A New Equivalence Principle with a Different Curvature of Light

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Abstract

According to Weyl and Chandrasekhar, general relativity (GR) is a triumph of speculative thought. But it is a well-known fact that GR is initiated by two analogies. Analogy is known to be a weak reasoning in science and philosophy. To redress the case this type of reasoning is renamed as Equivalence Principle (EP) in relativistic physics. The renaming, however, could not hide the fact that the presented analogy was not flawless. Irrefutable disproves were side-stepped and the analogy was instated to be the seed of new kind of physics. EP was defended by reducing the size of the lab and the duration of the experiment. This type of defending is like the proponents of flat-earth idea defend their case by reducing the patch of the land for examination until their pseudo-science theory is proven. The document is a short description of EP analogies and its well-known critics. The document also introduces a new EP based on Uniform Deceleration of a spaceship in open space. This new analogy results in a different curvature of light in comparison to what original EP has established using uniform acceleration. The author believes that none of the conclusions from EPs should be allowed in science as they are based on inconclusive comparison/analogy and they ignore glaring flaws in the argument.

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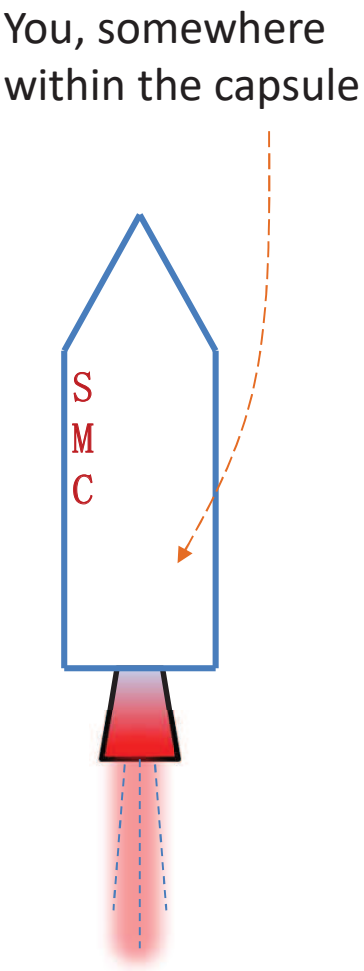
Setting

- Suppose you are a lone astronaut of a smart mobile capsule, equipped with all the potential instruments required for any possible experiment in physics
- The capsule has soundproof shell with no windows, thus you have no knowledge of your surroundings outside the capsule
- The capsule has a quiet engine with the state of the art intelligent command, to take it anywhere within the universe beyond your control or observation
- You have a very short memory or catnap frequently, especially during the important changes in the course of the travel of the capsule



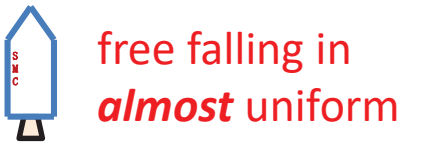
Smart Mobile Capsule

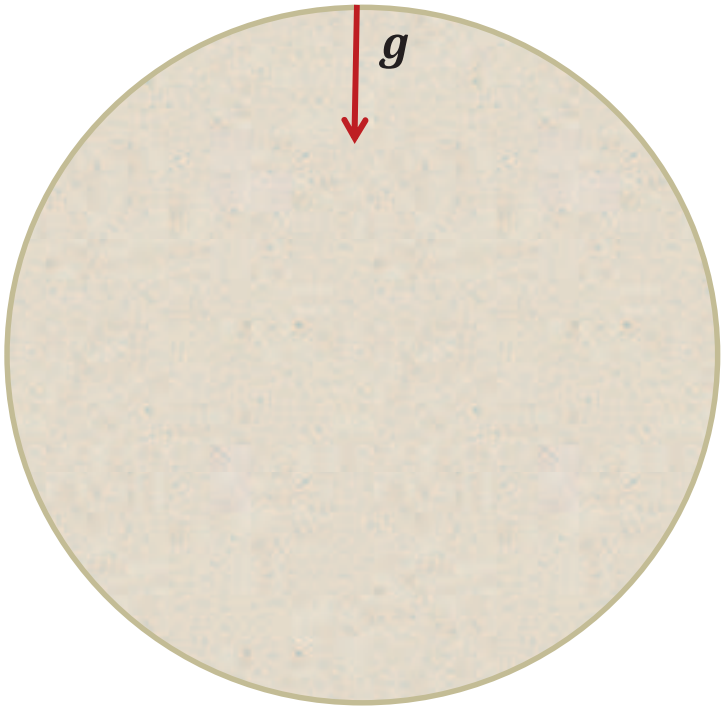
The Equivalence Principle 1/6 (Bern, Switzerland, 1907)

Einstein thought of the following two scenarios for the capsule

Case 1

Free Fall - After hovering at, say, $10{,}000\ m$ above an atmosphere-free planet, the engine switches off and the capsule falls freely backward towards the planet due to gravitational force. The gravitational field strength of the planet is $\boldsymbol{g}\ N/kg$ at the surface.

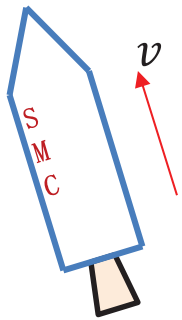




The Equivalence Principle 2/6

Case 2

Uniform Velocity - The capsule is in empty space away from any massive body (free of any gravitational field) and the engine is off. It moves with constant speed in a straight direction.



travel in empty space with uniform velocity

The Equivalence Principle 3/6

First equivalence

Einstein thought these two cases are physically equivalent and no experiment carried out inside the capsule can differentiate between the two cases. In other words, in the Free Fall case, the results of any experiments is independent of the magnitude of the field.

- **In both cases you become weightless. You can float in air at will and turn your full cup of coffee upside down with no calamitous consequences in your laboratory.**

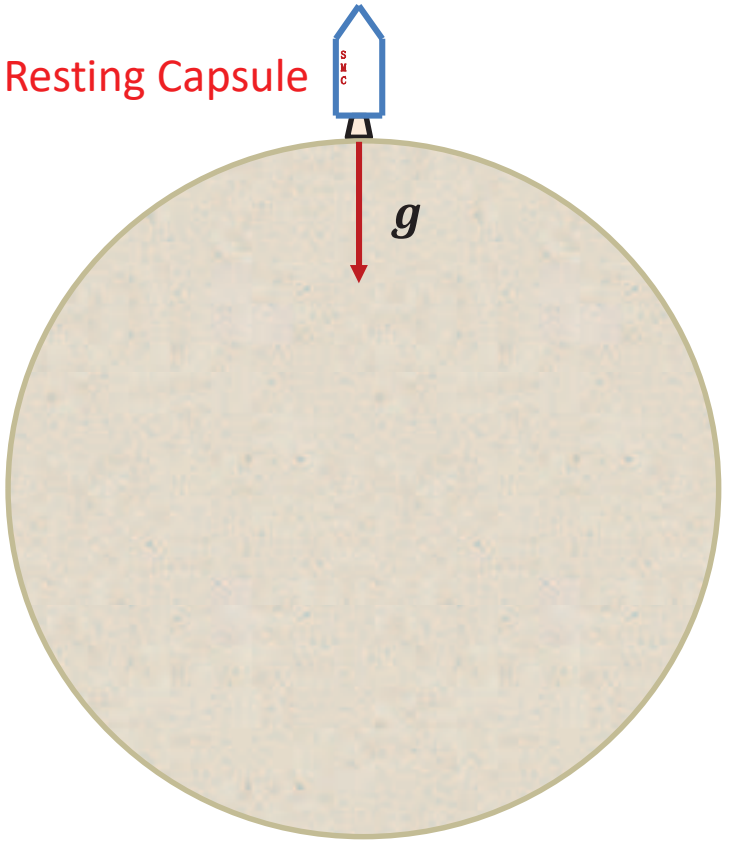
Therefor, any physical property of one case exactly applies to the second case. In general, laws of physics are indistinguishable in the Free Fall and Uniform Velocity cases, linking general to special relativity.

The Equivalence Principle 4/6

Einstein further thought of the following two scenarios

Case 3

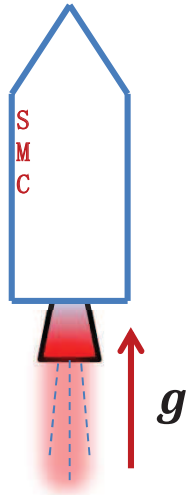
Standing Still - The capsule is standing upright on a planet with gravity g



The Equivalence Principle 5/6

Case 4

Uniform Acceleration -The capsule is in deep space, far away from any massive body, and the engine is on, causing an upward acceleration of $\boldsymbol{g}\ m/s^2$.



Accelerating in zero gravity
(uniform acceleration)

The Equivalence Principle 6/6

Second equivalence

Einstein thought these two cases are also physically equivalence

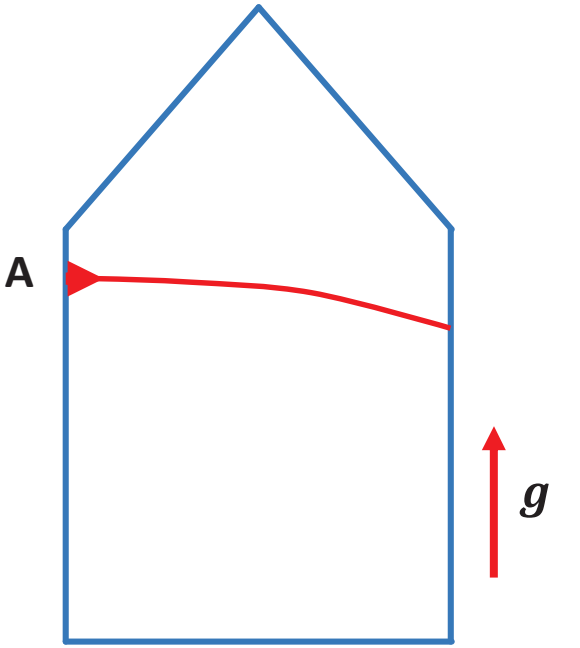
In both cases you regain some weight and if you let go of your cup of coffee it drops on the floor.

Laws of physics are indistinguishable in the Uniform Accelerating (case 4) and Standing Still on the surface of a planet (case 3).

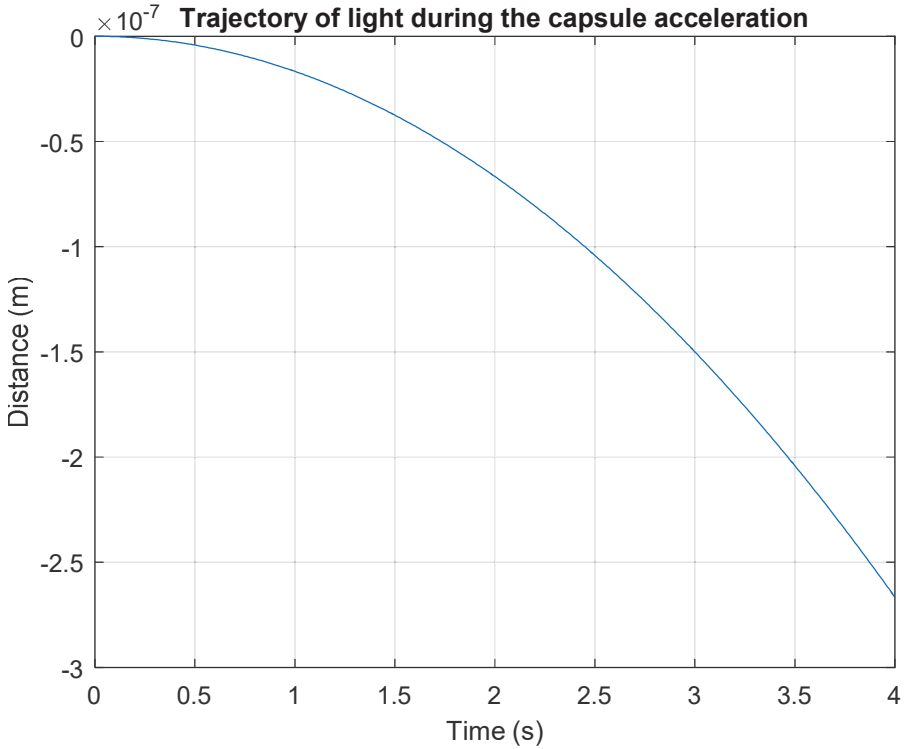
Conclusions from EP 1/5

Trajectory of light in the Uniform Acceleration case

Einstein highlighted the fact that if you shine a light beam from a point such as A inside the capsule to the opposite wall, the trajectory of light appears to be bending downwards due to the acceleration. The path of light is exaggeratingly illustrated inside the capsule. An almost accurate path is shown in the right plot for the capsule accelerating with $10\ m/s^2$.



Case 4 (uniform acceleration**)**

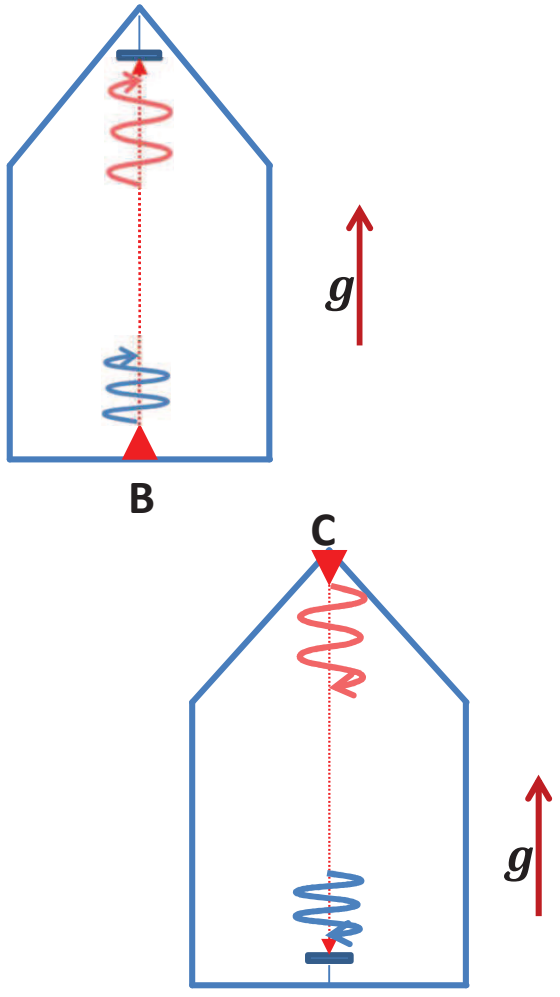


Conclusions from EP 2/5

Red and blue shifting of light in the Uniform Acceleration case

- Einstein also highlighted that if you shine a light beam from the bottom of the capsule (point B) to the top, the wavelength of the light is shifted towards the red end of the visible spectrum when it is monitored from the top of the capsule (its frequency decreases and its wavelength increases).

- Also any light emitted from the top of the capsule is blue shifted when monitored from the bottom of the capsule.



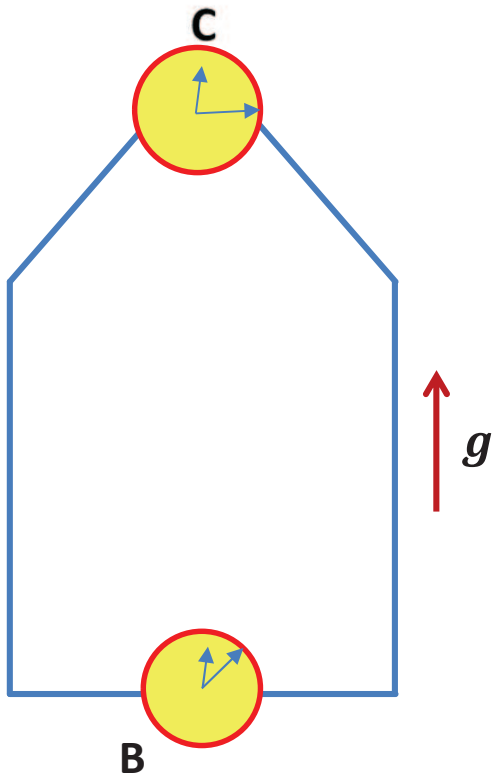
Case 4 (uniform acceleration**)**

Conclusions from EP 3/5

Clock speed changes in the Uniform Acceleration case

Einstein further pointed out that in the Uniform Acceleration case

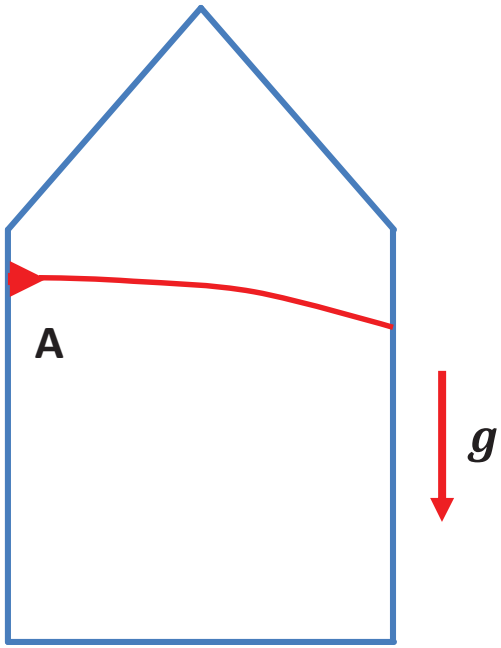
- A clock at point B goes slower if observed from point C
- A clock at point C goes faster if observed from point B



Conclusions from EP 4/5

The effect of gravity on light trajectory

Based on the assumed complete physical equivalence of the two cases[1], Einstein thus concluded that the trajectory of light in a gravitational field must follow the curve of the Uniform Acceleration case. That is if one shines a light beam from one side of any room on a planet to the opposite side (perpendicular to the direction of g) the path of the light is not straight rather it bends towards the source of the gravity



Case 3
(Standing still in a gravitational field)

1 – For example "If the equivalence principle applies for all the laws of physics then it will apply to electromagnetism as well as mechanics." [1]

Conclusions from EP 5/5

Major conclusions

1. **Weightless light photons bend when they pass through a gravitational field similar to case 4**
2. **Speed of light is constant hence photons must travel in straight lines. Straight line thus should be redefined as the shortest path in curved space-time**
3. **Spacetime Curvature; A massive body changes the geometry of the spacetime as the curved trajectory of light suggests**
4. **Gravitational Redshift; frequency of light changes due to gravitational field, depending on the direction of the light.**
   - Any light emitted from a massive body upward becomes red-shifted
   - Any light received at the direction of a gravitational field is blue-shifted
5. **Gravitational time dilation; time is warped by gravity (a clock goes slower in a gravitational field)**

Cornerstone of General Relativity (GR)

Einstein's general relativity theory, which is a theory of gravitation uses

1. **The Equivalence Principle as the cornerstone**
2. **The special theory of relativity (Minkowskian metric) as a guide (**The Free Fall case, GR, is equivalent to the Uniform Velocity, special relativity**)**

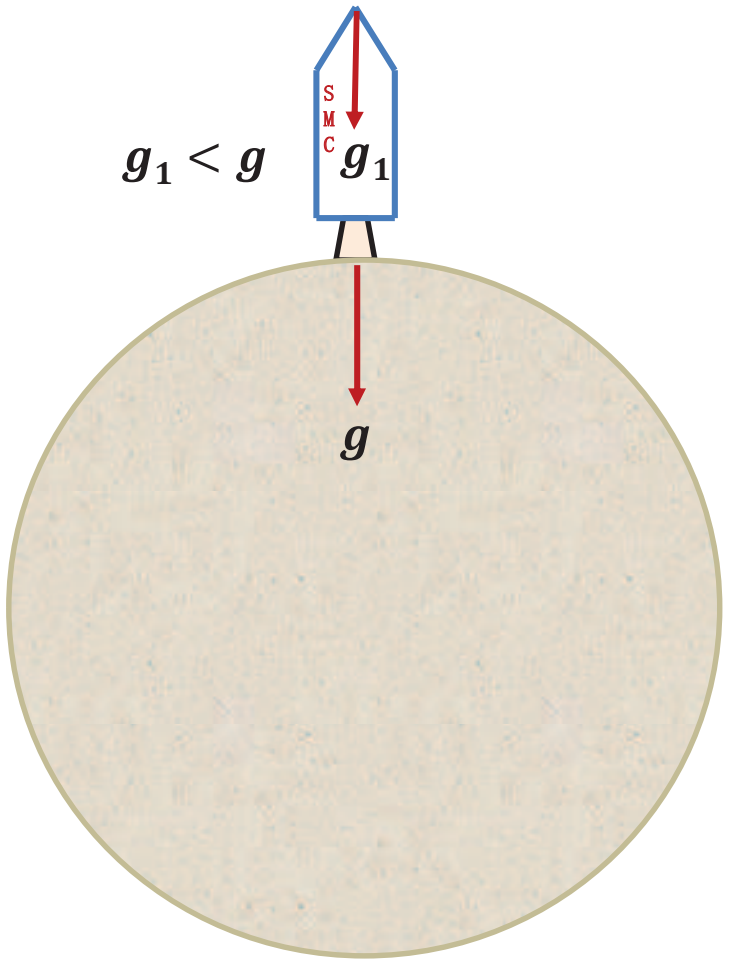
to argue that gravity is a fictitious force, a manifestation of space-time curvature. The theory is hailed as a triumph of speculative thought[1]

Issues identified with EP (1/4)

Two non-trivial problems have been identified with EP

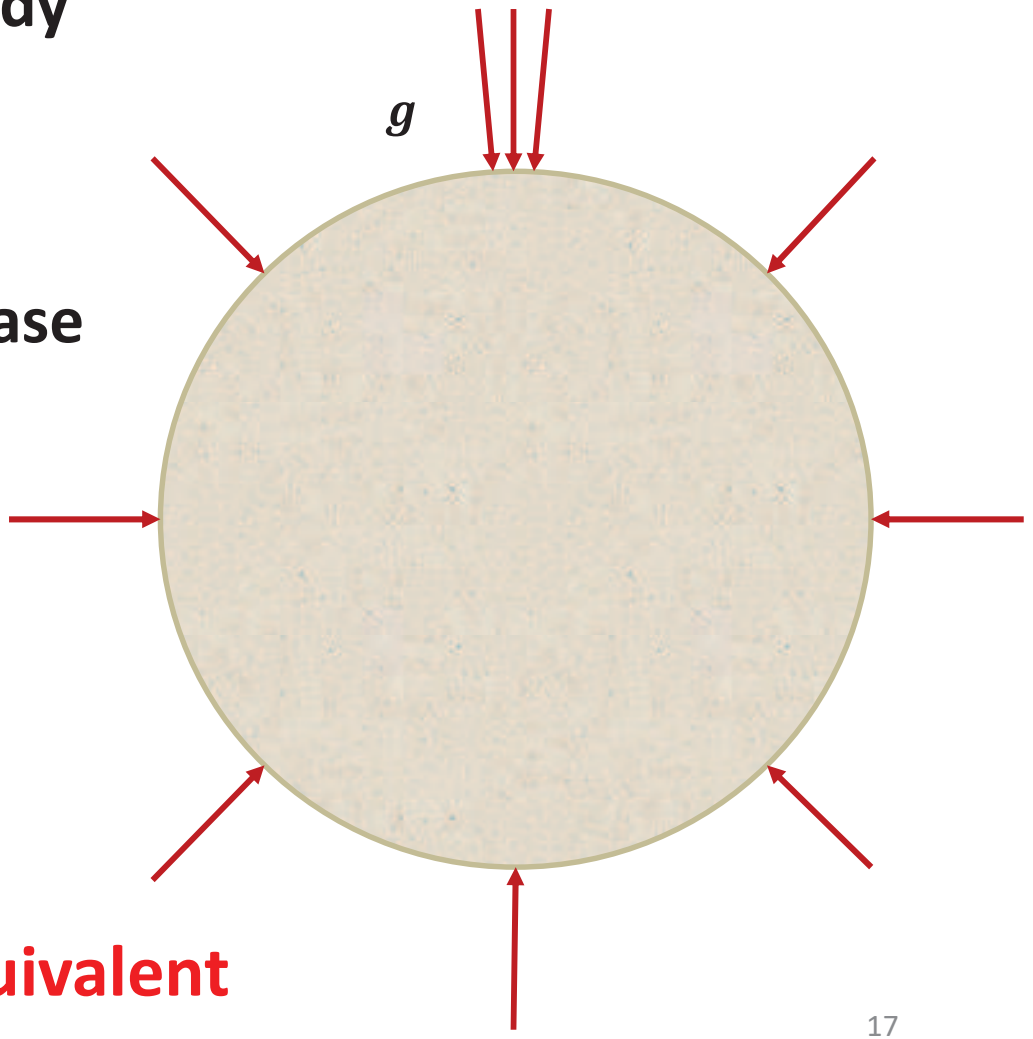
1. Tidal Effect

- **The gravitational force of the planet exerted on the capsule is not constant along the direction of the force. The nearest point to the planet is attracted more strongly than the furthest point. This difference in attraction is known as tidal effect and is detectable by a gradiometer in a local inertial frame**
- **A manifestation of this effect in an atmosphere free planet is the stretch of a drop of water in the direction of gravitational force. This phenomenon is climaxed into spagettification effect, which is the stretching of rigid bodies close to a black hole due to its immense gravitational gradient**
- **Tidal effect exists in case 3 but not in case 4**



Issues identified with EP (2/4)

- Gravitational field of a body such as a planet is nonparallel
- This phenomenon is also exists and detectable in case 3 but not in case 4



Thus based on the two dissimilarities,
Cases 1 is 2
and
Cases 3 and 4
cannot be qualified as equivalent

Issues identified with EP (3/4)

Einstein rejected these types of irrefutable criticism by shrinking the size of the capsule and reducing the time of an experiment short enough until the differences become insignificant. This is dubbed locality.

- **This rebuttal is neither scientific nor robust**
- **It is the music to the ears of, say, flat Earth believers. They also can argue that the Earth is flat if one chooses a patch of land (sphere) small enough to be recognized as a flat surface**

But Einstein's rebuttal has been accepted, EP and General Relativity are deemed unblemished and scientifically proven

Issues identified with EP (4/4)

Logical Comments

- **EP is an analogical reasoning**
- **If any two cases are physically equivalent then all their physical characteristics should be the same; science cannot be selective**
- **Otherwise it is possible to prove any two objects as equivalent. For example:**
  1. **A house is equivalent to a brick if you close your eyes and touch just a specific small area of a house.**
     So a family can live inside a brick or a worker can easily carry several houses around, etc, etc
  2. **A house is equivalent to glass if you limit the area one touches to another small and specific part of the house.**
     So a house is transparent
- **In short, EP insists to be based on meagre information from the elephant in the dark room**
- **Any conclusion from these types of equivalences is obviously baseless, though it may occasionally be correct.**

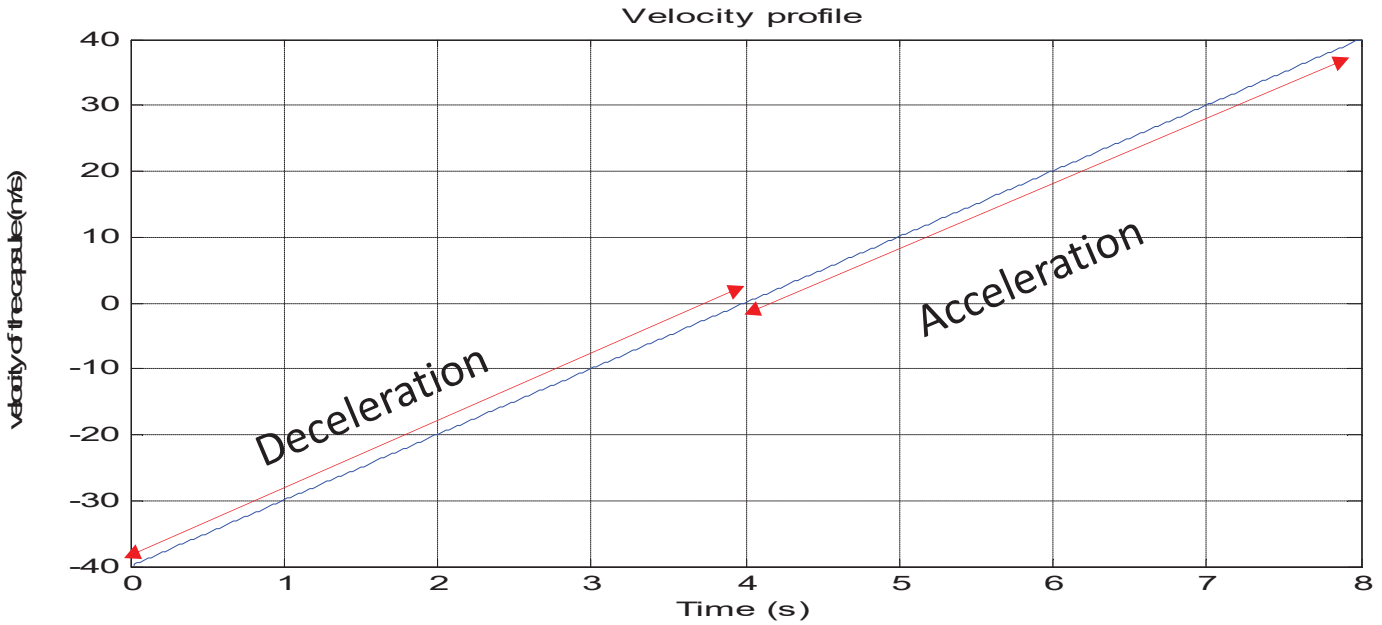
Extending the Second EP (1/2)

If Einstein's rebuttal is acceptable and we are allowed to voluntarily scale down our laboratory and minimize the duration of an experiment, then one can present a third equivalence

- **Consider the Uniform Acceleration case, Case 4. The speed of the capsule increases with time and it is assumed that the speed is always positive or in forward direction**
- **In the Uniform Velocity case (case 2) we assumed that the capsule can travel in any direction**
- **If the capsule happens to travel in backward direction with a constant velocity and then the engine is fired the capsule decelerates**

Extending the Second EP (2/2)

- Depending on the initial negative speed of the capsule, the deceleration can go on for a while until the speed goes to zero and then the capsule accelerates in forward direction.
- A segment of the velocity of the capsule during deceleration followed by an acceleration is plotted below
- The velocity is continuous and linear all the way both during deceleration and acceleration

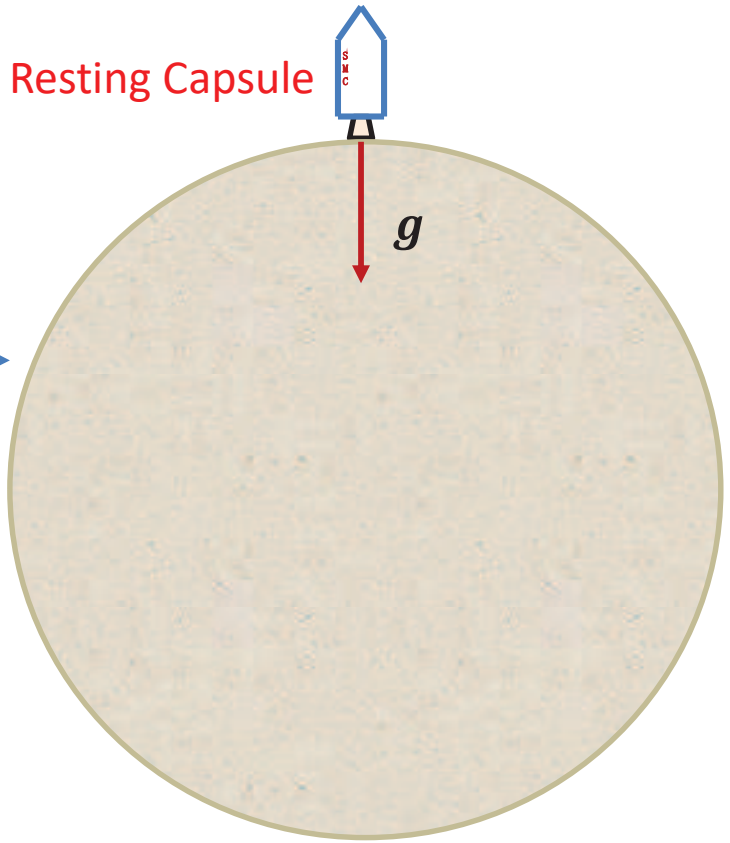


Third Equivalence 1/3

Consider the following two scenarios

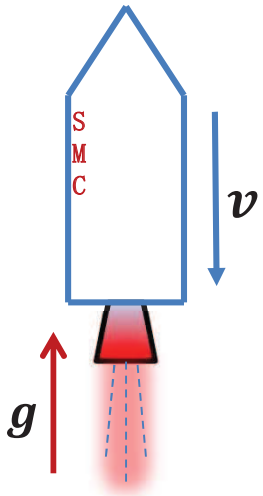
Case 3

Standing Still - The capsule is standing upright on a planet.



Case 5

Uniform Deceleration - The capsule is in deep space, far away from any massive body and was traveling in backward direction with a constant velocity. The engine is then switched on causing the capsule to be slowed down with uniform deceleration g



uniform deceleration in empty space

Third Equivalence 2/3

Following Einstein's thought experiment these two cases are also physically equivalent

- For example, in both cases the occupant has the same weight and if he let go of his cup of coffee it does drop on the floor.

Laws of physics are indistinguishable between Uniform Deceleration and Standing Still cases

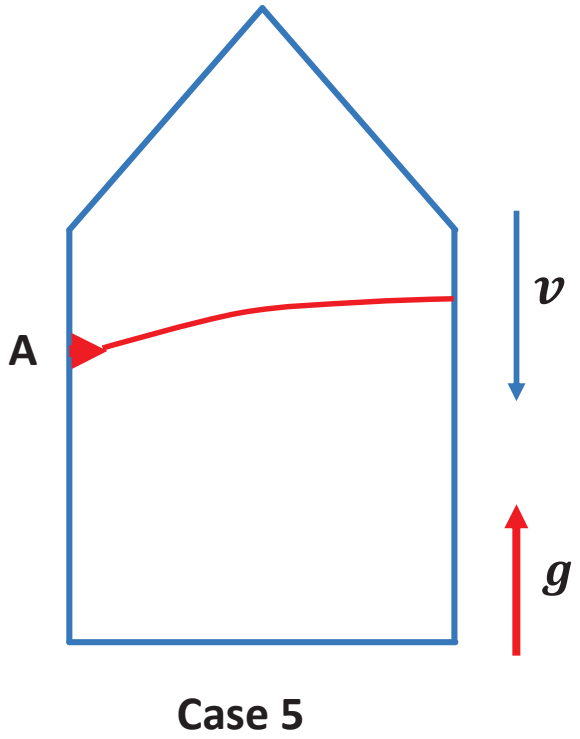
In the case of Uniform Deceleration

- **Red and blue shift of light is the same as the uniform acceleration case**
- **Gravitational time dilation is also the same as the uniform acceleration case**

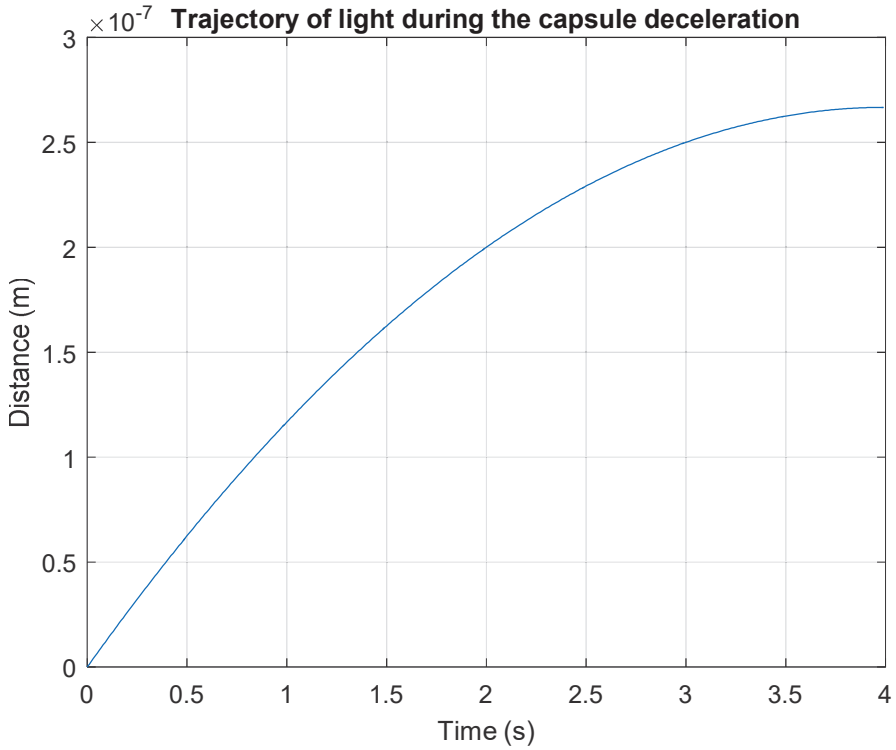
Third Equivalence 3/3

Trajectory of light in the Uniform Deceleration case

If a light beam is flashed from point A to the opposite side, its path appears to curve towards the top. The path of light is exaggeratingly illustrated inside the capsule. An almost accurate path is shown in the right hand side figure for the capsule decelerating with $10\ m/s^2$.



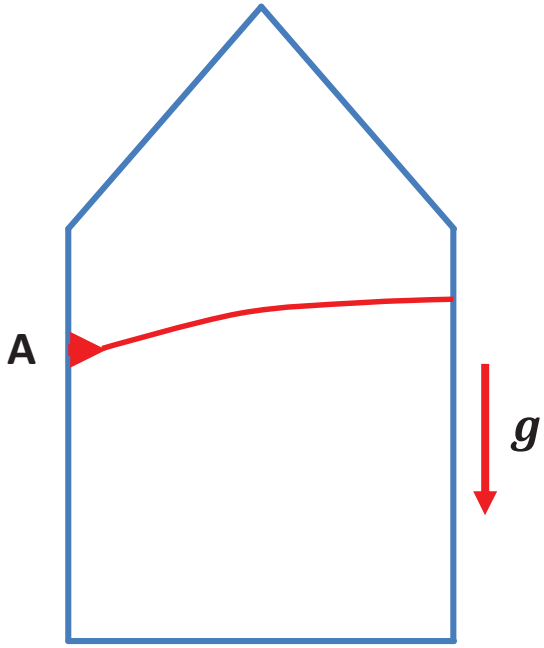
Case 5



Conclusions from the Third Equivalence 1/3

The effect of gravity on light trajectory

We now can conclude from the third equivalence that the trajectory of light in the Uniform Gravity case must be the same as Uniform Deceleration case. That is, if one shines a light beam from one side of any room on the Earth to the opposite side the trajectory of the light is a curved one, exactly similar to the trajectory of light in the Uniform Deceleration case decelerating with $g\ m/s^2$.



Case 3

Conclusions from the Third Equivalence 2/3

Major Conclusions

1. **Weightless light photons repel from a massive body due to its gravitational field**
2. **Any massive body changes the geometry of the space-time as the curved trajectory of light in a decelerating capsule suggests**
3. **Frequency of light changes due to gravitational field, depending on the direction of the light.**
   - **Any light emitted upward from a massive body becomes red-shifted**
   - **Any light received at the direction of a gravitational field is blue-shifted**
4. **A clock goes slower in a gravitational field**

Conclusions from the Third Equivalence 3/3

Case 5 (Uniform Deceleration) is not equivalent to case 4 (Uniform Acceleration) because light bends differently in each case but according to Einstein both are equivalent with case 3 (standing still on a planet).

The questions are:

- **How can the above paradox be explained?**
- **What is the correct curvature of light when it passes close to a planet or a star?**

Conclusion

- Equivalence Principle (EP) is based on weak analogy.
- There are irrefutable flaws, *e.g.* tidal effect, in the EP argument.
- But EP insists on identifying an elephant in the dark room with minimum information (by arbitrarily decreasing the size of the lab and reducing the duration of the experiment to hide away any evidence contrary to the analogy).
- This kind of defence teaches pseudo-scientists such as the proponents of the flat earth fiasco how to uphold their case successfully, just reduce the size of the land under examination.
- Simply put, Einstein insisted on not fully examining apples and oranges and just accept they are the same.
- A new counter example, new equivalence, is presented in this document which results in a different bending of light in the presence of gravity.
- There are now two sets of opposing conclusions (at least two different sets of results) from two different equivalence cases.
- The author believes that none of the conclusions should be allowed in science as they are based on inconclusive comparison/analogy and they ignore glaring flaws in the argument.

References

1. **S. Chandrasekhar - The Role of General Relativity in Astronomy: Retrospect and Prospect, J Astrophys Astron 1, 33–45 (1980).**
2. **S. Adams - Relativity, An Introduction to Space-time Physics, Taylor & Francis Ltd, 1997, p 193**

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