Re: the basis of relativity

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- *From*: Tom Roberts <tjroberts@xxxxxxxxxx>
- *Date*: Wed, 01 Jun 2005 03:44:14 GMT

Ken S. Tucker wrote:

> I think you'll find this fun, see Weinberg's
> "The Gravitational Action" pg 364.

> IMO, there is a clear geometric definition of
> the g−field, characterized by the gravitational
> action invariant.
> Please see Weinberg's "Grav & Cosmo", Eq.(12.4.2).
> Therein we see the Curvature Scalar "R".

> I understand a non−zero "R" at (x) denoted R(x)
> means a g−field exists at (x) that cannot be
> transformed away, due of course to the invariance
> of "R".

The actual value of the Action does not matter −− one can add an arbitrary constant to it without changing any physics.

>> Indeed, there is a much larger group of functions one
>> can add without changing any physics....

And, as the previous posts pointed out repeatedly: R^a_bcd can be nonzero but R is zero (because the terms in the contractions sum to zero), and this _ALWAYS_ happens in a vacuum region. The nonvanishing of R^a_bcd (the Riemann curvature tensor) is what indicates the manifold is not flat; whether or not that indicates the presence of a "g field" depends in detail on what you mean by "g field".

But yes, if R is nonzero at a given point that nonzeroness cannot be transformed away.

> Ok, in view of the above let me summarize my

> understanding of the discussion.
> The R_uv=0 has TWO solutions,
> 1) g_uv = constants
> or
> 2) g_uv = Schwarz Solution.

No. The eqution R_uv=0 has an infinite number of solutions, of which you named 2 (assumeng you means the Schwarzschild solution for (2)). That's why one needs boundary conditions (like any other set of PDEs)....

> However R^a_bcd =/=0 requires the g_uv are NOT
> constants, and that *implies* to me R=/=0, [...]

See above. You keep getting the implication backwards.

> IMO, the use of G_uv=T_uv=0 is a non-physical
> *approximation* of "empty space".

It's no "approximation", it is _exact_ -- that is what we mean by "empty space" (aka "vacuum"). This may not correspond to any region of the world we inhabit, but that's a different issue....

> In fact the
> space is NOT empty, as it contains the gravitating
> body.

What "gravitating body"???? -- if T_uv=0 in some region, there is nothing in that region. Period. This, of course, says nothing about other regions of the manifold. If there is matter in other regions, then even though T_uv=0 in the region in question[#], almost certainly R^a_bcd will be nonzero -- gravitational attraction exists in vacuum regions.

[#} Hence R_ab=0 and R=0 in that region.

The Riemann (components R^a_bcd) curvature tensor can be separated into two tensors: the Ricci tensor (components R_ab) and the Weyl tensor (components C^a_bcd); at each point Ricci is related to matter/energy at that point while Weyl is related to matter/energy elsewhere.

> The definition of a vacuum can then depend
> upon the arbituary volume one chooses, certainly
> that's not a good definition.

You are confused. See above. There is no such indefiniteness about what "vacuum" means -- it means T_uv=0 at any point in the vacuum region.

> I prepose the definition of a vacuum in GR to be
> defined by the effect of the spacetime field G_uv
> on light propagation, such as deflection, Shapiro,
> Pound-Rebka which differs from one that an inter-
> galatic "empty space" would be.

Don't "prepose" anything, just use the standard meanings of words, or you will get hopelessly confused (as if you aren't already (:-().

> Hence in the presence of the Sun a particle like
> Mercury would *strictly* require T_uv>0 to calculate
> it's precession, though retain G_uv=0 as an
> approximation, but not truly physical because of the
> two possible solutions above that are permitted.

You are confused. The usual approximation used for computing the precession of Mercury's perihelion is that the region of its orbit is truly vacuum, and the sun is spherically-symmetric and not rotating, so the Schwarzschild metric holds in that region. Hence in this approximation G_uv=0 and T_uv=0 and R_uv=0 in the region of its orbit. One can then calculate its precession using the Schw. metric. One can show that the error in assuming that region is vacuum is negligible.

> So I suggest recognizing Gravitation as an *Action*
> (not a field) as Weinberg describes in the ref.
> (Perhaps the field concept is a Newtonian hang-over).

Again you are confused. While indeed the notion "gravitational field" is quite ambiguous in GR, the action does not come close to meeting what people expect from that concept.

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