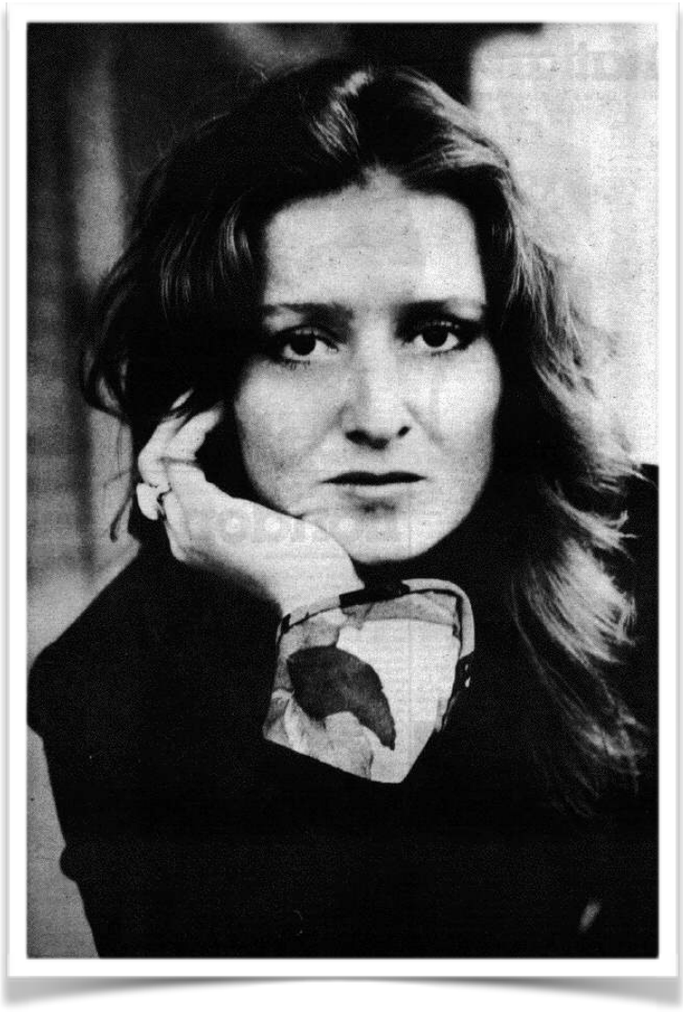
Solar power is the last energy resource that isn't owned yet - nobody taxes the sun yet.

Bonnie Rait



Arizona State University
SES 194

Energy in Everyday Life

Binding Protons and Neutrons

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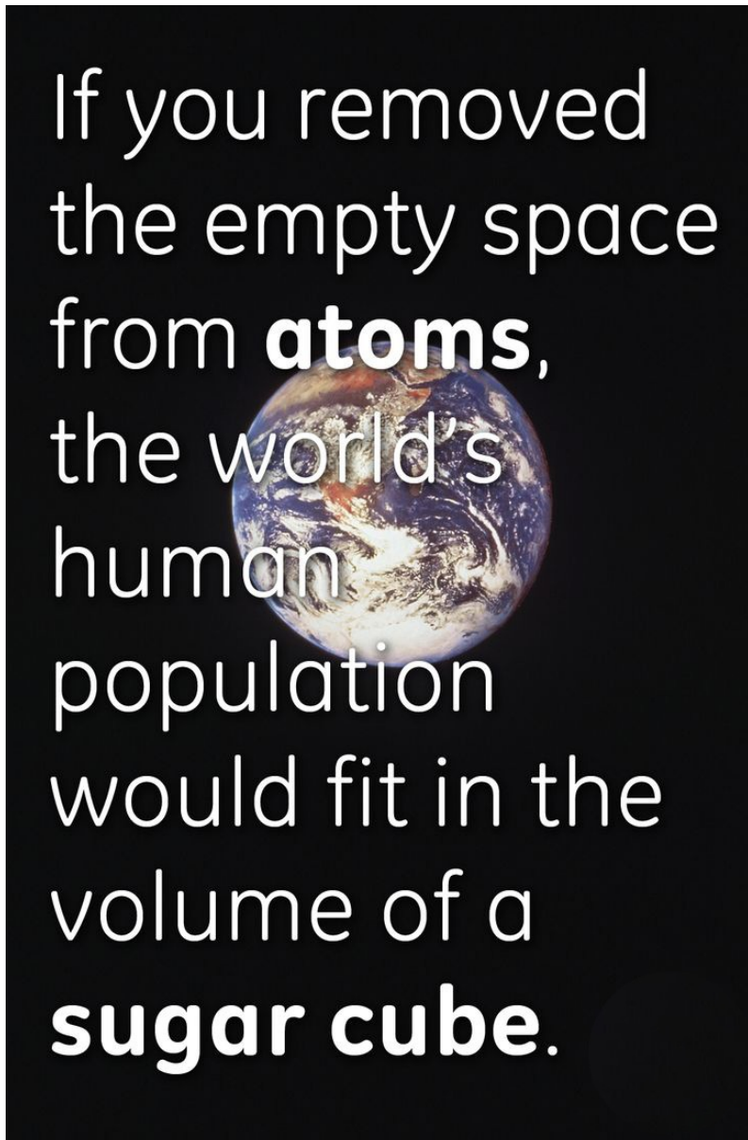
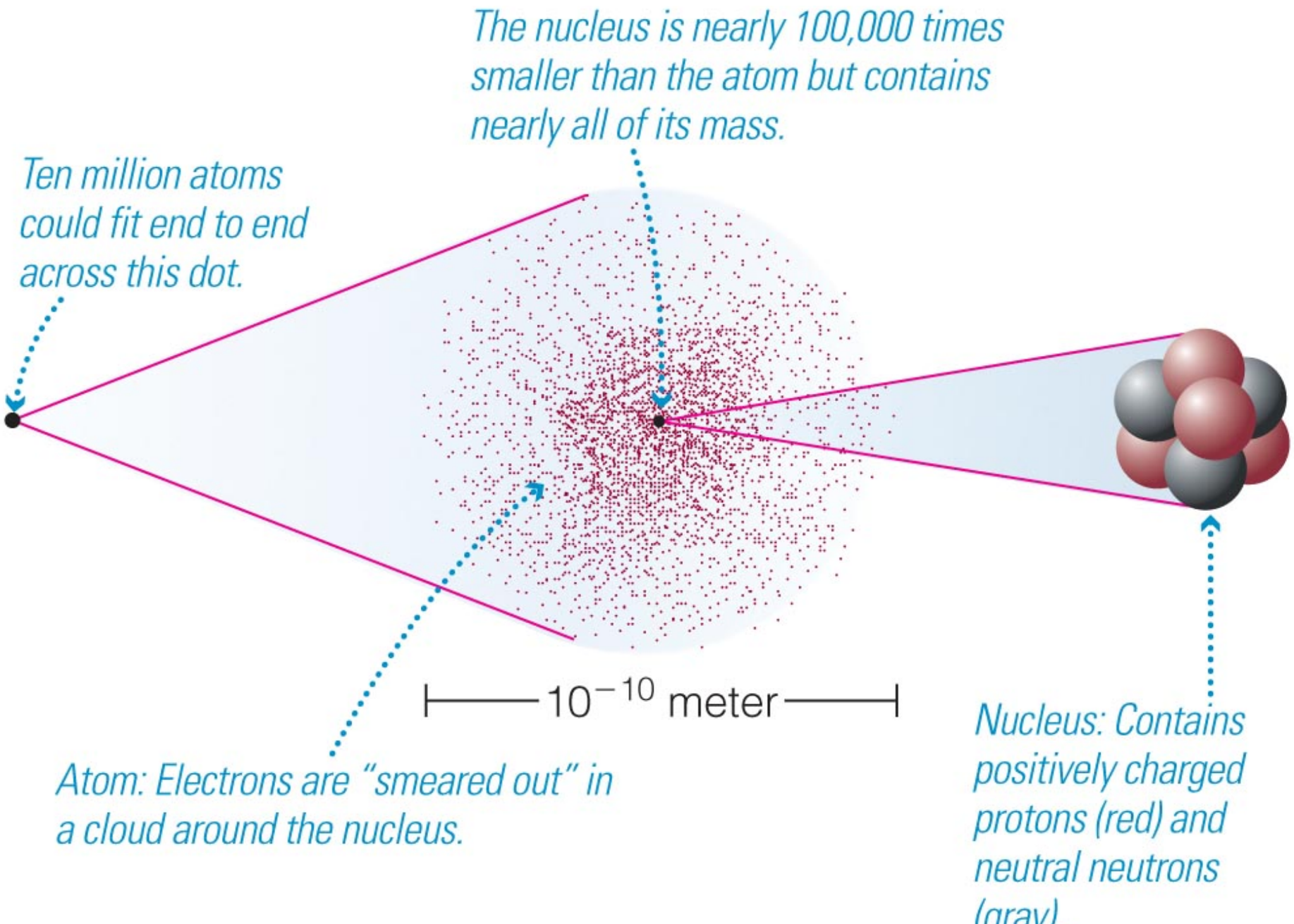
If we examine a material on a such smaller scale than the atom, ~10^{-10} m, we find that the atom is mainly composed of "empty" space.

At the atom's core lies the massive atomic nucleus, which has a diameter ~10^{-15} m.

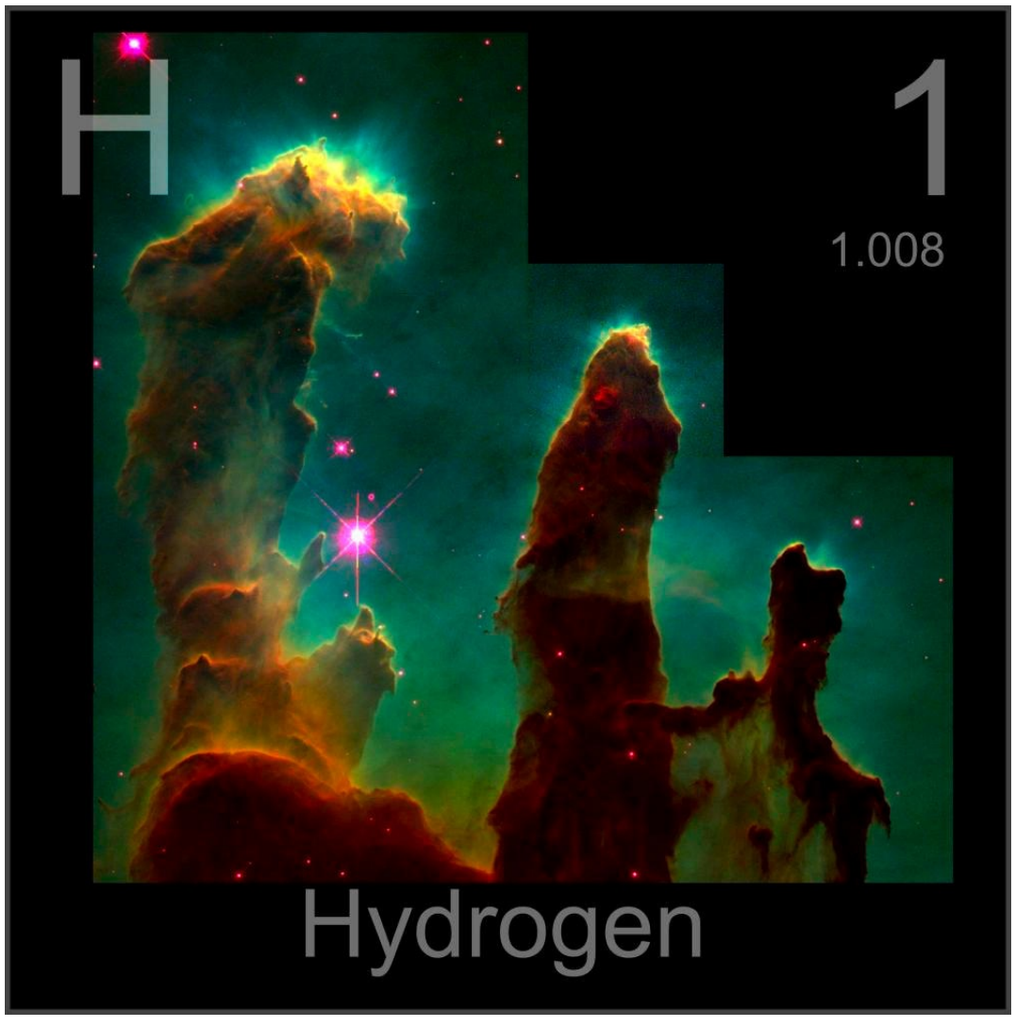
An atom is a mind-boggling 99.999999999996% "empty" space.



An atomic nucleus is built from protons and neutrons. These particles can also exist outside a nucleus.



A proton is the nucleus of a hydrogen atom. As the universe is mostly hydrogen, many protons exist in the universe.

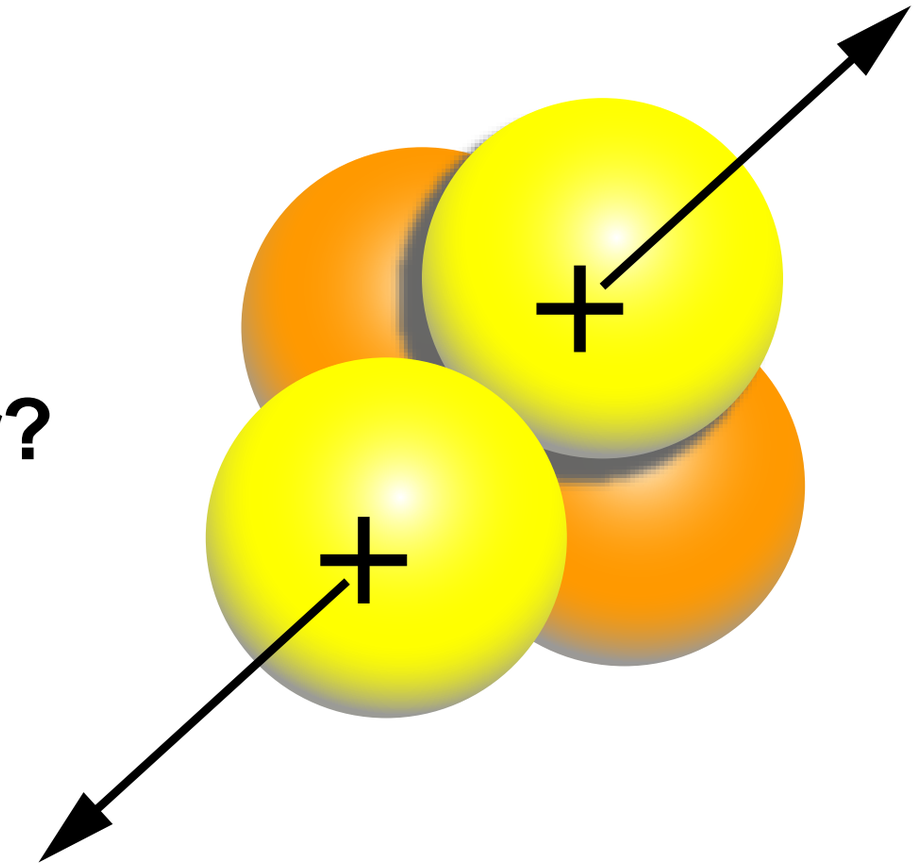


Neutrons are generally stable when they are inside a nucleus. If a neutron is outside a nucleus, it will decay to a proton and electron and neutrino in about 15 minutes.

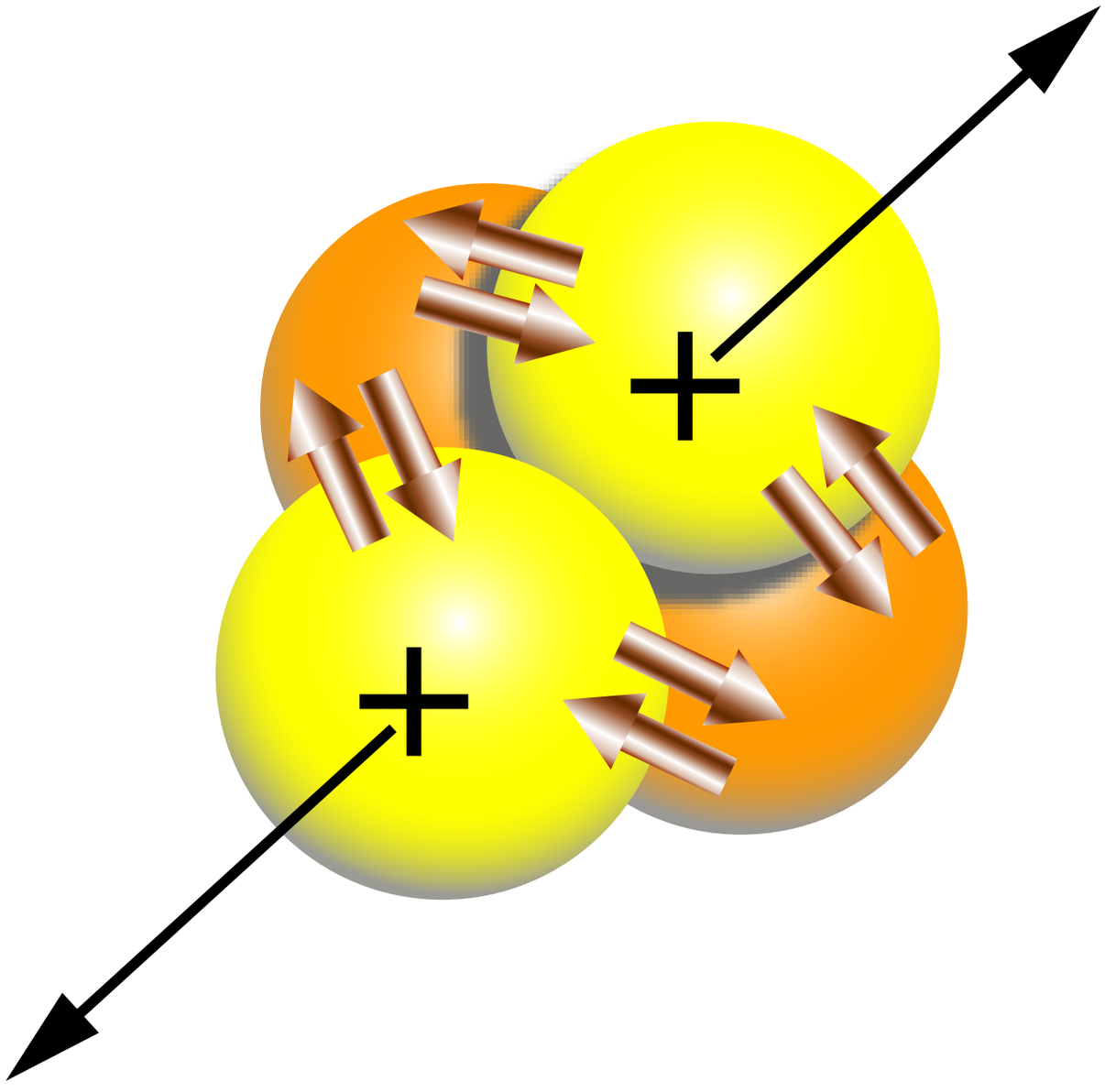
Protons and neutrons are almost indistinguishable; the proton has one unit of positive charge and the neutron has no charge being the main difference.

Since the protons have the same charge, they repel each other electrically. At a distance of an atomic nucleus, 10^{-15} m, the repulsive force between any two protons is ginormous.

So why does the nucleus stay together?

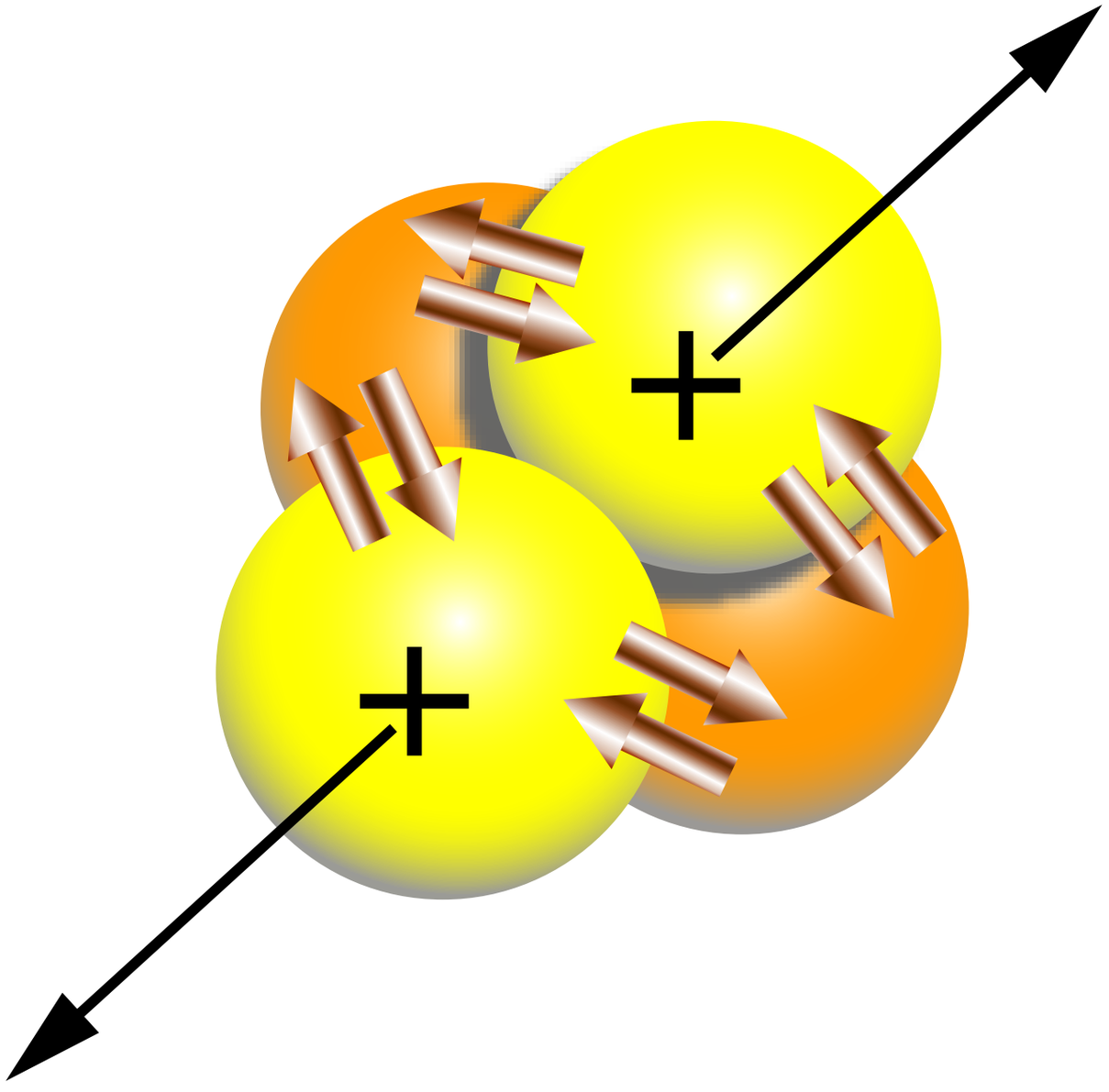


The neutrons and protons are bound together by the strong force, which is 100 times greater than the electrical force when the neutrons and protons are within 10^{-15} m of each other.



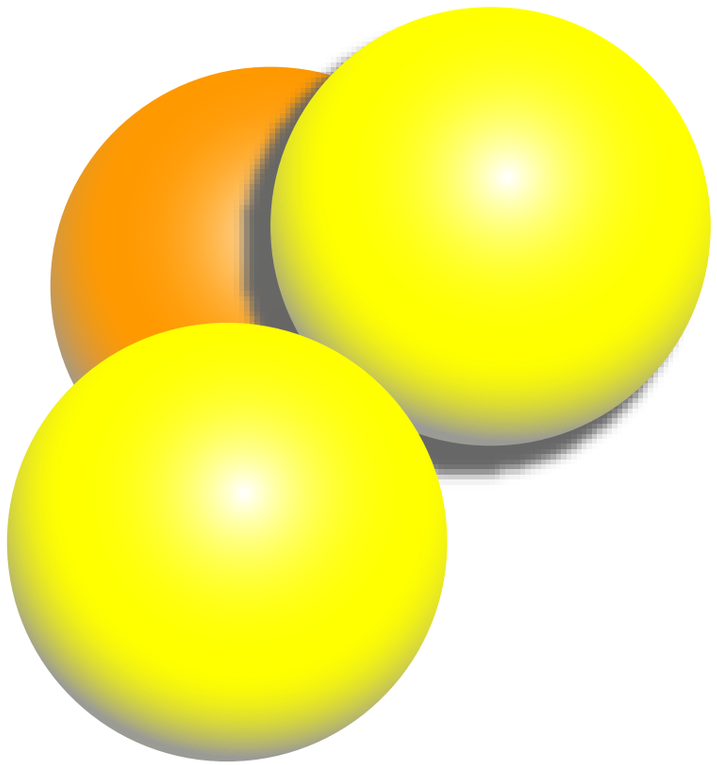
The strong force between neutrons and protons is attractive.

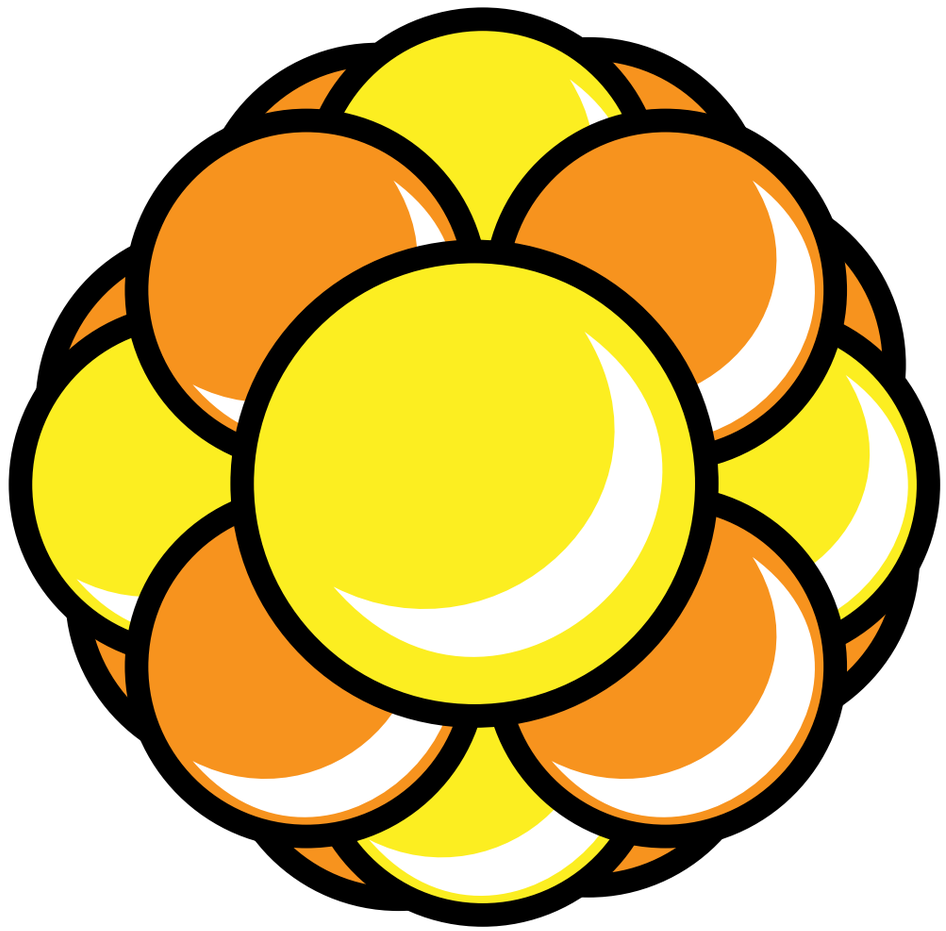
If neutrons get between protons, separating the protons from each other, the protons feel a weaker electrical repulsion.



This makes the nucleus stable by lowering its overall energy.

If there are two protons, it takes just one neutron to get between them to form a stable arrangement (helium-3).





If there are, say seven protons, it can take more than seven neutrons to be able to get between each pair of protons.

Thus, heavier stable elements have more neutrons than protons.