**Natural Nuclear Forces**

In Nature there are four basic forces: *Strong, Weak, Electrostatic, Gravitational.*

**The strong nuclear force**
This is the force that acts at small distances within an atoms nuclei and maintains the stability of this nuclei in spite of their tendency to fly apart because of the Coulomb repulsion due to similar charged particles. This force only acts at very short distances. At about 0.5×10-15 m the attraction between nuclear particles due to the strong nuclear force begins to decline. At the distance smaller than about 10-16 m the Coulomb force is more pronounces and particles of similar charge start to reject each other.

**The weak nuclear force**
A weak nuclear force exists between all pairs of elementary particles. It is the exclusive force between electrons and neutrinos, but the same force (albeit much weaker than the electric or strong nuclear force) exists even between two protons.

**The electrostatic force**
We define the electrostatic force only for charged particles at rest. It is know for more then two centuries that in Nature we have positively and negatively charged particles. Where protons are positively charged particles and electrons as negatively charged. All macroscopic matter is basically electrically neutral, because the magnitude of the negative electric charge carried by electrons is equal to that of the positive electric charge carried by a proton and all atoms in their natural state contain equal numbers of protons and electrons. Based on these properties it is known that in electricity like charges repel and opposite charges attract.

**The gravitational force**
The gravitational force is based on and proportional to an objects' masses. A larger object of similar density will 'pull' harder on a smaller object of the same density. It was Isaac Newton who described his 'universal law of gravitation' in 1666.

**FG = G (mM/r2)**

Where:
FG = the gravitational force
G = the gravitational constant (=6.67x10-11 Nm2/kg2)
m = mass of object
M = mass of the Earth
r = distance between the center of the two masses m and M.

The table below gives an impression of the relative strength of the four forces between nuclear particles such as the electron (e), neutrino (v), proton (p) and the neutron (n)

|  |
| --- |
| Ratio of force-strengths at small distances (10-15 m) |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Force** | **e-v** | **e-p** | **p-p** | **p-n, n-n** |
| Strong Nuclear Force (N) | 0 | 0 | 1 | 1 |
| Electrostatic Force (N) | 0 | 10-2 | 10-2 | 0 |
| Weak Nuclear Force (N) | 10-13 | 10-13 | 10-13 | 10-13 |
| Gravitational Force (N) | 0 | 10-41 | 10-38 | 10-38 |

As can be deduced from the table above, from all four basic forces gravity is by far the weakest at short distances. At a small scale at the level of subatomic particles, atoms, molecules, and even biological cells both nuclear forces and the electrostatic force are the dominating players. However, at a longer distances both the nuclear forces are reduced to zero, and only the electrostatic and the gravitational forces remain of importance. At even longer distances only the force of gravity prevails.

The dominance of gravity is one of the most obvious phenomena seen in our solar system. It is gravity that keeps the planets orbiting our Sun, gravity keeps the Moon rotating around the Earth, but gravity is also the main enemy of our precious china and glassware!

All the forces we see and experience around us, like our muscle force, the hydraulic force of car brakes, the frictional force when sliding, the elastic force, the force that the Earth atmosphere exerts on a barometer, electrical force that starts a car engine, etc., etc., etc., are forces deriving from these four basic forces as described above.

**References**

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