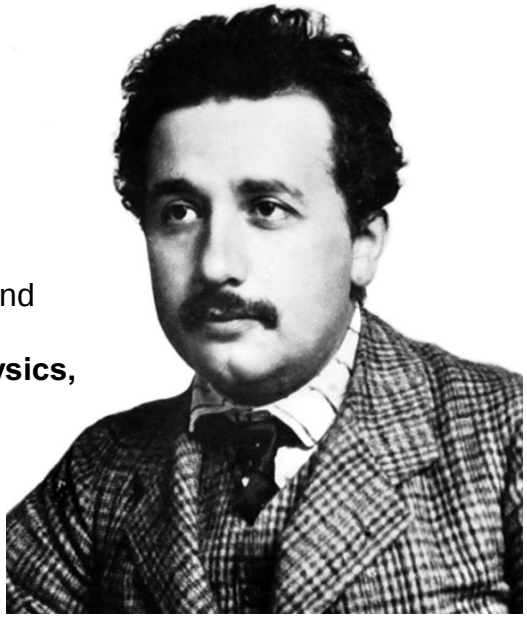
THIS DATE IN SCIENCE: $E=MC^2$

September 27, 1905. On this date, while he was employed at a patent office, **Albert Einstein** published a paper titled **"Does the Inertia of a Body Depend Upon Its Energy-Content?"**

It was the last of four papers he submitted that year to the journal Annalen der Physik:

1. Explaining the photoelectric effect
2. Offering experimental proof of the existence of atoms
3. Introducing the Theory of Special Relativity
4. Explaining the relationship between energy and mass. Mass and energy are interchangeable. That is, $E=mc^2$



Albert Einstein in 1905, his "miracle year." Image via Wikimedia Commons

What does it mean? It means that, from the standpoint of physics, energy and mass are interchangeable.

In the equation $E=mc^2$:

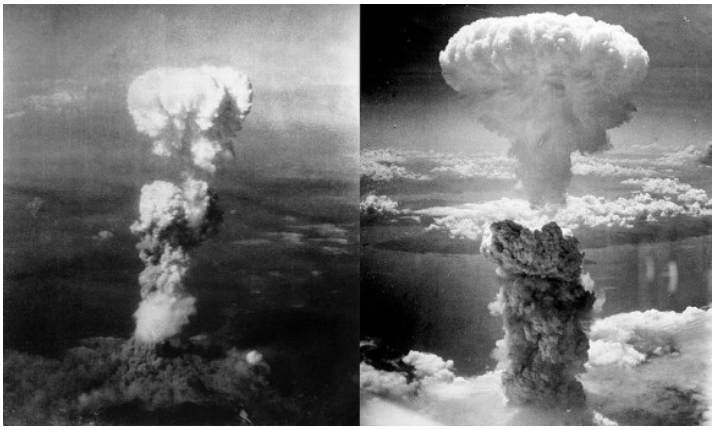
E is energy

m is mass

c is the speed of light

In other words, energy = mass x the speed of light squared.

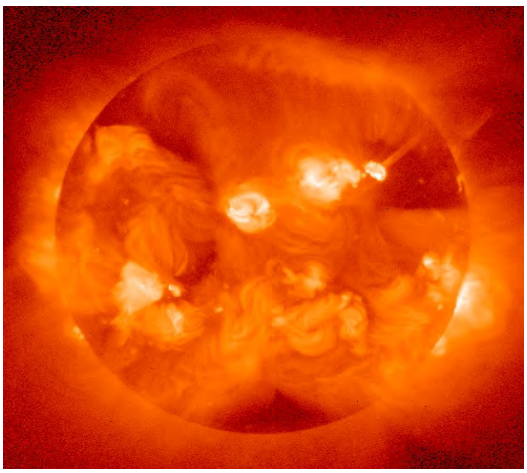
It sounds simple, and its simplicity does belie the genius required of Einstein to express it so elegantly. Mass and energy are interchangeable, and a small amount of mass can equal a large amount of energy. After all, the speed of light is a huge number (300,000 kilometres per second), and, in Einstein's famous equation, that huge number is squared. He saw that what we call matter and mass is just another way Nature has to keep huge amounts of energy in manageable form In the star's tremendous pressure and temperature atoms fuse together, creating the energy released as described by $E=mc^2$. That's how stars can afford to shine for billions of years It's also why, for example, man was able to build a bomb big enough to wipe out a complete city, such as the world's first deployed atom bombs over the cities of Hiroshima and Nagasaki that ended World War II. These early atomic bombs worked due to nuclear fission, as do still all the nuclear reactors in commercial use today.



Atomic bomb over Hiroshima (left) on August 6, 1945 and Nagasaki (right) on August 9, 1945.

Scientists use the principle that at the high end of the atomic table atoms are not fully stable anymore and can be made to break apart The sum of mass of the resulting element is a bit less than the original. The tiny amount of mass left over (less than1%) is radiated away in the form of energy. In cold numbers, less than one percent of the 1kg Plutonium contained in the atom bomb dropped on Hiroshima (~7 grams), contained enough energy to wipe out the city.

But the forces of nature can be creative as well as destructive, as in the life-giving energy we receive from our Sun. There the energy results from the action of fusing a lighter element (Hydrogen) into a heavier one (Helium), which also results in a left-over portion of uncommitted mass. **It is a strange quirk of Nature that its elements become comparatively lighter up to iron (26), and from there they become again progressively heavier up to Plutonium (94)**.



Our sun, as seen with an x-ray telescope, showing the corona: the glowing million degree plasma that surrounds the sun. The sun's energy is produced in its interior, via thermonuclear fusion, when mass is converted to energy.

Interestingly, the equation $E=mc^2$ does not appear in Einstein's paper's. He used V as the speed of light and L as the energy radiated away, like "if a body gives off the energy L in the form of radiation, its mass diminishes by L/V^2 ". **It changed our perception of Nature.** AK, with EarthSky and Wikipedia Notes