

The laws of physics may be written in the same form in all inertial frames with any physical constants retained (ie they should be form invariant under transformation between inertial frames).

Then Newton's law of Gravitation may take the form

$$F_{12} = G m_1 m_2 \frac{(\underline{x}_2 - \underline{x}_1)}{|\underline{x}_2 - \underline{x}_1|^2}$$

but not the form

$$F_{12} = G m_1 m_2 \frac{(\underline{x}_2 + \underline{x}_1)}{|\underline{x}_2 + \underline{x}_1|^2}$$

Since the first is form invariant but the second is not.

Newtonian theory was very successful. From it could be derived Galileo's laws of motion and Kepler's laws for planetary bodies, and it predicted the existence of the planets Uranus and Neptune - a great triumph.

However, there were problems. The equality of gravitation and inertia did not emerge naturally from the theory. Newton hypothesized their equality and tested this to 1 part in 1000, but it was a hand and eye move.

In the 19th, electromagnetism developed as a science and was put on a theoretical footing with the formulation of Maxwell's laws of electromagnetism. Maxwell's laws predicted a ~~physical~~ quantity