Albert Einstein's famous formula $E=mc^2$

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My dear friend asked me a simple but very important question. His question was:

"Has Albert Einstein's famous formula **$E=mc^2$** changed?!"

I decided to share the answer to this question with you in very simple language.

Albert Einstein's famous formula, **$E=mc^2$**, has not changed at all; rather, it remains one of the most accurate, proven, and important equations in physics, especially modern physics, or more specifically, the theory of special relativity. However, the reason you might have heard that this formula "has changed" or "is incomplete" relates to how it is used for objects in motion.

In fact, the formula **$E=mc^2$** is merely a summarized version and a special case of a much larger and more comprehensive equation.

Let's first see what the full equation is. In reality, the formula **$E=mc^2$** only works for objects that are at rest, meaning without motion. If an object is moving, in addition to mass, it also has kinetic energy or "momentum". Einstein's complete and original equation for energy is as follows:

$$E^2 = (pc)^2 + (mc^2)^2$$

In this equation:

- **E** = total energy of the object
- (**p** = momentum (related to the object's motion
- **c** = speed of light
- (**m** = rest mass of the object (the mass of the object when motionless

?Now the question is, why do we usually only see **$E=mc^2$**

If an object is standing still in one place, its velocity is zero; consequently, its momentum (**p**) will also be zero. If we plug **p=0** into the above formula, the **$(pc)^2$** part is completely eliminated, and :we arrive at this

$E^2 = (mc^2)^2$

Taking the square root of both sides to simplify yields the familiar equation **$E=mc^2$**. Therefore, this ."formula is not wrong at all, but only shows the "energy of objects at rest

.Now we need to know why the complete equation is necessary. For example, particles of light

If we only rely on **$E=mc^2$**, we run into problems regarding photons, or particles of light. Photons have no mass at all, meaning **m=0**. If we consider the mass to be zero in the simplified formula, the energy of light should be zero, which we know is not the case, and light does indeed have .energy

But if we use the complete equation, the secret of light's energy is solved. Since photons have no :mass, the **$(mc^2)^2$** part becomes zero, and the equation becomes

$(E^2 = (pc)^2 \Rightarrow E = (pc$

This means that particles of light, despite having no mass, have energy because they are moving .(at the speed of light and possess momentum (**p**

In the past (mid-20th century), some physicists invented a concept called "relativistic mass" so they could use the same simple formula **$E=mc^2$** for moving objects. They said that when an .object moves faster, its mass increases

But today, in modern physics, this concept has been discarded. Physicists realized that considering a variable mass causes confusion. Today, "mass" is considered an intrinsic constant value (rest mass), and to calculate the energy of moving objects, instead of assuming the object gets heavier, they use the same complete equation containing momentum. This change in "physics literature and education" might have created the misconception in public media that .physicists have changed Einstein's formula

Einstein's discovery has not been invalidated. For the sake of greater accuracy, instead of relying on the summarized state of rest ($\mathbf{E=mc^2}$), the science of physics simply emphasizes the complete original equation, namely $\mathbf{E^2 = (pc)^2 + (mc^2)^2}$, so that it can explain the behavior of all particles in the universe, whether stationary, moving, or massless.