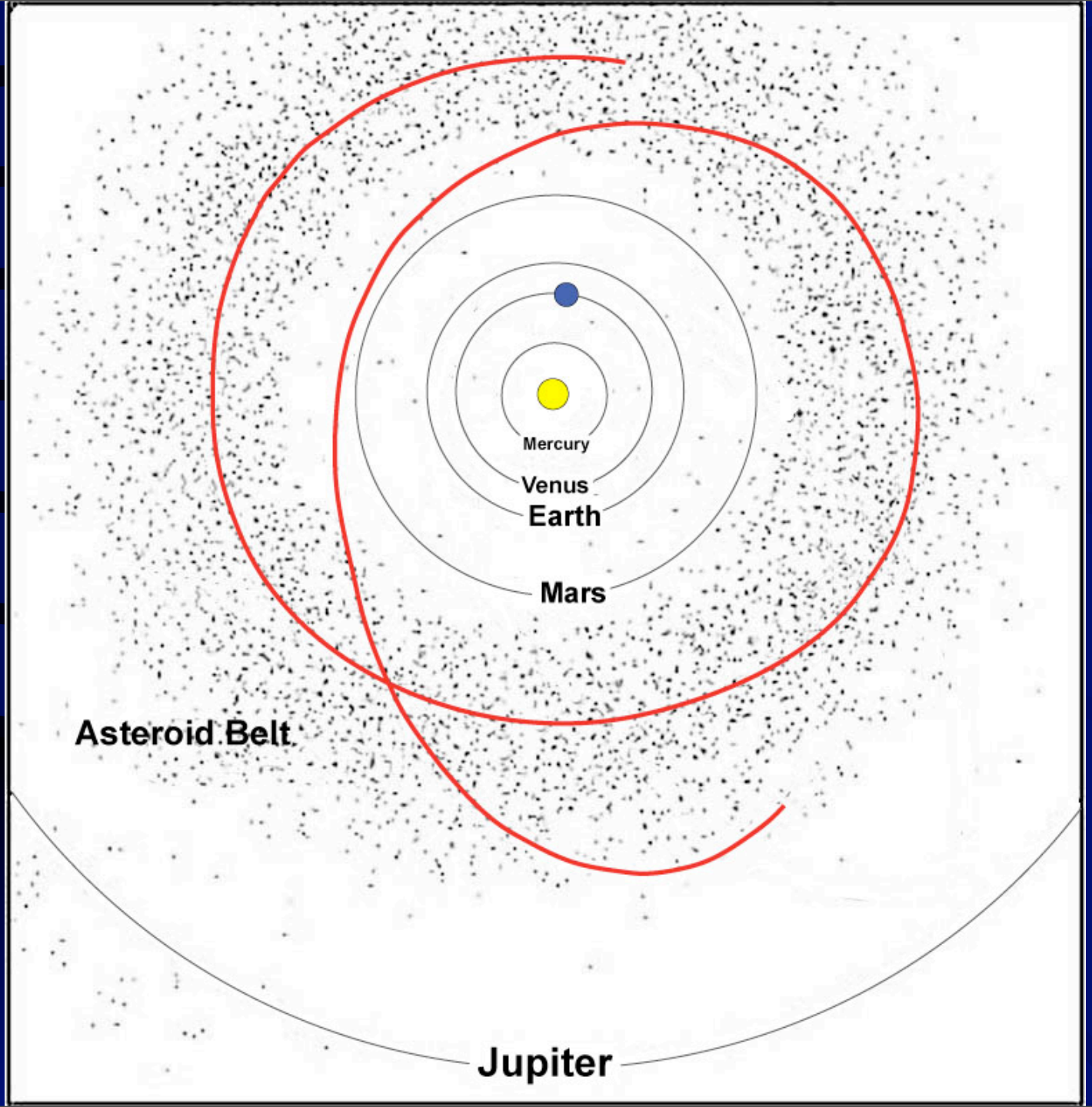
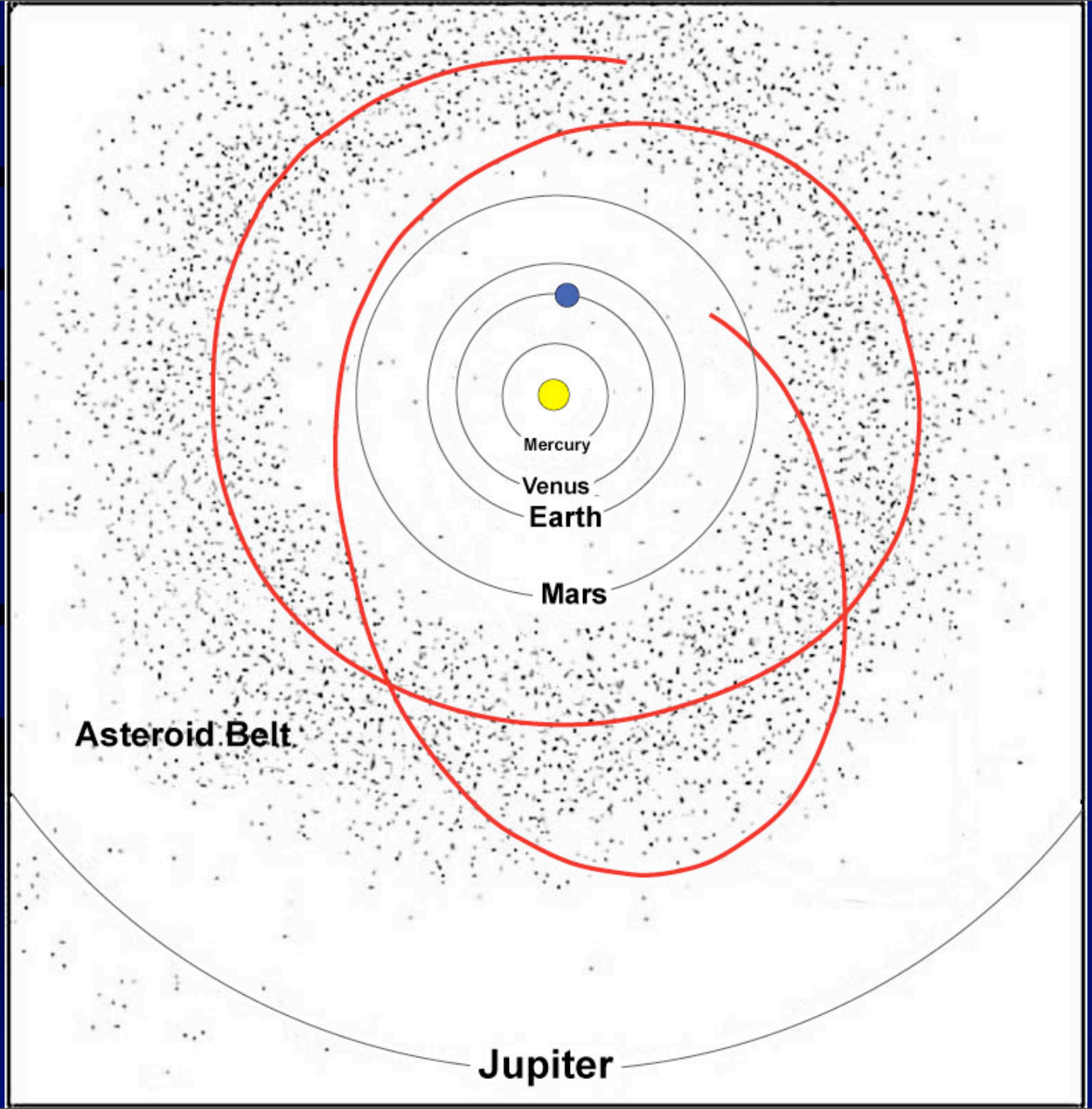
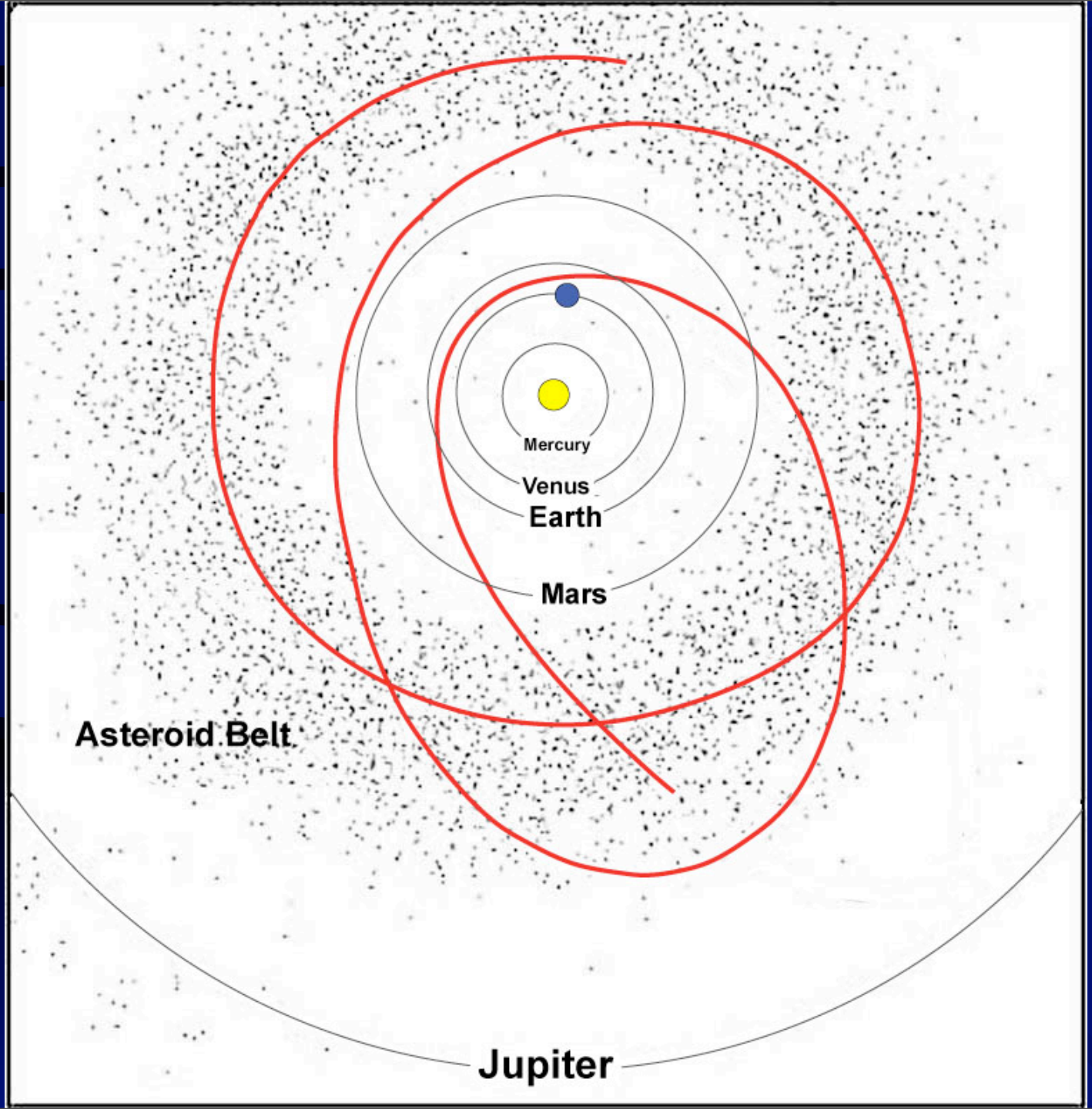
Mars
Asteroid Belt
Jupiter

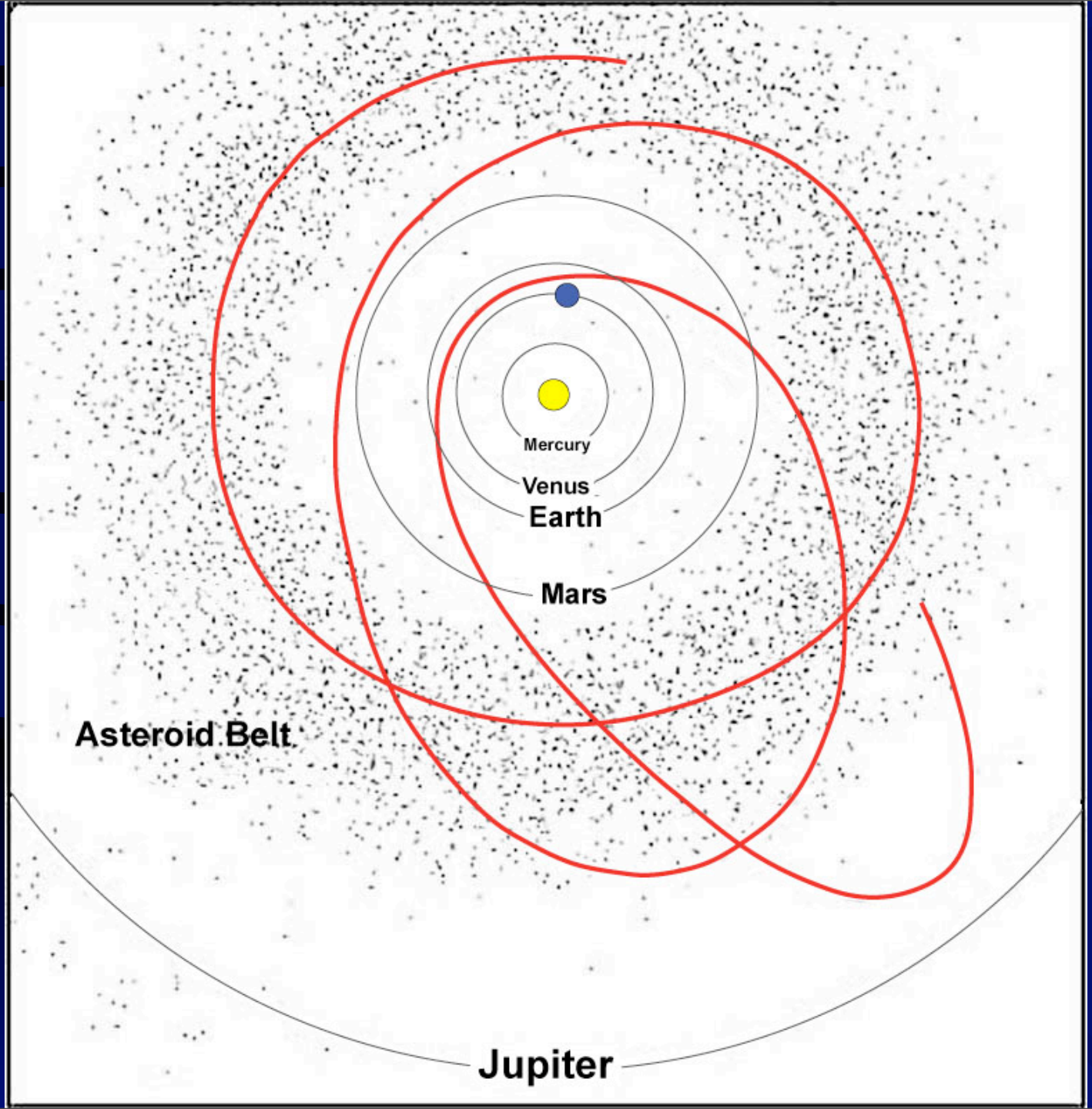

Mercury
Venus
Earth
Mars
Asteroid Belt
Jupiter

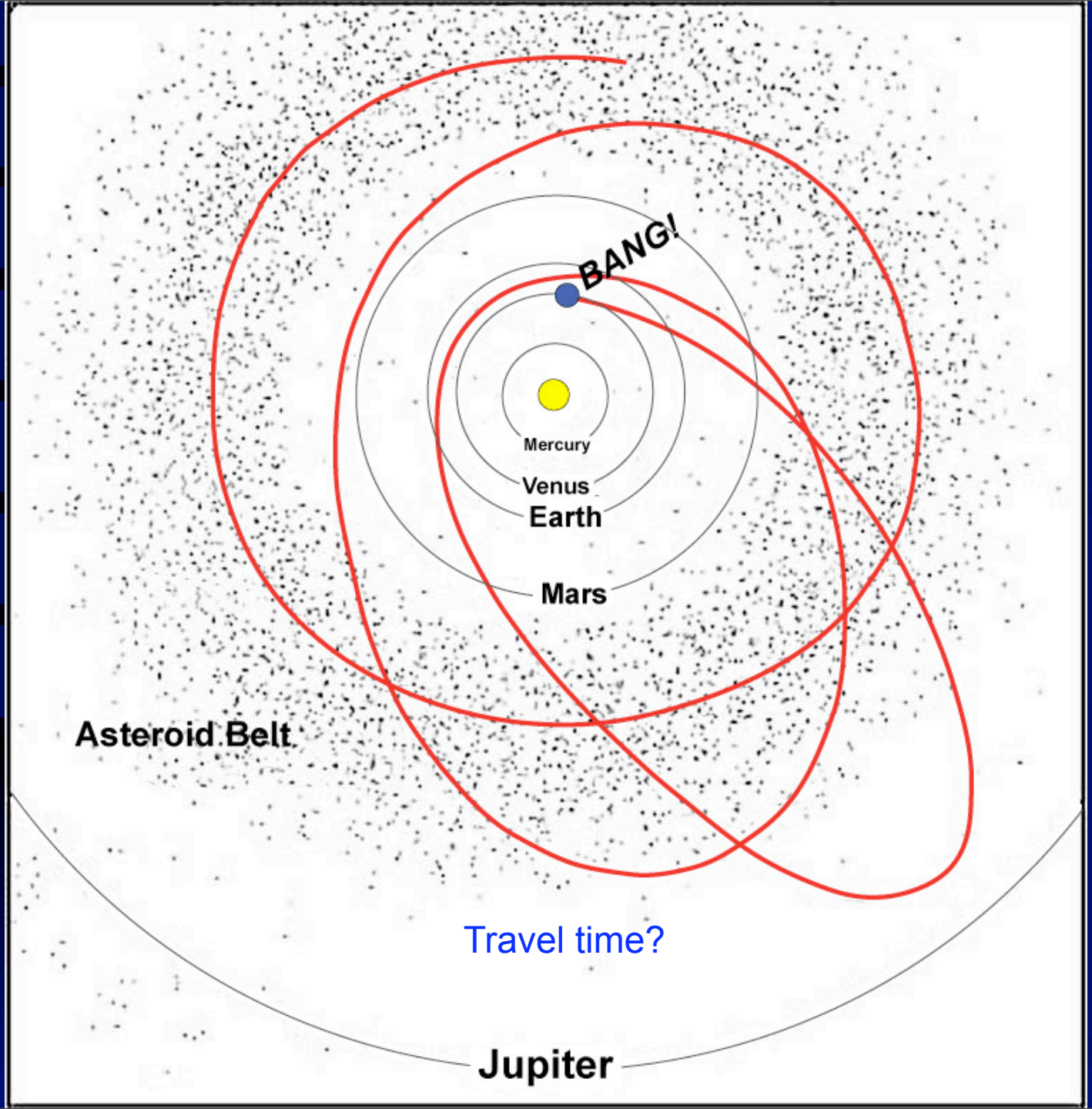

Mercury
Venus
Earth
Mars
Asteroid Belt
Jupiter

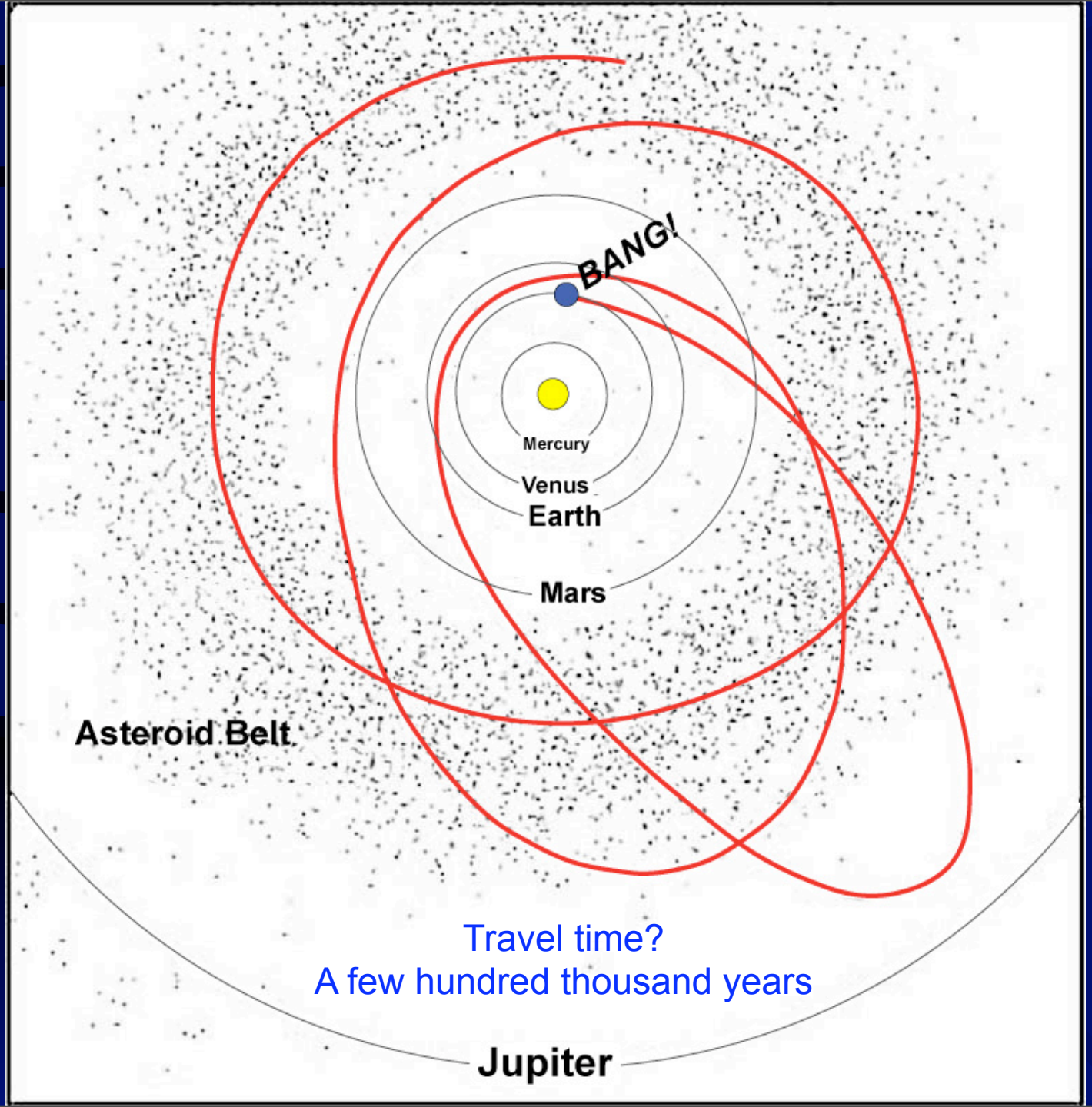

Mercury
Venus
Earth
Mars
Asteroid Belt
Jupiter


Mercury
Venus
Earth
Mars
Asteroid Belt
Jupiter


Mercury
Venus
Earth
Mars
Asteroid Belt
Jupiter

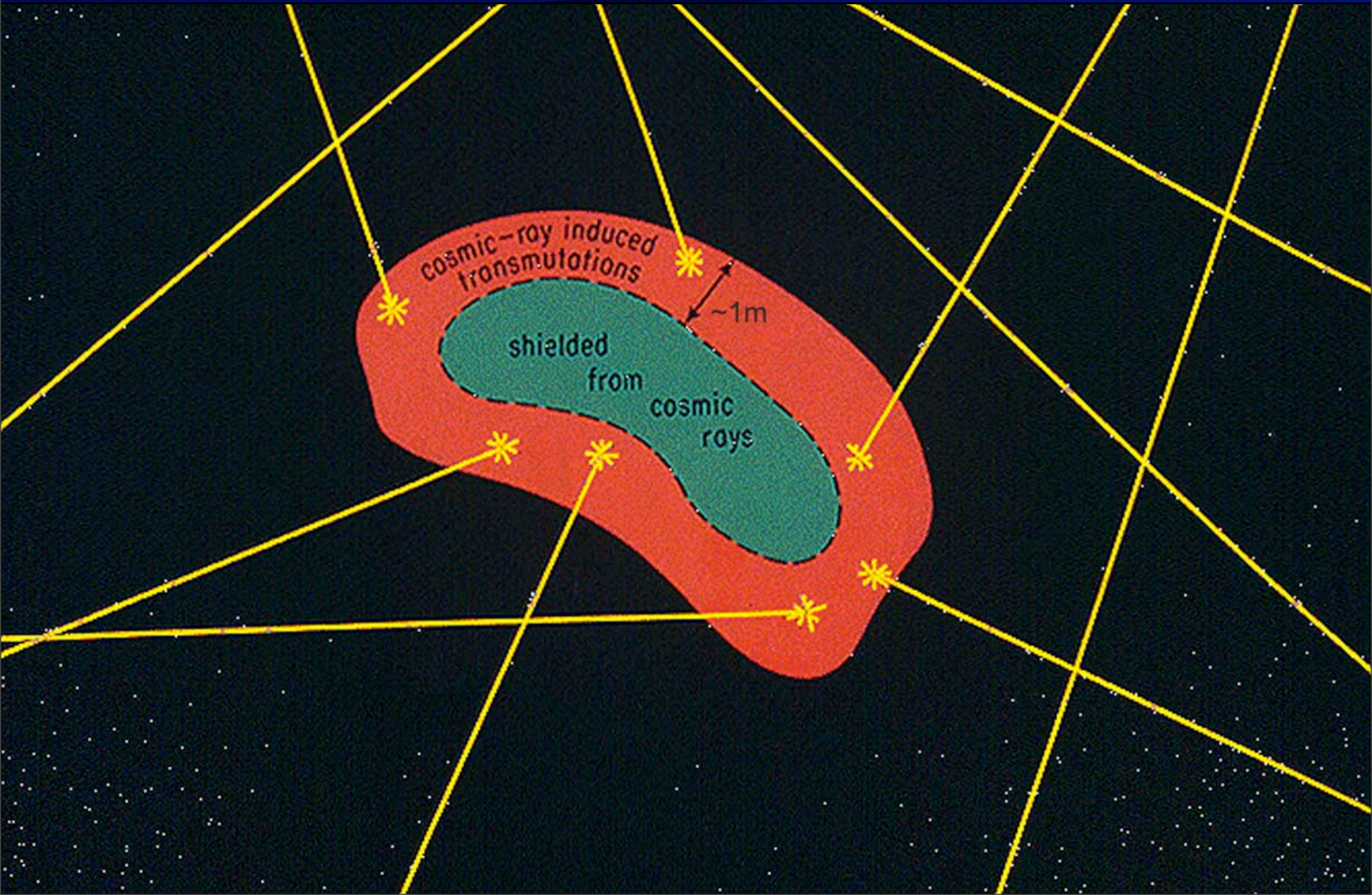

Mercury
Venus
Earth
Mars
Asteroid Belt
Jupiter

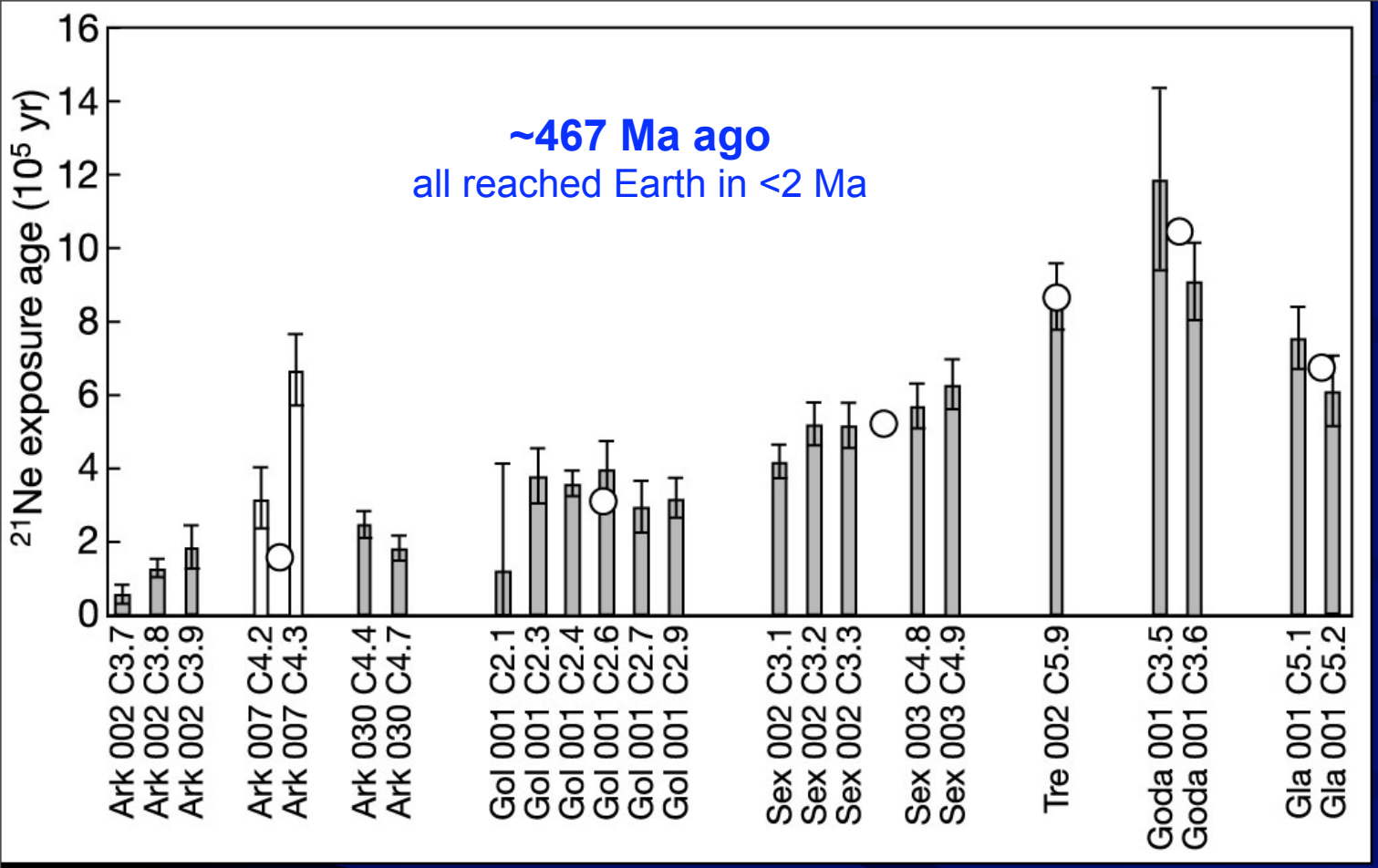

BANG!
Mercury
Venus
Earth
Mars
Asteroid Belt
Jupiter
Travel time?

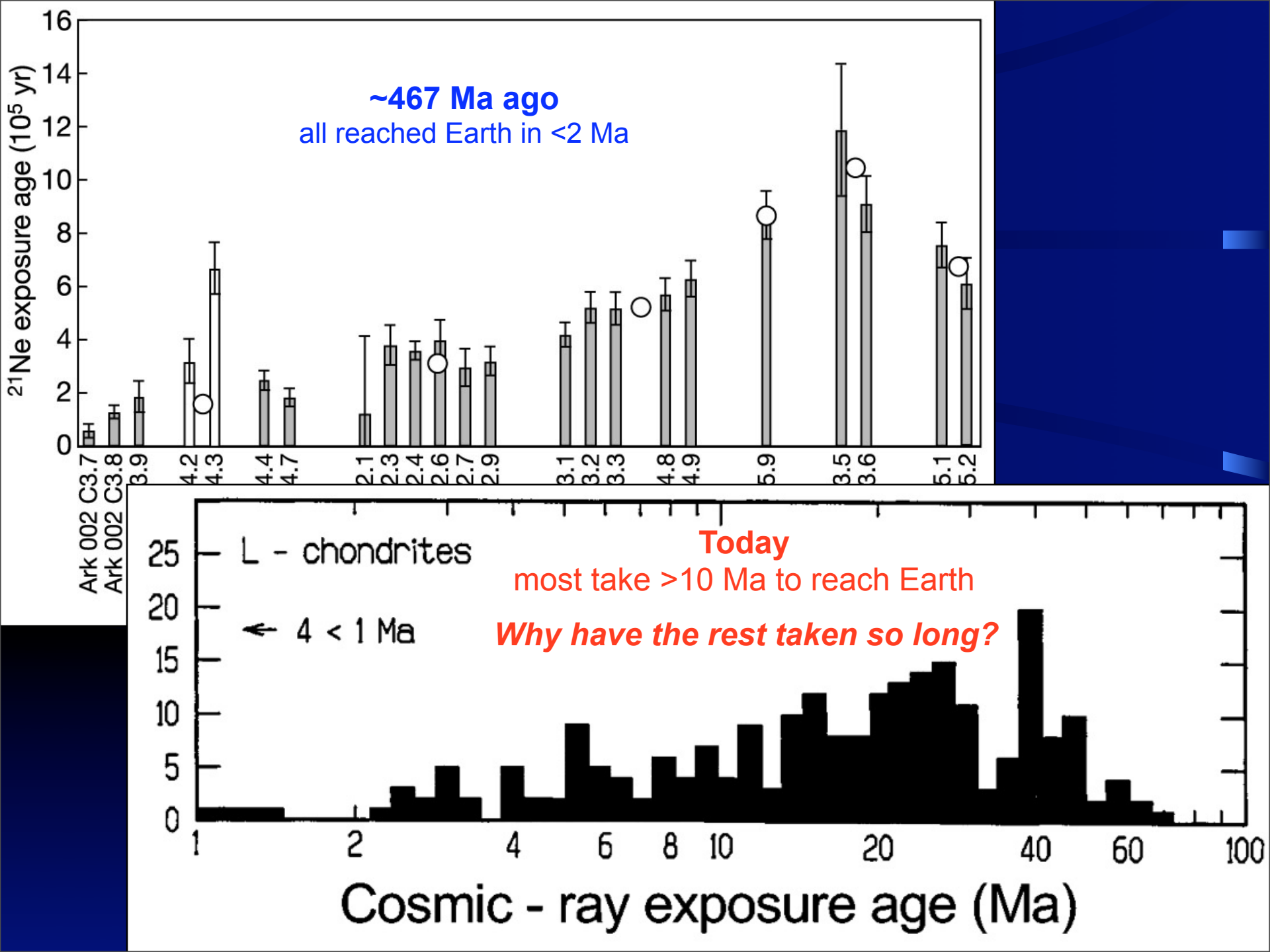


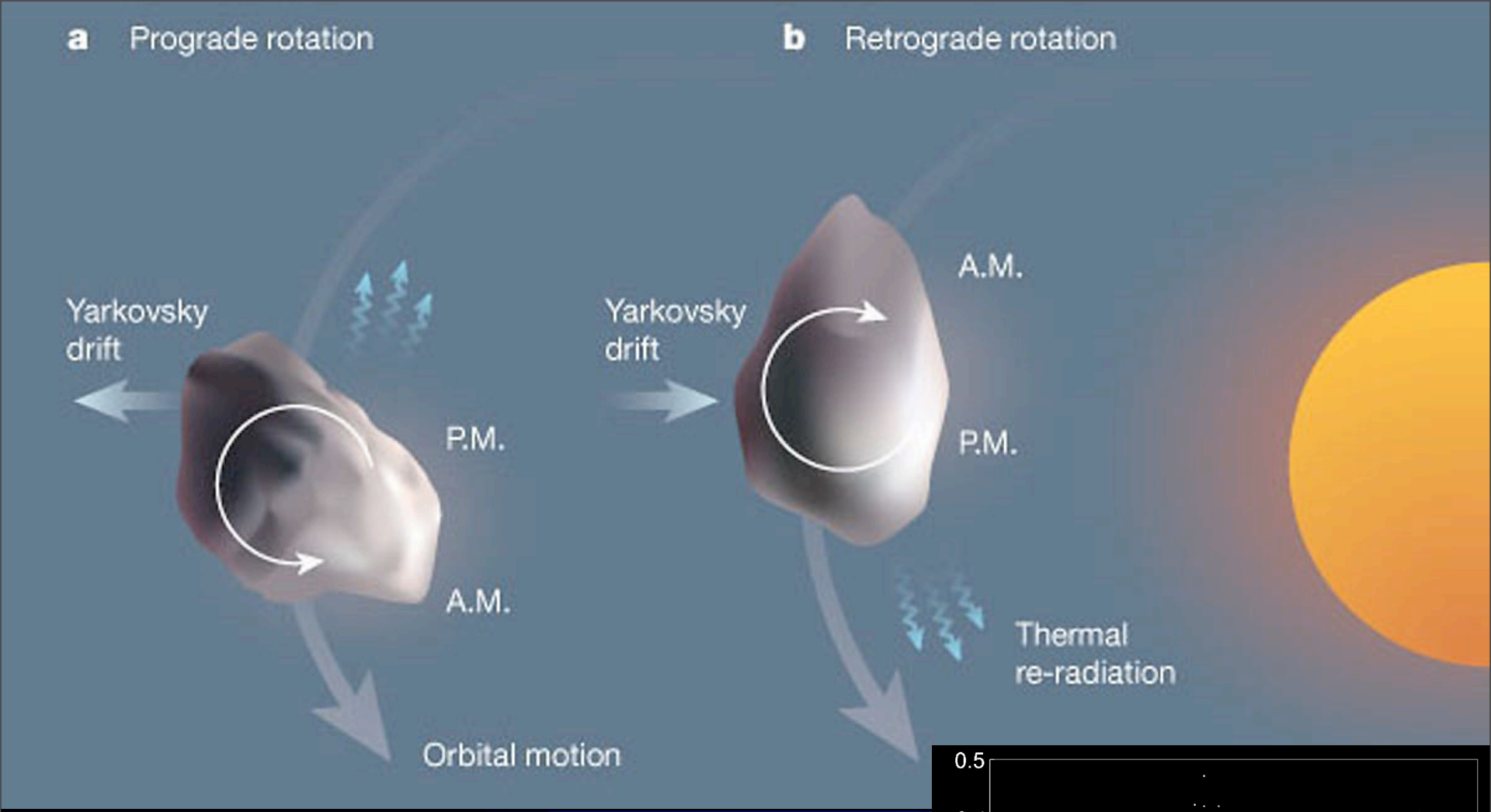
Travel time?
A few hundred thousand years

Meteorite travel times: Cosmic Ray Exposure ages

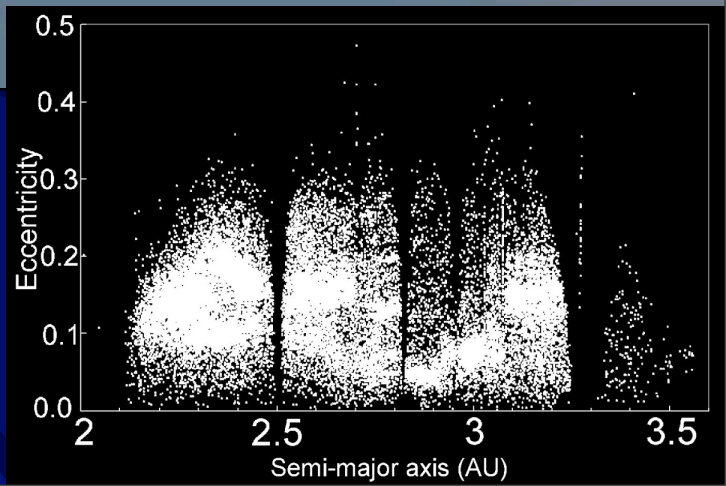



~467 Ma ago
all reached Earth in <2 Ma
^{21}Ne exposure age (10^5 yr)
0
2
4
6
8
10
12
14
16
Ark 002 C3.7
Ark 002 C3.8
Ark 002 C3.9
Ark 007 C4.2
Ark 007 C4.3
Ark 030 C4.4
Ark 030 C4.7
Gol 001 C2.1
Gol 001 C2.3
Gol 001 C2.4
Gol 001 C2.6
Gol 001 C2.7
Gol 001 C2.9
Sex 002 C3.1
Sex 002 C3.2
Sex 002 C3.3
Sex 003 C4.8
Sex 003 C4.9
Tre 002 C5.9
Goda 001 C3.5
Goda 001 C3.6
Gla 001 C5.1
Gla 001 C5.2


~467 Ma ago
all reached Earth in <2 Ma
^{21}Ne exposure age (10^5 yr)
Ark 002 C3.7
Ark 002 C3.8
3.9
4.2
4.3
4.4
4.7
2.1
2.3
2.4
2.6
2.7
2.9
3.1
3.2
3.3
4.8
4.9
5.9
3.5
3.6
5.1
5.2
Today
most take >10 Ma to reach Earth
Why have the rest taken so long?
L - chondrites
← 4 < 1 Ma
Cosmic - ray exposure age (Ma)



Yarkovsky Drift to reach a Kirkwood Gap

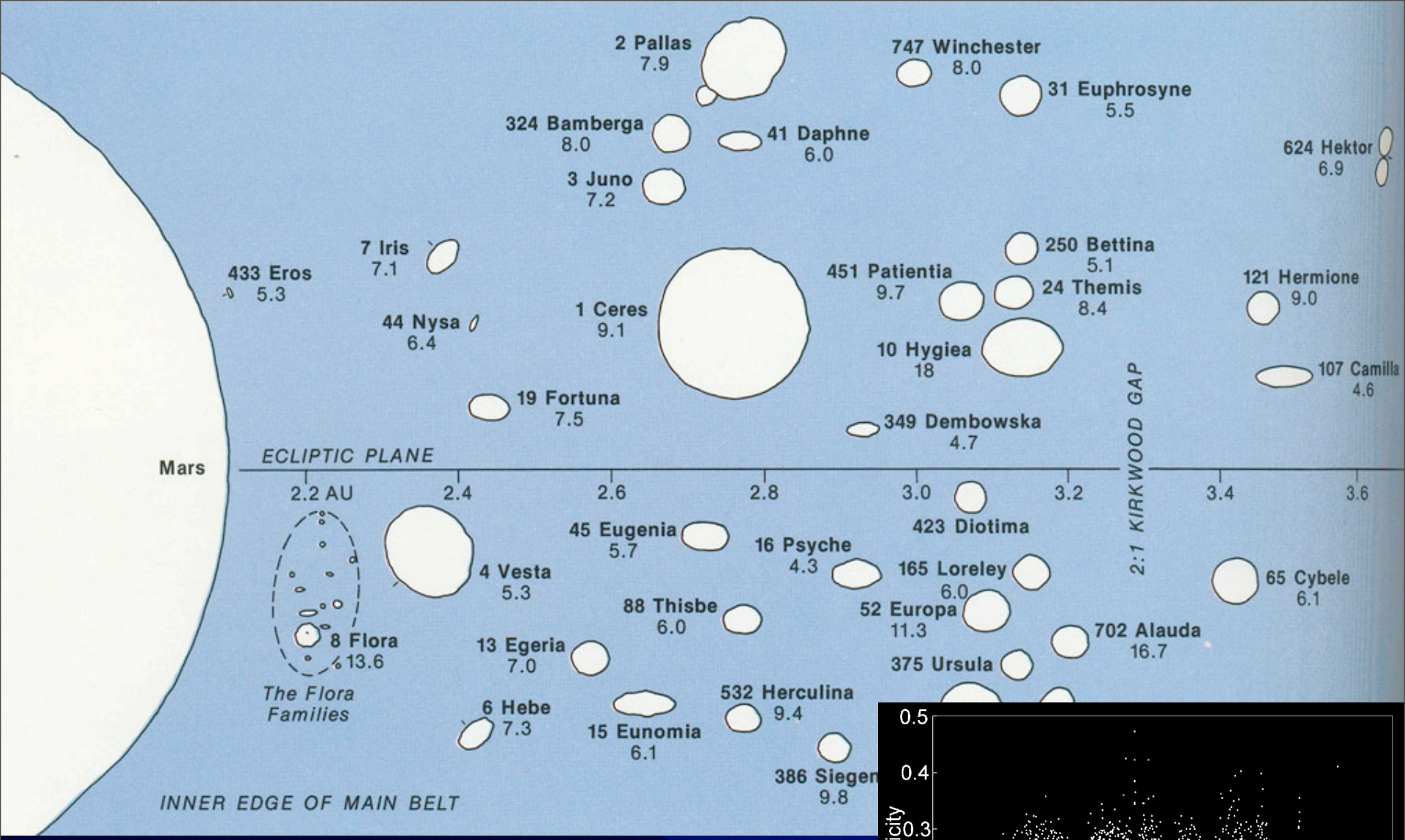


Where is the L Chondrite parent body?

Are there many to choose from?

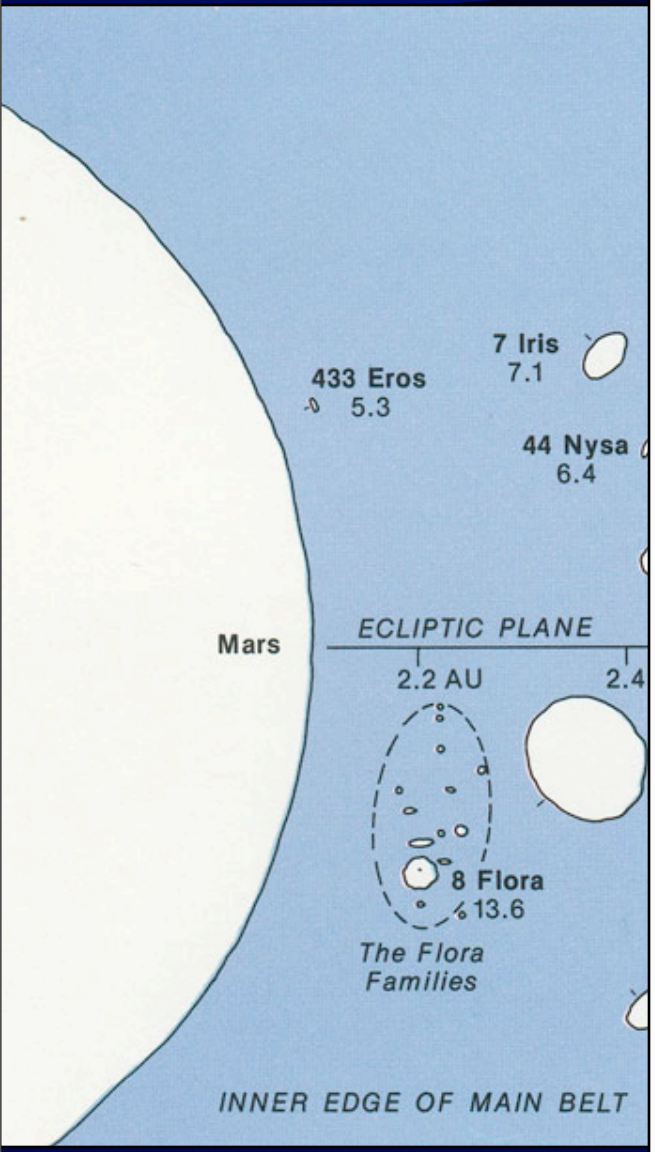
Where is the L Chondrite parent body?

Must be near a Kirkwood Resonance that delivers to Earth

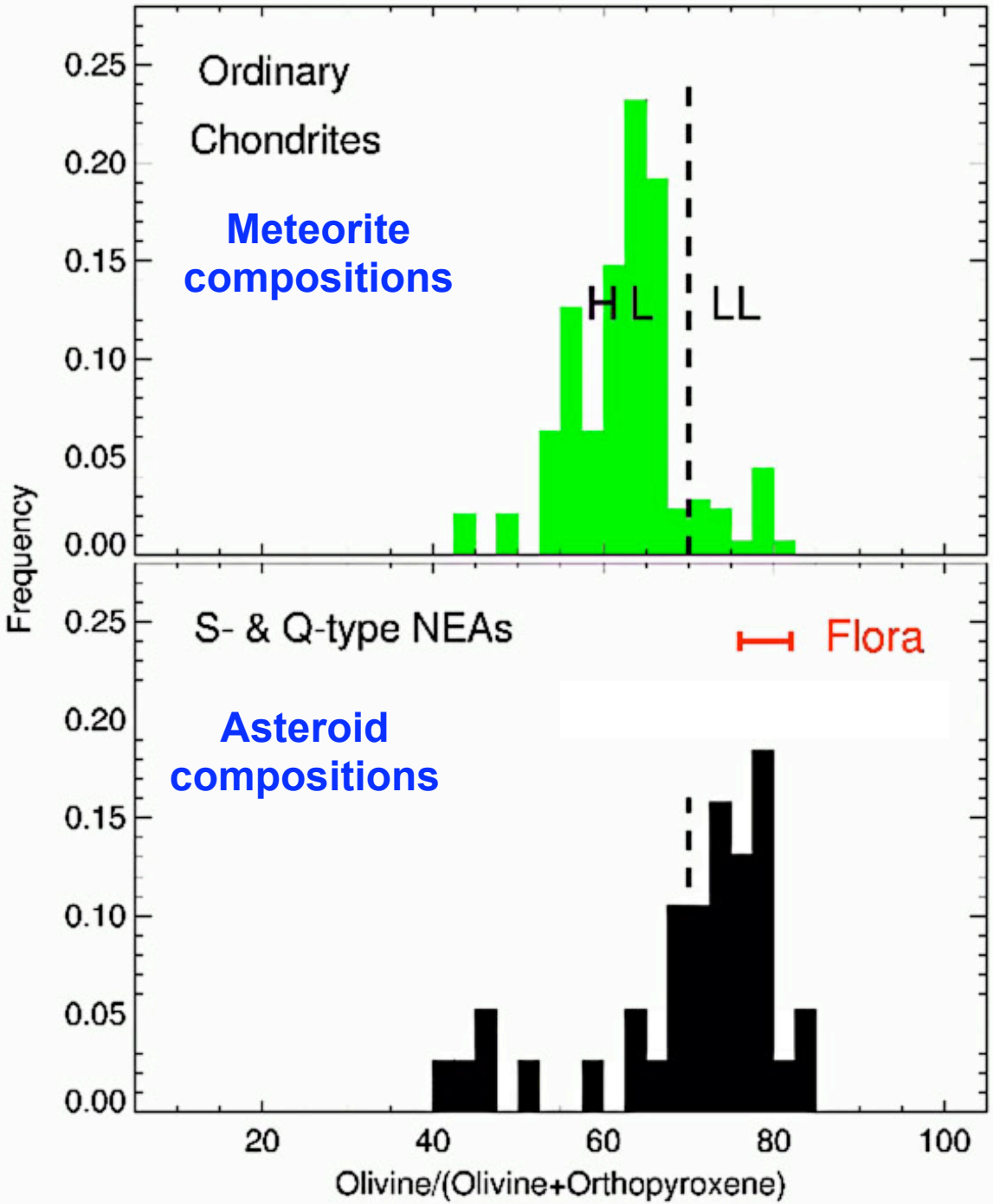


Is it Flora?

Close to the 7:2 and nu6 resonances

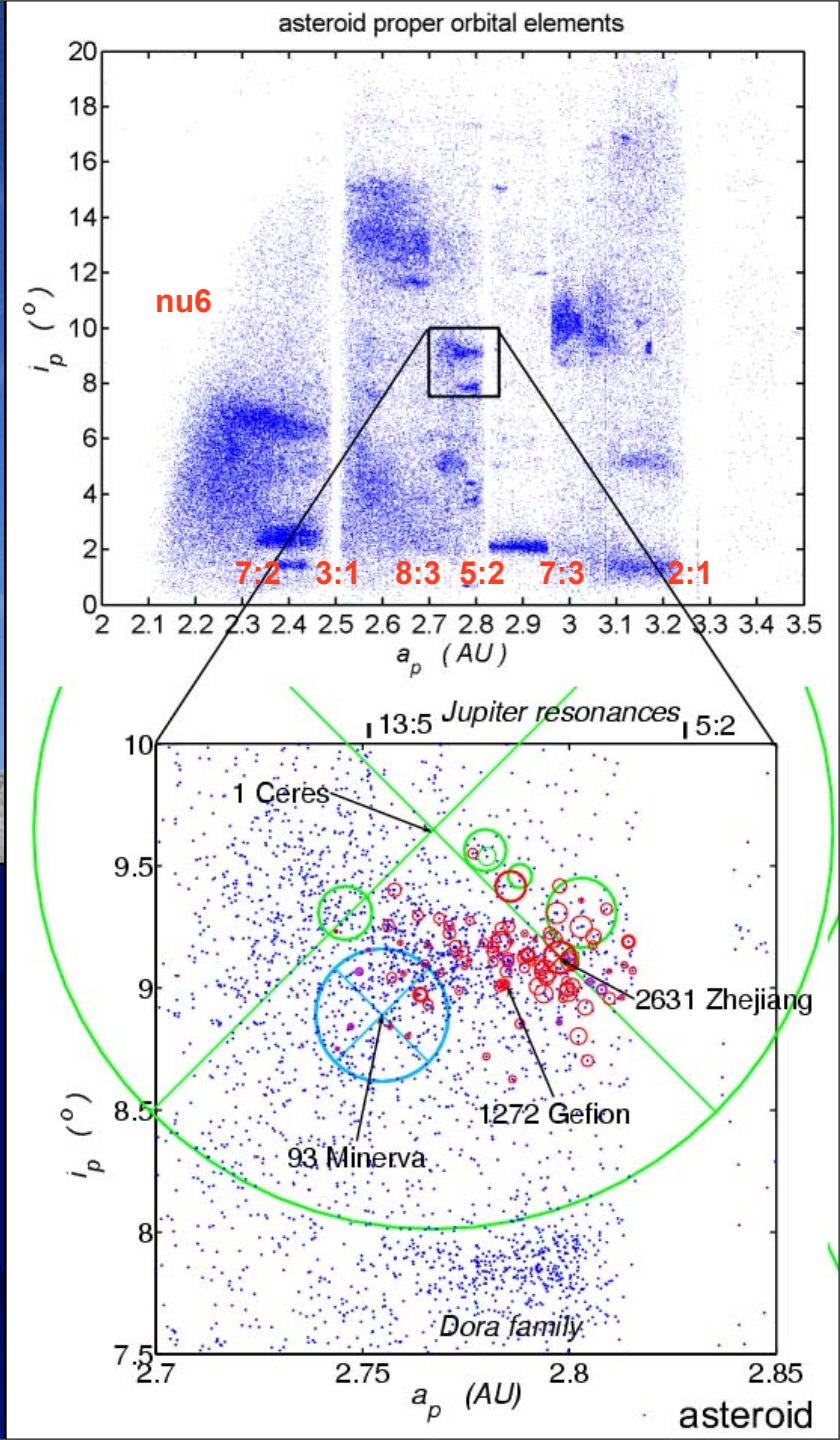


apparently not…



Perhaps Gefion?

Close to the 5:2 resonance



Where can I go to see meteorites?

See Bovedy and other meteorites at Armagh Planetarium

New meteorite display at the Ulster Museum