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Tapping, Ken

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A SIMPLE COSMIC RECIPE

Ken Tapping, 10th February, 2015

Stars, planets, moons, asteroids, comets, meteors and the other objects we see in space are quite different from one another. Stars are big balls of hot gas, mainly hydrogen, producing energy in their cores by nuclear fusion. Planets are smaller, and depend on the star they orbit for heat and light. They are mainly rocky. Some have more or less no atmosphere, while others have deep, dense ones. Moons are generally smaller, and orbit planets. They are generally lumps of ice and rock, depending on their temperatures and usually have either no atmospheres or very thin ones. However, some, such as Titan, have dense atmospheres. Asteroids are lumps of rock and ice orbiting a star. Comets are lumps of dirty ice a few kilometres or so in size that for most of their lives orbit far from a star, where it is extremely cold, so that ice, organic chemicals and most gases are frozen solid. Then some accident puts them into a new orbit, which takes them closer to their star. As they heat up, the volatile material and the objects slowly disintegrate, with the debris forming their magnificent tails. Meteors are bits of comet debris or material left over from the birth of the Solar System burning up in the atmosphere.

It is really intriguing that the recipe for making all these bodies lists only one ingredient, and it is the same ingredient for all of them. What we end up with depends upon just the amount. That universal ingredient is the material in cosmic clouds, which contain a mixture of gases (mainly hydrogen), rock, ice, metals and a mixture of chemicals. The Hubble Space Telescope has produced dramatic and beautiful images of these clouds.

Sometimes a disturbance makes part of one of these clouds unstable, so it starts to collapse under its own gravity. The result is a rotating disc with a denser region in the centre. Sometimes all the material ultimately collapses into one lump.

However, in general this cannot happen because of a principle known as the conservation of angular momentum. This is why a spinning skater speeds up when she pulls in her arms. This makes it much easier for the disc to collapse into a collection of smaller lumps, orbiting the biggest one.

If the biggest lump is large enough for the pressure of infalling material to heat the core to ten million degrees or so, nuclear fusion will start and we will have a new star. If any of the other lumps are also big enough we will get a binary or multiple star. The remaining, smaller lumps become all the other objects. Lumps near the new star will have their gases evaporated and mostly driven off, leaving a rocky body with possibly some remaining gases providing an atmosphere. These are planets.

Planets lying further from their star, like Jupiter, manage to hang onto more gas, forming “gas giants”. Smaller lumps, less than a few hundred kilometres in diameter, will have insufficient gravity to hang onto an atmosphere unless they are far enough from their star to remain extremely cold. Many of these are so small there is not enough gravity to pull them into a spherical shape. These are asteroids. Some asteroids or small planets form close to a larger planet and orbit that. These are moons. A host of deeply frozen fragments remain in the outer disc. These bodies form a reservoir for making new comets.

There is an enormous amount of small particles, grit, dust and gravel that never form planets. Sometimes we see it illuminated by the Sun, glowing like a phantom Milky Way. This is the zodiacal light. If those particles come into our atmosphere at tens of kilometres a second, they burn up as “shooting stars”, or more correctly, meteors. Their material drifts down to the ground, continuing the slow process of planet building.

Venus lies in the southwest after sunset, with Mars nearby and much fainter. Jupiter dominates the southern sky overnight and Saturn rises around 3am. The Moon reaches Last Quarter on the 11th.

Ken Tapping is an astronomer with the National Research Council's Dominion Radio Astrophysical Observatory, Penticton, BC, V2A 6J9.
Tel (250) 497-2300, Fax (250) 497-2355
E-mail: ken.tapping@nrc-cnrc.gc.ca