General Relativity For Tellytubbys

Special Relativity, Postulate 1

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Overview

This section is about clarifying what the 1st postulate of Special Relativity really means, i.e. the uniform motion one. In the literature there is an enormous about of waffle on this, such that many descriptions of this postulate are one big pile of excrement. Despite the fact that this is well treated by thy High Lords of Gravity in *the* Gravity Bible, i.e. "Gravitation, by Misner, Thorne and Wheeler", often called MTW in the news groups. The relevant quote is:

"Mathematics was not sufficiently refined in 1917 to cleave apart the demands for "no prior geometry" and for a geometric, co-ordinate independent formulation of physics. Einstein described both demands by a single phrase, "general covariance" The "no prior geometry" demand actually fathered General Relativity, but by doing so anonymously, disguised as "general covariance", it also fathered half a century of confusion."

This statement essentially says that "Relativity" was used as a backbone for General Relativity, but was *mistakenly* referred to as "covariance". Relativity is concerned with whether or not there are preferred *real* physical positions and velocities in the universe. Covariance is whether or not one can write general equations independent of coordinate systems, irrespective of whether or not these preferred characteristics actually exist in the universe.

This confusion still persists today, even for those with Ph.D. 's in Physics. Historically, even Einstein confused "general covariance" with "general relativity", of which he is on record as acknowledging that he had such confusion.

Postulate 1 of Special Relativity

Many words and phrases abound, that all profess to be cast under the banner of the "Principle of Relativity" or POR. These typically are:

1 The laws of physics are independent of inertial frames.

2 The mathematical form of the laws of physics are independent of co-ordinate systems.

3 All uniform or inertial motion is relative.

4 The laws of physics are covariant with respect to co-ordinate systems

5 The laws of physics are the same in all inertial frames of reference

6 The general laws of nature are to be expressed by equations which hold good for all systems of coordinates, that is, are covariant with respect to any substitutions whatever." - Einstein, and *not* the POR!

7 No experiment can detect an observers absolute velocity. That is, an absolute velocity does not exist.

8 If there are two objects, relatively uniformly moving wrt each other, then either object may be considered to be at rest without effecting certain physical results.

Etc… etc…

The fundamental error in understanding the meaning of the "Principle of Relativity" is that some of the above are statements about pure mathematics, and others are statements about reality (physics).

Another issue that also crops up, is the meaning of the phrase "The laws of Physics …". Does this phrases refer to the mathematical equations of physics or the reality that they describe?

If one physically does something over here, does it result in the same result over there, if so this is a POR. If one physically does something when going 100 M/S with respect to (wrt) the earth, does it result in the same result as being stationary wrt the earth, if so, this is a POR.

Or does the phrase actually refer to having a set of equations that are correct both here and correct over there, independent of any coordinate system used, and irrespective of whether the same causes give different effects over here and over there.

Conception of Covariance

This is a definition of pure mathematics. It is not open to debate and does not necessarily relate to physical reality.

If a system of equations is such that they are mathematically valid in any mathematical co-ordinate system, then those equations are said to be a covariant set of equations. Typically covariance is expressed by Tensor Equations.

*It can be shown that **any** set of equations can be put into covariant form.* This states that there are no *physical* implications of covariant or non-covariant equations whatsoever. Equations that "hold good in all co-ordinate systems" say *nothing* at all about physical reality.

Note:

Obviously, it is quite desirable to have valid equations that can describe physics, whether that physics done over there is the same as physics done over here, *or* not. i.e. that the equations are valid, irrespective of whether the physics obeys the POR or not. The fact that there might be some varying "background geometry", that might need to be built into the equations themselves, has no relevance to the fact that such a set of equations can still be formulated such that they are independent of any coordinate system. After all, coordinate systems are nothing more then a mathematical change of variables.

Conception of the "Principle of Relativity"

The POR is a statement about reality or physics, not mathematics. The concept applies to many physical situations.

If the result of an experiment is independent of an object's uniform/inertial motion wrt to a reference frame, then that experiment express a POR for that result.

If the result of an experiment is independent of an object's position wrt to a reference position, then that experiment express a POR for that result. This POR can still apply if the "background" geometry is uniform.

If it is impossible to determine ones absolute velocity, then this is an expression of the POR.

Postulate 2

It is also sometimes erroneously stated that the invariance of the speed of light in vacuum, is a consequence of the 1st Postulate. This is of course, quite nonsense. This is easily dismissed as Newtonian Mechanics satisfies the 1st postulate, but certainly does not require the invariance of light postulate. The rational for this assertion is sometimes given by invoking the "Form of the laws of physics should be the same etc", which as now explained, says nothing about reality.

Summary

The Special Theory of Relativity *requires* the POR postulate. The POR means something physically, covariance has no physical meaning.

Hope that clears up the confusion my Teletubbys.

POR != Covariance.