

Reminder: no food or
drinks in the planetarium!

Astronomy 4 - Solar System Astronomy

Reminders

Instructor: Dr. Ann Marie Cody

codyannmarie@fhda.edu

-Feel free to email me about course questions or astronomy in general.

Class website:

-*<https://amcody.github.io/astro4>*

Your one-stop shop for anything course related, including homework readings and exam practice material.

Lost and found:

-At the end of class, check to make sure you aren't leaving anything behind. Any items will be added to the Lost and Found box in back.

CHANGES I WOULD MAKE TO THE SOLAR SYSTEM

ADD MYSTERIOUS PLANETS
INSIDE MERCURY'S ORBIT

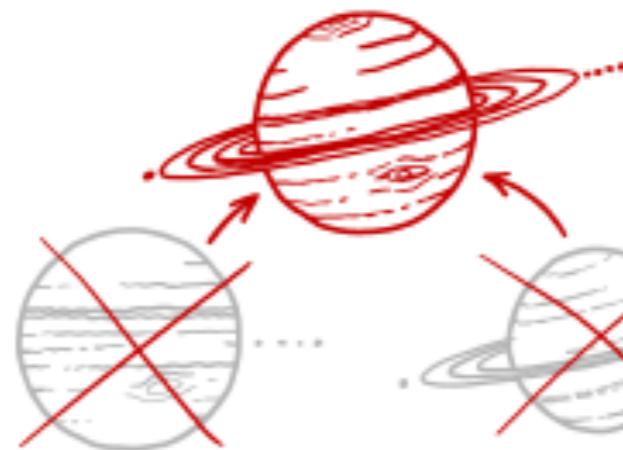
REPLACE OUR MOON WITH MARS.
MARS IS MORE INTERESTING AND
WE CAN CONSOLIDATE MISSIONS.



AFTER WHAT IT'S
BEEN THROUGH, VENUS
DESERVES RINGS
AND A MOON

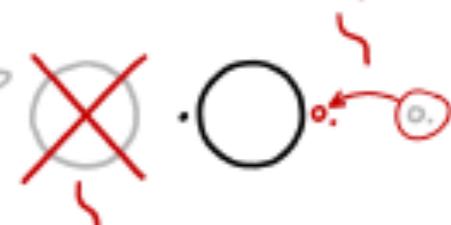
THE SOLAR
SYSTEM NEEDS A
SUPER-EARTH

MORE
ASTEROIDS!



MERGE THE BIG
PLANET AND THE
RINGED PLANET
INTO A BIG RINGED
PLANET ("JATURN")

SETTLE THE
PLANET THING BY
MAKING PLUTO A
MOON OF NEPTUNE



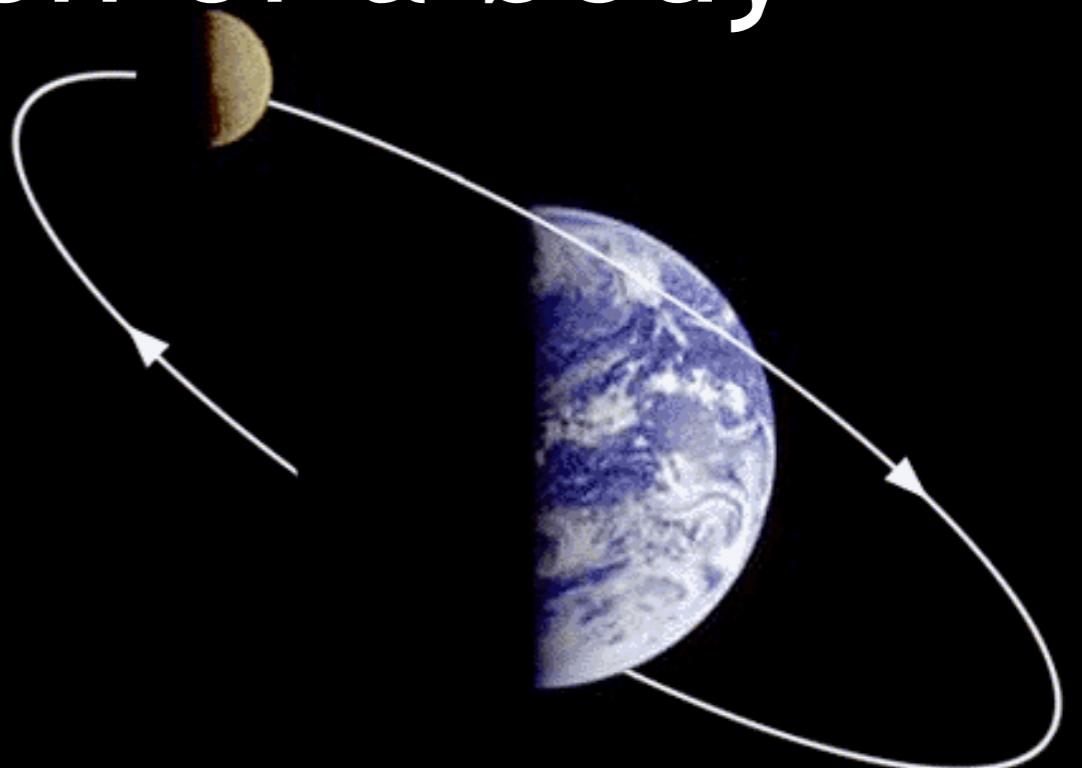
CUT URANUS.
URANUS AND NEPTUNE
ARE REDUNDANT AND
NEPTUNE IS BETTER.
TOUGH BUT FAIR.



Starting where we left off...

- Picture the moon circling Earth.
- If there were no force altering the moon's motion, it would continue moving in a straight line and leave Earth forever.
- It can circle Earth *only* if Earth attracts it- i.e., by *gravity*

An orbit is the motion of a body through space, under the influence of gravity.

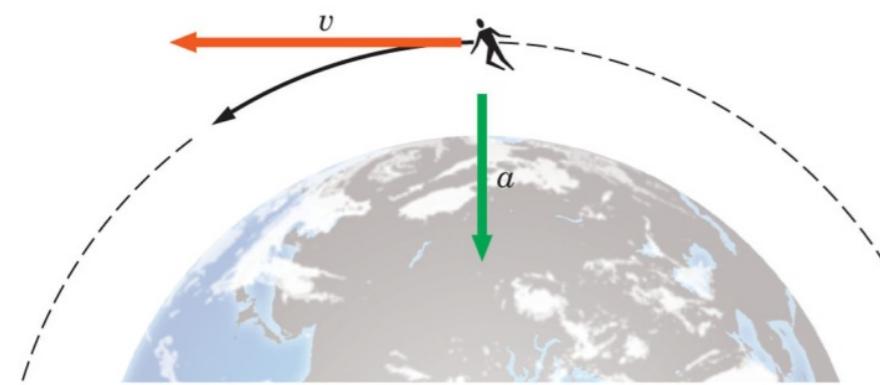




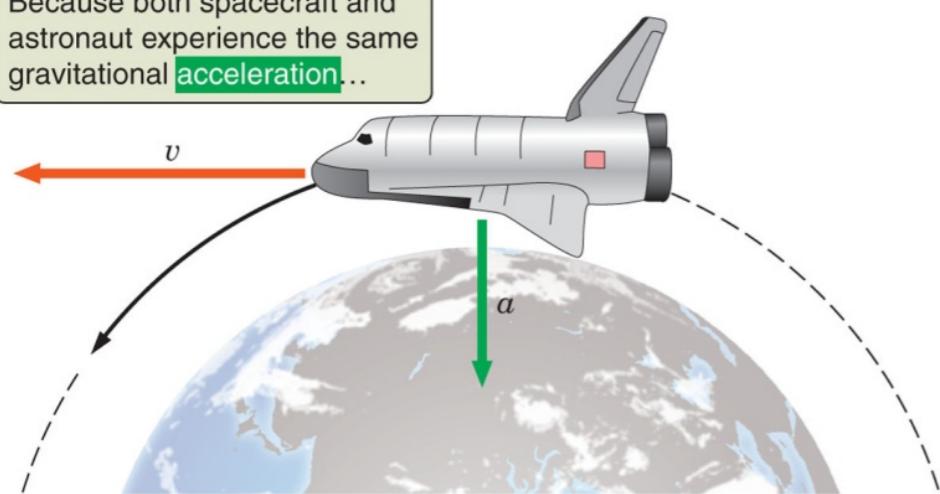
- The gravitational force results in an acceleration
- All objects on Earth fall with the same acceleration known as g .
- $g = 9.8 \text{ m/s}^2$

$$F_{\text{weight}} = m \times g$$

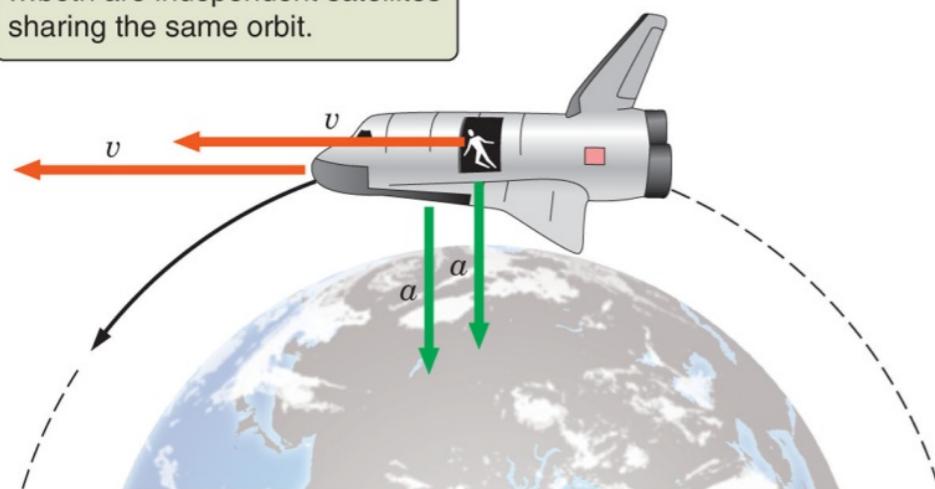
Like Newton's cannonball, an astronaut **falls** freely around Earth.



Because both spacecraft and astronaut experience the same gravitational **acceleration**...



...both are independent satellites sharing the same orbit.



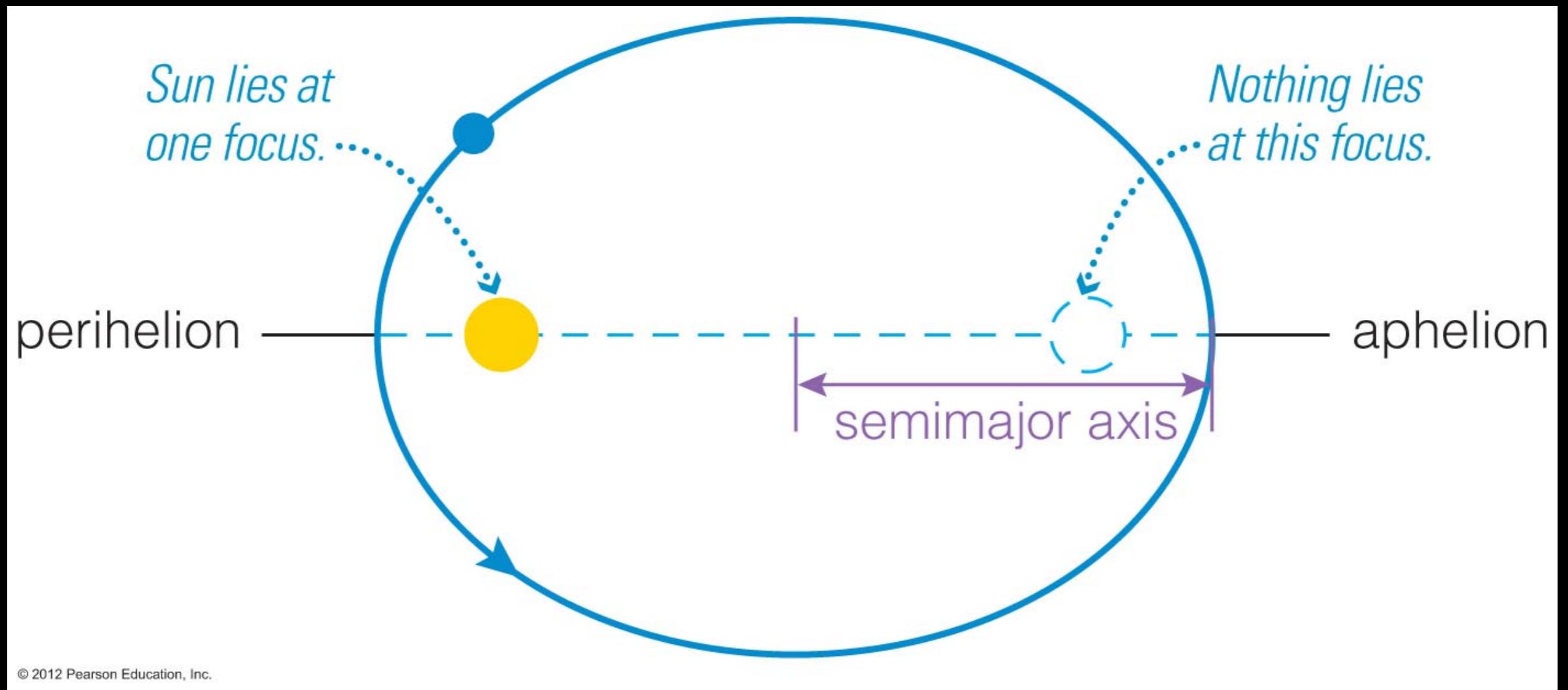
- An astronaut inside an orbiting space shuttle will experience **free fall** because he/she is falling around Earth at the same rate as the shuttle.

- He/she is not weightless.



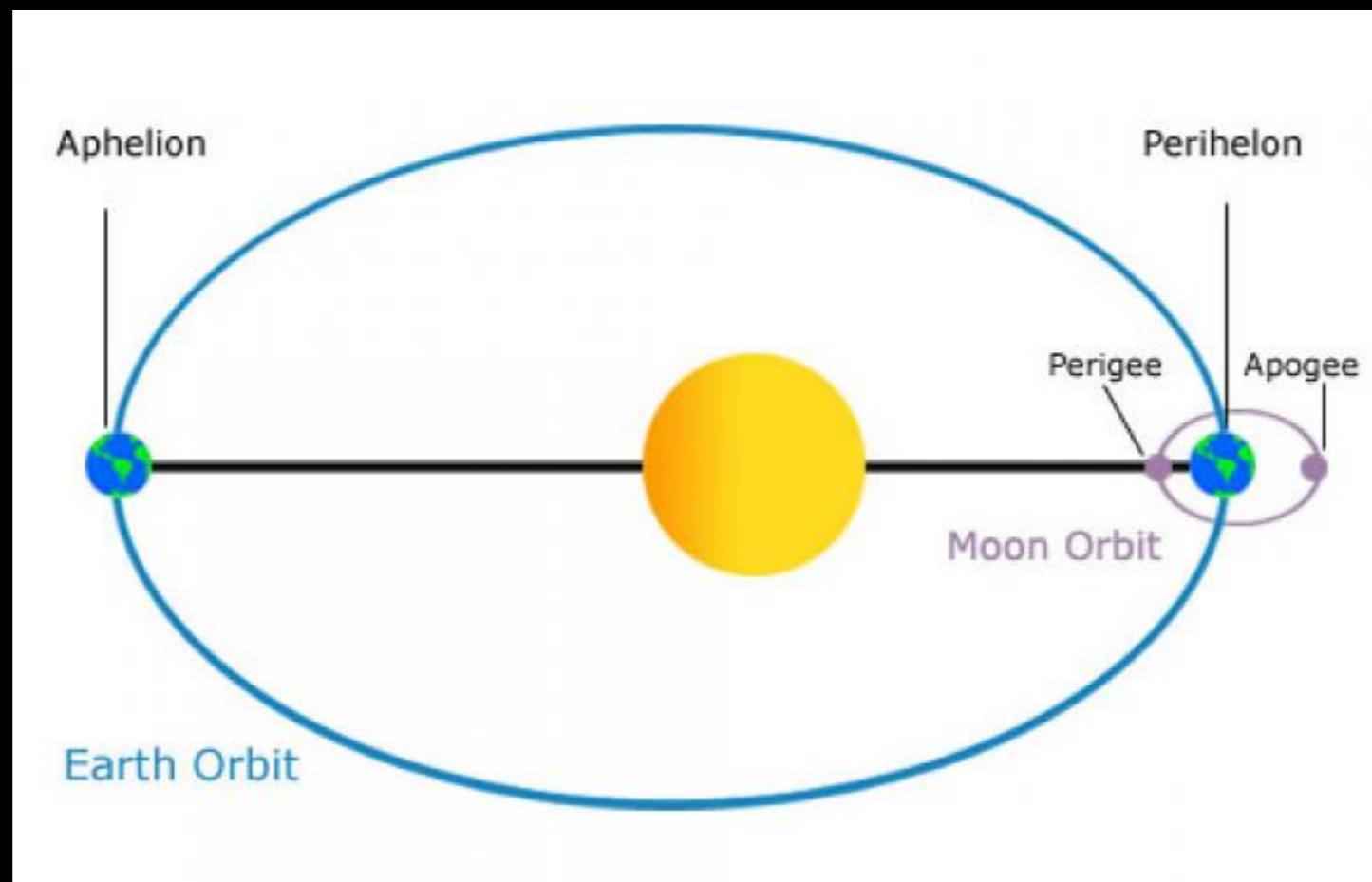
S131E010040

As we know, orbits are ellipses



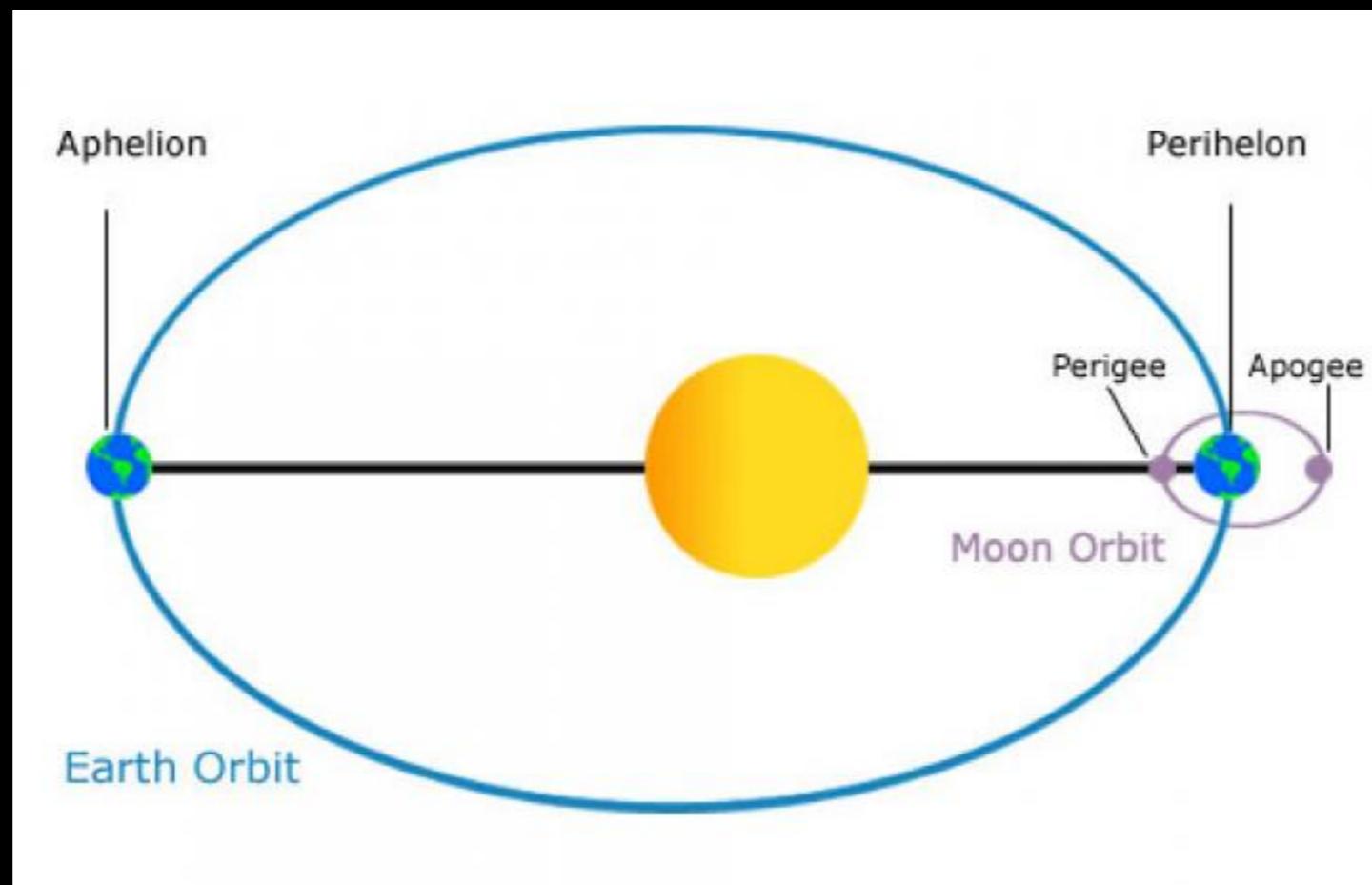
Some terminology

- Perihelion/aphelion – Earth's closest approach/farthest point from the Sun
- Perigee/apogee – Moon's closest/farthest point from the Earth



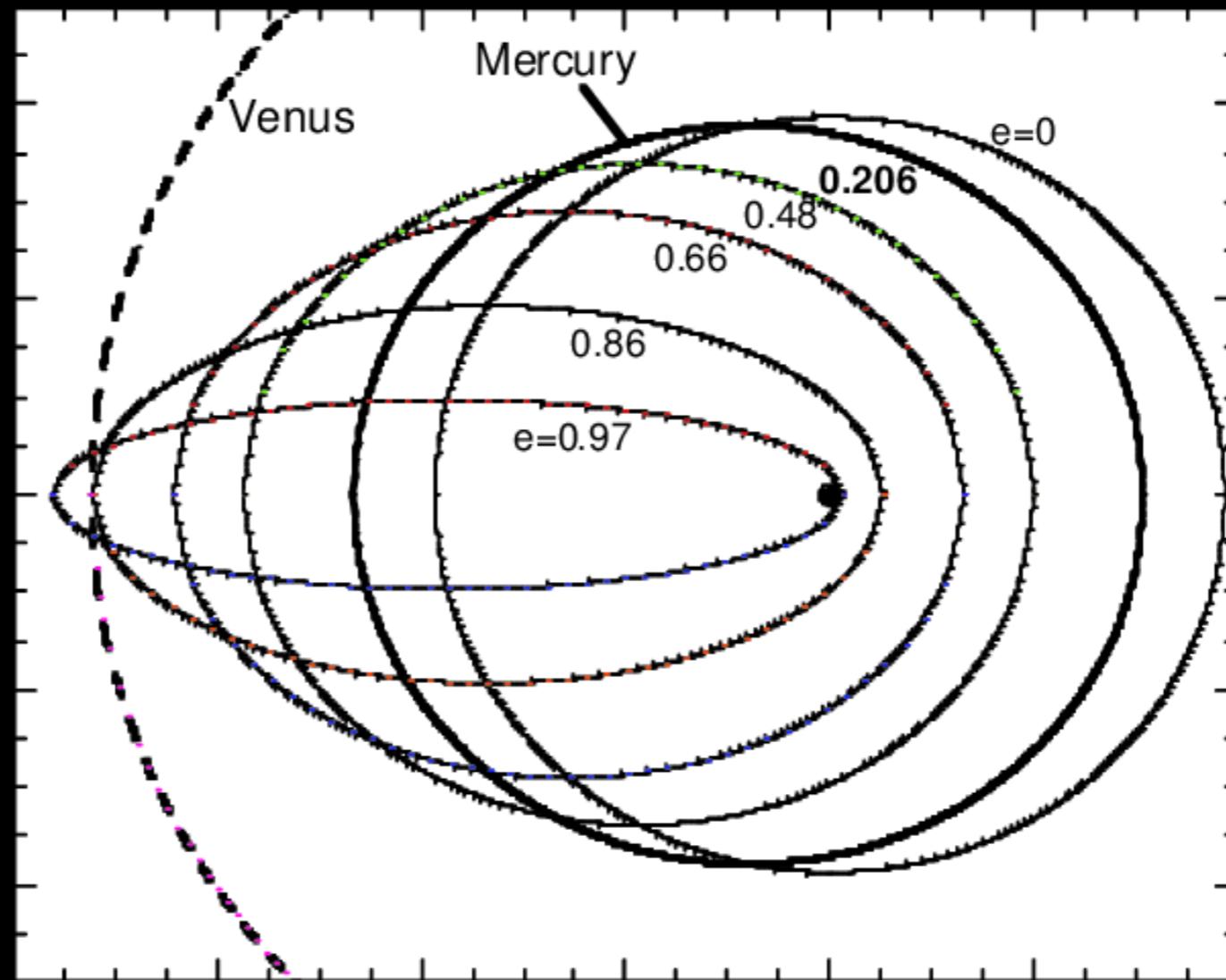
Close approach does NOT mean summertime!

- Perihelion – Earth’s closest approach/ farthest point from the Sun
- This year, perihelion occurred on January 4th.



Orbits of the Planets

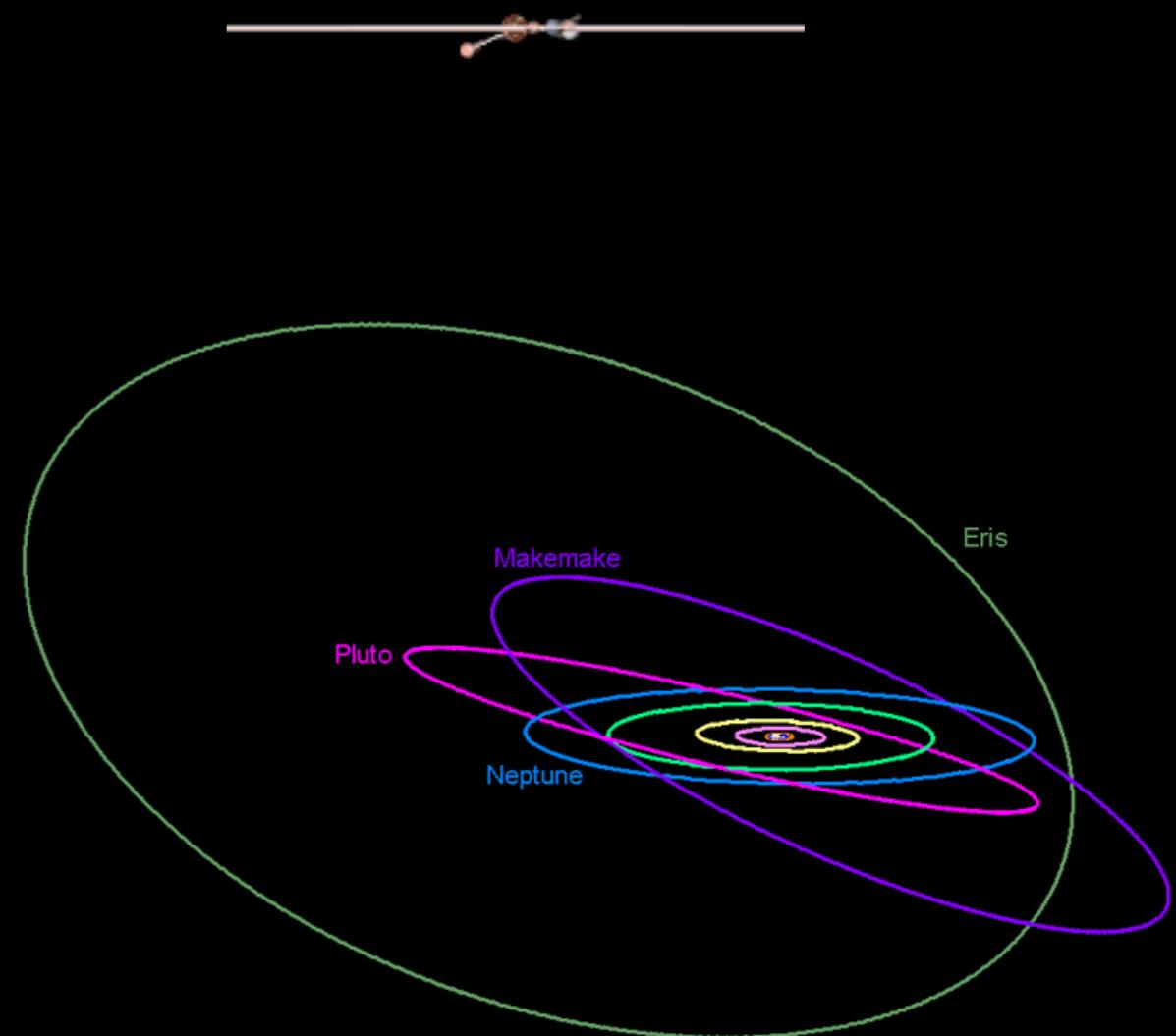
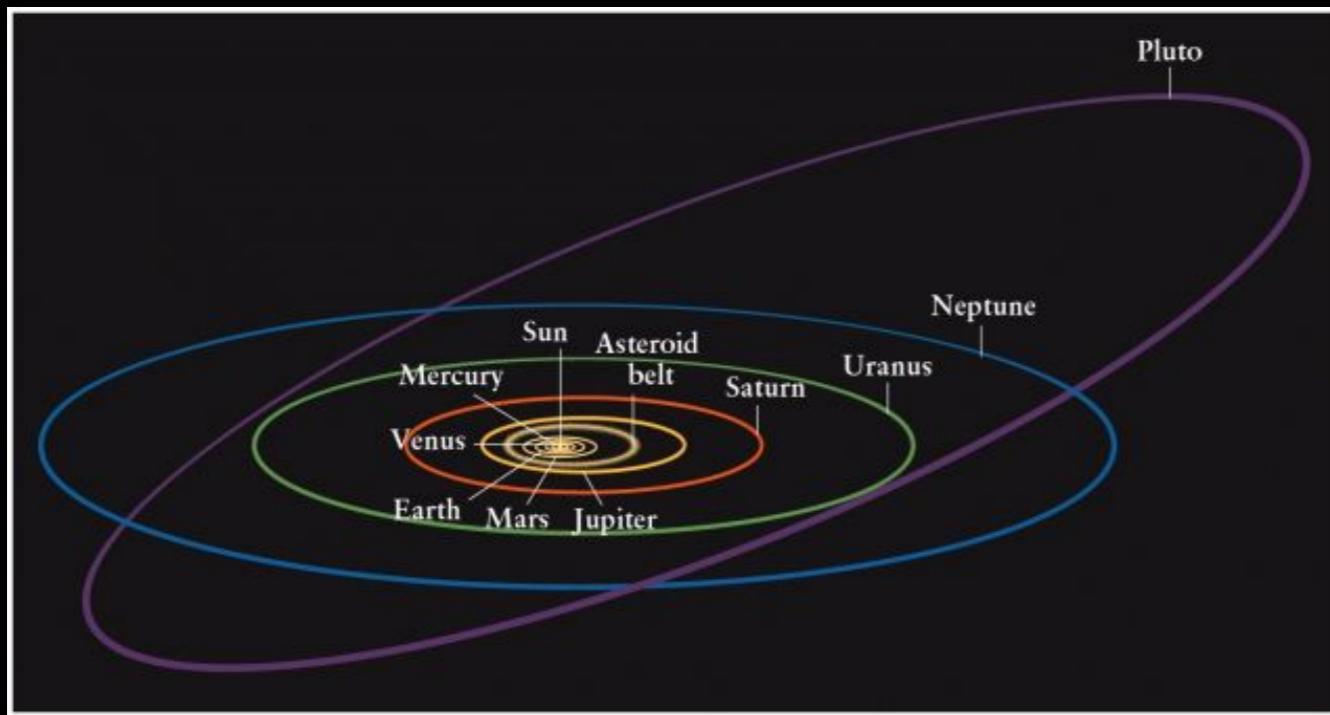
- The orbits lie in nearly the same plane
- Mercury's orbit is the most eccentric, at $e=0.21$



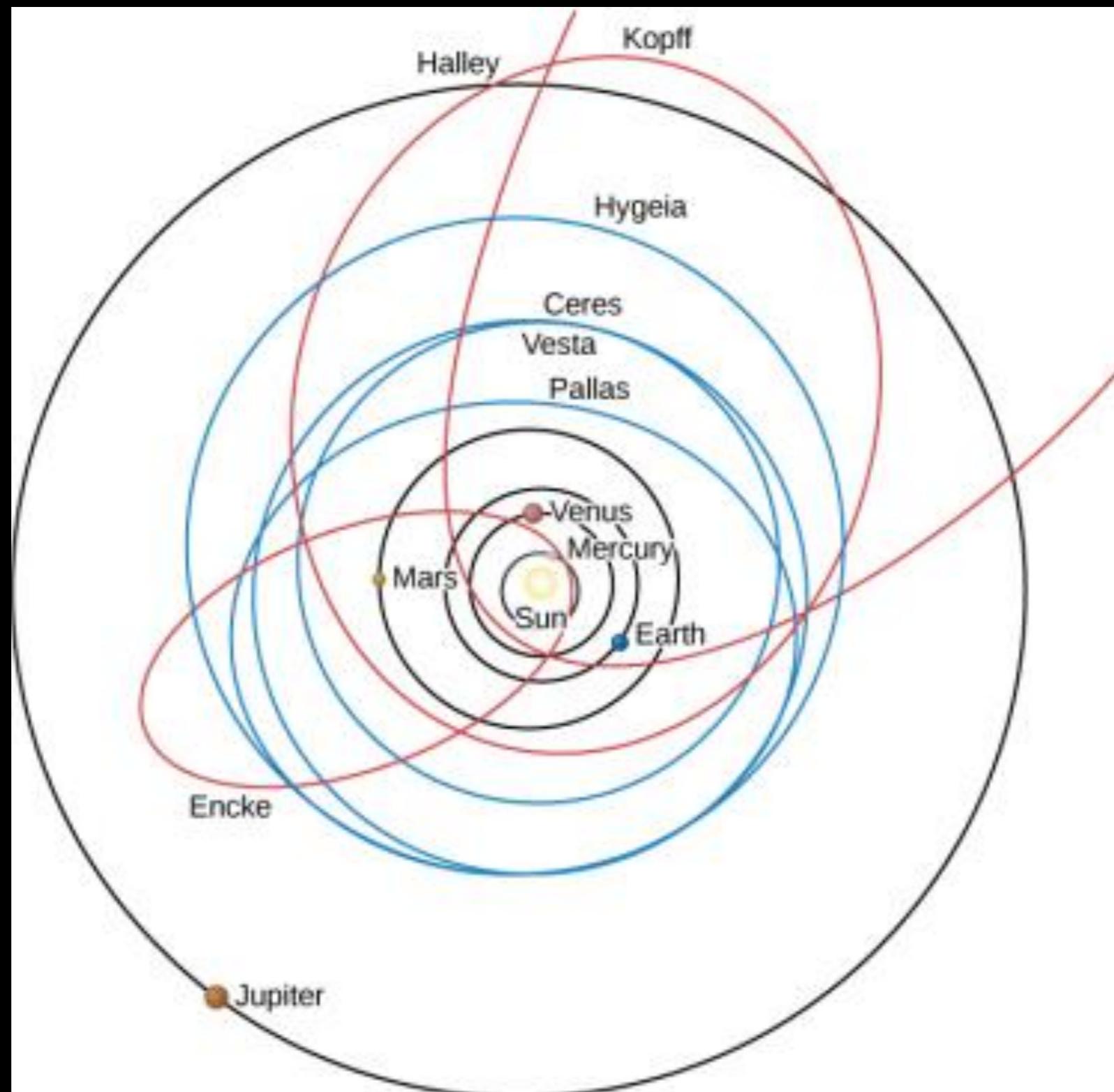
Dwarf Planets

Orbital inclination...out of the “ecliptic plane”

- Pluto is tilted by 17°
- Eris is inclined by a full 44° !



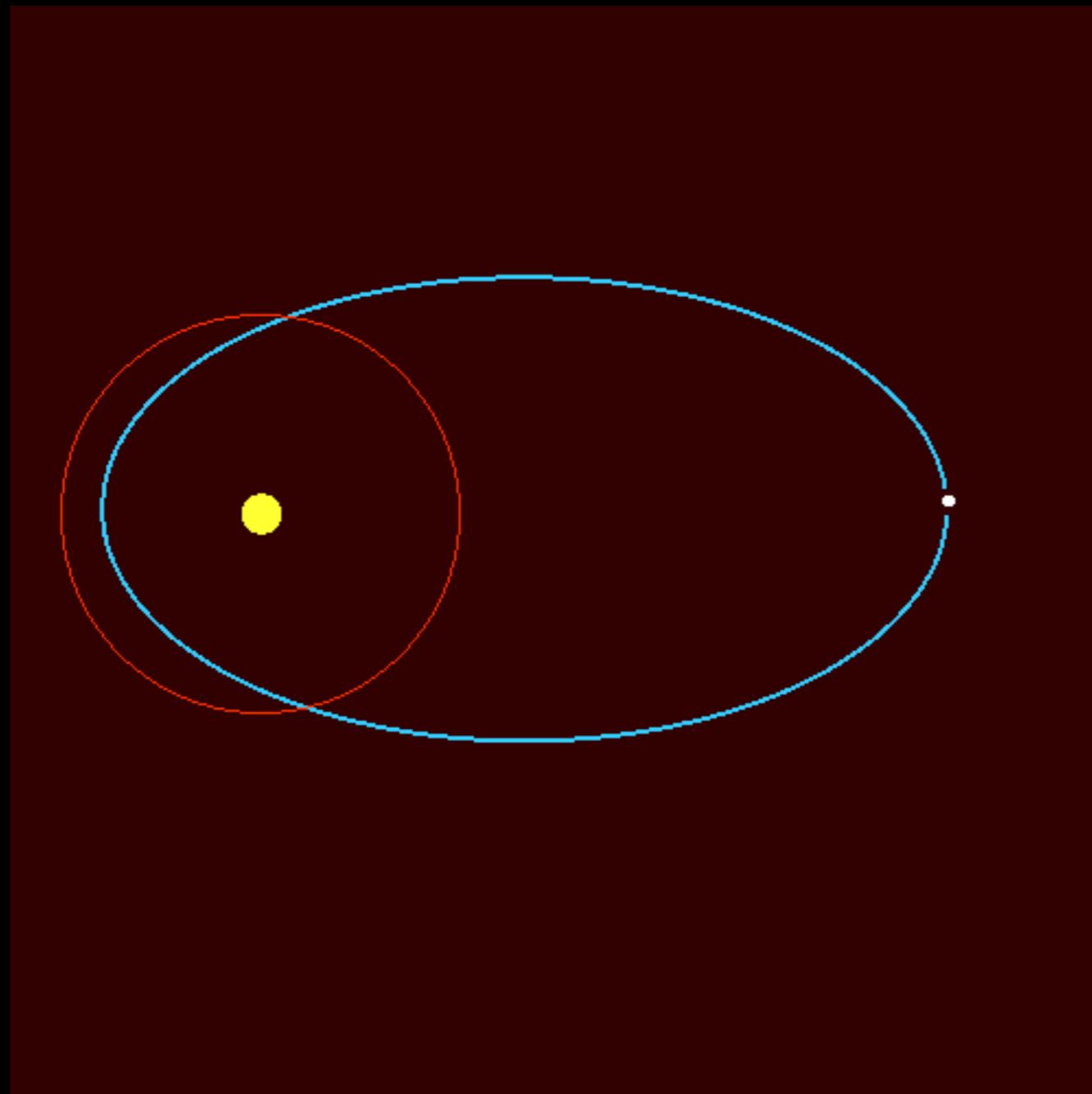
Orbits of Planets, Asteroids, and Comets



Orbits of Asteroids and Comets

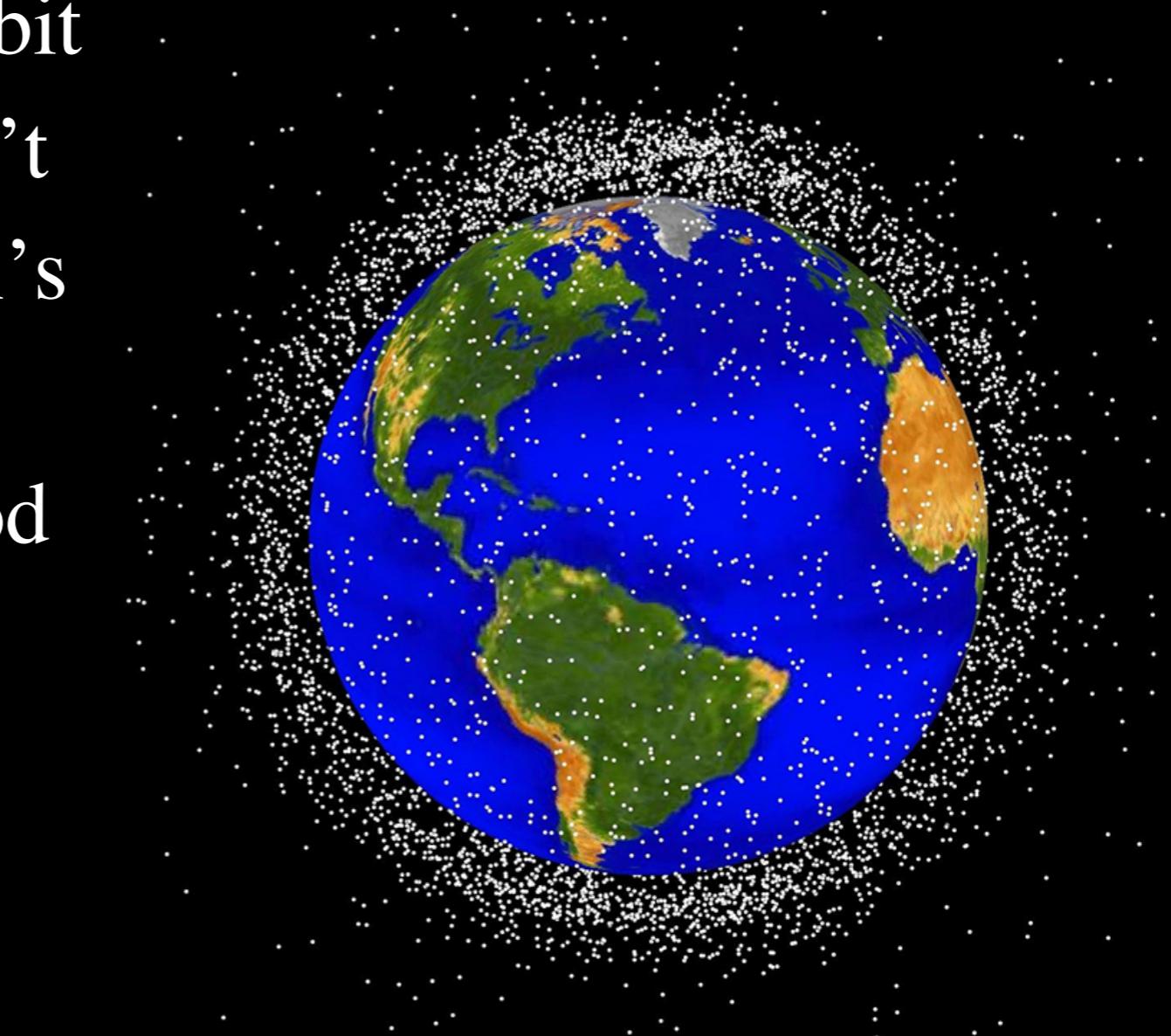
- These smaller objects are the remnants of solar system formation
- Asteroids are irregularly shaped bodies with no atmosphere; most of them orbit between Mars and Jupiter
- Comets are icy bodies that formed in the outer solar system. Most have highly eccentric orbits.

What do Kepler's Laws say about comets?
They spend a lot of time in the outer reaches
of the solar system.



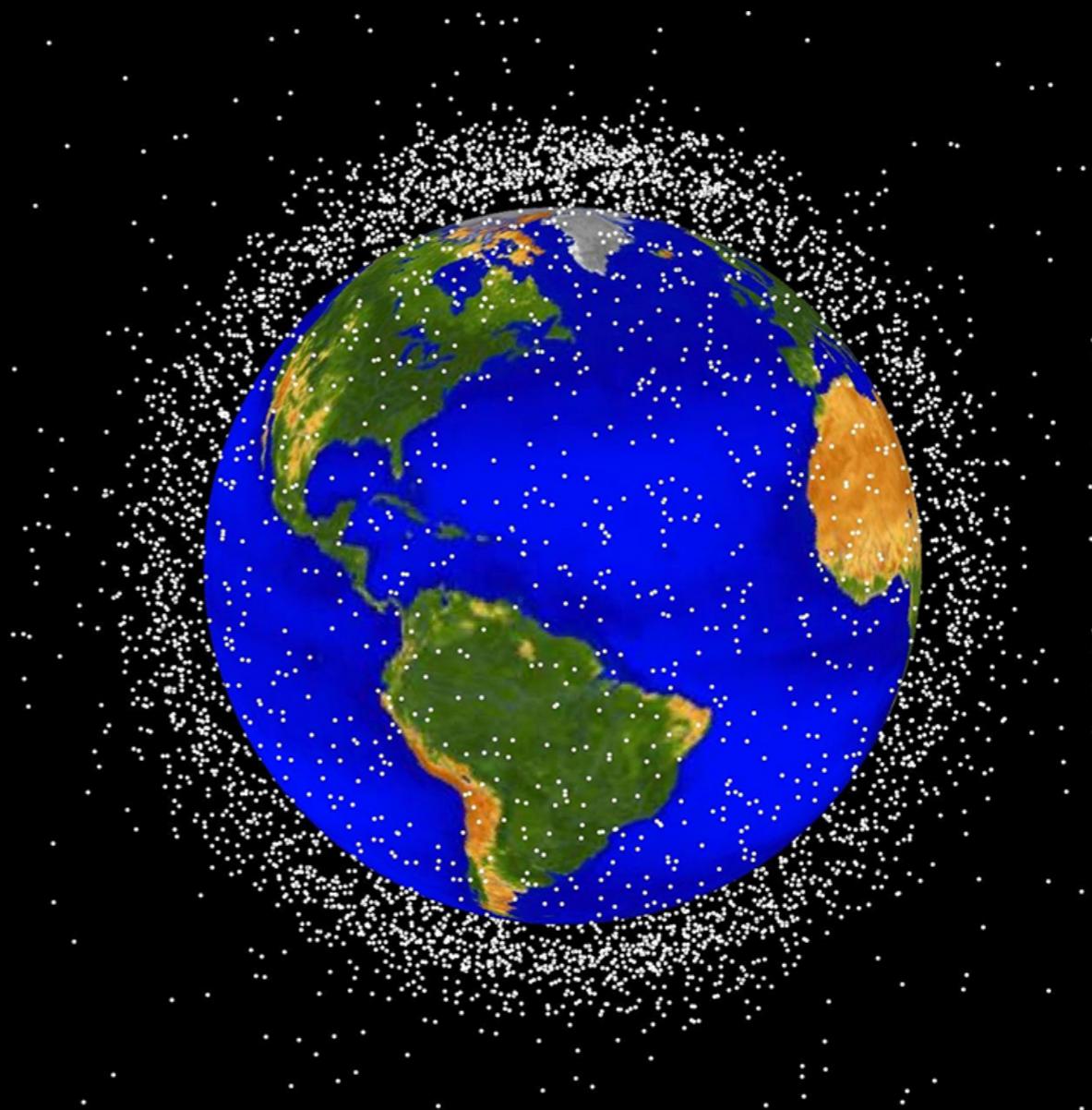
Man-made objects orbit too

- Satellites
 - Would remain in orbit perpetually if it weren't for friction from Earth's atmosphere
 - 90-min orbital period
- Space probes

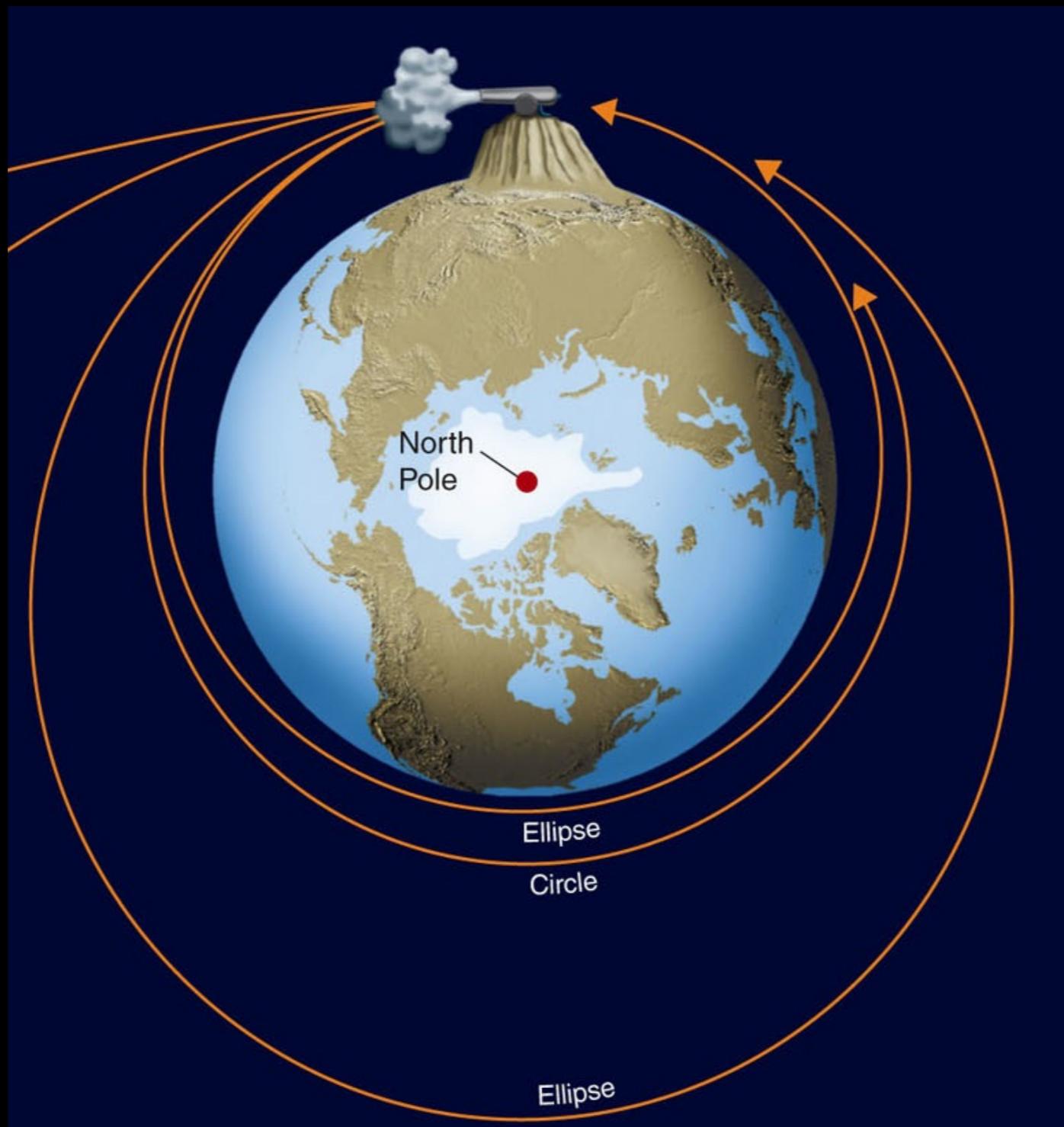


How many satellites are orbiting Earth nowadays?

- A. 50
- B. 500
- C. 5,000
- D. 50,000

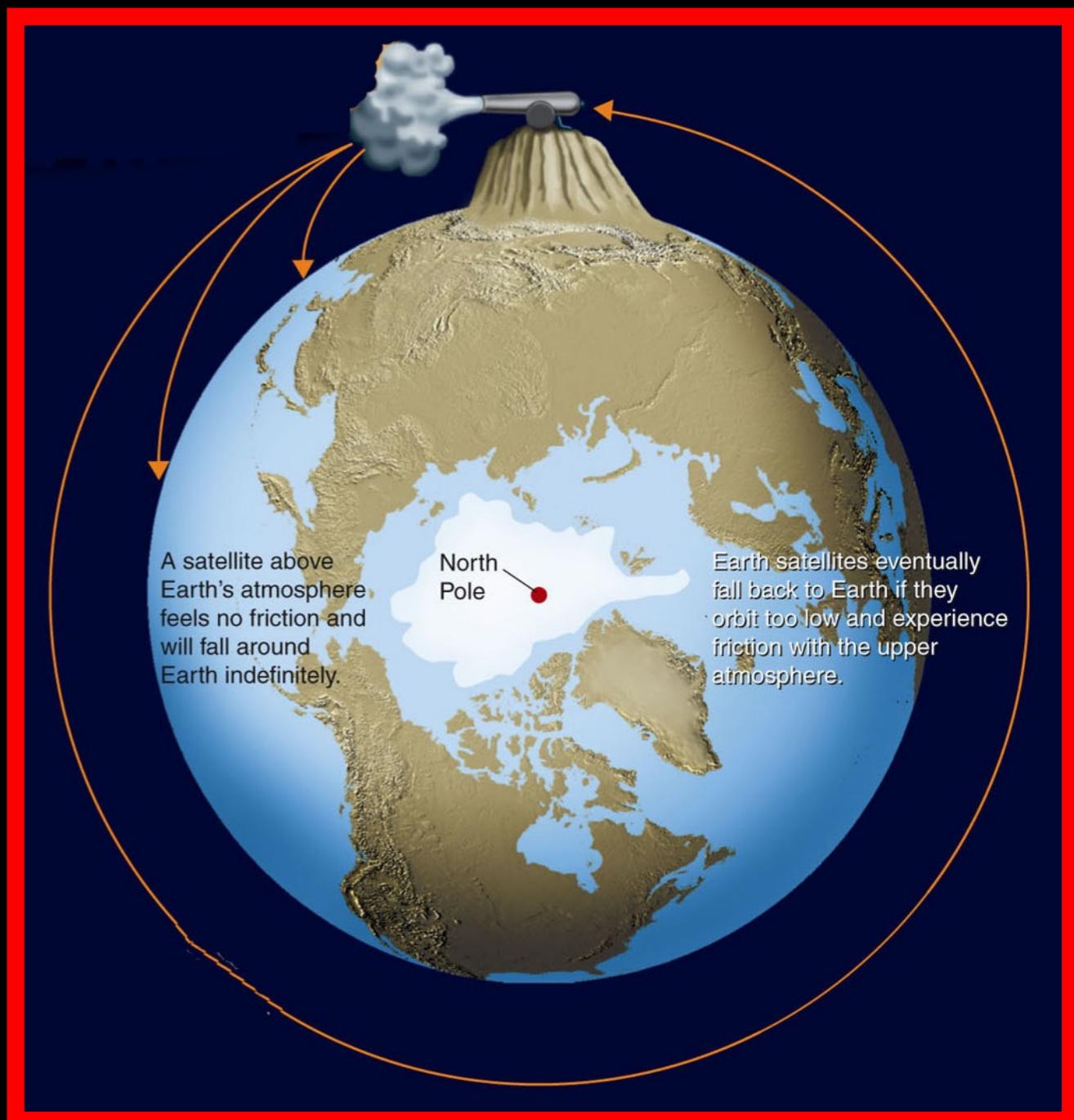


There are three important ideas to note about orbiting the Earth.

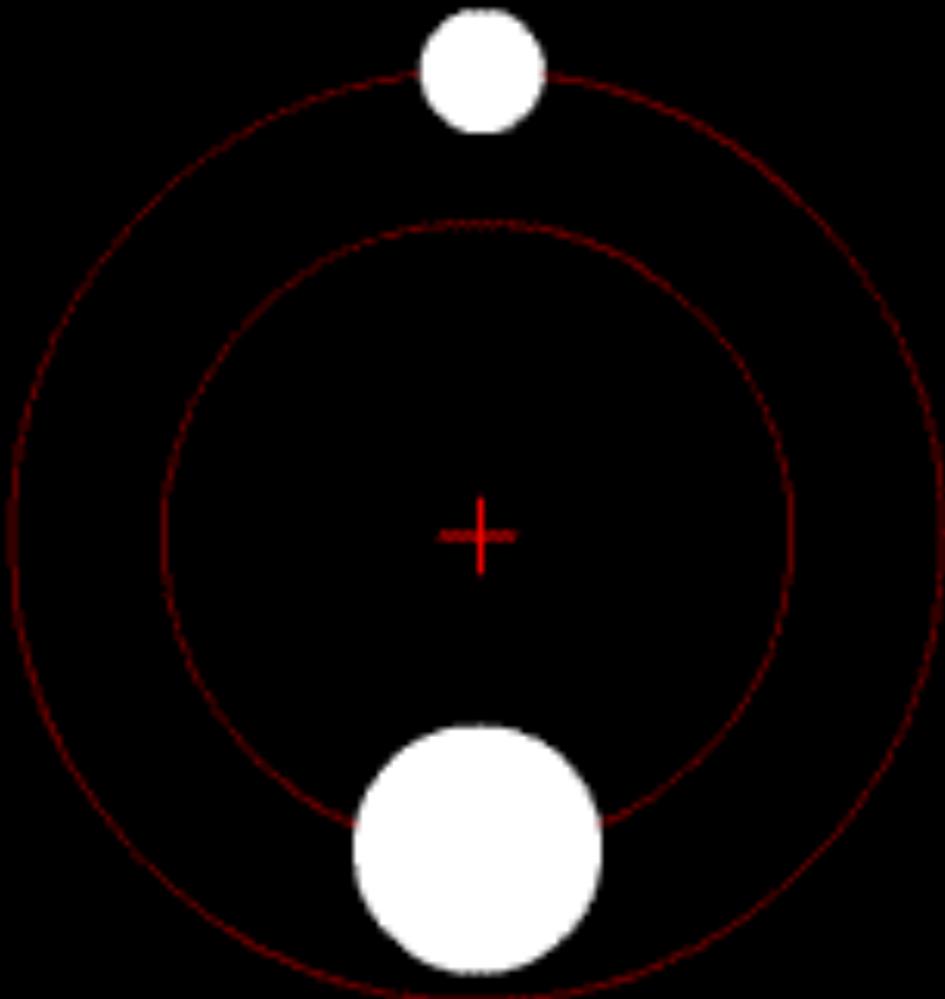


One, an object orbiting Earth is actually falling (being accelerated) toward Earth's center.

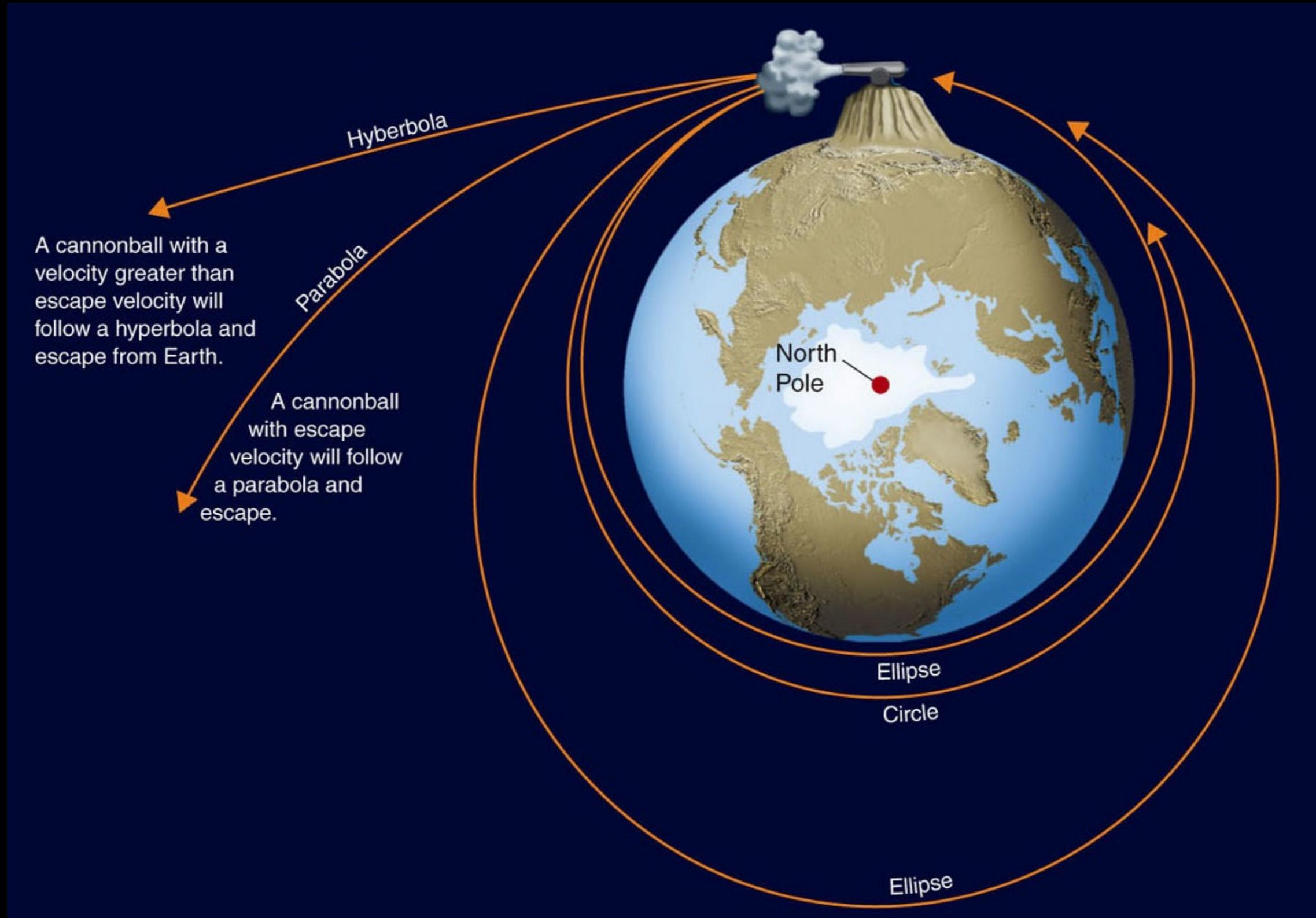
An object in a stable orbit continuously misses Earth because of its orbital velocity.



Two, objects orbiting each other
actually revolve around their mutual
center of mass.



Three, the difference between closed orbits and open orbits.

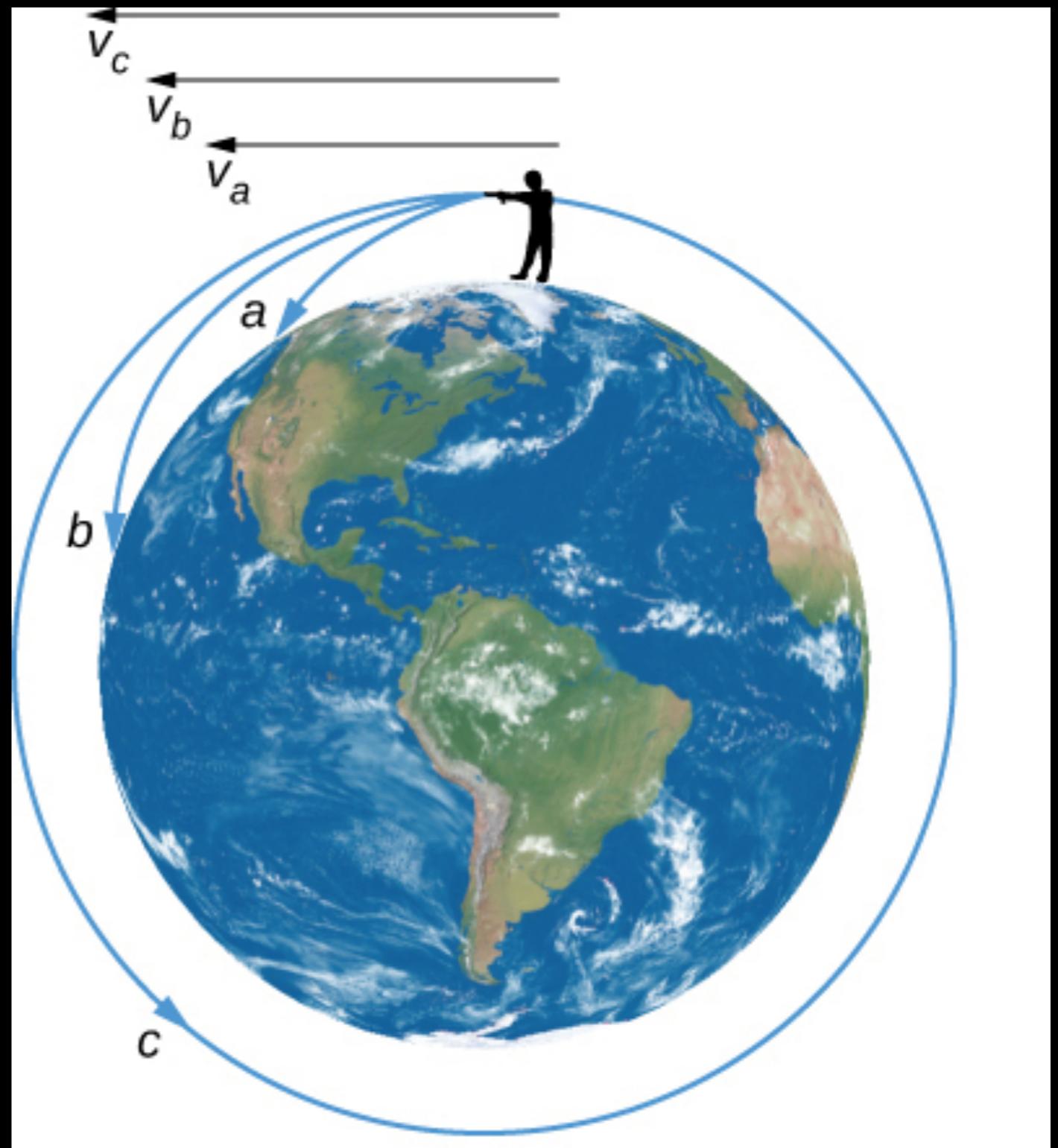


How do we launch something into orbit?

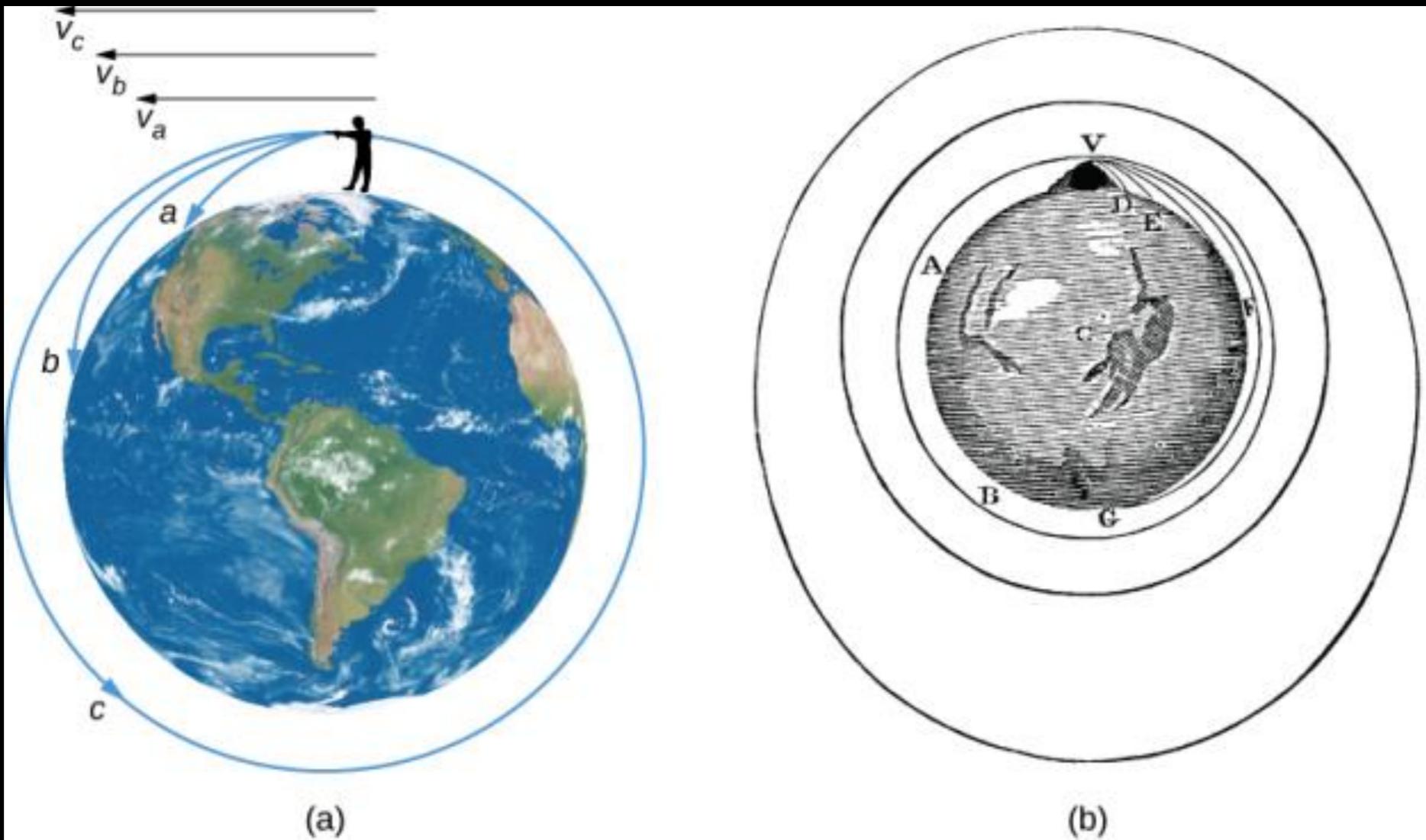
By firing it fast enough to escape our planet.

$$V_{\text{escape}} \sim 8 \text{ km/s}$$

An object in a stable orbit continuously misses Earth because of its orbital velocity.



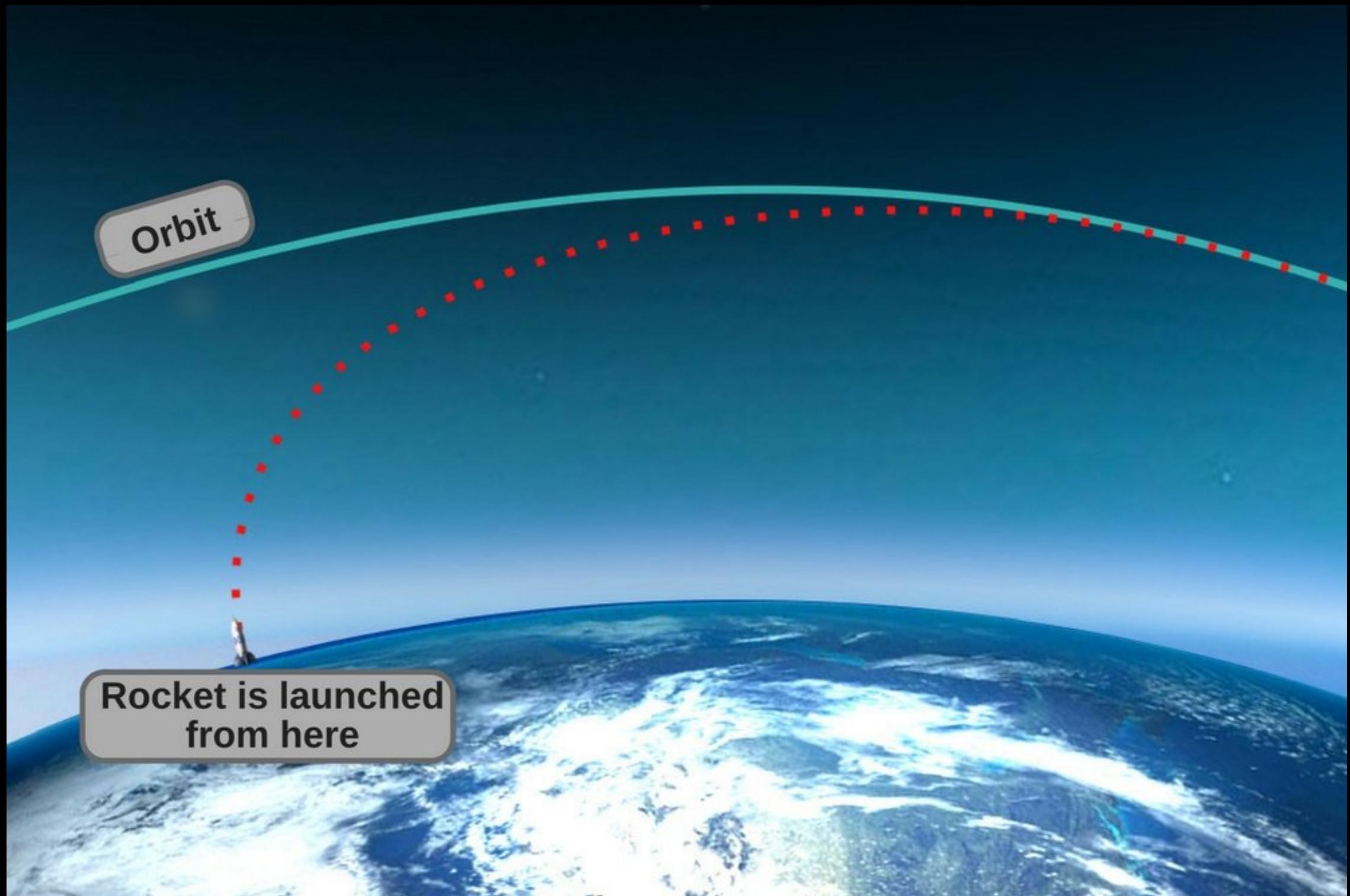
Newton's cannon



Launch your own cannons here!

<https://spaceplace.nasa.gov/how-orbits-work/en/>

How do we actually launch something into orbit?



Kaboom! The Biggest Space Bloopers of 2019

By [Elizabeth Howell](#) a month ago

Spaceflight is hard.

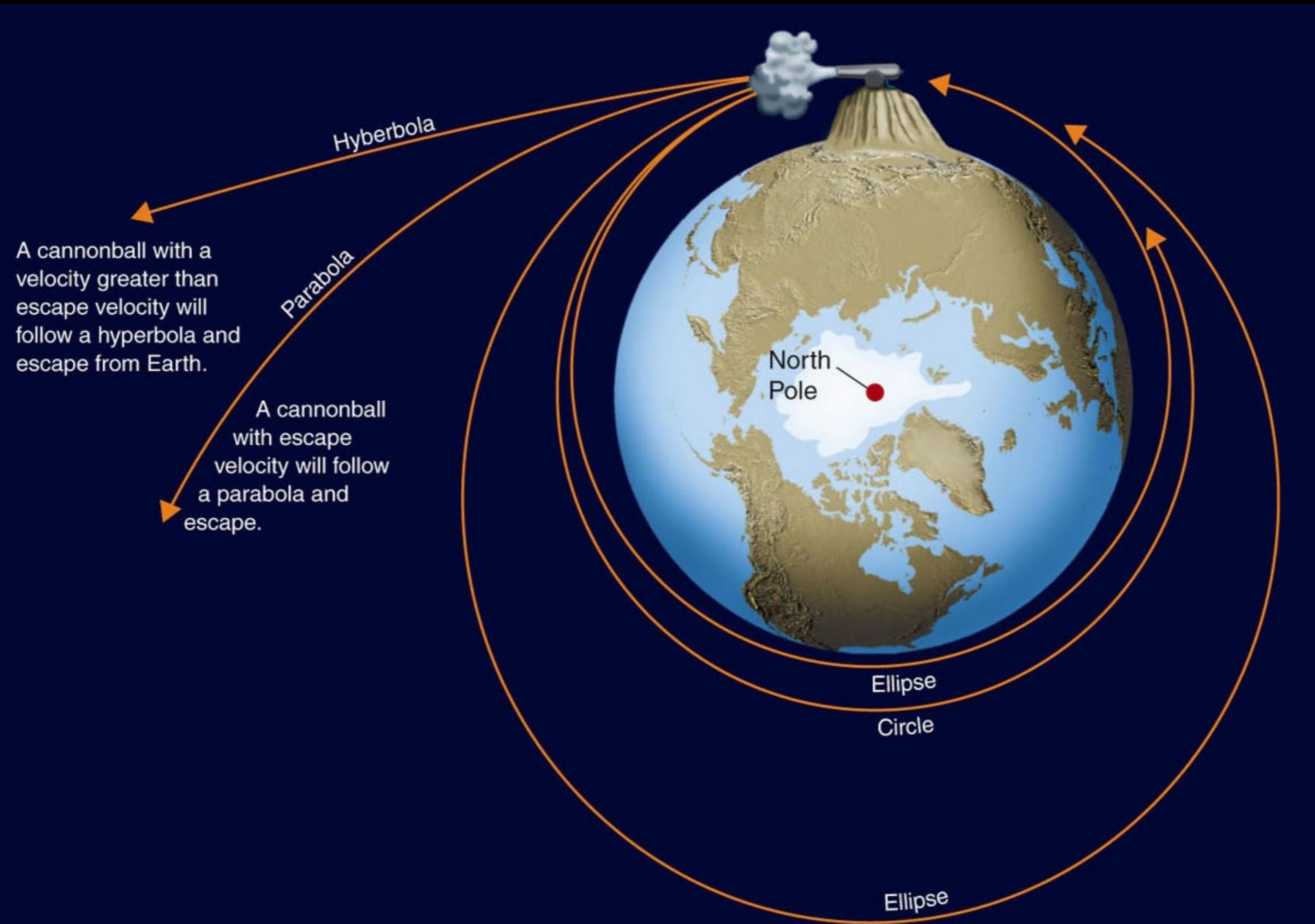
Boeing Starliner in wrong orbit

[Click here for more Space.com videos...](#)

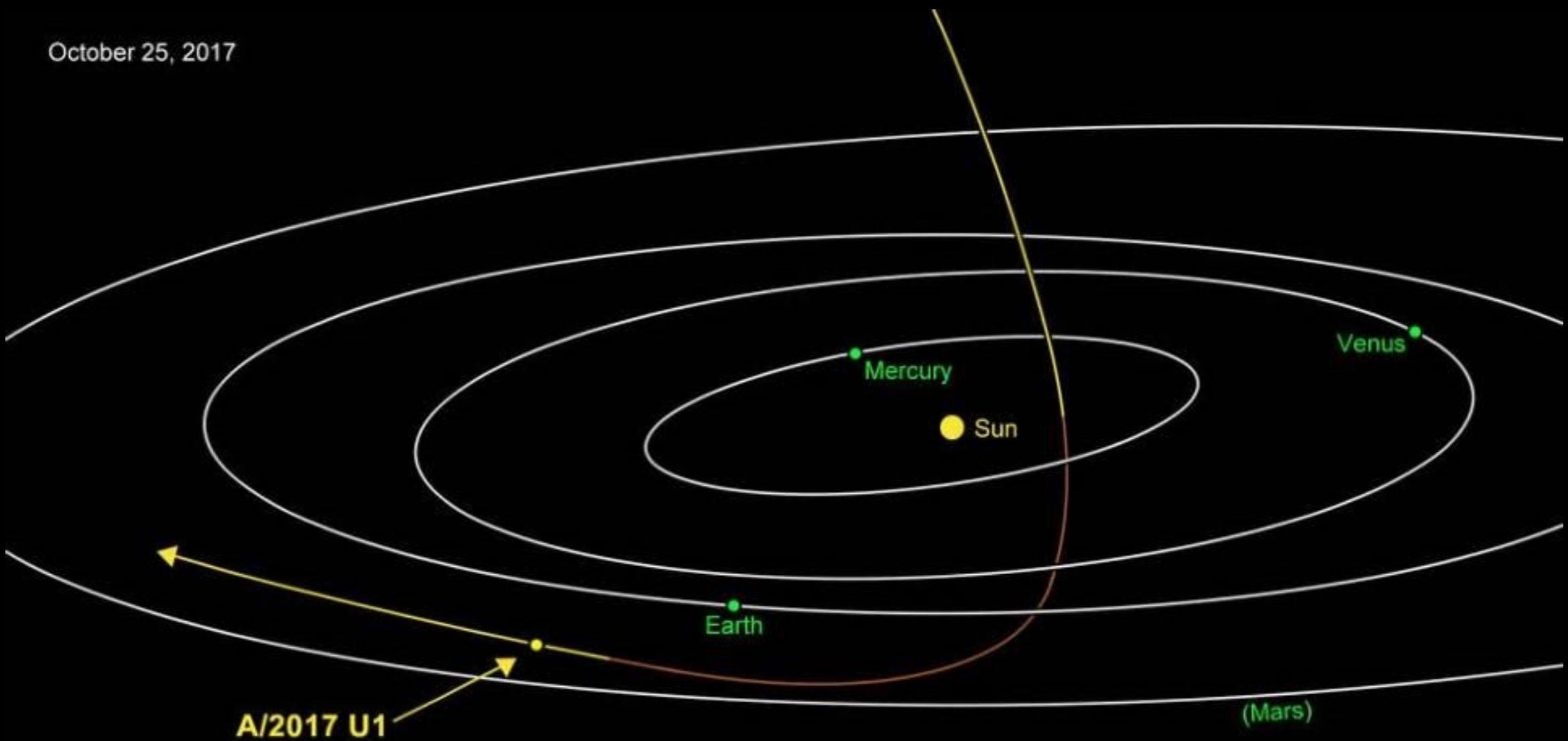
Boeing Starliner Will Not Make It to Space Station ...



If you want to leave Earth never to return, you must give your spaceship a high enough velocity so it will follow an open orbit.



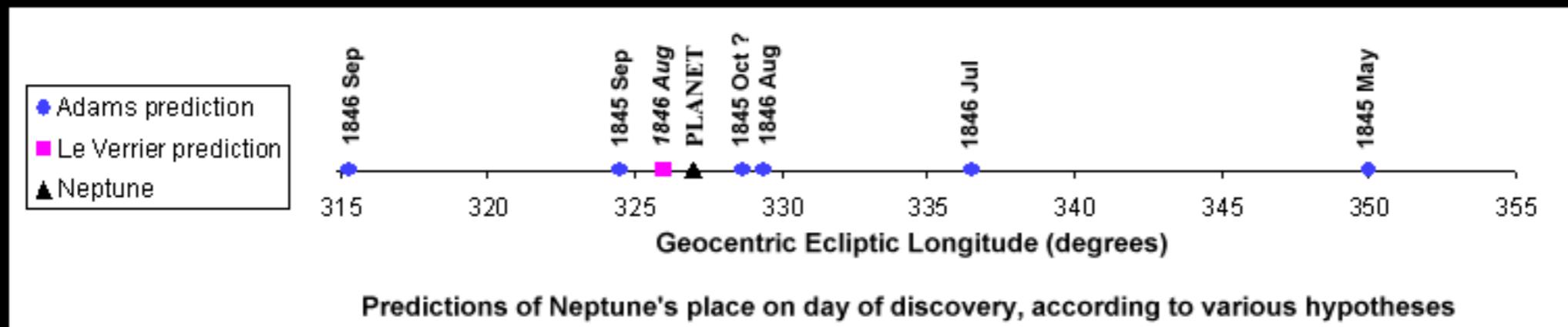
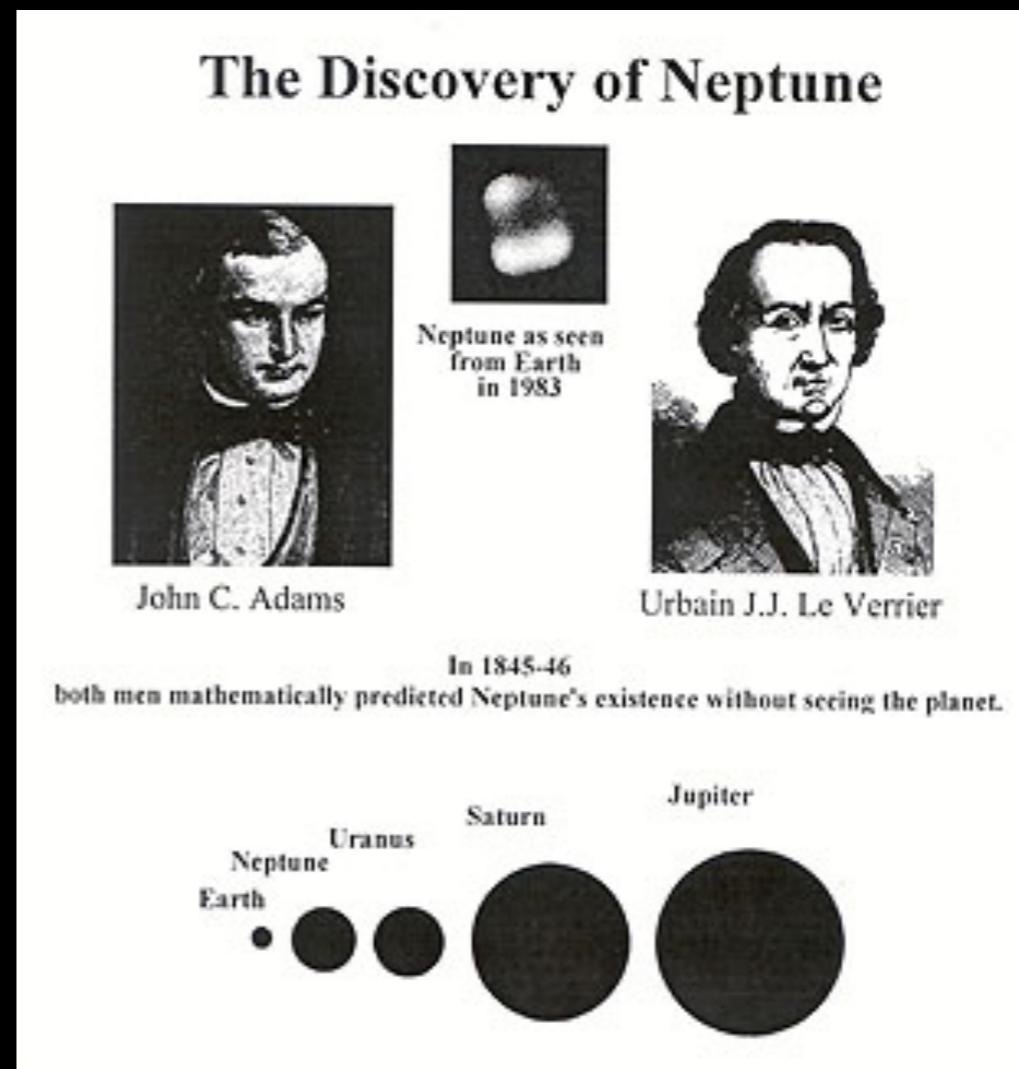
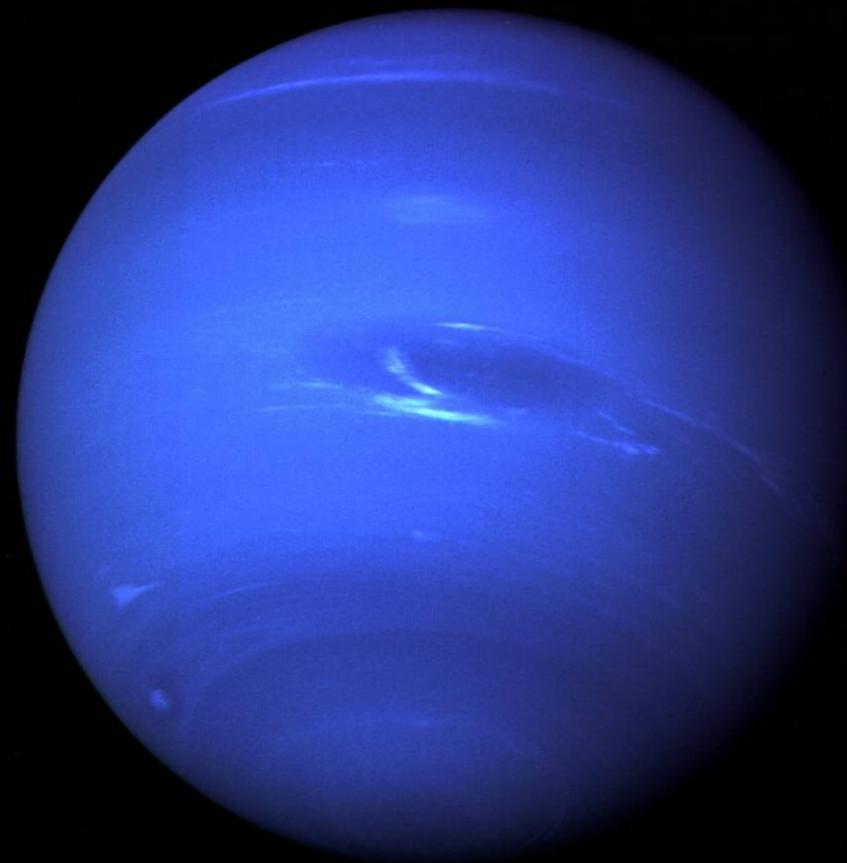
Comet A/2017 U1 is on its way out of the Solar System...



Orbits of multiple bodies

- Kepler's Laws do not take into account the effects of other planets' gravity
- In reality, the planets *perturb* each other's orbits a bit
- Neptune and Pluto were predicted mathematically before their discovery!

Predicting Neptune



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* * * *

NINTH PLANET DISCOVERED ON EDGE OF SOLAR SYSTEM; FIRST FOUND IN 84 YEARS

LIES FAR BEYOND NEPTUNE

Sighted Jan. 21 After 25
Years' Search Begun by
Late Percival Lowell.

New Planet Compared With Earth and Neptune

Size:

Earth—8,000 miles in diameter.
Neptune—32,000.

New Planet—8,000 or more.

Distance from Sun:

Earth—One astronomical unit.
Neptune—Thirty astronomical
units.

New Planet—About fifty units.

Japan invited to prevent activity to insure Japan to join Great Britain and America in a three power naval limitation treaty in the event a four or five power treaty fails through.

It is understood now a basis of agreement with Japan has virtually been established and an announcement of the agreement between the three leading naval powers is imminent excepted.

End of strategy.

Its purpose is said to be to confront President André Tardieu of France upon his arrival, with an understanding between Great Britain, America and Japan which, in the event France refuses to compromise on its demands, will be translated into a three power or four power treaty if France consents to join. The strategy is also to alienate France with India.

Delegates left to pay early parley back on the fast as MacDonald sees "fair hope" for its success. Page 16.

United States officials in Hanoi demand American rule before Hoover investigating commission. Page 14.

LOCAL.

Home of Broadview village president is bombed for second time in two months.

United States inquiry reveals high incomes of Chicago politicians, agents and military officials. Page 1.

Students at Chicago U. disagree with Stagg's statement that few students drink. Page 2.

State official signs order revoking license of Henry J. Schlesinger to practice medicine. Page 3.

Red Aid, Hells, in Jewish mood, dooms for two year term in Europe.

PROHIBITION HAD BY STAGG AS CRIMES ON POST-WAR YOUTH

Chicago Athletic Dire

Chief Dry W
Ending in C

DRY MEMBE

Celler Is Accu
Mrs. Peabo
She Prom

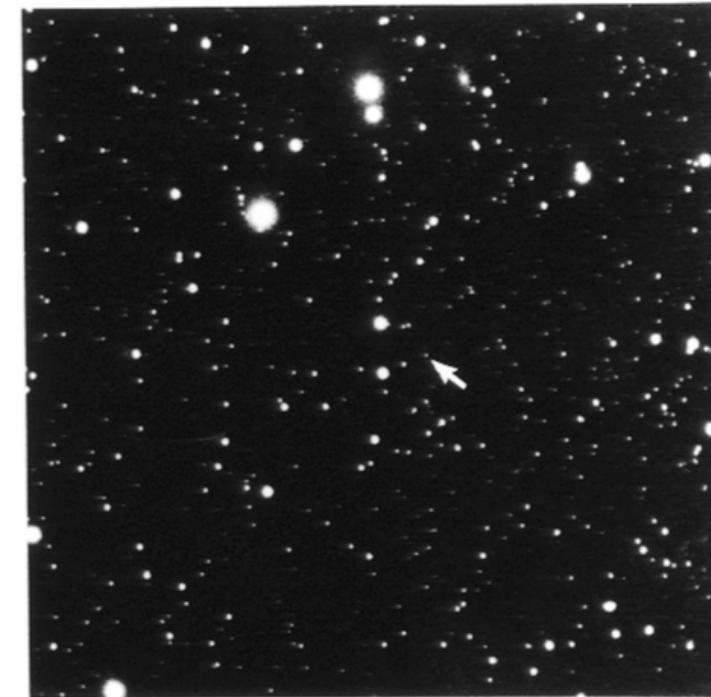
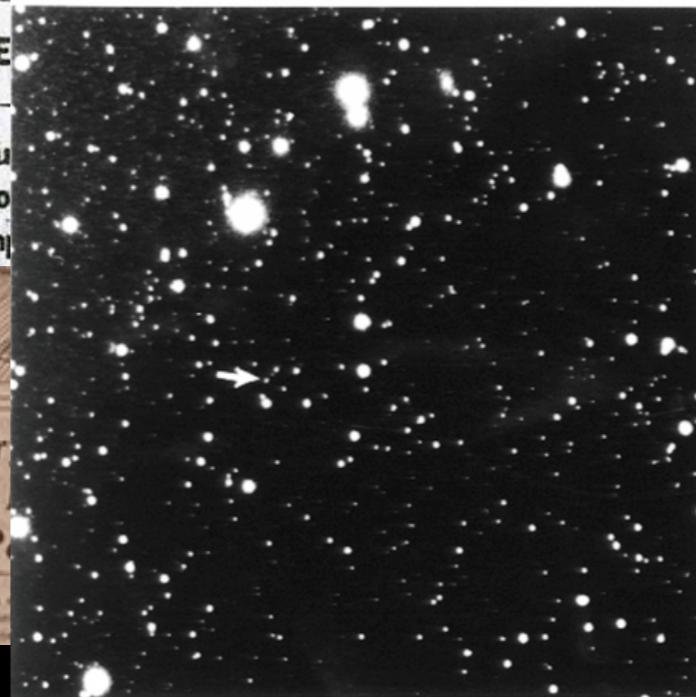


SCIENTISTS SPY PLANET HUNTED FOR 25 YEARS

Astronomers Believe
It's Big and Cold.

(Picture on back page.)
Flagstaff, Ariz., March 13—(AP)—A
large cluster of stars which scienti-

DISCOVERY OF THE PLANET PLUTO



Bomb Village President a Second Time

For the second time in two months
the home of William Evans, president
of the village of Broadview, at 27th
avenue and Roosevelt road, was
bombed early this morning. The bomb,
placed at the head of the steps lead-
ing to the front porch of the two story
frame house, wrecked the porch and
smashed every window in the dwelling,
with damage estimated at \$1,000.

Evans and his wife were in bed at
the time, but were not injured.

Now Two Men Flying.
A brakeman on an Illinois Central
freight train which was being enroute

VOLSTEAD FIGHT SO HOT REFEREE CALLS TIME OUT

Stagg Defends Law,
Flays 'Idle Rich.'

(Chicago Tribune Photo Service.)
(Picture on back page.)
Washington, D. C., March 14.—
A brakeman on an Illinois Central
freight train which was being enroute