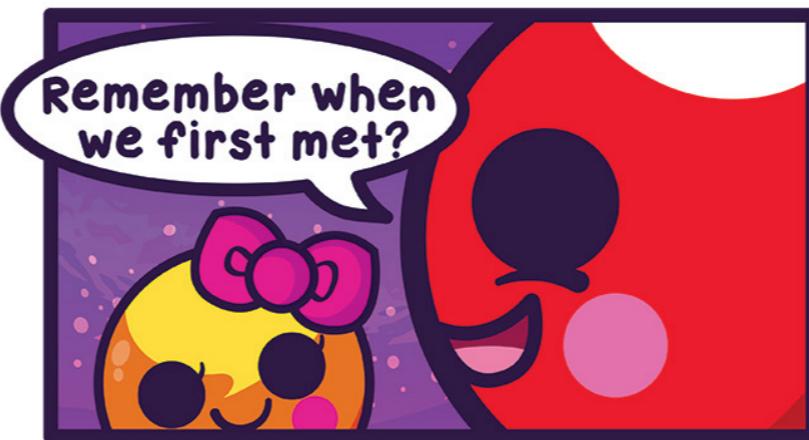
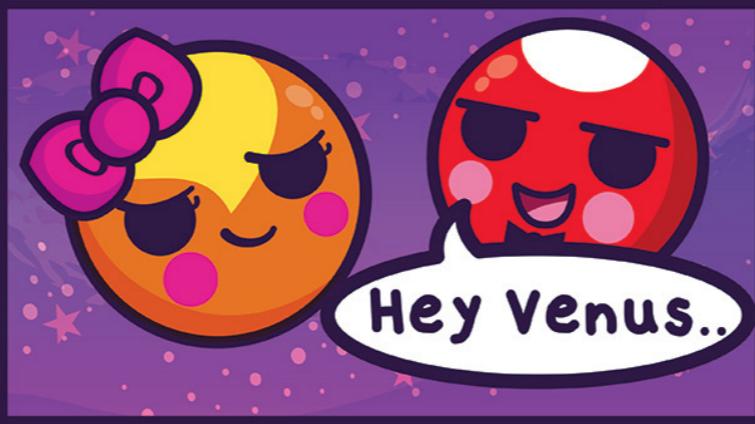
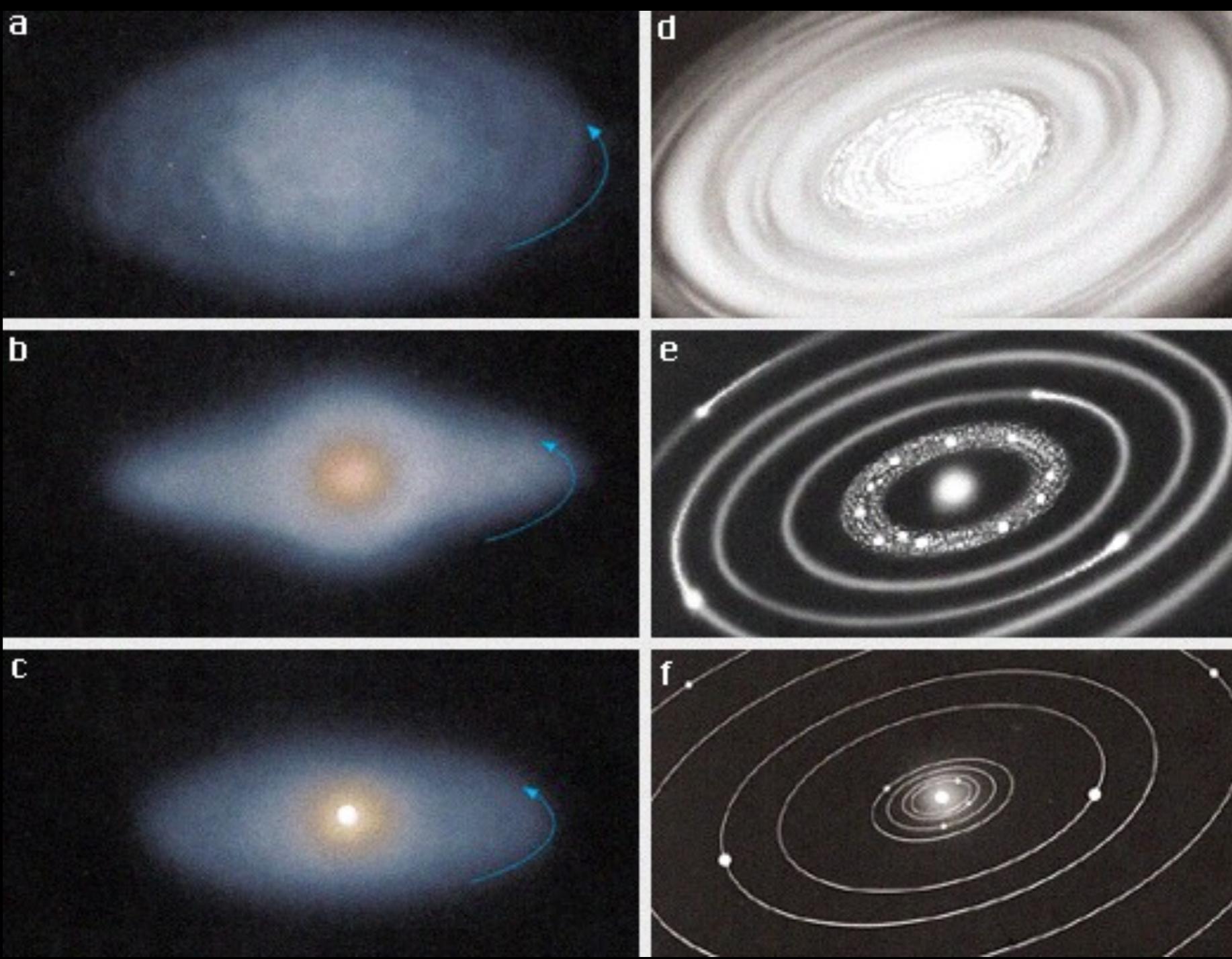


# origin of venus



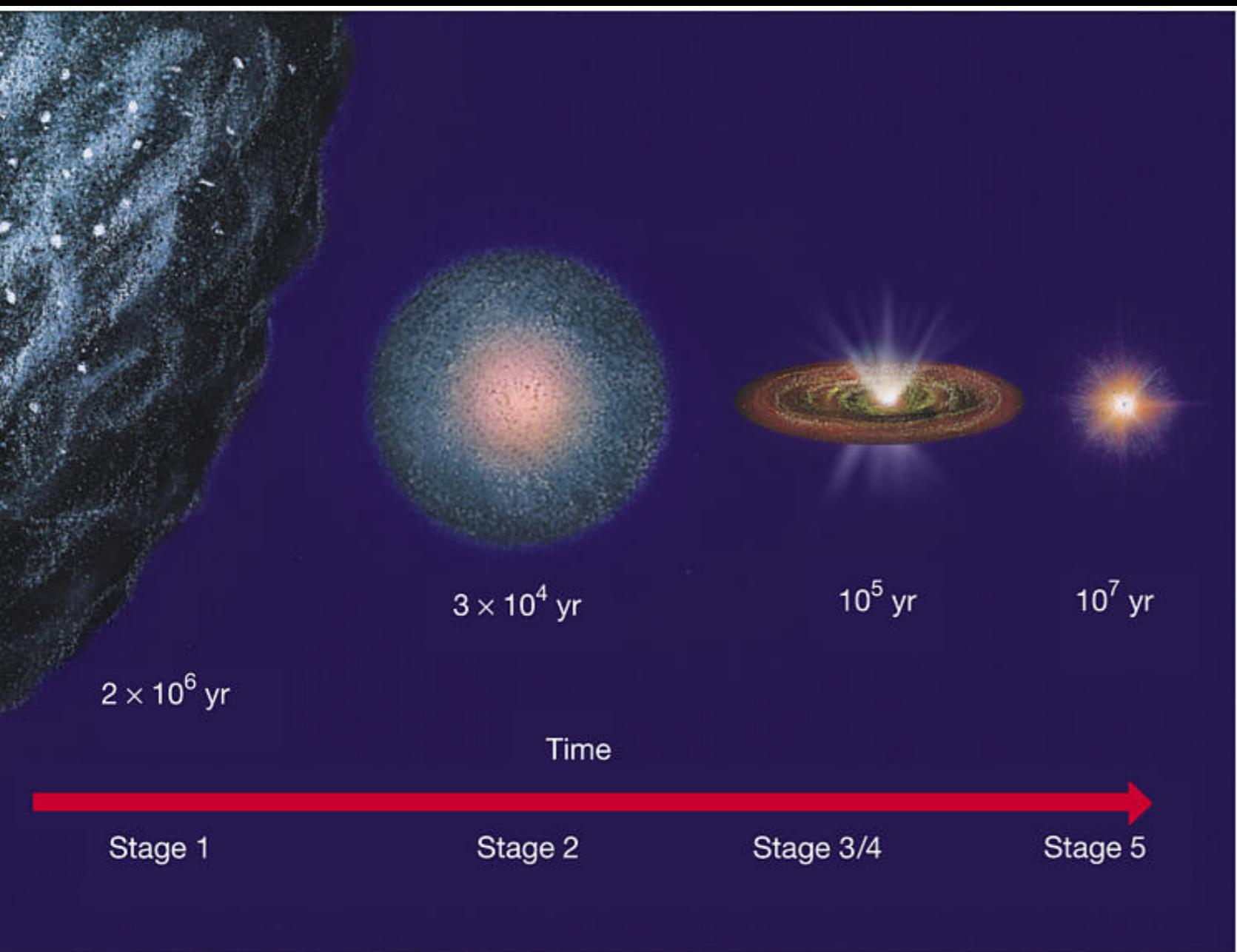
Stars and planet form in stellar nurseries like the Orion Nebula





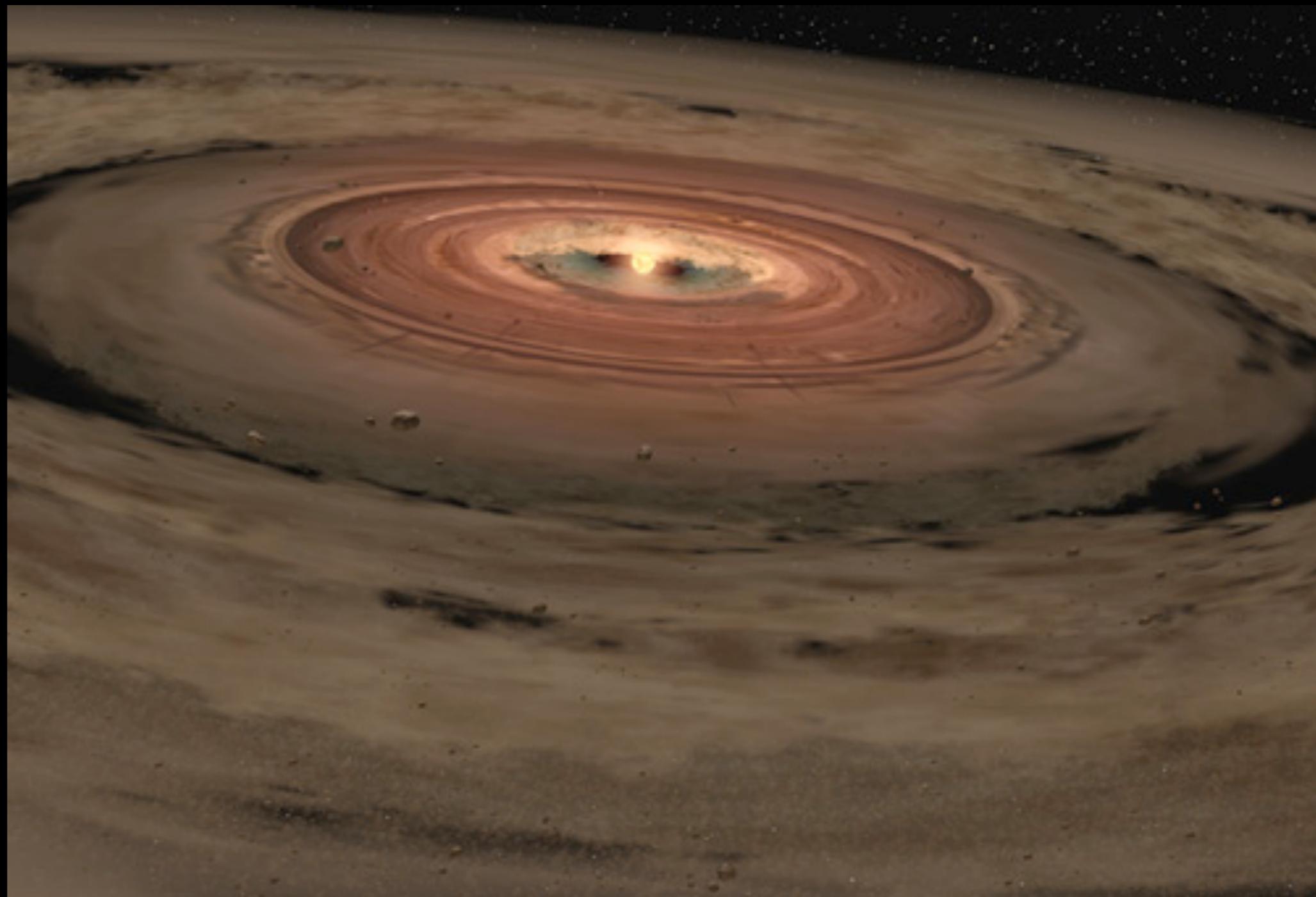
The solar system formed from a cloud of cold gas and dust called the solar nebula about 4.6 billion years ago

What we know about the solar system and star formation suggests our **solar nebula** started as a fragment of an interstellar gas cloud.



- 1) It collapsed
- 2) It was rotating
- 3) It flattened out
- 4) It cleared out and planets formed

The flattening is due to the **conservation** of **angular momentum** and causes the rotation to speed up.

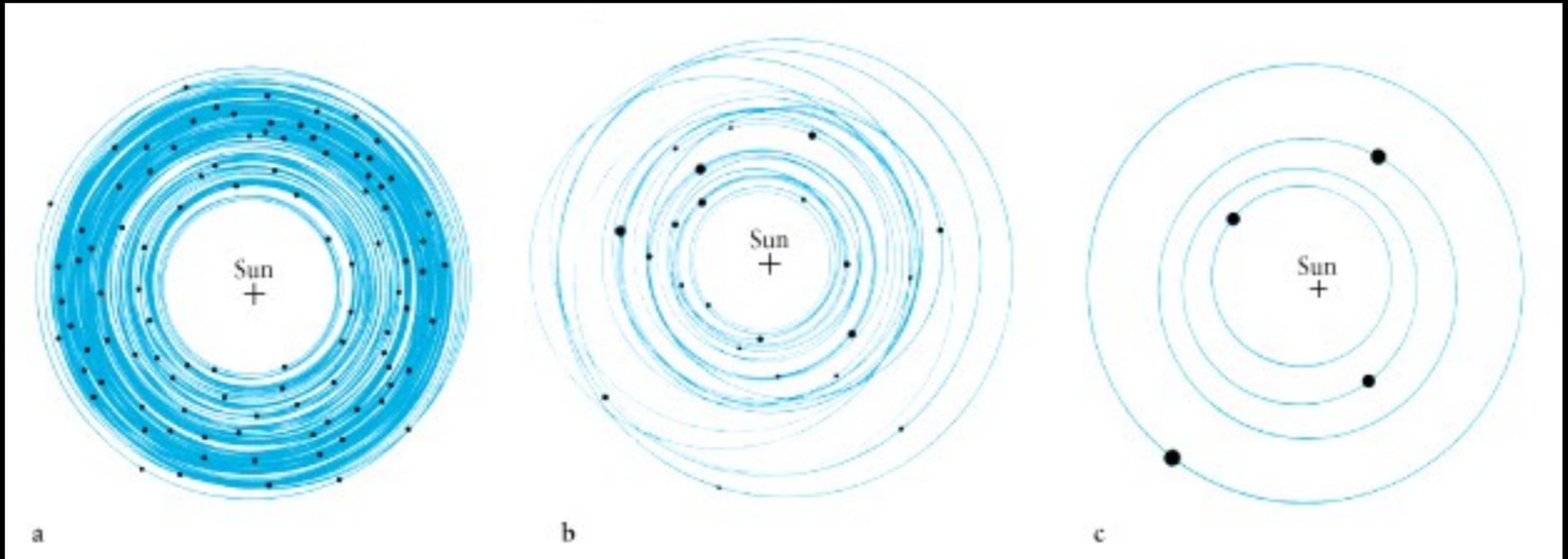


In the development of a planet, multiple process operate to collect solid bits of matter—rock, metal, or ices—into larger bodies called **planetesimals**

Planetesimals group together to form a **protoplanet**

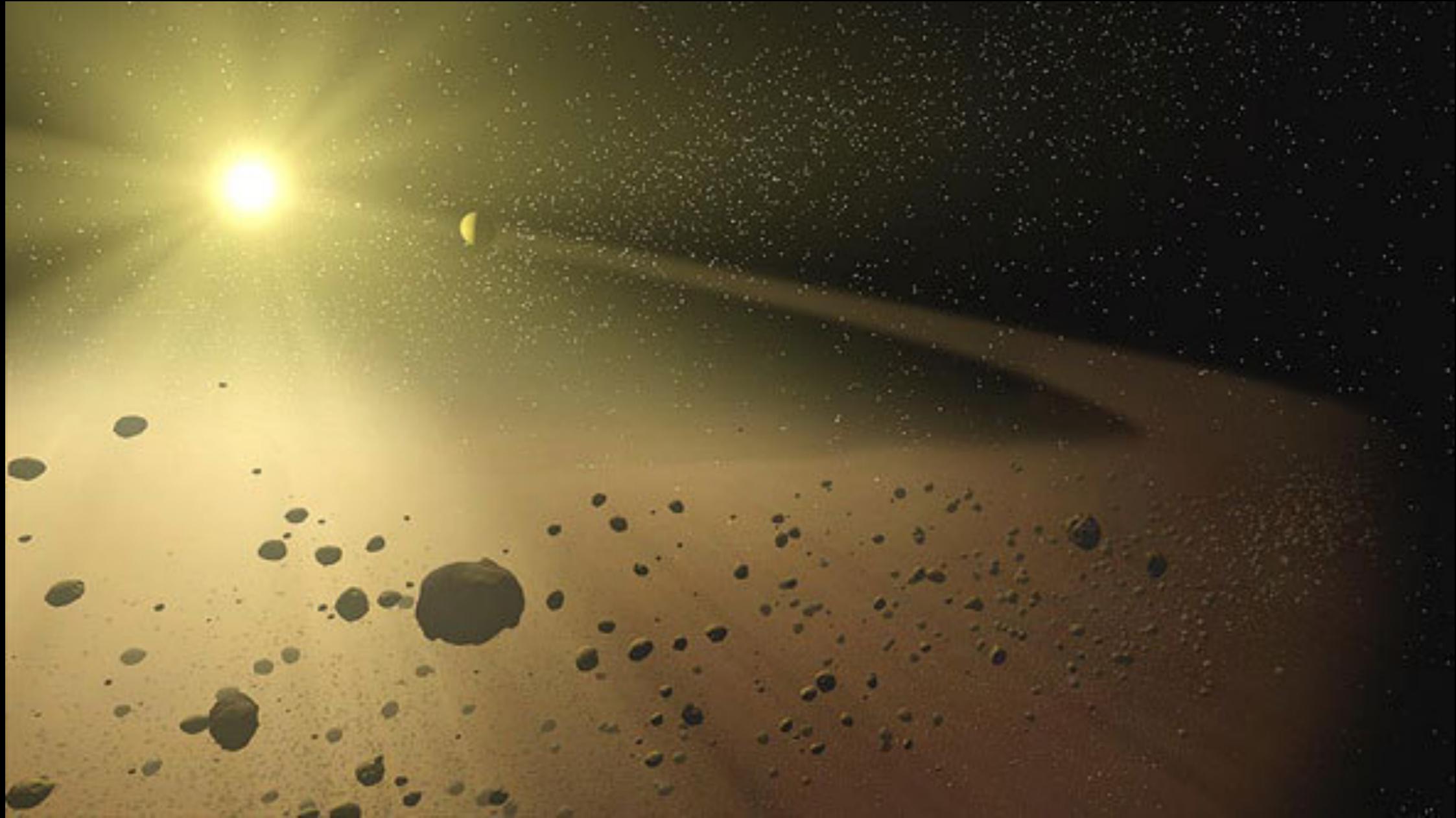
That protoplanet eventually turns into a terrestrial or gas planet depending on its location in the **protostellar disk**

# Collisions dominated the early solar system

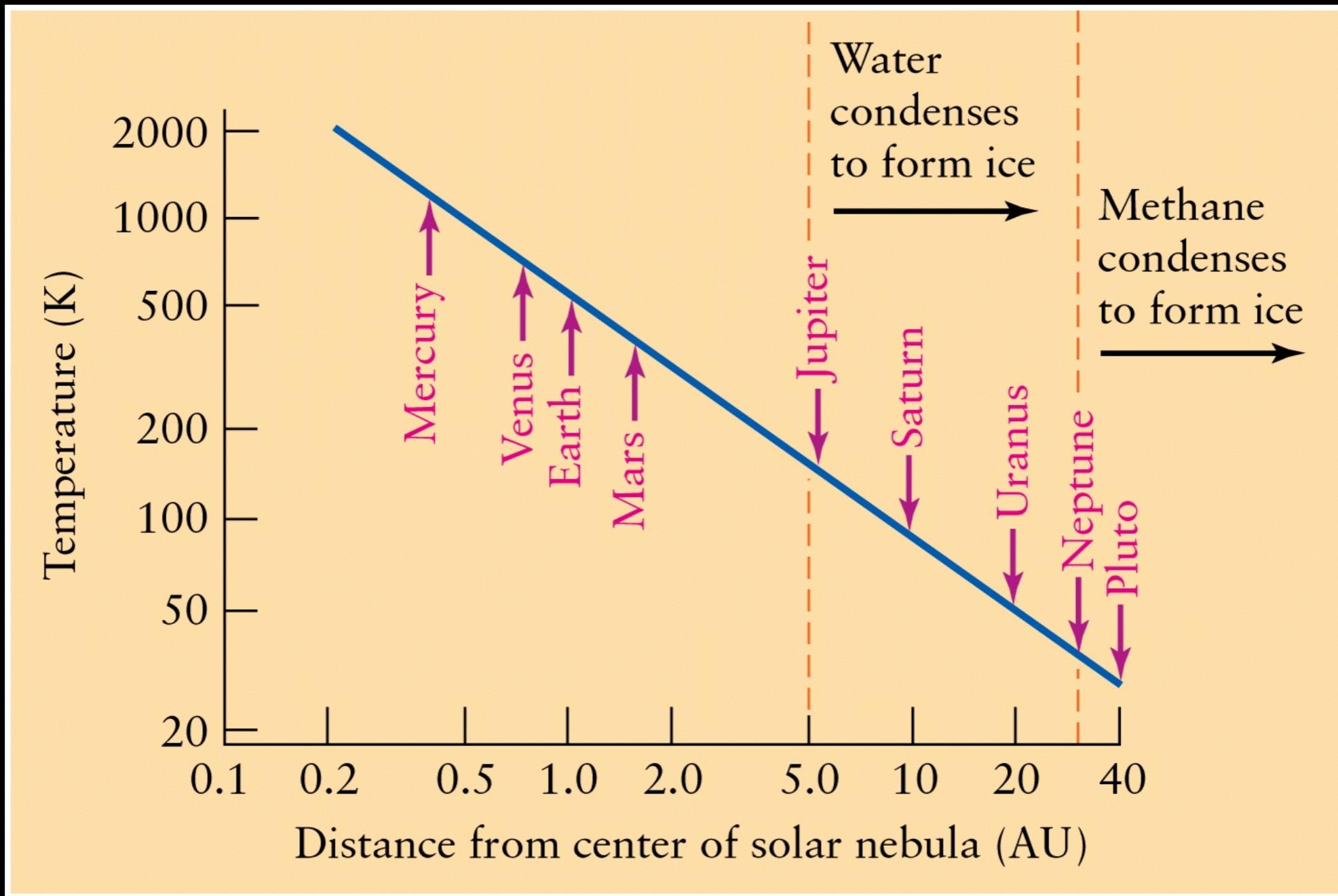


- dust collects together into planetesimals
- planetesimals collect together into protoplanets
- Protoplanets gather up left over debris and became planets

In the inner parts of the solar nebula, the temperature was so high that only metals like iron can form the dust grains that form planets - and its too hot for the gases to condense onto these cores and stay there

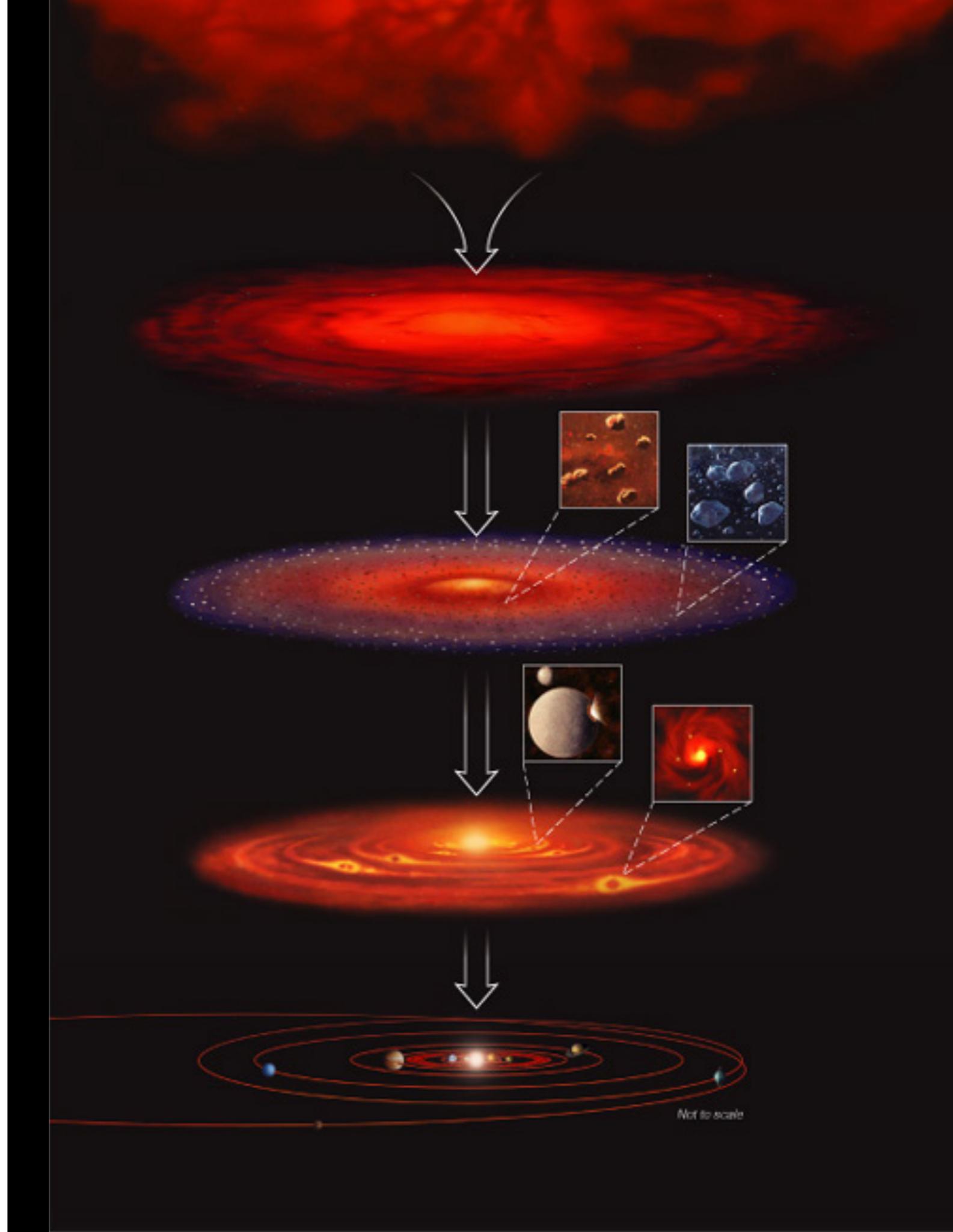


# The planets formed by the accretion of planetesimals and the accumulation of gases in the solar nebula



Which planet formed at the furthest location from the Sun where it was hot enough to boil water ?

- A. Mercury
- B. Mars
- C. Jupiter
- D. Neptune
- E. None of the above



# Farther out in the nebula, it was cooler.

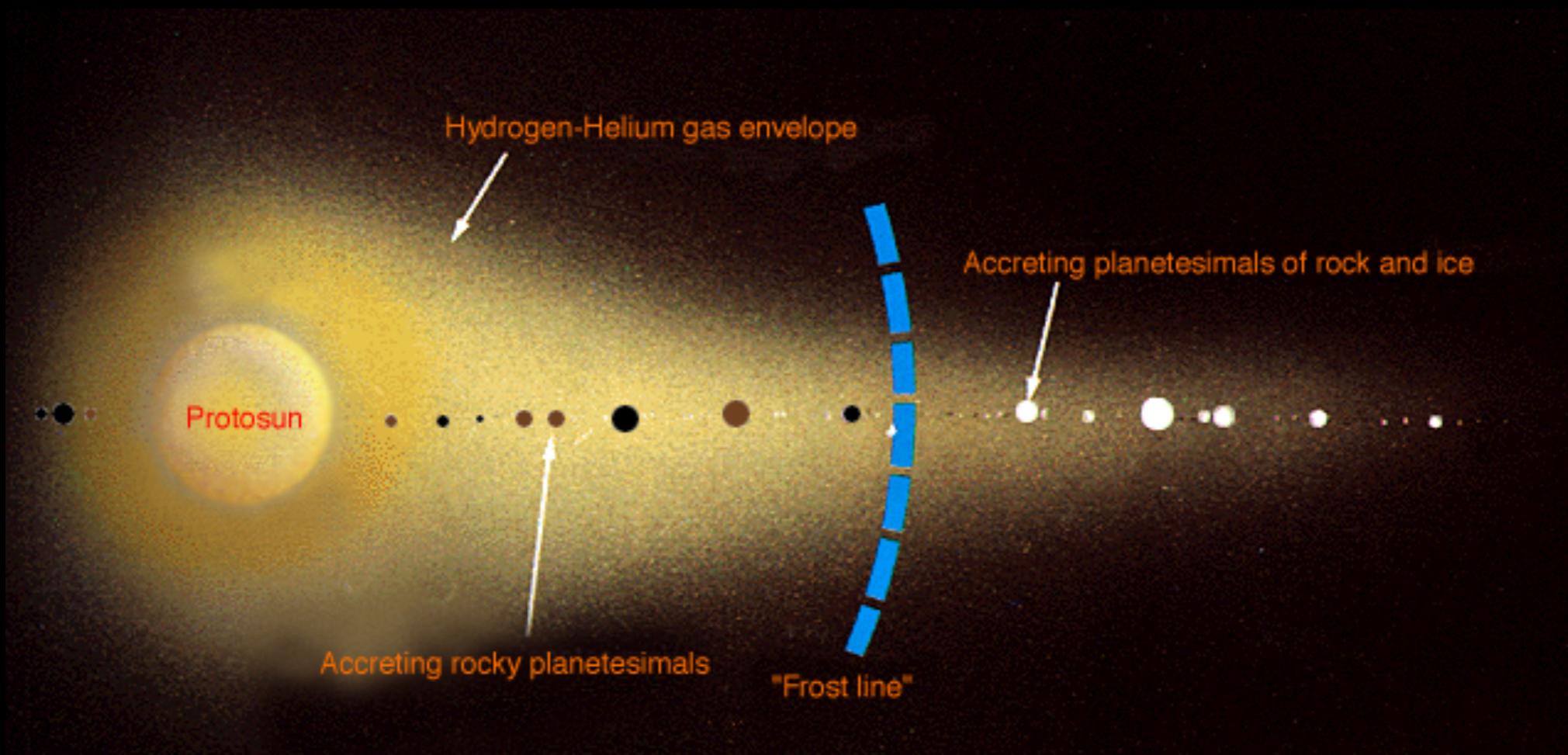
- Silicates could condense.
- These grains are less dense than metal oxides and metals, corresponding more to the compositions of Venus, Earth, and Mars.



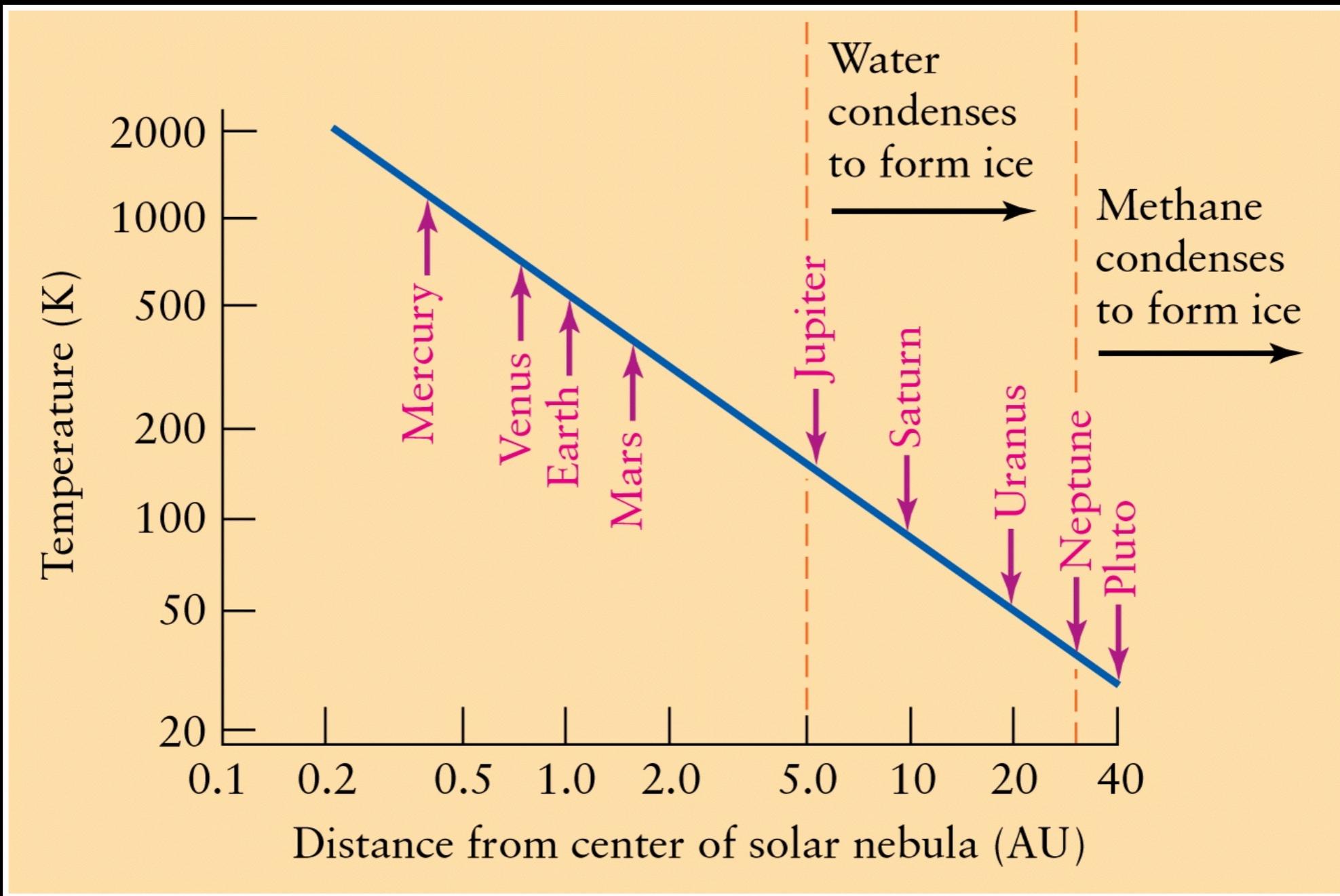
Not much farther out, compounds such as methane and ammonia can condense to form other ices.

- Water vapor, methane, and ammonia were abundant in the solar nebula.

This boundary is called the **ice/frost line**.



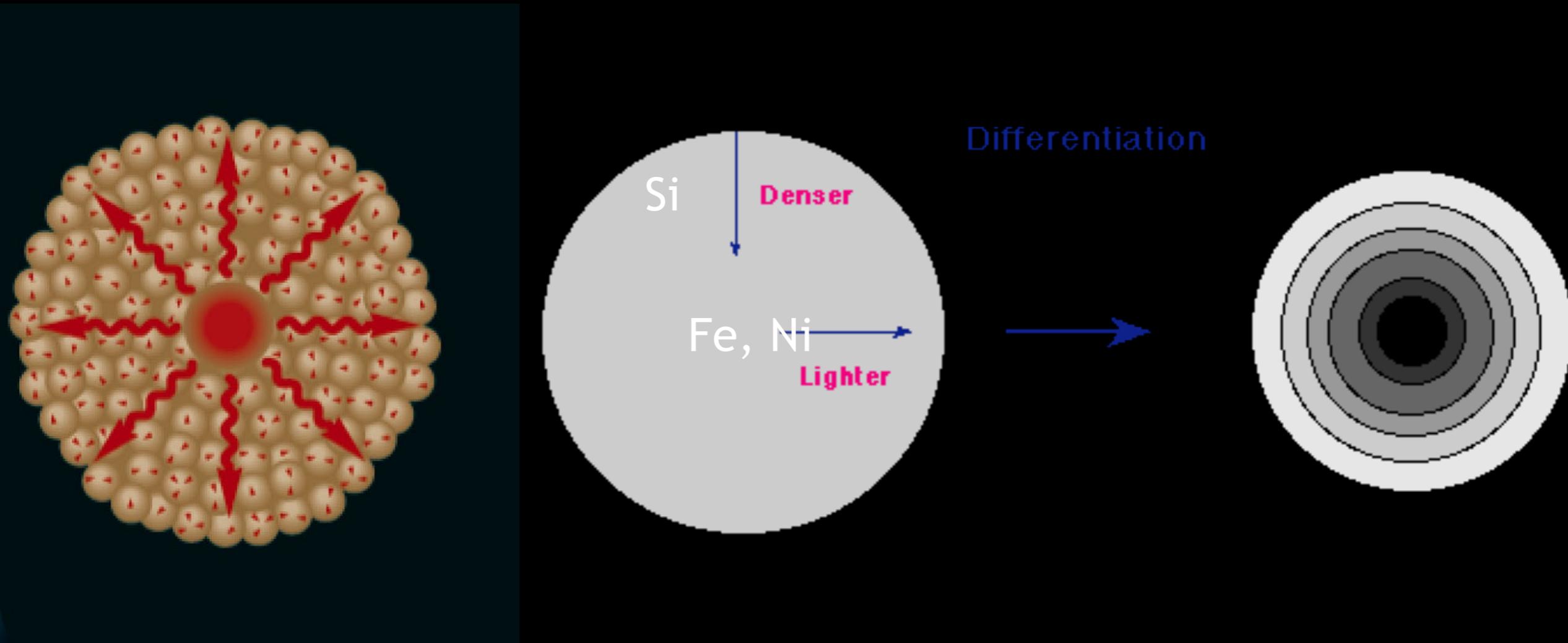
# The planets formed by the accretion of planetesimals and the accumulation of gases in the solar nebula



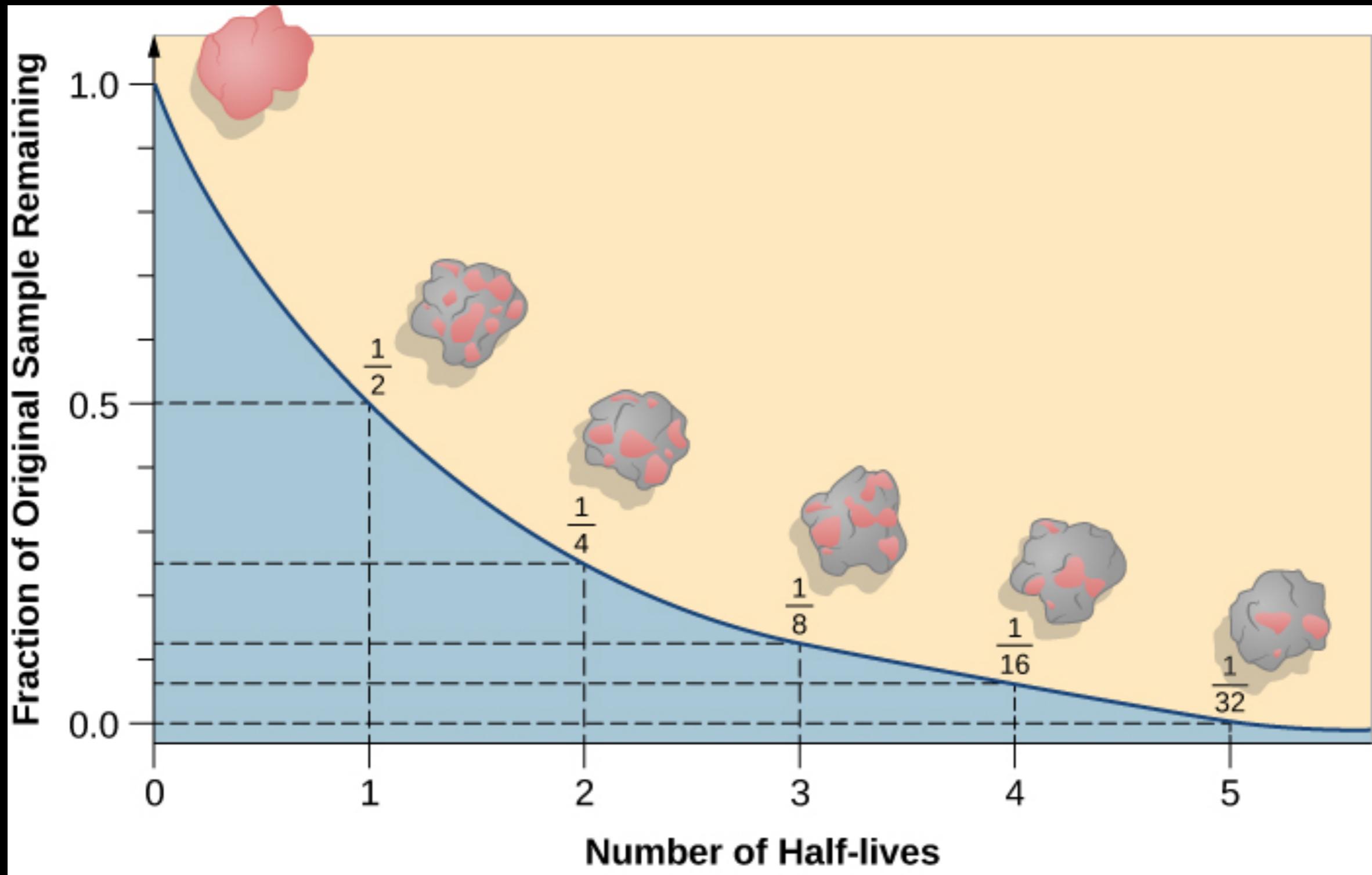
How many planets (not including Pluto) formed at locations in the early solar nebula at temperatures cooler than your body temperature?

- a. Only one
- b. Two planets
- c. Three planets
- d. Four planets
- e. More than four planets

- As a planet forms, heat begins to accumulate in its interior from the decay of short-lived radioactive elements.
- This heat eventually melted the planet and allowed it to differentiate.
- **Differentiation** is the separation of material according to density.



# Radioactivity: A measure of age



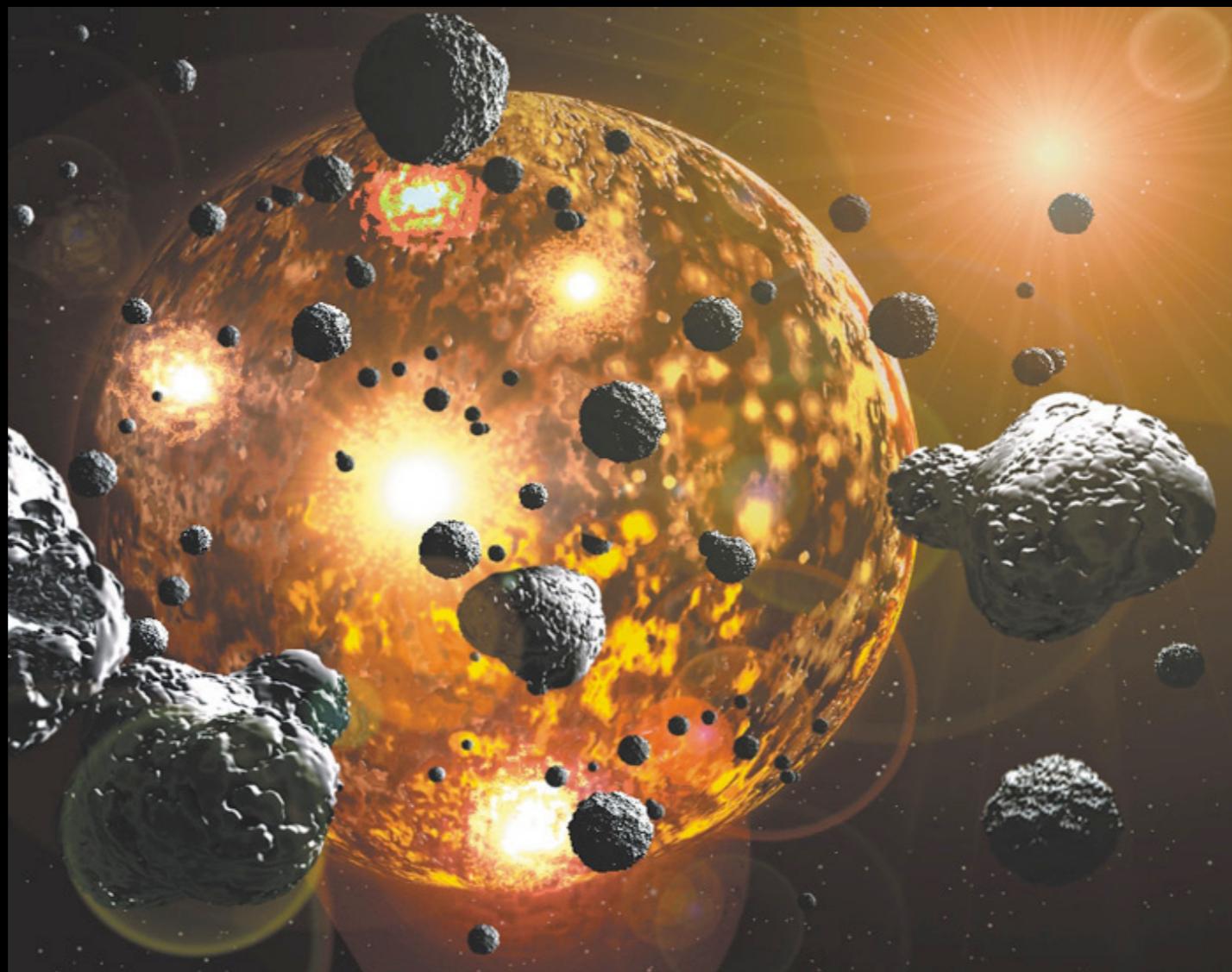
- Unlike Earth's surface, the moon's surface is not being recycled by constant geologic activity.
- The oldest rocks brought back by the Apollo astronauts are 4.48 billion years old.
- That means the moon must be at least 4.48 billion years old.
- Oldest rocks on Earth have been found in Canada and Australia and are ~4 billion years old



# Craters: A measure of age

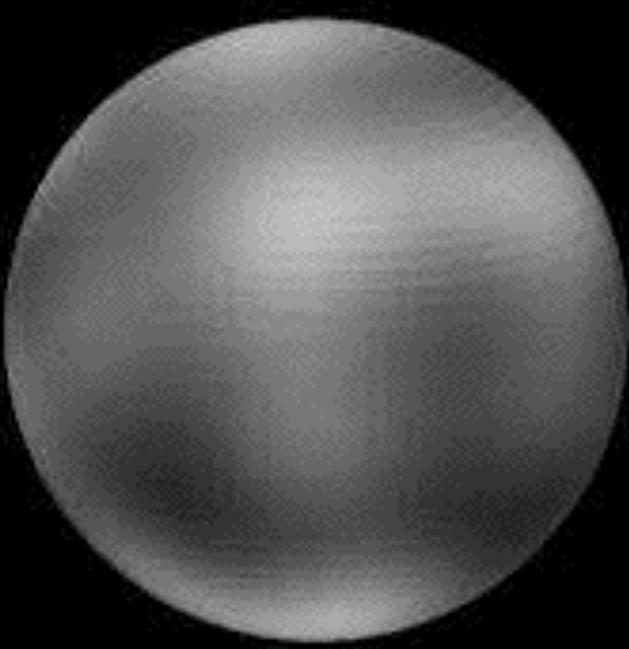
Most of the craters we have on the Earth today appear to have been formed roughly 4 billion years ago as the last of the debris in the solar nebula was swept up by the planets.

- This is called the **heavy bombardment**.

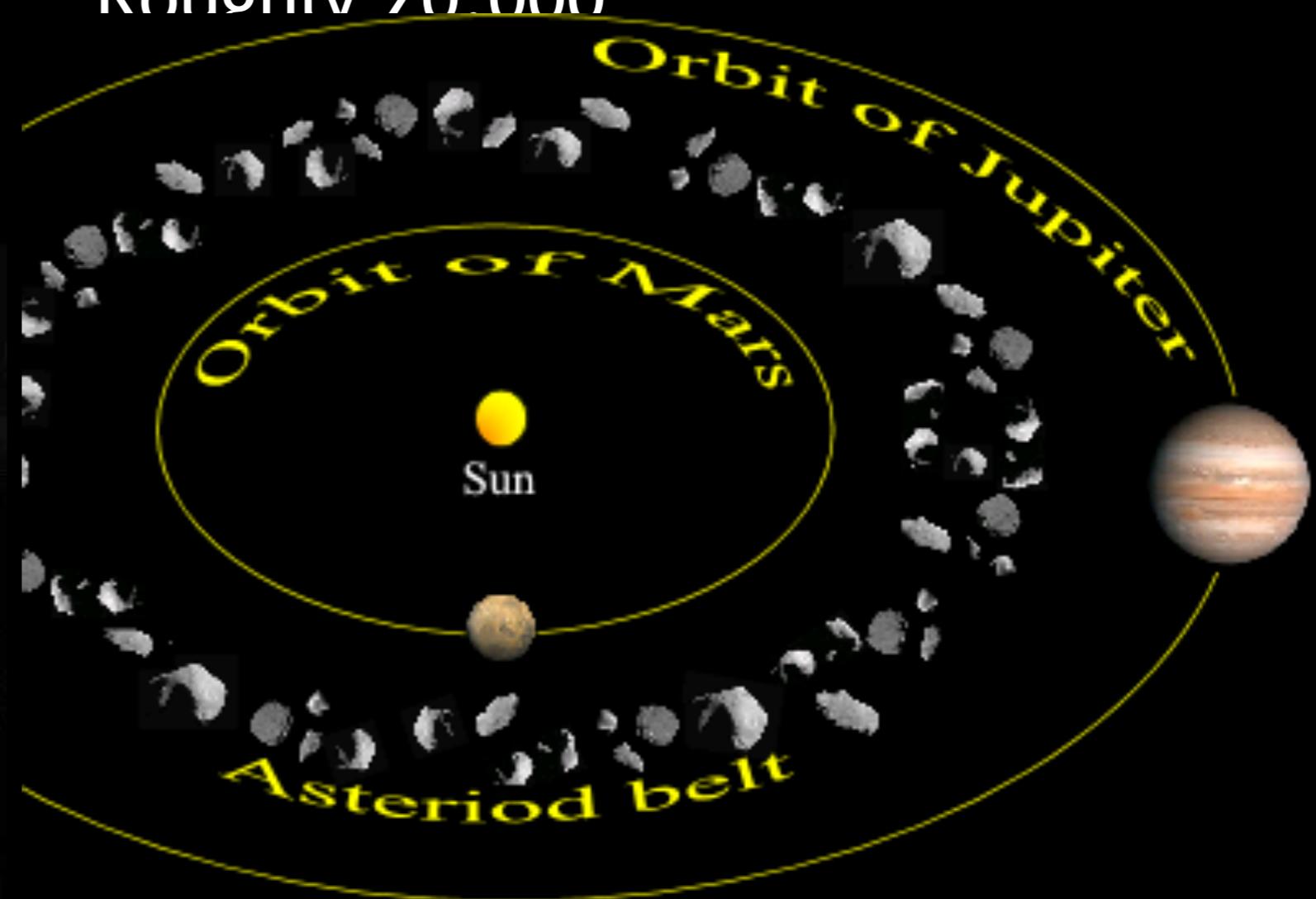
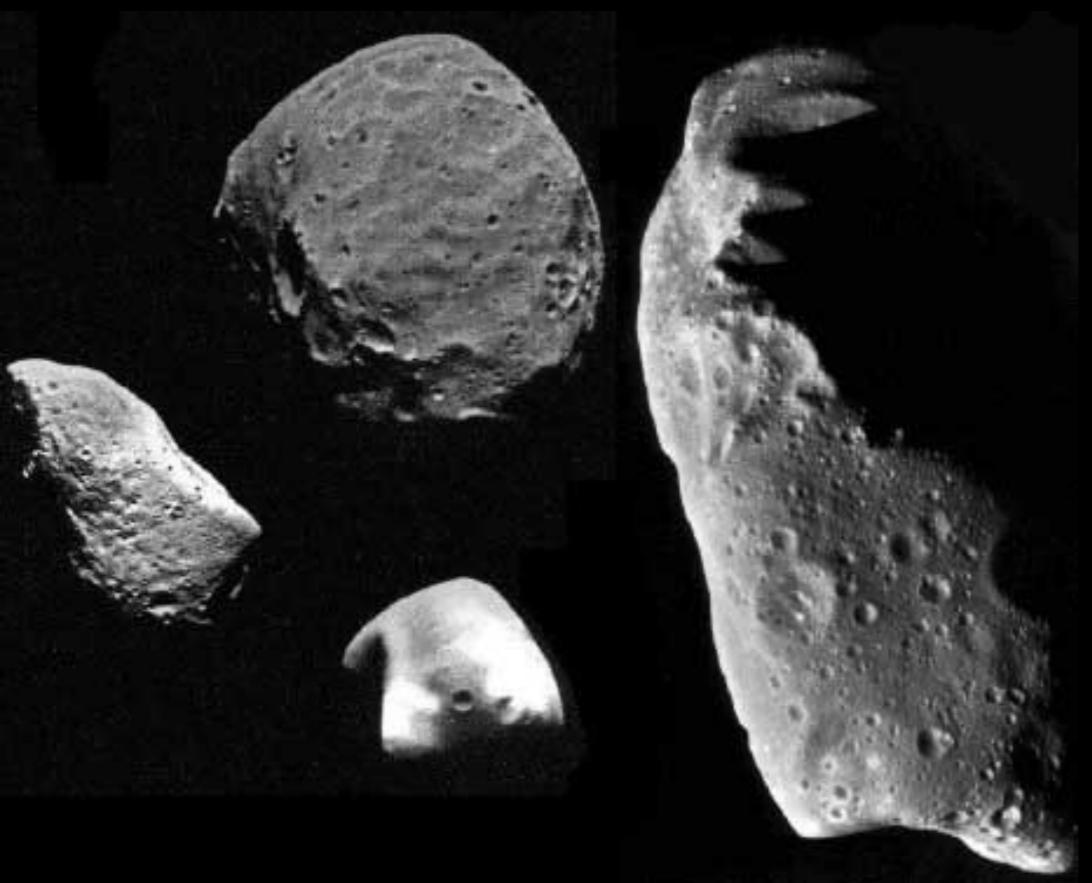


- The solar system is littered with space debris:

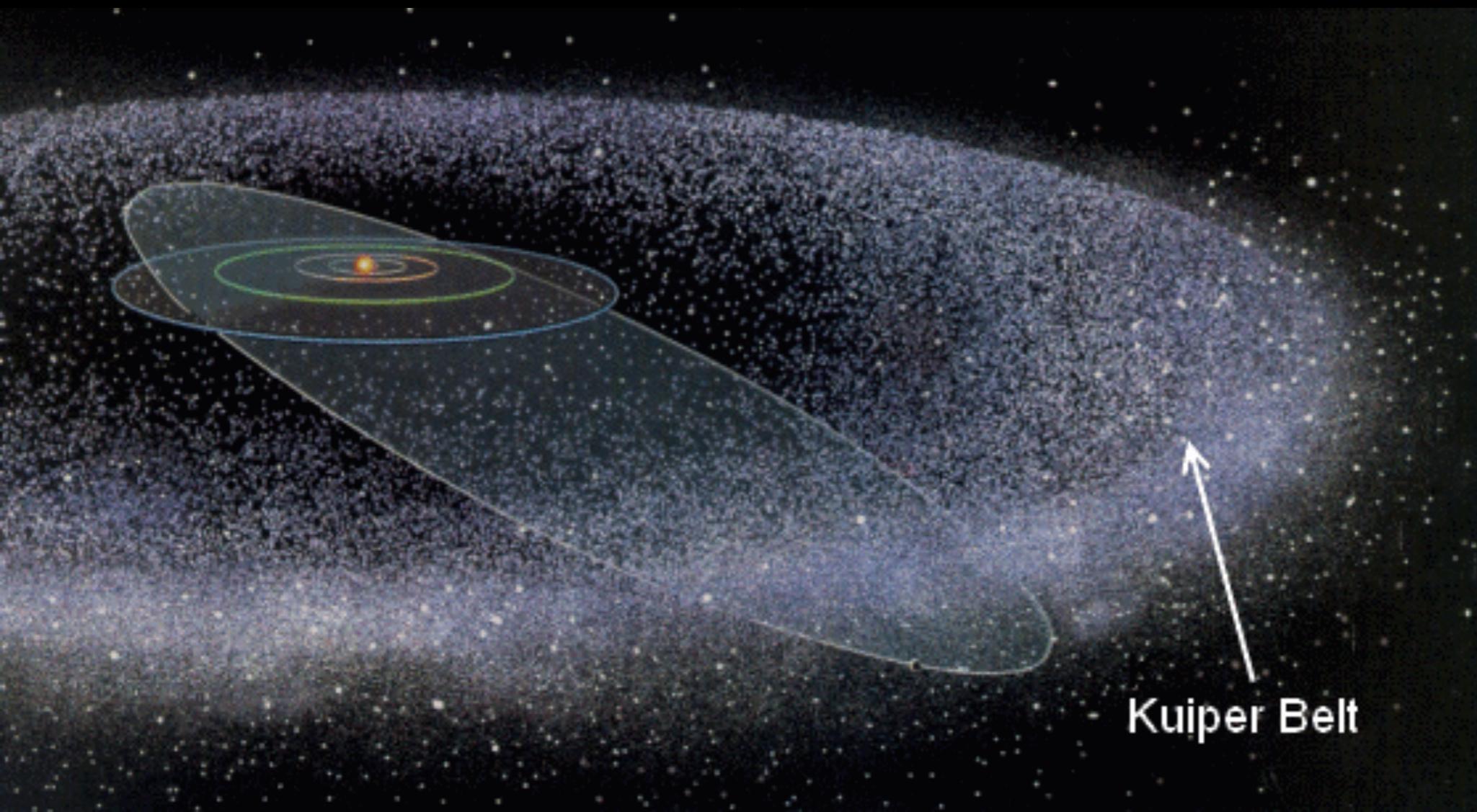
- Asteroids in the asteroid belt
- Comets in the Kuiper belt
- Kuiper belt objects like Pluto and Sedna
  - The Oort Cloud



- The **asteroids**, sometimes called minor planets, are small rocky worlds.
- Most of them orbit the sun in a belt between the orbits of Mars and Jupiter.
  - Roughly 20,000

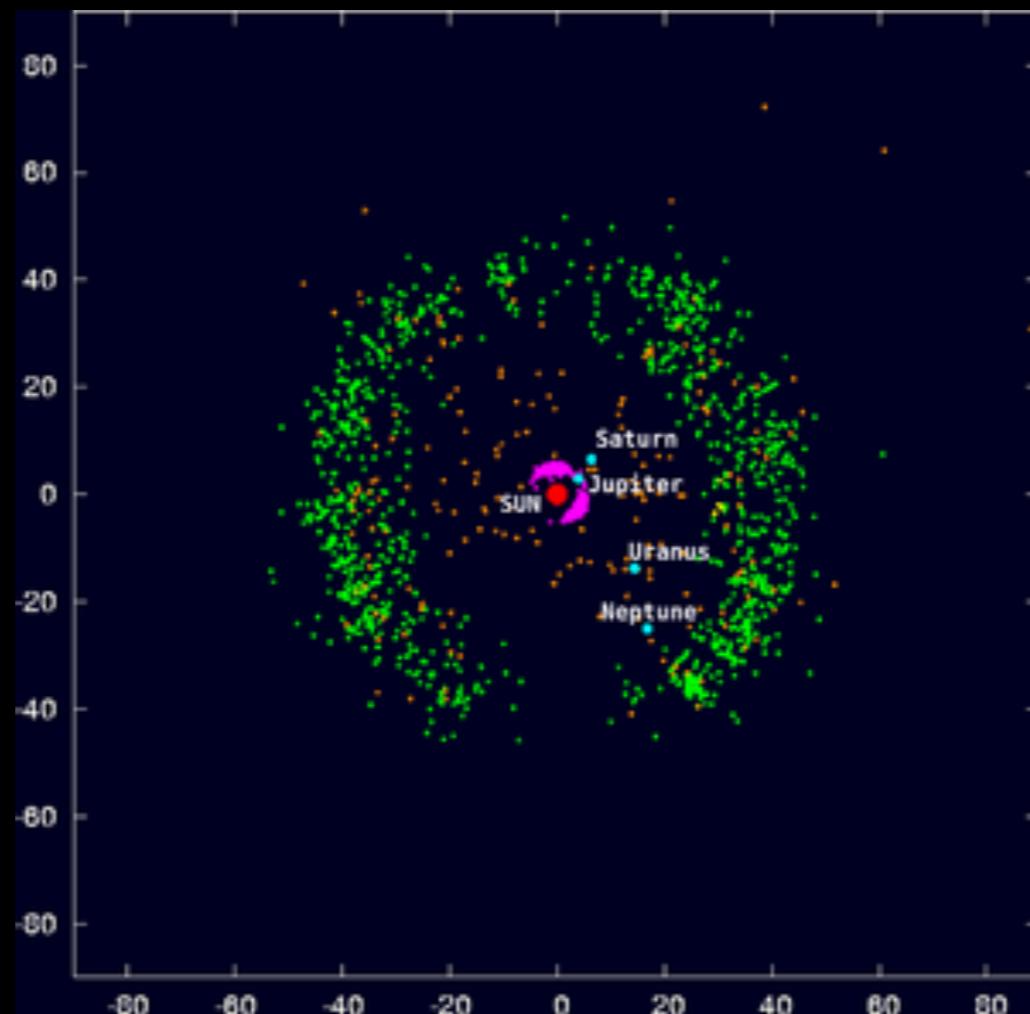


- Since 1992, astronomers have discovered roughly a thousand small, dark, icy bodies orbiting in the outer fringes of the solar system beyond Neptune.
- This collection of objects is called the **Kuiper belt**.



The icy Kuiper belt objects, including Pluto, appear to be ancient planetesimals.

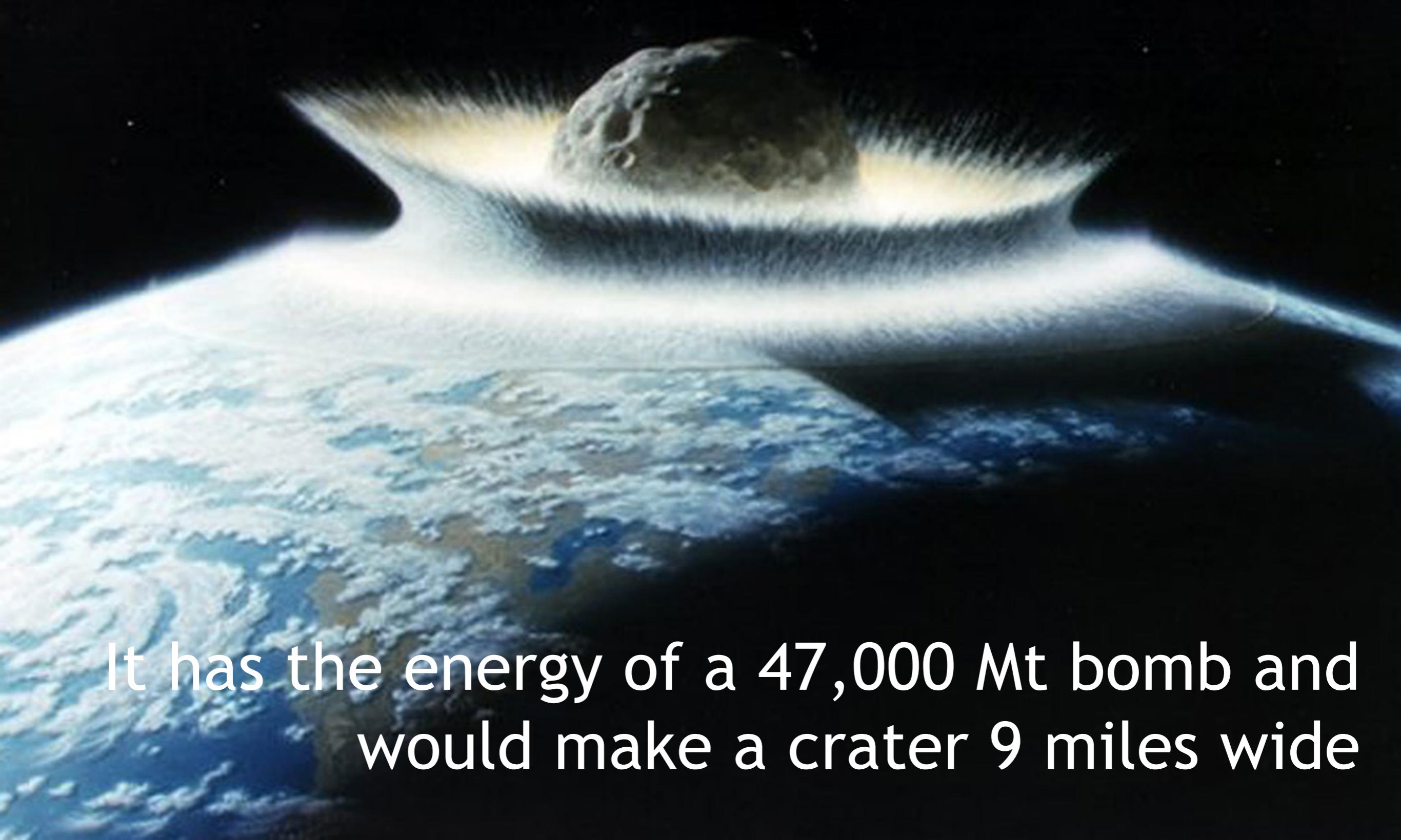
- They formed in the outer solar system but were never incorporated into a planet.



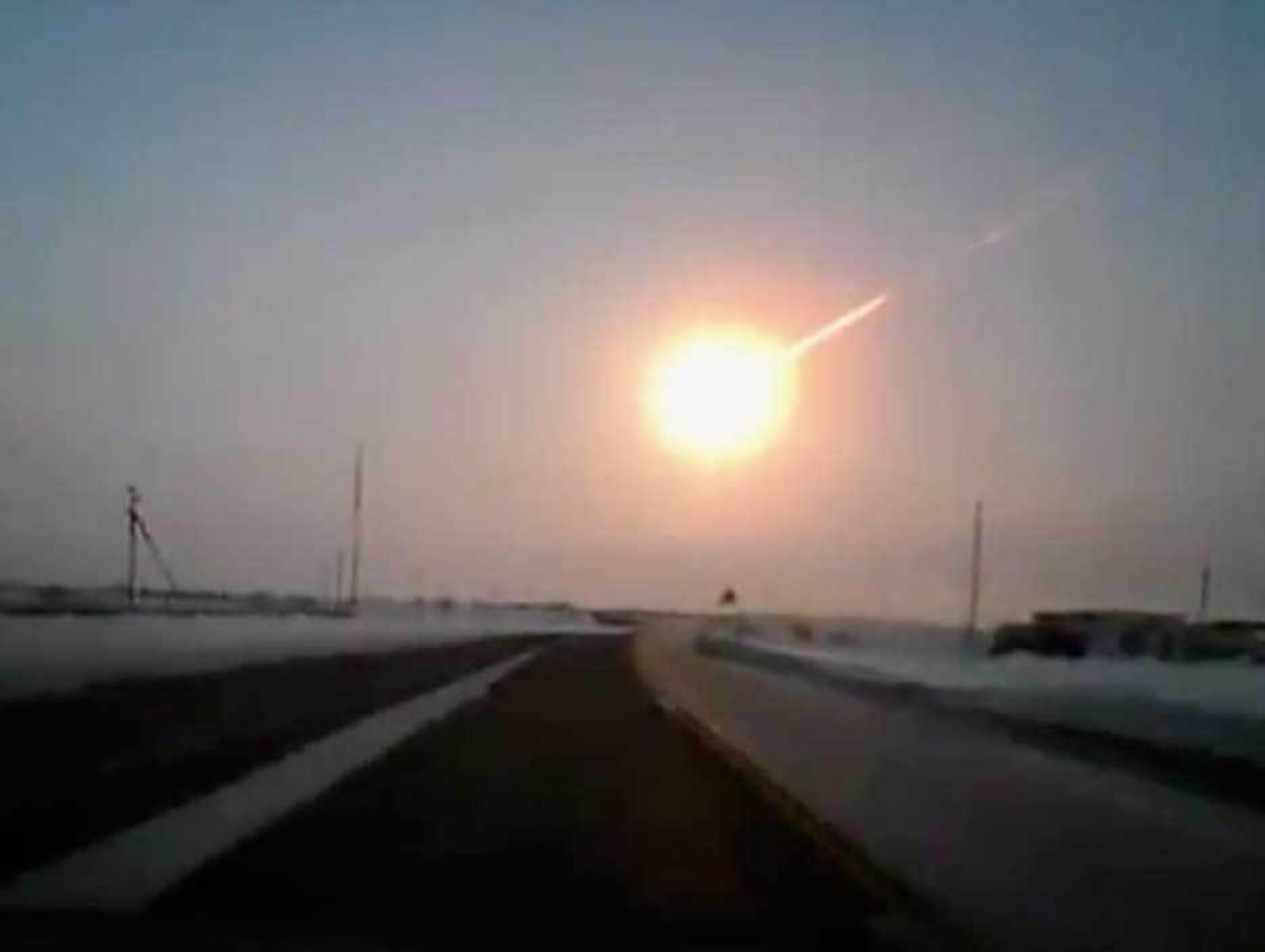
How often is the Earth hit with a killer asteroid?  
(about 1000m or 1/5 of a mile )

- A) Once a year
- B) Once every 1,000 years
- C) Once every 10,000 years
- D) Once every 100,000 years
- E) Once every 500,000 years

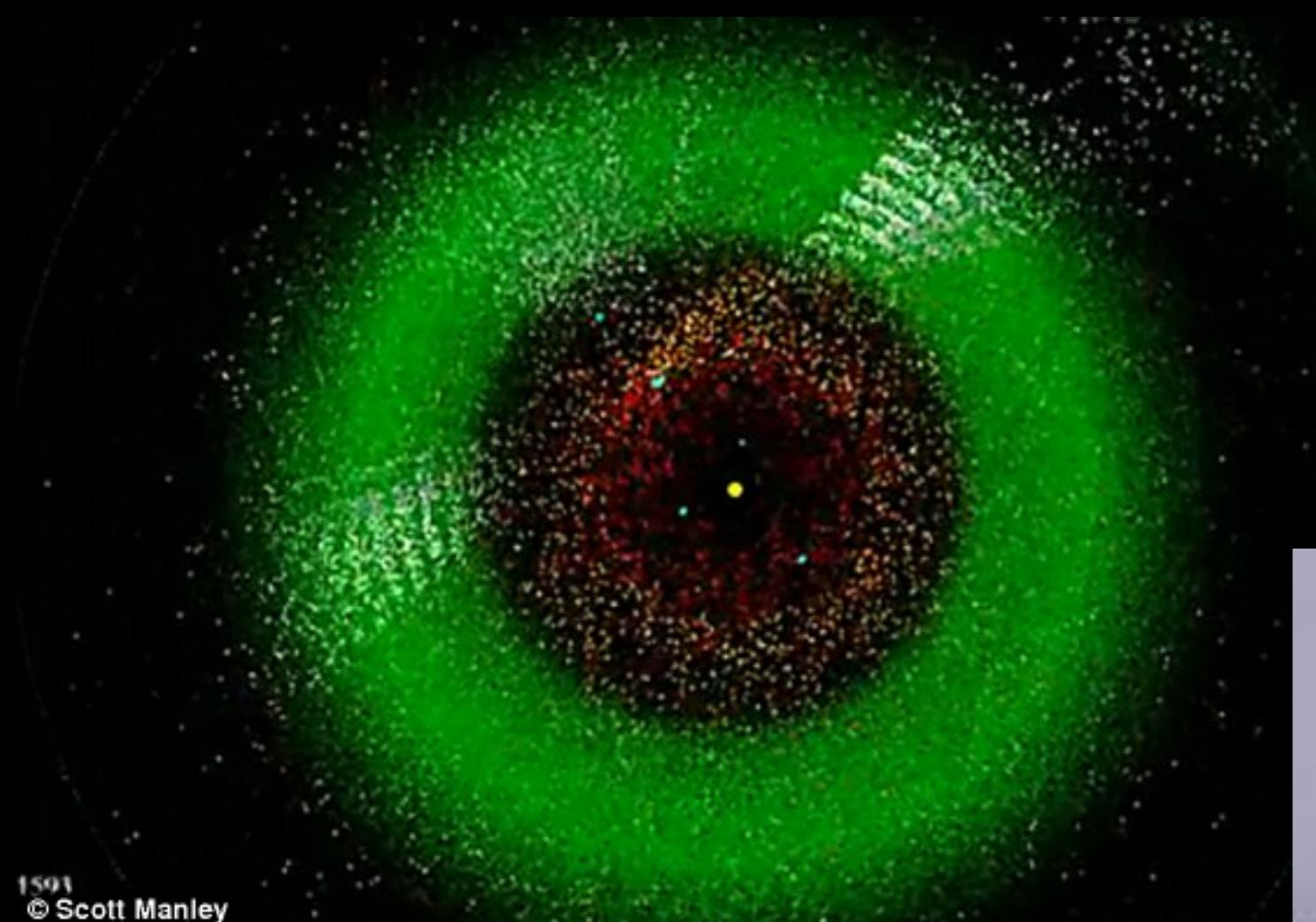
Earth is hit by a 1/5 of a mile sized rock  
about every 400000 years



It has the energy of a 47,000 Mt bomb and  
would make a crater 9 miles wide



There ARE programs looking for the next dangerous impactor ...



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Tunguska

