

Peer Review

Review of: "Why Is Gravitational Mass Equal to Inertial Mass?"

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The topic is interesting and the subject of rather intense experimental work. However, this article claims to demonstrate that gravitational mass is equal to inertial mass, which if true would invalidate any need for the experimental programs aimed the direct test of this question for antimatter. For example, about 200 physicists and engineers are working at CERN in three experiments (ALPHA-g, AEGIS and Gbar) to test the equivalence principle for antihydrogen.

While the historical part of the paper is interesting, it uses ideas now considered as purely historical, such as longitudinal and transverse mass. In the Newtonian analysis, Part 3 of the paper could be suppressed as it is a rather trivial discussion about the definition of units in the Newtonian theory and not relevant to the question at hand.

Also, while General relativity is quoted in the text, its ideas and equations are not used. The analysis is purely Newtonian, and the different definitions of mass in general relativity (Arnowitt-Deser-Misner, Bondi, Komar, ...) are not quoted or analyzed according to their differences. In particular, the historical paper by Bondi about negative masses and their counter-intuitive behavior is not quoted. Similarly, the work by Dennis Sciama and his followers is completely missing, while the paper "The origin of inertia" by Sciama is of direct relevance to the present topic.

D. Sciama, "On the origin of inertia",
MNRAS, 113 (1953) 34-42}.

Less well-known are the papers by Hoyle and Narlikar, and the related paper by Hawking dealing with the Machian expression of general relativity proposed by the former authors (references below). Interestingly, Hawking shows that the Hoyle-Narlikar theory of gravitation is equivalent to General Relativity in the smooth fluid approximation, but that its limit conditions diverge, unless negative mass particles exist in the Universe.

Hoyle, Fred, and Jayant V. Narlikar. "A new theory of gravitation." Proceedings of the Royal Society of London. Series A. Mathematical and Physical Sciences 282.1389 (1964): 191-207.

Hawking, Stephen William. "On the Hoyle-Narlikar theory of gravitation." Proceedings of the Royal Society of London. Mathematical and Physical Sciences 286.1406 (1965): 313-319.

Finally, I disagree with some rather definitive statements, such as "gravitational mass (is) operationally unmeasurable" (page 9, next to last line), a statement in full disagreement with the analysis of Sciama. In conclusion, the present paper does not prove its point and its analysis, by being entirely Newtonian, is not adapted to a modern analysis of this (important) question.

Declarations

Potential competing interests: No potential competing interests to declare.