

Re: how is it that the Atomic Mass Unit is less than either the

Re: how is it that the Atomic Mass Unit is less than either the

Source: <http://sci.tech-archive.net/Archive/sci.physics.research/2006-09/msg00132.html>

- *From:* "Timo A. Nieminen" <timo@xxxxxxxxxxxxxxxxxxxxx>
 - *Date:* Wed, 20 Sep 2006 09:29:50 +0000 (UTC)
-

On Tue, 19 Sep 2006, robert bristow-johnson wrote:

the amu is defined to be 1/12 the mass of a carbon-12 atom, i presume complete with 6 protons, 6 neutrons, and 6 electrons.

even if the electrons weighed nothing, each proton and neutron is more than the amu so it must add to more than 12 amu. how can this be?? i know that this is a definition, but it seems to me that the definition does not square with CODATA values of the most massive components of a carbon-12 atom and the conservation of mass principle. how does sticking these 6 neutrons and 6 protons together, toss in 6 electrons and maybe some binding energy/c² add up to less than the total? i don't get it.

i had always assumed that the amu was somewhere nearly halfway between the proton and neutron rest mass, but it's less than either. how can that be?

can someone make sense of this?

Very simple; the mass of a system is not the sum of the masses of the components. Energy matters, $E=mc^2$ and all that. You need to add energy to carbon to break it into isolated protons, neutrons, and electrons. That means that the energy of a single carbon atom is less than that of its individual constituents. Thus, there is a negative amount of energy – the binding energy – associated with assembling them into carbon. $E=mc^2$ with a negative energy means that that amount of negative energy has a negative mass, and the mass of a carbon atom is less than the sum of the masses of 6 electrons + 6 protons + 6 neutrons.

Strange? Maybe so. But consider the best(?) definition of rest mass we have: the magnitude of the energy-momentum 4-vector, with appropriate unit conversion as required. For example, take 1 photon, and you get zero rest mass. Take two identical photons going in opposite directions, and since the total momentum is zero, but the energy is not, the rest mass cannot be zero.

Re: how is it that the Atomic Mass Unit is less than either the

Re: how is it that the Atomic Mass Unit is less than either the

Timo Nieminen – Home page: <http://www.physics.uq.edu.au/people/nieminen/>

E-prints: http://eprint.uq.edu.au/view/person/Nieminen,_Timo_A..html

Shrine to Spirits: http://www.users.bigpond.com/timo_nieminen/spirits.html

.