General Relativity For Tellytubbys

Special Relativity

Postulate 1

The Principle Of Relativity

POR

Sir Kevin Aylward B.Sc., Warden of the Kings Ale

Back to the Contents section

Overview

This section is about clarifying what the 1st postulate of Special Relativity really means, i.e. the inertial motion one. In the literature there is an enormous about of twaddle on this, such that many descriptions of this postulate are simple wrong.

The authoritative reference is by thy High Lords of Gravity in *the* Gravity Bible, i.e. "Gravitation, by Misner, Thorne and Wheeler", often referred to as “MTW”. 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”

The Principle Of Relativity - Postulate 1

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 *wrong.*

7 No experiment can detect an observer's 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 physical 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.

The actual true meaning of the Principle Of Relativity is:

POR – The forces between co-moving objects, as measured by the co-moving objects, are independent of their joint inertial (non accelerating) velocity with respect to other observers.

Physics is about forces. It is forces that determine whether a needle pointer on a dial changes from the position that it would have had, if not acted on by a force.

If the measured forces change, whilst in an isolated system, one would be able detect that one is moving with respect to other observers. The POR states that such an event doesn't occur

General Covariance

This is a definition of pure mathematics. It is not open to debate and does not necessarily relate to physical reality. The current Wikipedia entry on this is wrong.

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:

Clearly, it is 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.

Reference Frames and Coordinate Systems

With regard to the POR, Reference Frames and Coordinate Systems are systematically confused and conflated. The confusion is such that even Einstein was truly led up the garden path. Many of Einstein's descriptions regarding frames and coordinate systems were simply wrong. Unfortunately, many have propagated these errors.

The concepts of independence of reference frames and independence of coordinate systems are entirely different. This led to the false idea that *because* events are inherently independent of coordinate systems that that this meant that events in frames *must* be independent of reference frame. A key source of the misunderstanding is that typically, coordinate systems are locked to the motion of the frame. This does not have to be true in general.

Reference Frames describe, essentially, the physical "box" of the system that is being described. They form the motion and the physical forces that physical objects are experiencing. Whether or not a frame has physical effects due to its motion is a matter of physics, to be experimentally decided.

Coordinate systems are simply the numbers that are attached to events in reference frames. Coordinates systems simply label the events in frames. Events in frames are intrinsically independent of coordinate systems.

Coordinate systems form a mathematically tautology by construction. One simple replaces one number by another numbers to describe the same events. For example x=cos(r), y=sin(r) , with a corresponding inverse. It's simply impossible for changes in coordinate systems to result in physical implications.

For example, on might have an inertial frame and describe it by a rotating coordinate system. However, such a rotating coordinate system would not imply any acceleration forces existed in the inertial frame.

Validity Of The POR

The POR may be false in that the forces between commoving objects may be measured to be independent of motion, but actually not be so independent.

For example, the POR holds that clocks in inertial motion must always tick independently of inertial motion. This results in the viewpoint of Special Relativity that holds that objects travel through "space-time" at different rates to account for the observed different clock readings

However, if all processes of all objects in an inertial frame, slowed by the same amount, no one would be the wiser inside the frame, giving an *apparent* POR. However, outside the frame, different observers would record different clock readings, that is, twins would experience different aging with respect to each other.

Thus, properties attributed to the theory of Special Relativity may actually be explained by mathematically identical alternatives. This is addressed here:

Special Relativity Background

Summary

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

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.

Website last modified 27st Dec 2022

http://www.kevinaylward.co.uk/gr/index.html

www.kevinaylward.co.uk
