The sample of a book

PhDr. Mgr. Virlupus Volchv

Schola Versipellem
Jihlava

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Contents

Two things are infinite: the universe and the human stupidity.

Albert Einstein

1 Shall we try physics?

What is physics? We can say that it is an attempt to understand the events that we see around us in the nature.

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Let's look at force, it's just a mathematical construct, but it can facilitate a lot of calculations that are useful in practical applications. Whether it's space flights or children playing on a swing.

1.1 Newton's laws

Issac Newton left us several interesting insights that have been denied for centuries, mainly by church organizations.

Definition 1.1.1 • Newton first law

An object at rest remains at rest, or if in motion, remains in motion at a constant velocity unless acted on by a net external force.

Corpus omne perseverare in statu suo quiescendi vel movendi uniformiter in directum, nisi quatenus a viribus impressis cogitur statum illum mutare.

...

Definition 1.1.2 • Newton's gravity

Any particle of matter in the universe attracts any other with a force varying directly as the product of the masses and inversely as the square of the distance between them.

The equation for universal gravitation thus takes the form:

$$F = G\frac{m_1 \cdot m_2}{r^2}$$

where F is the gravitational force acting between two objects, m_1 and m_2 are the masses of the objects, r is the distance between the centers of their masses, and G is the gravitational constant.

Over time, it was necessary to replace this theory with a more accurate one. Although Newton's equation is still valid, it is only a certain limit. The reason is that it does not respect the role of time and its results are sometimes inaccurate.

That's why we use Einstein's special and general relativity today.

$$R_{\mu\nu} - \frac{1}{2}R\,g_{\mu\nu} + \Lambda\,g_{\mu\nu} = \frac{8\pi G}{c^4}\,T_{\mu\nu}$$

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Let's Try Mathematics

Geometry gives us powerful tools to describe space. One of the most famous results in geometry is the Pythagorean theorem.

Definition 2.0.1 • Pythagorean Theorem

In a right-angled triangle, the square of the hypotenuse is equal to the sum of the squares of the other two sides.

$$c^2 = a^2 + b^2$$

Let's now look at a simple algebraic proof of this statement.

Proof 2.0.1 • Algebraic proof using square area

Consider a square of side length $(a+b)$, divided as shown below into four right-angled triangles and a small inner square.

The area of the large square is:

$$(a+b)^2$$

The area can also be expressed as the sum of the areas of the four right-angled triangles and the small inner square:

$$4 \cdot \left(\frac{1}{2}ab\right) + c^2$$

Equating both expressions:

$$\begin{aligned} (a+b)^2 &= 4 \cdot \left(\frac{1}{2}ab\right) + c^2 \\ a^2 + 2ab + b^2 &= 2ab + c^2 \end{aligned}$$

Subtract $2ab$ from both sides:

$$a^2 + b^2 = c^2$$

Which is exactly the Pythagorean theorem.

This proof shows that the theorem is not just a geometric rule, but also an algebraic identity based on area manipulation.

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