Einstein's Formula:

$$E=MC^2$$

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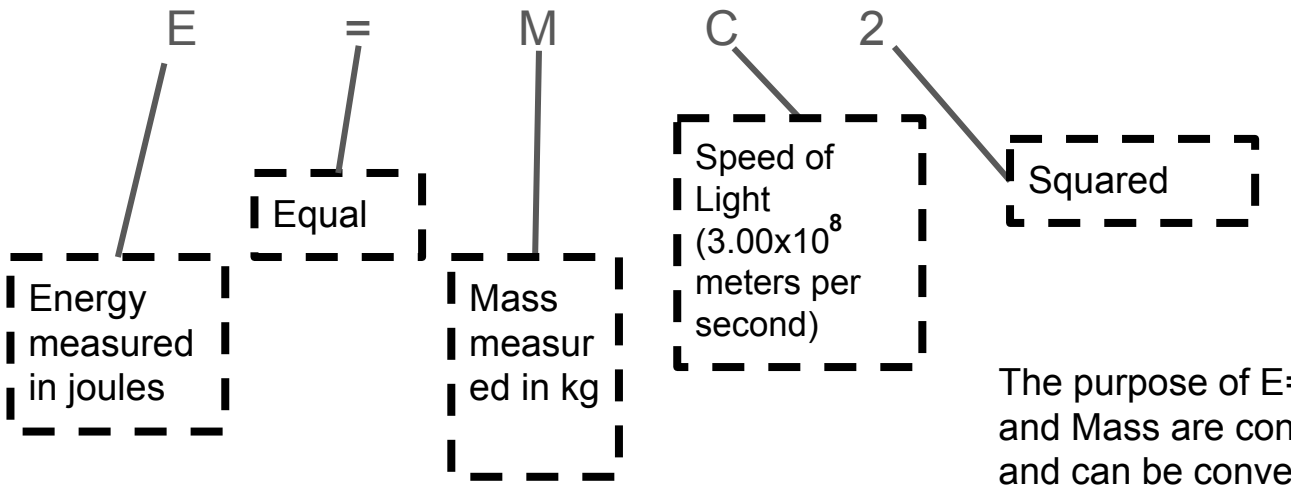
E=mc2 Introduction

Question: What is the value of each character within E=mc2? Can there be multiple formulas to describe it?

Hypothesis: If “E” equals energy, then “mc2” would be interchangeable with “E” (energy). That is because mc2, is mass times the speed of light squared.

What is E=mc2

E=mc2 is a formula created by Albert Einstein. It is one of the most famous formulas ever created to be in physics. The value of each variable within this equation/formula is shown below:



Albert Einstein originally wrote E=mc2 as:

$$M = \frac{E}{C2}$$

The purpose of E=mc2 is to demonstrate that Energy and Mass are considered the same physical unit, and can be converted into both forms/terms. In simple words you can switch energy with mass.

Example #1

Dog and Car example

Our example to construct E=mc2 is imagine there was a dog on the road at night and it emits flash of energy symmetrically in all directions but it would not have changed the dogs velocity. This reduces the energy (“E”) due to the conservation of energy. Now imagine that you zoom off in an car while abandoning your dog.

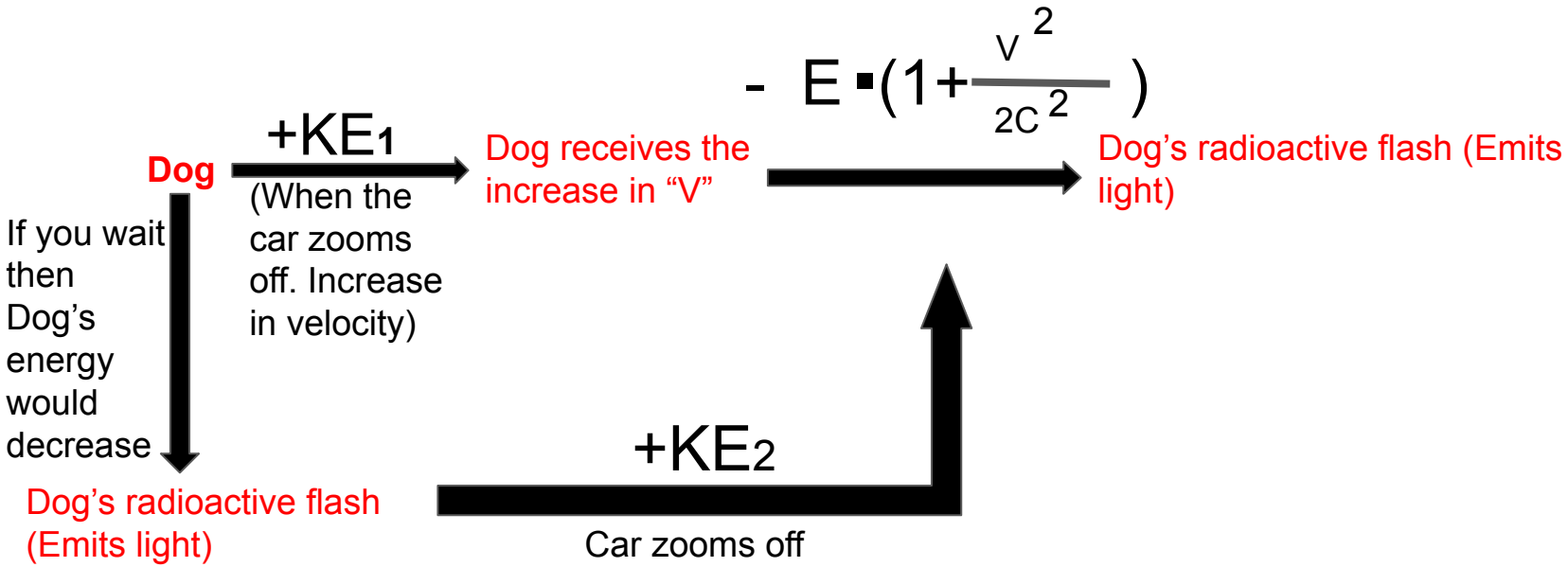
Example #1 Continued

Then while on your ride you notice that your dog keeps up with you, this means that the dog involves some kinetic energy while also losing energy. But due to aerodynamics of the 2 objects, special relativity tells us that each object is moving at different rates. Therefore, the frequency is measured in different values for the energy of the light. This is known as the doppler effect, for our examples it construct a formula like:

$$E \longrightarrow E\blacksquare\left(1+\frac{V^2}{2C^2}\right)$$

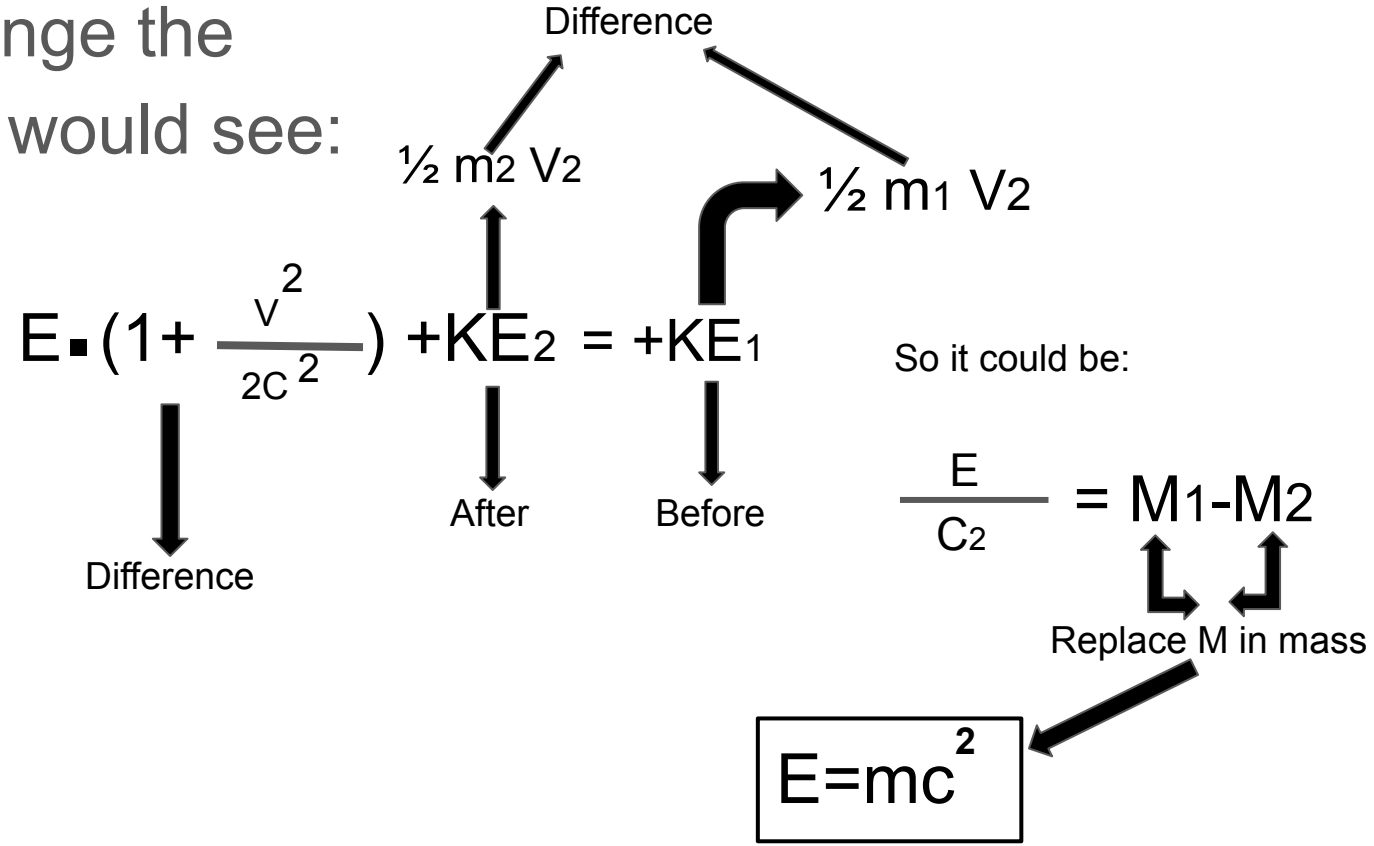
Example #1 Continued

So to review, this formula so far has demonstrated:



Conclusion of Example #1

To rearrange the cycle we would see:



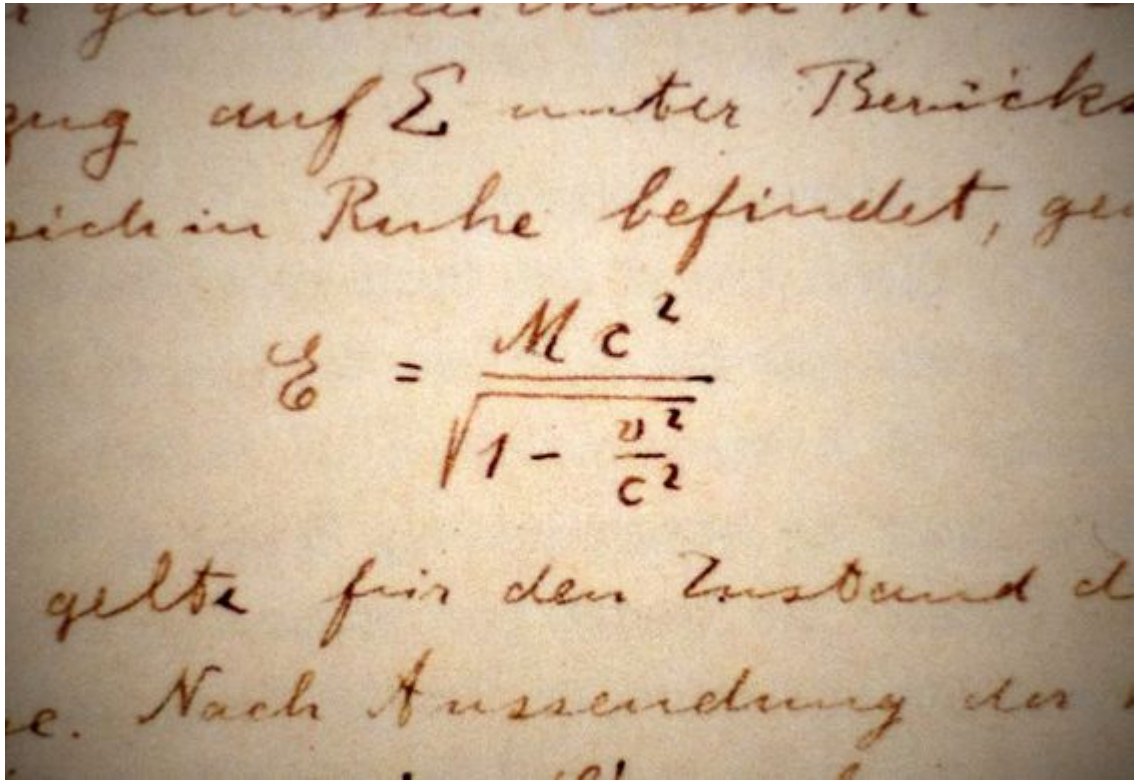
Example #2

Flashlight example

If you were to turn on a flashlight in the middle of the night it would release a flash toward 1 direction. This means the light/energy involves some kinetic energy. And now if you were to try the flashlight in space, it still would have the same velocity. But since in both ways it moves at the speed of light it would involve no mass.

Examples #2 continued

So now this describes E=mc2 since the kinetic energy released was moving at the speed of light which describes “C”. Also the speed of light would calculate to 186,000 miles per second which is “C2”, this means it would involve no mass. That is because if a object had mass it would not be possible to move at the speed of light. So to sum it up, the kinetic energy would be equivalent to “E”, since kinetic energy is also a source of energy. And the energy would be moving at 186,000 miles per second, which describes mc2. Meaning it would construct the formula of E=mc2.


ung auf Σ unter Bedi
sich in Ruhe befindet, ge

$$E = \frac{Mc^2}{\sqrt{1 - \frac{v^2}{c^2}}}$$

gelte für den Zustand d
e. Nach Aussendung der

Es befinde sich nun im System (x, y, z) ein ruhender Körper, dessen Energie — auf das System (x, y, z) bezogen — E_0 sei. Relativ zu dem wie oben mit der Geschwindigkeit v bewegten System (ξ, η, ζ) sei die Energie des Körpers H_0.

Dieser Körper sende in einer mit der x-Achse den Winkel φ bildenden Richtung ebene Lichtwellen von der Energie $L/2$ (relativ zu (x, y, z) gemessen) und gleichzeitig eine gleich große Lichtmenge nach der entgegengesetzten Richtung. Hierbei bleibt der Körper in Ruhe in bezug auf das System (x, y, z). Für diesen Vorgang muß das Energieprinzip gelten und zwar (nach dem Prinzip der Relativität) in bezug auf beide Koordinatensysteme. Nennen wir E_1 bez. H_1 die Energie des Körpers nach der Lichtaussendung relativ zum System (x, y, z) bez. (ξ, η, ζ) gemessen, so erhalten wir mit Benutzung der oben angegebenen Relation:

$$E_0 = E_1 + \left[\frac{L}{2} + \frac{L}{2}\right],$$

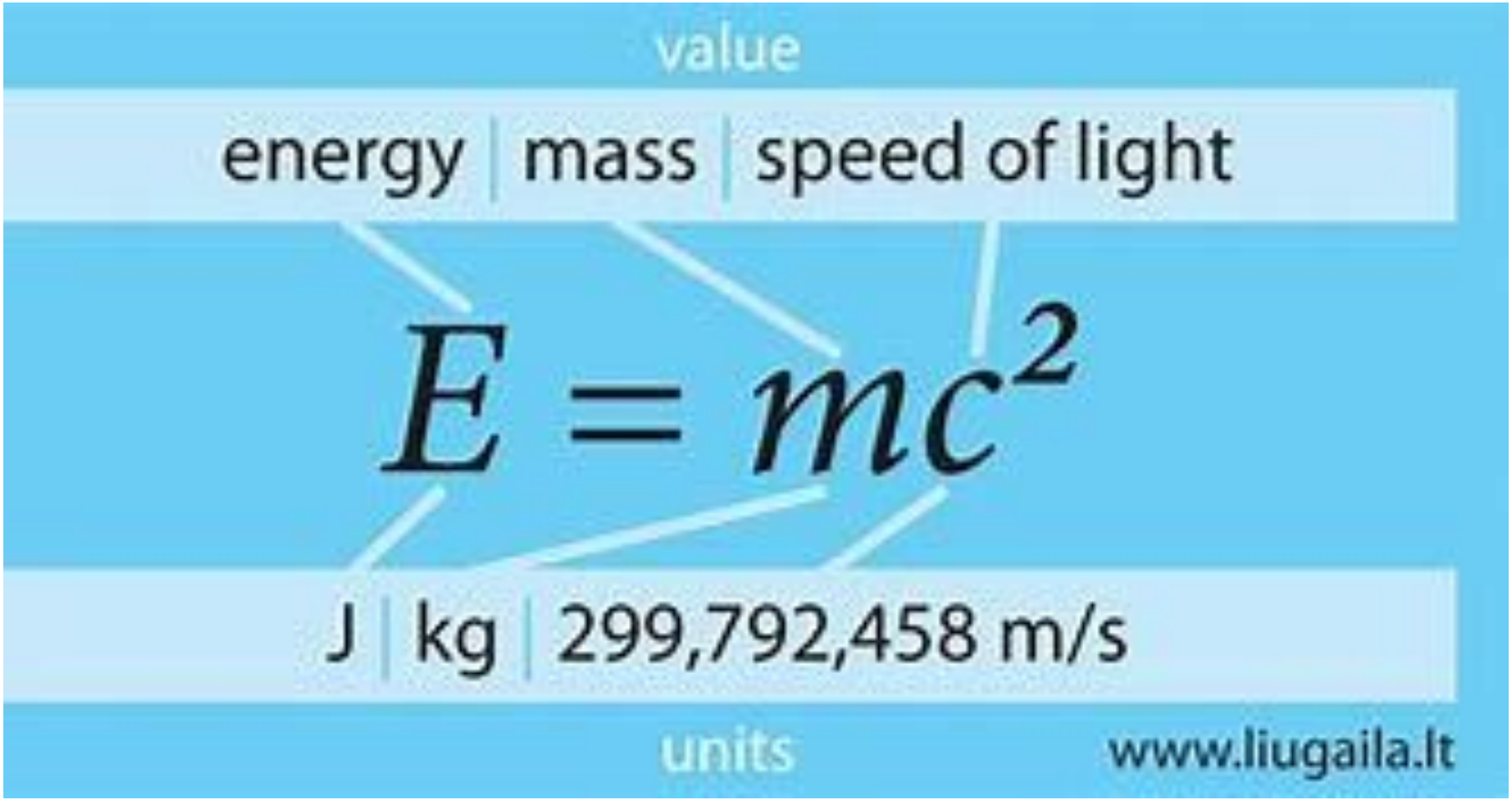
$$H_0 = H_1 + \left[\frac{L}{2}\frac{1 - \frac{v}{V}\cos\varphi}{\sqrt{1 - \left(\frac{v}{V}\right)^2}} + \frac{L}{2}\frac{1 + \frac{v}{V}\cos\varphi}{\sqrt{1 - \left(\frac{v}{V}\right)^2}}\right]$$

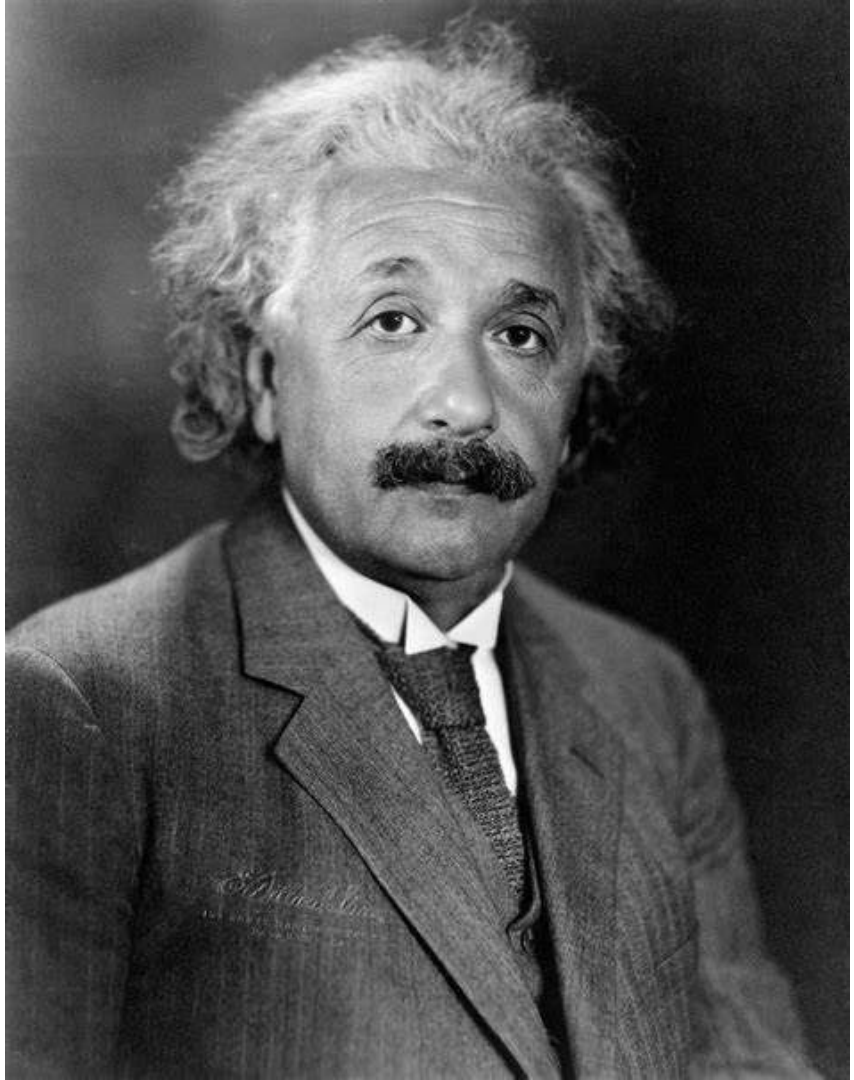
$$= H_1 + \frac{L}{\sqrt{1 - \left(\frac{v}{V}\right)^2}}.$$

Durch Subtraktion erhält man aus diesen Gleichungen:

$$(H_0 - E_0) - (H_1 - E_1) = L\left\{\frac{1}{\sqrt{1 - \left(\frac{v}{V}\right)^2}} - 1\right\}.$$

Die beiden in diesem Ausdruck auftretenden Differenzen von der Form $H - E$ haben einfache physikalische Bedeutungen. H und E sind Energiewerte desselben Körpers, bezogen auf zwei relativ zueinander bewegte Koordinatensysteme, wobei der Körper in dem einen System (System (x, y, z)) ruht. Es ist also klar, daß die Differenz $H - E$ sich von der kinetischen Energie K des Körpers in bezug auf das andere System (System (ξ, η, ζ)) nur durch eine additive Konstante C unterscheiden kann, welche von der Wahl der willkürlichen addi-


value
energy | mass | speed of light
$E = mc^2$
J | kg | 299,792,458 m/s
units
www.liugaila.lt



History and Background

In 1905, Einstein arranged his equation in an understandable manner within a document collected by the: *Annalen der Physik.* The paper was focused on knowing, "Does the Inertia of a Body Depend Upon Its Energy Content?". The similarities between energy and mass were determined by another idea of Einstein known as, “special relativity”. This formed a radical opportunity to connect the aerodynamics within the universe.

Calculations

- So “Energy” in this equation is equal to “mc2”, (mass times the speed of light squared). This calculates to 186,000 miles per second. This results in “E” holding the value of 186,000 miles per second or mc2.
- If a motion of an object is at a high enough velocity rate to be considered the speed of light, its mass will grow exponentially. If an object involves the same amount of velocity as the speed of light it will receive infinite mass, hence infinite energy will be needed.
- Special relativity tells us that an object moving at the speed of light would involve 0 mass/weight, that would be the only way for the object to obtain that speed.

Predictions

-I think only energy could have the ability to move at the speed of light. For example kinetic energy can travel at the speed of light since it involves 0 mass. Most sources of energy/light will involve 0 mass allowing them to travel at the speed of light.

-Adding on to my prediction above, that is why I think energy is considered in this equation. That is because most energy will have zero mass.

-I think they included “M” in this equation since it is important to know that there has to be 0 mass for light to move at the speed of light.

Predictions continued

-I think Einstein originally wrote this equation as “M= E/C2” because mass and energy are interchangeable, hence it would not change the equation that much since if both terms hold the same value, the arrangement of the variables would not vary the formula in a crucial way.

Conclusion

On this project and we learned many equations and that energy and mass are interchangeable meaning they are equivalent in this equation. Also this equation can be viewed in our everyday lives when we see kinetic energy or any source of light. We also learned multiple examples that helped us understand E=mc2 and further expand on our understanding. To conclude, “E” is energy, “M” is mass and “C2” is the speed of light squared and there are a few equations that can help you understand the fundamentals of E=mc2.

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