Origin of the Solar System Reading

Relationship to the Big Bang

The universe started 13.77 billion years ago in an event known as the Big Bang. This was a rapid expansion of space, time and matter. The first atoms were created after about a second, but it was about 400 million years before the first stars had formed from the hydrogen atoms created in the early universe.

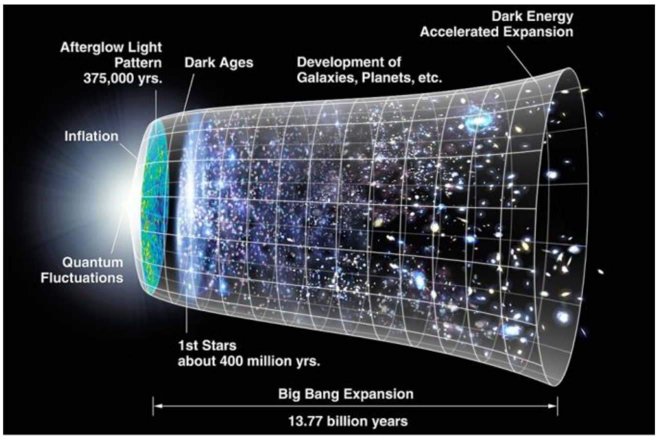
In the centre of stars, hydrogen atoms fuse to form larger atoms of carbon, oxygen, silicon and iron. Eventually, the fusion reactions end and stars 'die'. Sometimes they collapse inward and explode, throwing the heavier atoms out into a great cloud called a nebula. This star stuff then clumps again and forms a new star, but with rocky matter and planets around it. Our solar system formed from a nebula.

Forces that bring matter together

There are four fundamental forces in the universe. In order of strength, they are:

- Strong nuclear
- Electromagnetic
- Weak nuclear
- Gravity

The nuclear forces act across very tiny distances in the nucleus of an atom. Although they are vital for all matter to exist, they are not drivers of solar system formation. Electromagnetic and gravitational forces are they key to assembling the stars and planets.



Timeline of the Universe since the Big Bang (NASA/ WMAP Science Team 2006, public domain)

Swirling into a planetary nebula

The nebular that gave birth to our solar system began to collapse and swirl. Although not certain, scientist believe this was caused by shockwaves from a supernova. The swirling motion of the gas caused particles to rub against each other. It also began to concentrate matter in the centre of the new protoplanetary disk. The centre of our disk, the Sun, contains 99% of the matter in our solar system.

The role of static electricity

Because gravity is proportional to mass, it provides little attractive force between microscopic particles of dust in a nebula. Particles in microgravity develop strong electrical charges. This allows particles to clump to a sufficient size for mutual gravity to begin the process of accretion. When modeled in the lab, basalt spheres (a good model for protoplanetary dust) aggregated much more strongly than glass spheres. This provides strong experimental evidence for the role of static charges in early clumping in protoplanetary disks.

Gravity and accretion

The clumping particles in the nebula eventually reached the size at which gravity became an important attractive force. Gravitational attraction is caused by a bending of space/time. The greater the mass of an object, the more it bends space/time and the more gravitational attraction it has.

The sun has a large gravitational attraction that keeps the planets, asteroids, meteors and comets of our solar system in orbit around its central mass. A supermassive black hole (collapsed star) called Sgr A* extends it gravitational influence over all of our galaxy, forming the Milky Way. This black hole is 400 million times the mass of the Sun and its gravity is so strong that photons of light cannot escape it.

Experiment and explore

- See an incredible scale model of the solar system from To Scale: The Solar System
- Make your own scale model of the solar system or try this one using toilet paper.
- Learn more about meteorites – material left over after solar system formation.
- Watch this video about the formation of the solar system.
- Carry out your own experiments with static electricity and gravity.

References:

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