

How the Sun and the Solar System might form
commentary

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Hubble Space Telescope observations of the Orion nebula, showing how a star with a solar system can form

We start with a large cloud of gas and dusty material in deep space. The cloud is at least a million times the mass of the Sun, and is held together by gravity. Gradually, over millions of years, the cloud collapses and clumps form in the cloud. These clumps will eventually become stars.

As the material collapses it heats up from $-265\text{ }^{\circ}\text{C}$ to $-260\text{ }^{\circ}\text{C}$ (so it is still very, very cold). This small temperature rise allows the 'star' to shine by its own light, although we would detect heat, and not visible light, from the star. Eventually the cloud is dense enough and hot enough for nuclear fusion to take place, and hydrogen turns into helium by burning. Some stars are so small that they never ignite the hydrogen. These stars just glow feebly for tens of millions of years as gravity continues to collapse them, until it can do so no longer and the star goes out.

The nuclear fusion makes a big difference to the new star. It starts to get rid of material from the poles of the star, and has a thick ring of material around its equator. There can be as much material in the ring as there is in the star - about the same amount of mass as in the Sun. The energy from the new star tries to blow away the ring, and at the same time material from the ring is held onto the star by gravity.

If enough of the material stays in the ring, planets can be formed by small grains of dust sticking together, then bigger rocks sticking together, then the larger lumps (which are the size of asteroids and comets) sticking together, and so on. Giant planets like Jupiter are formed far enough away from the star so that they can keep a lot of gas from the ring. Planets like Earth are too small and too close to the Sun to have much hydrogen and helium gas in their atmosphere. However, Earth has kept hydrogen, although it is locked up with oxygen in water.