Introduction

I got the impulse for the present work by reading a scientific article entitled *An elementary derivation of $E = mc^2$* (see Appendix A I)[1].

With this article the physicist Fritz Rohrlich was able to show that Einstein's famous equation $\boldsymbol{E = mc^2}$, which describes the equivalence of energy and mass, can be deduced from the laws of classical physics without the use of relativistic mechanics.

The proof, based on the Doppler Effect for electromagnetic waves, shows that Einstein's famous formula does not necessarily presuppose the Theory of Relativity.

The question that now arises is this:

Under the assumption that the equivalence between energy and mass can be derived from classical physics, is it then possible, based on this principle, to introduce a more direct approach to the theory of relativity than that which has been established since the beginning of the 20th century?

The established derivation method, which starts from the postulate of the constancy of the speed of light for all inertial systems and rests on the Lorentz transformations, rejects the conception of an absolute space and an absolute time and is therefore not easily graspable.

Is it then possible to follow another, easily comprehensible path to prove the relativistic laws?

Through my research I have found that it is possible, starting from the second law of dynamics in conjunction with the principle of equivalence between energy and mass, to pursue a new approach in which variable masses are included and thus a direct connection between classical and relativistic mechanics can be established.

The present study shows the results of these investigations. The work is divided into **three parts**:

The **first part** examines the scope of the second principle of dynamics (chapters 1 and 2) and presents three alternative proofs of the equivalence principle of energy and mass (chapters 3 and 4).

In the **second part**, the second law of dynamics is used in conjunction with the Mass-Energy Equivalence Principle to derive the dependence of mass on velocity (chapter 5) and to extend the calculation of kinetic energy to high velocities close to the speed of light (chapter 6).

These two principles then form the basis for further derivations during the **third part** of the thesis.

Within the framework of thought experiments and by applying the law of conservation of energy and momentum, the relativistic addition formula of velocities can thus be derived without using the Lorentz transformations (chapters 8 and 10).

1 Published 1990 in the American Journal of Physics, on page 348, Volume 58, Issue 4.

Chapter 13 concerns the central objective of the work.

Among the phenomena of nature currently considered incompatible with Newtonian mechanics in the physics world, the constancy of the velocity of light in vacuum, which can be demonstrated for all inertial systems, is the most important one.

The constancy of the speed of light is the central postulate of the theory of relativity and stands symptomatically for the gap between classical and relativistic mechanics.

Chapter 13 nevertheless shows that the theoretical confirmation of the constancy of the speed of light can be achieved with the help of Newtonian mechanics.

Finally, in the last two chapters, the kinetic dependencies of the frequency of the electromagnetic radiation (chapter 15) and of the acceleration (chapter 16) are derived.

For the derivation of the formulas, only the conservation laws of energy and momentum are used.

As a result of the entire study, the following conclusions can be drawn:

- The equivalence energy-mass is not necessarily a relativistic principle but, as Einstein himself proved (see chapter 3), a principle derivable from the laws of classical physics.
- The constancy of the speed of light in vacuum, which is valid for all inertial systems, is not a postulate to be assumed a priori, but a principle provable by the laws of physics.
- If Newtonian mechanics, with reference to the second law of motion, is pursued as the leading approach, then the theory of relativity can be regarded as a consequence of the equivalence principle of energy-mass.

Finally, Newton's laws of dynamics form a broader physical basis than is usually assumed.