

Re: Did Einstein Repeal Newton's Second Law?

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"Donald Macnaughton" <donmac@matstat.com> wrote in message news:iTW5d.1930\$tT2.384584@news20.bellglobal.com...

- > *I'm a statistician, not a physicist. In an essay I'm writing*
- > *about scientific reasoning I would like to say whether Newton's*
- > *second law of motion ($F = ma$) was "repealed" by one of Einstein's*
- > *two theories of relativity. However, although I've done some*
- > *digging, I haven't found a good discussion of this topic. So I*
- > *have the following questions:*
- >
- > *1. Does one of Einstein's theories repeal (or modify) Newton's*
- > *second law? If so, how? If not, do Einstein's theories take*
- > *Newton's second law as a given?*

A partial answer:

Actually Newton's second law does not give force as mass times acceleration,

$$F = m a$$

but as the time derivative of momentum,

$$F = dp/dt$$

Newton defined momentum p as mass times velocity

$$p = m v$$

and velocity v as

$$v = ds/dt$$

hence, when mass is invariant or constant, the force is given by

$$\begin{aligned} F &= m dv/dt \\ &= m a \end{aligned}$$

Einstein treated mass M as dependent on the so-called rest-mass m and the velocity v :

$$M = \gamma m$$

where

$$\gamma = 1 / \sqrt{1 - v^2/c^2}$$

so he kept Newton's second law

$$F = dp/dt$$

and still defined defined momentum p as mass times velocity,

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$$p = M v$$
$$= \gamma m v.$$

So we could say that Einstein did not change Newton's second law,
but he used another definition of mass.

The force is now given by

$$F = d(M v)/dt$$
$$= m d(\gamma v)/dt$$

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