GENERAL RELATIVITY: as incoherent as SR?

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(rev: 22/07/2021)

Abstract

No. Even more so! An argument exactly analogous to the one Einstein uses to "prove" the equivalence principle refutes it. 'Warped spacetime' is a nonsense found only in warped minds. GR spectacularly fails to account for Hubble expansion. And it incorporates the SR postulates, shown by the clock absurdity to be rationally incoherent.

CONTENTS

EQUIVALENCE PRINCIPLE

Equivalence principle

Einstein's[a] Special Relativity (SR), published in 1905, was restricted to *inertial conditions* where there is no acceleration. After this he turned his mind to *gravity*. To put the relations into mathematical form, he however first had to learn a new technique, tensor calculus, which took him eight years.

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[a] Albert Einstein (1879-1955), German theoretical physicist.

The outcome was 1915 *General Relativity* (GR), which as most of us know is highly mathematical and complex, comprising:

> "A set of ten coupled hyperbolic-elliptic nonlinear partial differential equations, known as the Einstein field equations, which take many pages to write down, and a deep breath just to say."[1]

It's basics are however very simple. Einstein recounted how after two years of excrutiating mental torment his *eureka* moment − what he later called "the happiest thought of my life" − came while sitting in his office in Berne:

> "Suddenly a thought struck me. A man falling freely from the roof of a house doesn't feel his own weight. There exists − at least in his immediate surroundings − no gravitational field. In his reference frame a new gravitational field cancels that due to the Earth."[2]

This is shown in Fig. 1.

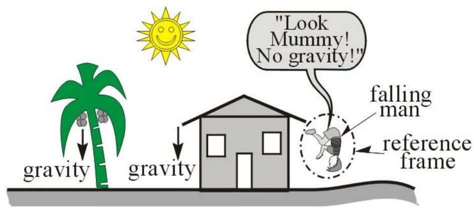

Fig. 1. Falling man.

Based on this, Einstein envisaged a thought exercise*:*

> "Imagine a portion of empty space far removed from stars and all other appreciable masses; and a spacious chest with an observer inside it. To the middle of its lid is fixed externally a hook with a rope. A 'being' (what kind is immaterial to us) begins pulling the rope with a constant force. The chest and observer move 'upwards' with uniform acceleration. But how does the man in the chest regard the process? He will come to the conclusion that he and the chest are in a constant gravitational field. Ought we to smile at the man and say that he errs? I do not believe so. We must rather admit that his mode of grasping the situation violates neither reason nor known mechanical laws."[3]

He went on to say:

> "We thus have good grounds for extending the principle of [special] relativity to bodies accelerated with respect to each other. This gives a powerful argument for a generalised postulate of relativity. We shall *assume the complete physical equivalence* of a gravitational field and a corresponding acceleration. Whenever an observer detects the presence of a force acting on

all objects in proportion to their mass, *he is in an accelerated reference frame*."[4] (emphasis added)

In space-age terms, an astronaut in a windowless space capsule cannot distinguish between being:

– 1) at rest on the surface of a massive object, Fig. 2a
– 2) in deep space accelerated by his capsule's engines, Fig. 2b

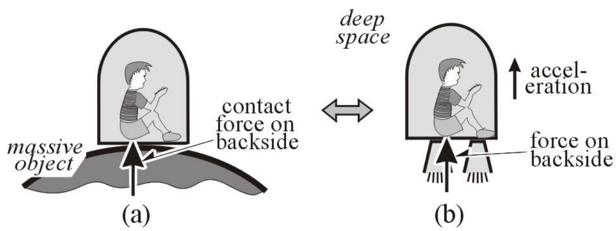

Fig. 2. Equivalence principle (1).

Einstein called this the *Equivalence Principle*[a5], effectively arguing that if a man in a windowless space capsule cannot distinguish between gravity and acceleration, then the two are equivalent.

However, a man in a *windowed* space capsule *can* distinguish the two. On the same basis "proving" that they are *not* equivalent. An exactly analogous argument to the one Einstein uses to establish the equivalence principle, can equally well be used to *refute* it:

an exactly analogous argument to the one that Einstein uses to "prove" the equivalence principle refutes it

Moral of the story: if you want a comprehensive model for the overall universe, *don't* go asking a man in a windowless space capsule.

SPACETIME

Spacetime

Apart from the equivalence principle, General Relativity contains a number of other anomalies.

Gravity according to Einstein is not a force acting between massive[b] objects as Newton held. It is caused by the *curvature of spacetime*:

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[a] First formulated in 1907.

[b] Having mass.

> "Einstein showed that rather than objects pulling on each other, gravity is best understood as a warping of spacetime. Objects move along geodesics, the shortest distance between two points on a curved surface. The Moon appears to curve as it orbits the Earth. But in reality it follows a straight line in curved spacetime."[6]

Spacetime being defined as:

> "Any *mathematical model* that combines space and time into a single inter-woven continuum."[7] (emphasis added)

Spacetime is *not* therefore itself a physical object. It is a *mathematical abstraction*, a *string of symbols* on a piece of paper, an *idea* in someone's mind. The question then being: how can a zillion-ton object like the Moon follow *any* kind of path, let alone a curved one, in symbols on a piece of paper, or an idea in someone's mind?

how can any material object follow a path in string of symbols on a piece of paper?

This is an excellent question, to which relativists to date have provided no convincing answer. Einstein on his own admission couldn't conceive of 'space':

> "We entirely shun the vague word 'space', of which – we must honestly acknowledge – we cannot form the slightest conception."[8]

How much less then the even vaguer word "spacetime"? Reginald Cahill[a]:

> "Spacetime is a mathematical construct with no ontological significance."[9]

Nicola Tesla[b]:

> "All literature on space curvature is futile and destined to oblivion."[10]

A contemporary blogger asks:

> "Are we being taken to the cleaners by spacetime physicists?"[11]

The answer is a resounding "Yes", 'warped spacetime' being a *conceptual non-sense* 'found' only in warped minds[c].

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[a] Reginald Cahill (1948-), Australian theoretical physicist.

[b] Nicola Tesla (1856-1943), Serbian electrical engineer.

[c] Cf Tesla and Cahill (p.4).

EXPANSION

General Relativity

On the *Big Bang model* the universe erupted some 13.8 billion years ago in a very very big Big Bang, and has been expanding ever since. General Relativity provides three options for the universe's ultimate destiny, depending on whether its mean density is greater than, equal to, or less than a critical value:

– 1) a higher-than-critical density universe is 'closed'[a]. Due to gravity it will eventually stop expanding and start contracting, ending up in a 'Big Crunch', an 'inverse Big Bang'
– 2) an exactly-critical density universe is 'flat'. It will eventually stabilize at some fixed size
– 3) a lower-than-critical density universe is 'open'. It will expand endlessly, ending up in a 'Big Freeze', a heat death

Measurements from the Wilkinson Microwave Anisotropy Probe suggest that the universe's density is within 0.4% of its critical value. And so that it is 'flat' and will end up stabilizing[12]. The three possibilities are shown schematically in Fig. 0-3.

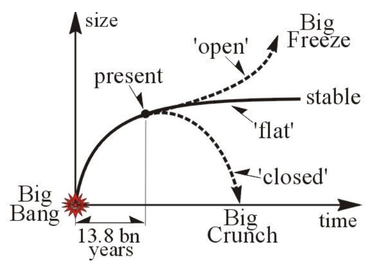

Fig. 0-3. GR expansion.

Balloon-surface model

As far as we can make out, our 3-d universe conforms to the *cosmological principle*[b] being[c]:

– 1) *isotropic*: it looks the same in all directions
– 2) *homogeneous*: it has the same composition everywhere
– 3) *boundless*: it has no limits no matter how far one goes

---

[a] 'Mathematically closed'.

[b] Aka 'the Copernican principle' after the Polish astronomer Nicolaus Copernicus (1473-1543) who said that the Earth is not the centre of the universe.

[c] At sufficiently large distances, in practice greater than ~300 mega-light-years.

A 2-d analogy, first proposed by Arthur Eddington[a], is the *expanding-balloon-surface model* of Fig. 0-4. Flat 2-d galaxies with length and breadth but no height are imagined distributed over the balloon surface. As it expands the distances between them increase proportionally. Noting that the 'universe' is here the 2-d *balloon surface*, and not the 3-d balloon itself.

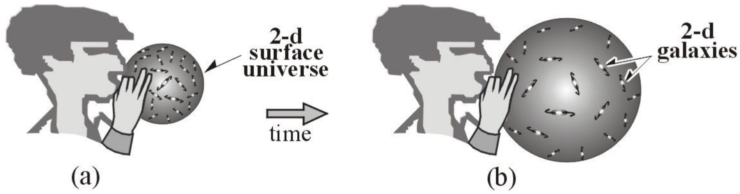

Fig. 0-4. Expanding balloon surface model.

The balloon model involves a 2-d surface expanding into 3-d space. To visualize our 3-d universe in this way would therefore require us visualizing a *3-d volume* expanding into a hypothetical *4-d space*, which is evidently beyond our capacity. As 3-d beings living in a 3-d universe, we can visualize a maximum of three dimensions.

We can *imagine* hypothetical 4-d beings looking into our 3-d universe from the outside, and seeing it expanding into their 4-d space. But we ourselves inherently cannot visualize our universe in this way. So in answer to Einstein's question:

"Can we visualize a 3-d universe that is finite yet unbounded? "[13]

the answer is "No". The best we can do is to *imagine* our 3-d universe being *like* a 2-d expanding balloon surface, but in three dimensions rather than two:

we imagine our 3-d universe to be like a 2-d expanding balloon surface, but in three dimensions rather than two

Hubble

In 1929 Edwin Hubble[b] plotted the redshifts z[c] for ~20 galaxies against their estimated distances d away. He obtained an approximately linear relation of the form, Fig. 0-5a:

eq.1]
$$z = \frac{H_0}{c} d$$

where c is the speed of light. This is known as *Hubble's law*, and the slope H_0 of the curve as *Hubble's constant*[d].

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[a] Arthur Eddington (1882–1944), English astronomer.

[b] Edwin Hubble (1889-1953), American astronomer.

[c] The amount the spectral lines of elements are displaced towards the red end of the spectrum.

[d] Strictly: the *present value* of the *Hubble parameter* H.

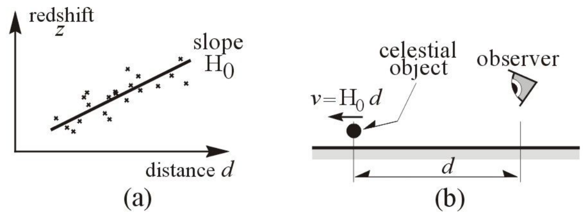

Fig. 0-5. Hubble expansion (1).

Values for the Hubble parameter vary somewhat, according to the method used to determine it. They normally lie in the range 68-74 (km/s)/Mpc[a]. In most cosmological models they vary somewhat with time.

The speed of recession *v* of a galaxy in terms of its redshift *z* being:

eq.2]
$$v = cz$$

substituting from eq.1 gives, Fig. 0-5b:

eq.3]
$$v = H_0 d$$

Imagine an observer on a 2-d balloon surface with instantaneous radius *r* and rate of expansion d*r*/d*t*. This is shown in section in Fig. 0-6.

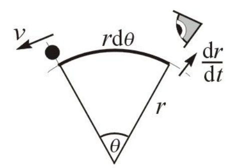

Fig. 0-6. Hubble expansion (2).

Differentiating the arc length $d=\theta r$, and using eq.3, the apparent speed of recession *v* seen by the observer:

eq.4]
$$v = \frac{\mathrm{d}}{\mathrm{d}t}(r\theta) = H_0 r\theta$$

"Apparent", since the 'recession' is in fact due to the universe's expansion. The subtended angle θ being constant, this reduces to:

eq.5]
$$\frac{\mathrm{d}r}{\mathrm{d}t} = H_0 r$$

The universe expands at a rate proportional to its instantaneous radius, effectively *exponentially*, Fig. 0-7a:

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[a] Km/s per Megaparsec, a somewhat exotic astronomers'unit.

the universe expands exponentially

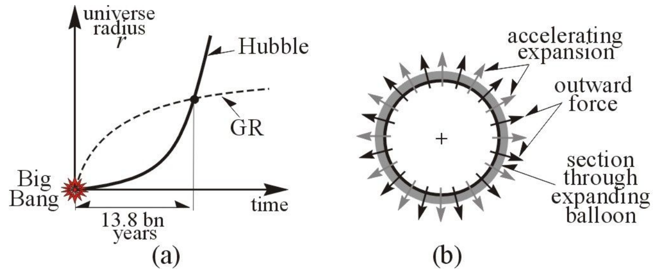

Fig. 0-7. Hubble expansion (3).

Its radius as a function of time is readily shown to be:

eq.6] $$r = \mathrm{H}_0 r_0 \mathrm{e}^t$$

where r_0 is its radius at the time origin t=0. Relatively small variations in the value of the Hubble 'constant' H_0[a] evidently won't substantially affect the essentially exponential nature of the expansion.

This expansion however firstly *directly contradicts* the GR predictions of Fig. 0-3:

Hubble expansion directly contradicts the GR predictions

And secondly, an exponentially increasing expansion implies an *accelerating force* on the universe's mass, Fig. 0-7b, but which is *nowhere to be found* in GR. The Hubble result refuted GR experimentally way back in 1929:

the Hubble result refuted GR experimentally already in 1929

Between the Hubble and GR versions, as Einstein himself recognized:

Experimentum summus judex[14].

(Experiment is the supreme judge.)

Universe density

Relativists are fond of quoting John Wheeler's[b]:

"Matter tells space how to curve. Space tells matter how to move."

The mean density of the universe, including dark matter, is an estimated ~1.44×10^{-27} kg/m^3, equivalent to a speck of dust[a] for every 520 million km^3 of space[b].

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[a] p.6, note.

[b] John Wheeler (1911–2008), American theoretical physicist.

Wheeler's thesis thus implies *520 million km^3 of space* receiving curvature orders from a *single speck of dust*:

Wheeler's thesis implies 520 million km^3 of space receiving curvature orders from a single speck of dust

Some non-conformist cubic kilometres of space could well find this a somewhat tall order.

One wonders whether the universe's matter has *any effect at all* on its expansion. The dust is swept up by a tornado doesn't affect its course. It could well be that space simply expands at the Hubble rate. And is for practical purposes unaffected by the puny amount of matter it contains.
Resuming:

Fig. 0-8. RIP GR.

APPENDIX

Special Relativity

Apart from all the above, General Relativity incorporates Special Relativity's two *'Einstein postulates'*. They can be resumed.

– 1) *there is no absolute 'at rest'. All inertial observers' views are equivalent, effectively correct*
– 2) *the speed of light c in vacuo is the same for all inertial observers*

The second 'speed of light' postulate predicts that for two twins in spaceships free-floating in outer space, passing each other at some relativistic speed, Fig. 0-9, each will see the other's clock running slower than his own. And because they are both moving inertially[c], according to the first 'relativity' postulate both their viewpoints are correct.

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[a] Of mass ~7.5x10^{-10} kg.

[b] That contained in a cube with 800 km sides.

[c] With their engines switched off.

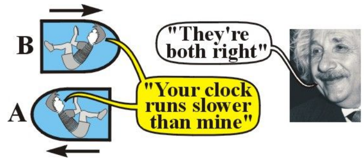

Fig. 0-9. Clock absurdity (1).

The nonsensicality of this alone is sufficient to falsify Special Relativity. Experimental refutations, of which there are many[a], are interesting but superfluous. Logical contradictions cannot correspond to physical reality. One doesn't need experiment to show that there are no square circles. To say Special Relativity is correct is like saying there can be square circles[b][15]:

to say Special Relativity is correct is like saying there can be square circles

'Weak' equivalence

Along with many others', Einstein had the weird idea of separate 'inertial' and 'gravitational' masses. He wrote:

> " The same quality of a body manifests itself, according to circumstances, as 'inertia' or as weight (lit. 'heaviness'), giving rise to the following law:
>
> *the gravitational mass of a body is equal to its inertial mass"*[16]

This has even been formalized as the 'Weak Equivalence Principle'.

The distinction makes little sense. 'Mass' is defined in terms of the standard 1 kg platinum-iridium block kept in Paris[c]. It isn't defined as "inertial mass"; nor as "gravitational mass"; but simply as "mass".

The fundamental MKS mechanical units are mass (kg), length (m) and time (s). Force not being one of these, it has to be defined in terms of them, for instance via Newton's second law. If a force applied to the standard 1 kg mass in Paris results in an acceleration of 1 m/s^2, then its value is 1 N[d].

This allows the masses of other objects to be determined. If a force applied to a body gives an acceleration a; and the same force applied to the standard 1 kg mass in Paris gives an acceleration a_1; then the mass of that body is by definition $M=a_1/a$.

In possession of operational procedures for measuring quantitatively force and mass, Newton's gravitational constant G can be determined by experiment.

And that's it. No separate inertial and gravitational masses. Simply mass.

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[a] Starting with the 1887 Michelson-Morley experiment.

[b] Set out in more detail in the ref.

[c] Or at least *was* in the good old days.

[d] One Newton of force.

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