Why $E = mc^2$ Emerges in the Process of Neutron Capture

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Abstract

This paper is a short commentary on the 2005 paper in Nature by S. Rainville et al., which claimed to be “the most precise direct test of the famous equation”, $E = mc^2$. This communication is directed only to the readers who are familiar with the earlier papers by the author on the subject of mass-energy equivalence.

In a paper published in Nature in December of 2005, entitled: “A Direct Test of $E = mc^2$” [1], author Simon Rainville et al. demonstrated the results of an experiment in which the fundamental process of neutron capture by nuclei of sulfur and silicon results in gamma radiation the energy content of which matches precisely the quantity $\Delta mc^2$. The authors claimed that the experiment represents “the most precise direct test of the famous equation”.

It seems that the physics community has totally forgotten that Einstein made two separate conclusions concerning the concept of mass-energy equivalence in his famous paper of 1905. The first conclusion predicts that the kinetic energy of a particle is numerically equiv-
alent to $\Delta mc^2$, and that if kinetic energy is converted to electromagnetic radiation then
the energy content of that radiation would precisely match that quantity. That conclusion,
fortunately, was correct (see the main paper by the author on this subject [2]). In the last
few lines of his paper, however, Einstein made a second, “general conclusion”, which he gave
without any proof (amazingly, after 100 years, that general conclusion is still without any
proof): the conclusion that the total energy of a particle is equal to the total mass multiplied
by $c^2$. Unfortunately, Einstein’s “general conclusion” was incorrect! (see ref. [2]).

What Rainville et al. have demonstrated in their experiment, as a matter of fact, is the
equivalence between kinetic energy and electromagnetic energy (Einstein’s first conclusion).
The process of neutron capture by nuclei, unfortunately, has nothing to do with Einstein’s
“general conclusion” (the direct conversion of mass into energy). That general conclusion
can only be tested in particle decays. The reason is the following: in the process of neu-
tron capture, a neutron is attracted to the nucleus by the strong nuclear force and becomes
trapped inside a potential well [3]. It is currently recognized that the partons (quarks) com-
posing the neutron will lose part of their kinetic energies once inside the potential well [4].
This also means that the neutron will lose part of its apparent mass and actually become
“lighter” inside the nucleus (this accounts, for example, for the mass difference between the
$^{28}\text{Si}$ nucleus and its components, $^{28}\text{Si} +$ neutron ). Now, the quarks’ loss of kinetic energy
does of course result in the emission of a gamma ray, which, thanks to the Rainville et al.
experiment, is found to have an energy that matches precisely the quantity $\Delta mc^2$. Notice,
however, that no direct mass to energy transformation ever occurs in the process of neutron
capture. The Rainville et al. experiment therefore proves only Einstein’s conclusion con-
cerning kinetic energy.

How about the plethora of experiments that have attempted in the past to prove Einstein’s
“general conclusion”, or the direct conversion of mass into energy? Except in the very few
cases where the particle velocities actually approach the speed of light, they all failed! (see
the previous papers by the author).

**For the Record:**

This communication was rejected by the journal Nature without any review. I am highly
indebted to the arXiv, to the journal Physics Essays, and to other “free speech” scientific
publication media.
References

[1] S. Rainville et al., *A Direct Test of E = mc²*, Nature, 438, 22, 2005, p.1096.

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[3] W.S.C. Williams, *Nuclear and Particle Physics* (Oxford Univ. Press, 1991).

[4] J.G. Cramer et al., *Quantum Opacity, the RHIC HBT Puzzle, and the Chiral Phase Transition*, Phys. Rev. Lett. 94 (2005), E-print archive: nucl-th/0411031.