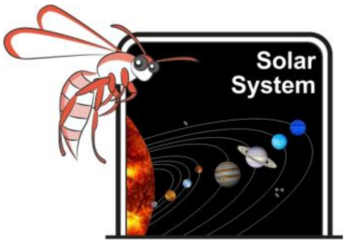



# Formation of our Solar System – Teacher Background

So far, our best explanation about the origin of the Universe is “The Big Bang Theory”. This suggests that a mighty explosion about 13 billion years ago sent hot dense particles (mostly hydrogen) streaming outwards from a central point of singularity. Astronomers have measured that all celestial objects appear to be streaming away from an original central position.

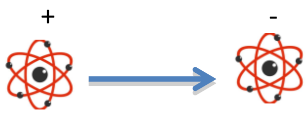

Gravity is the major force or “glue” that holds the universe together. Gravity pulls together matter to form galaxies, stars, planets and their satellites. The cores of stars are natural nuclear reactors that smash simple atoms together to form more complex ones. When stars lose energy they collapse then explode to create great clouds of dust called nebulae that blast back out into space and eventually reform into other stars, planets etc. One such explosion blasted dust out through the western spiral arm of our galaxy, the Milky Way and it was this raw material that formed our solar system about 4.6 billion years ago. We know that our planet is made from star stuff because there are complex elements such as iron and potassium found in the rocks, soils and in ourselves. These elements are only made in the cores of very large, very hot, stars

We are all made of “star stuff” recycled by our planet.

## Static Electricity and Gravity – The Universe’s Glue

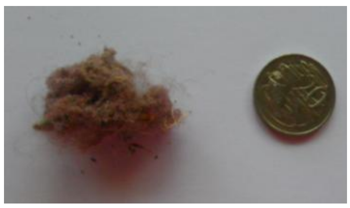
Both static electricity and gravity are forces. Forces cause other objects to move or change the direction of their movement. Both static electricity and gravity can also act at a distance unlike a push or a pull, which need contact. Static electricity acts over small distances while gravity can act over great distances.

Static electricity however is the first weak force that pulls together small particles that rub against each other. It is the build up of small particles to more massive ones that permit gravity to exert its pulling force.

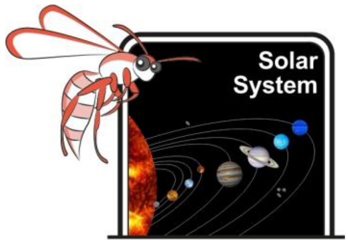



1. **Static electricity** – a minor weak force

During the explosion forming the nebula, small particles in the dust cloud rush out into space. When affected by gravity from another large body such as another star, they would be drawn together to form a proto-planetary disc and some would start rubbing together. Outer electrons would be lost from one atom and transferred to another. This would leave the atom that had lost an electron with a positive electrical charge and the atom that had gained an electron with a negative electrical charge. They would then stick to each other like little magnets because of their opposing electrostatic charges. Opposites attract. (Static electricity does not flow like the electricity we use as power but completely discharges at once.)



The dust “bugs” and “mice” that are often found under student’s beds are bound together by such a rubbing and charging process. The moving draft from wind or a fan causes particles to rub, become charged and then to stick together. Students may also have felt static discharge from the release and rubbing of a car seatbelt or by rubbing a balloon against a jumper and “sticking” it to a wall or ceiling.




With the clumping of dust due to static electricity, the first step towards building the solar system had been taken.

2. **Gravity** – the major force.

Gravity is a force related to the mass of an object. Mass is the “stuff” (atoms and molecules) that the body is made from. Any object which has mass will attract another object which has mass. Apocryphal tales have it that Isaac Newton first proposed this force after he saw an apple fall down from the tree was sitting under. He realised that on Earth all things fall downwards towards the centre of the planet, that they must be attracted to it. He proposed that the force of attraction is dependant on the size of the masses and how far apart they are. The larger its mass, the larger its gravitational force of attraction. The closer the bodies are the greater their attraction.

The more massive lumps of the proto-planetary dust cloud were gravitationally attracted to each other slowly accreting until they fell towards the centre of the solar disc to form the Sun. (This sun used to be named ***Sol***, hence the ***sol***ar system). The remaining lighter matter formed the outer, mostly gassy solar disc. Rocky denser planets were pulled closer to the sun and the larger gassy less dense planets pushed further out. The position of the inner planets is thought to have been relatively constant. The outer gas giants however are thought to have migrated under the effect of each other’s gravitational pull. The rocky and icy lumps forming the asteroid belt that lies between the inner rocky planets and the outer gas giants is thought to be remnants of the proto planetary disc which did not have sufficient mass to be pulled together and form a planet. The number and position of planets has changed over time. It is thought that one of the smaller earlier planets smashed into the Earth early after its formation, remelting its surface and leaving fragments in our orbit that came together to form the Moon. Interestingly, astronomers studying other distant suns and their exo-planets have found that most have gas giants much closer to their sun than we have in our solar system. Perhaps the “Goldilocks” set of conditions that required to support life as we know it are rarer than we initially had thought.

Australian Aboriginal creation stories can be found at:
[www.abc.net.au/dustechoes/dustEchoesFlash.htm](www.abc.net.au/dustechoes/dustEchoesFlash.htm)

The Sun’s gravity holds the planets in their orbits though, of course, they are affected by the gravitational pull of each other. About 5 billion years from now the Sun will be less massive, it will cool and start to expand enveloping the inner planets including Earth before eventually it collapses in on itself.
The weight of an object (or person) on Earth is a measure of their mass and the force that gravity has on that mass.

***Weight = Mass + Gravity***

If you were weighed on a smaller planet or on a moon our mass (the amount of stuff that makes our body) would remain the same because all the body would still be there but your weight would be much less as the moon has a much smaller mass and consequently smaller gravitational pull than the Earth. A student who weighs 32 kg on Earth will weigh 5.3kg on the moon. If they survived the horrific heat on the Sun their weight would be an equally horrific 866.3kg.

“Your weight on other worlds” at [www.exploratorium.edu/ronh/weight/](www.exploratorium.edu/ronh/weight/) will allow students to calculate their weight on planets and moons of our solar system.

Students may also be horrified to know that that although their body is attracted to the centre of the Earth it is also attracted towards other students body mass and even to the more massive school building! Even our Moon, which is a relatively small piece of rock in the solar system, can attract the mobile water in Earth's oceans when it is close and pull them upwards creating high and low tides.

In the words of Monty Python's "Universe Song"

Just remember that you're standing on a planet that's evolving
And revolving at nine hundred miles an hour
That's orbiting at nineteen miles a second, so it's reckoned
A sun that is the source of all our power

The Sun and you and me and all the stars that we can see
Are moving at a million miles a day
In an outer spiral arm, at forty thousand miles an hour
Of the galaxy we call the 'Milky Way'

Although most of the measurements in the song are fairly accurate and the concepts well covered, some of the language used in other verses is perhaps not suitable for students.