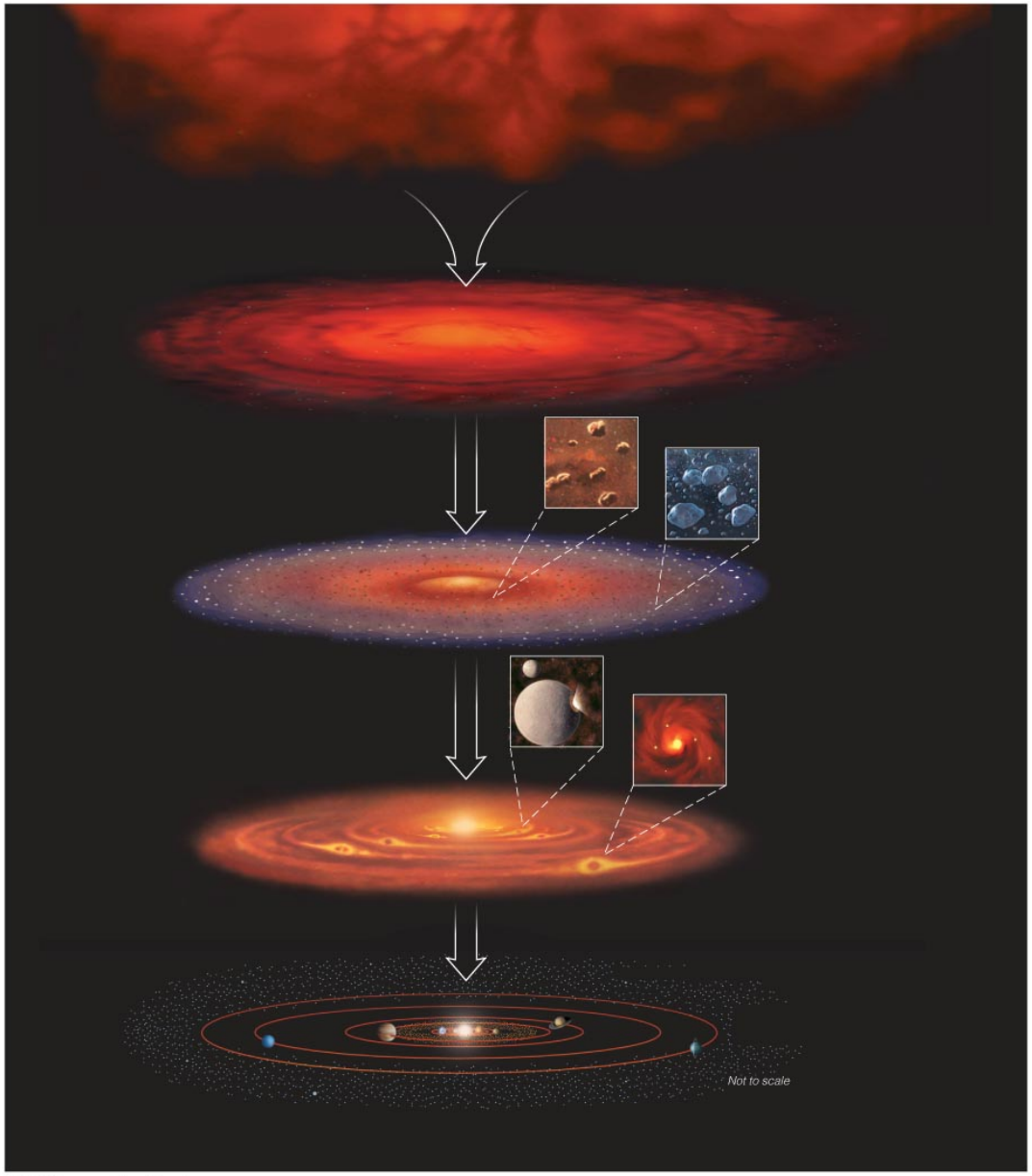
Solar system formation: Major clues

- **Patterns of Motion**
  - Orbits of planets
  - Rotation of planets
- **Two classes of Planets**
  - Terrestrials and Jovians
- **Asteroids and Comets**
  - Existence
  - Location
- **Exceptions to the Rule**
  - Differences in moons
  - Tilted spin axes

Was our solar system destined to be?



Formation of planets in the solar nebula seems inevitable.

But details of individual planets could have been different.

What have we learned?

- **What caused the orderly patterns of motion in our solar system?**
  - Solar nebula spun faster as it contracted because of conservation of angular momentum.
  - Collisions between gas particles then caused the nebula to flatten into a disk.
- **Why are there two major types of planets?**
  - Only rock and metals condensed inside the frost line.
  - Rock, metals, and ices condensed outside the frost line.
  - Larger planetesimals outside the frost line drew in H and He gas.

What have we learned?

- **Where did asteroids and comets come from?**
  - They are leftover planetesimals, according to the nebular theory.
- **How do we explain "exceptions to the rules"?**
  - Bombardment of newly formed planets by planetesimals may explain the exceptions.

8.3 The Age of the Solar System

- Our goals for learning:
  - **How do we measure the age of a rock?**
  - **How do we know the age of the solar system?**

How do we measure the age of a rock ?

Radioactive Decay

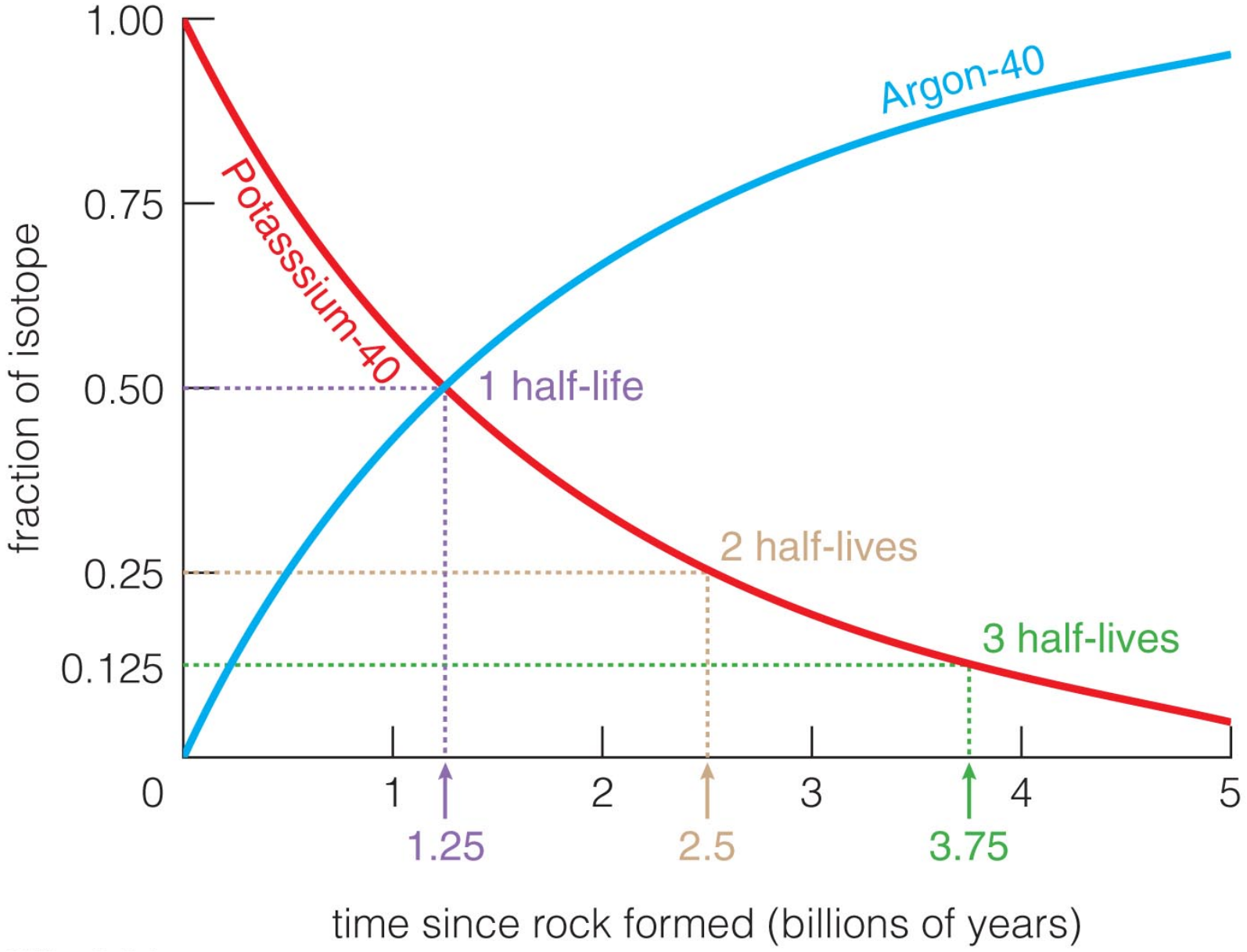
Some isotopes of elements are unstable, and spontaneously turn into other elements through radioactive decay, where a proton in the nucleus turns into a neutron.

Example: Potassium-40 (^{40}K) → Argon-40 (^{40}Ar)

Half life: the timescale on which half of the isotope decays into the new element (1.25 billion years for the example)

By measuring the amount of Potassium-40 and Argon-40, you can measure the age of a rock.

How do we measure the age of a rock ?



How do we know the age of the solar system?

- Radiometric dating tells us that oldest moon rocks are 4.4 billion years old.
- Oldest meteorites are 4.55 billion years old.
- Planets probably formed 4.5 billion years ago.

What have we learned?

- **How do we measure the age of a rock?**
  - Some isotopes decay with a well-known half-life.
  - Comparing the proportions of those isotopes with their decay products tells us age of rock.
- **How do we know the age of the solar system?**
  - Radiometric dating indicates that planets formed 4.5 billion years ago.