THE VIRUS OF RELATIVISTIC MASS IN THE YEAR OF PHYSICS*

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The "famous formula" $E = mc^2$ and the concept of "relativistic mass" increasing with velocity, which follows from it, are historical artifacts, contradicting the basic symmetry of Einstein's Special Relativity, the symmetry of 4-dimensional space-time. The relation discovered by Einstein is not $E = mc^2$, but $E_0 = mc^2$, where E_0 is the energy of a free body at rest introduced by Einstein in 1905. The source of the longevity of the "famous formula" is the irresponsible attitude of relativity theory experts to the task of explaining it to the non-experts.
The notion of "relativistic mass" presents a kind of pedagogical virus which very effectively infects new generations of students and professors and shows no signs of decline. Moreover in the Year of Physics it threatens to produce a real pandemia.

Before writing my first article against the "Einstein famous equation $E = mc^2$" I mentioned in 1987 this intention to Volodya Gribov in one of our daily conversations. We had a complete unanimity on the issue of physics. But Volodya was a better friend of mine than I myself. And his understanding of life was better than mine. Therefore he tried to dissuade me from wasting my time on a fight against an obviously wrong cliché, which I would inevitably loose. I discarded his wise advice and wrote my first two papers on the concept of mass [1,2].

The subject seemed important to me because it concerned the proper teaching of special relativity at high schools, colleges and universities and explaining its genuine meaning to a wide audience of non-physicists, the so-called "pedestrians" in popular science magazines and books.

The task looked also not absolutely formidable because a consistent presentation of relativity existed for a long time in the world-wide accepted text-book by Landau and Lifshitz [3], which was the basis of my own understanding, and in some other text-books.

*The paper was written for the Gribov Memorial Volume dedicated to the 75th birthday of V.N. Gribov.

The existence of countless texts, in which the essence of relativity was mutilated (or semi-mutilated) had two sides. On one hand, it looked discouraging, especially because among the authors of these texts there were many famous physicists, the fathers and greatest authorities of modern physics. On the other hand, it was a challenge. So I tried to explain clearly to the readers the beauty of four-dimensional space-time approach and the ugliness and inconsistency of "relativistic mass", an illegitimate child of relativistic and non-relativistic equations.

My optimism had increased when in 1992 Taylor and Wheeler in the second edition of the influential and popular "*Spacetime Physics*" [4] included a "Dialog: Use and Abuse of the Concept of Mass", in which they supported my articles [1,2]. A copy of this book is in my bookcase with a postcard sent to me in October 1991 by John Archibald Wheeler. The postcard has a photo of the famous Albert Einstein Memorial in front of the building of the National Academy of Sciences, Washington, DC. The bronze sculpture of Einstein includes a copy book with $E = mc^2$ on an open page.

Since that time I received hundreds of letters from physicists (both professors and students) stating their adherence to the four-dimensional formulation of relativity and to the Lorentz invariant concept of mass. In a few cases I helped the authors to correct erroneous explanations of the concept of mass in preparing new editions of their textbooks. However the number of proponents of relativistic mass seemed not to decrease.

A leading role in promoting the relativistic mass have played the books by Max Jammer [5,6]. Especially aggressive the proponents of relativistic mass became in connection with the World Year of Physics, which marks the 90th anniversary of fundamental articles published by Einstein in 1905.

The campaign started by the September 2004 issue of "*Scientific American*", full with "relativistic mass" equal to $m_0/\sqrt{1 - v^2/c^2}$, where m_0 is rest mass, and "the most famous equation $E = mc^2$". A letter to the editors, defending the four-dimentional approach and invariant mass had been rejected by the editor G. Collins who in April 2005 wrote: "Most important, we believe that tackling the issue head-on in the manner you and your coauthors want in the letters column of *Sci. Am.* would be very confusing to our general audience and it would make the subject seen all the more mysterious and impenetrable to them". Thus to avoid "head-on" collision of correct and false arguments the editors of *Sci. Am.* preferred to hide from the readers the correct viewpoint.

P. Rodgers – the Editor of European "*Physics World*" wrote in January 2005 in editorial [7]: "... $E = mc^2$ led to the remarkable conclusion that mass and energy are one and the same". Unlike G. Collins, P. Rodgers published a letter criticizing this statement and partly agreed with the criticism [8].

In September 2005 the bandwagon of relativistic mass was joined by "*The New York Times*", which published an article by B. Green [9].

The journalists were supported by renowned scientists, such as R. Penrose, who in a new thousand pages thick book had written [10]:

"In a clear sense mass and energy become completely equivalent to one another according to Einstein's most famous equation $E = mc^2$."

How many students, teachers and journalists will be infected by this sentence? How many readers had been infected by the famous book by S. Hawking [11], the second edition of which appeared in 2005? On the very first page of it Hawking wrote:

"Someone told me that each equation I included in the book would halve the sales. I therefore resolved not to have any equations at all. In the end, however, I did put in one equation, Einstein's famous equation $E = mc^2$. I hope that this will not scare off half of my potential readers."

I am sure that the usage of $E = mc^2$ had doubled the sales of his book, the buyers being attracted by the famous brand. But is it possible to estimate the damage done to their understanding of relativity theory and to the general level of the literature on relativity incurred by this case of spreading the virus.

Two recent preprints by Gary Oas [12,13] written in the framework of Educational Program for Gifted Youth at Stanford University were devoted to the use of relativistic mass. The author "urged, once again, that the use of the concept at all levels to be abandoned" [12]. The manuscript has been submitted for publication to the "*Americal Journal of Physics*", but was rejected as being "too lengthy" (it contains 12 pages!). A lengthy bibliography (on 30 pages) of books referring to special and/or general relativity is provided in Ref. [13] to give a background for discussions of the historical use of the concept of relativistic mass. It is easy to forecast the aggressive reaction of the virus infected community to this attempt to cure it.

I am grateful to the grant of Russian Ministry of Education and Science No. 2328.2003.2 for partial support of this work.

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