



# Elementary components of matter

## Fundamental interactions

There are **PARTICLES ASSOCIATED** to each fundamental interaction, allowing its propagation.

	1 <sup>st</sup> family	2 <sup>nd</sup> family	3 <sup>rd</sup> family
	Particles of the first family make up all ordinary matter (protons, neutrons, atoms,...)	More massive & instable replica of the first family. The muon is 200 times heavier than the electron.	Even more massive replica of the first family. The lepton tau is 3600 times heavier than the electron.
<b>LEPTONS</b>	<b>e</b> electron $m_e = 9.109 \cdot 10^{-31} \text{ kg}$ $Q = -Q_e = -1.602 \cdot 10^{-19} \text{ C}$	<b>μ</b> muon $Q = -Q_e$	<b>τ</b> tau $Q = -Q_e$
These particles are insensitive to strong interaction.	<b>ν<sub>e</sub></b> neutrino e $Q = 0$	<b>ν<sub>μ</sub></b> neutrino muon $Q = 0$	<b>ν<sub>τ</sub></b> neutrino tau $Q = 0$
<b>QUARKS</b>	<b>u</b> up $Q = 2/3 Q_e$	<b>c</b> charm $Q = 2/3 Q_e$	<b>t</b> top $Q = 2/3 Q_e$
The numerous subatomic particles are all made of quark triplets or of quark-antiquark pairs.	<b>d</b> down $Q = -1/3 Q_e$	<b>s</b> strange $Q = -1/3 Q_e$	<b>b</b> bottom $Q = -1/3 Q_e$

<b>Gravity</b> Universal attraction, planets, galaxies. <b>GRAVITON?</b>
<b>Weak interaction</b> Radioactive decays. <b>Z<sup>0</sup>, W<sup>+</sup>, W<sup>-</sup></b>
<b>Electromagnetism</b> Electricity, magnetism, atom and crystal cohesion, chemistry. <b>PHOTON</b>
<b>Strong interaction</b> Proton and neutron cohesion. <b>GLUON</b>

The 4 fundamental interactions are all needed for the sun (and all the stars) to shine:

- Star formation caused by gravity;
- Nuclear fusion reactions caused by weak and strong interactions;
- Light production: electromagnetic interaction.

The 4 particles of the first family are all present in the sun who sends to earth an intense flux of photons and neutrinos.

To each particle, corresponds an antiparticle with quasi identical properties. The electric charge of an antiparticle is opposite to the one of the corresponding particle.

<http://sfp.in2p3.fr/affiche>

