

Noether corrects Einstein's variable speed of light

Introduction and relevance

When Einstein published his theory of General Relativity (GR) on May 11th 1916, he was hailed for his explanation of Mercury's perihelion precession and later for his explanation of the bending of starlight around the sun (by Eddington). Since then we know the influence of gravitation on time, the curvature of space-time, and the existence of gravitational waves. Brilliant. Then came Emmy Noether. Noether defined the conditions under which energy conservation can be proven¹. In essence, the laws of physics and its constants like the speed of light "c", must be invariant to time translations (stay the same over time). Emmy Noether wrote a letter to Einstein on the 7th of January 1926, to emphasize for a *second time* the importance of her theorem of energy conservation. Einstein praised her as a brilliant mathematician, but totally ignored her, see also footnote 1.

What is wrong with Einstein's GR according to Noether? The variable speed of light in GR is the culprit. Although Einstein, in his theory of Special Relativity (SR), was the inventor of the constancy of the speed of light, in his GR the speed of light, on the larger scale within the reference frame, is *not* staying constant. For example, in the radial direction (towards the center-of-mass) of the Schwarzschild Solution on earth, the speed of light is exactly "c" or exactly 299,792,458.0 [m/s], but the speed of light in transversal direction (along the surface of the earth) equals 299,792,457.8 [m/s].

Einstein realized this difference but ignored it as hardly measurable. Within the solar system it is neglectable, but in strong gravitation it surely becomes relevant. Later, astronomers tried to settle this issue by an unscientific change of a crucial variable. If they would have listened to Noether, then they would not have to get rid of an awkward variable in the Schwarzschild Solution and the constancy of the speed of light would have been restored. The repair of the Schwarzschild solution for Noether's theorem comes with amazing results. No more (back hole) singularities in physics and the computation of the core temperature of the sun (15.5 million degrees K). Most importantly, the repair of Einstein's GR for Noether's theorem unites SR with GR again! Here is what happened.

Einstein's variable speed of light in strong gravitation

In 1911, in preparation of GR, he published the document "On the influence of gravitation on the propagation of light", in which he is convinced that the speed of light is not constant in gravitation. This is reflected in his GR, so *none* of the solutions (Schwarzschild, Kerr, Robertson-Walker) have a constant speed of light under all circumstances, like we have seen in the transversal Schwarzschild Solution. These solutions don't abide by Noether's theorem of energy conservation. Does that make these solutions useless? No, as long as the effect of a small deviation of the speed of light disappears within the measurement error of the experiment or observation; for example within our solar system.

However, in the strong gravitational field of black holes, we may not assume that a deviation from the speed of light "c" is neglectable. For example, you might argue, completely in agreement with Einstein's GR, that the speed of light at the edge of a black hole is zero, but this is in conflict with Noether's theorem of energy conservation. Allowing a variable speed of light (in vacuum) has curious consequences. If you would accept that the speed of light could be zero ($c = 0$), then the energy of a black hole would be zero according to Einstein's $E = m \cdot c^2$ in his SR! SR in conflict with GR... We must listen to Noether, it will bring Einstein's SR (like $E = m \cdot c^2$) closer to, and part of, his GR. Actually in the *repaired* Schwarzschild Solution is $E = m \cdot c^2$ again!

¹ Noether E. "Invariant variation problems" translated by Tavel M. TTSP 1971 p. 186-207. Letter from Noether to Einstein on the 7th of January 1926 repeating the importance of the principles of her theorems.

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How did it go wrong?

Karl Schwarzschild read all of Einstein's documents right from the start. Based on Einstein's documents until December of 1915, he solved Einstein's field equations of GR for a mass-point (in January 1916) and for a sphere of incompressible liquid like the earth (in February 1916). These were *exact* solutions, but not abiding by Noether's theorems. Karl Schwarzschild died on the 11th of May, 1916, on the same day that Einstein formally published his GR. In his official publication Einstein changed one formula, which Karl Schwarzschild had used to find his two solutions. For the experts: the determinant $g = -1$ was no longer required but became *optional* in a footnote in paragraph 19.

If one chooses to use the $g = -1$ condition, as is used in the Schwarzschild Solutions, the solution does not abide by Noether's theorems. In contrast, if one chooses *not* to use the $g = -1$ condition, as is the case for the Robertson-Walker Solution, the four field equations cannot be solved uniquely! In other words, to abide by Noether's theorems, the $g = -1$ condition must be replaced by a condition ensuring a constant speed of light under all circumstances. After 1916, Eddington (1922), Misner, Thorne, and Wheeler (1970), and Oas (2005) wanted to copy the original exact solution of Karl Schwarzschild.

However, they did not redo the complicated tensor analysis, which Karl did. They started off at an intermediate result of Karl, but replaced Karl's auxiliary variable "R" by coordinate "r". This created a problem: How to get rid of an awkward variable to make the formula *look like* Karl's original solution (except for replacing "R" by "r")? They all resorted to semantics: "drop the suffix", "primes dropped", and "without loss of generality" respectively. The scars of which are still felt today. The irony is that if they had listened to Noether, they could have repaired the original Schwarzschild solution by *not* getting rid of that variable (for the experts: $g_{11} = g_{22} = g_{33}$ instead of $g_{22} = g_{33} = -1$).

Where are the scientists today that take Noether serious and admit that Einstein's Relativity is in respect of the speed of light in conflict with Noether's theorem? Einstein's SR does not join up with his own GR.

Repairing Einstein's GR and Schwarzschild's solutions

It does not take an awful lot to repair Einstein's theories for Noether's theorems. Einstein's original and disregarded demand $g = -1$ must be replaced by the demand that the speed of light is constant under all circumstances. For example, in the Schwarzschild solution the constancy of the speed of light is restored by a single and simple modification (for the experts: $g_{11} = g_{22} = g_{33} = -1 / g_{00}$, see other articles for expert readers). If Einstein had listened to Noether, he would have completed a better theory of general relativity, in which the speed of light is constant, energy is conserved under all circumstances and there would not be widely copied *incorrect* Schwarzschild Solutions delivering black hole "singularities" with "event horizons".

More information?

Our three books and articles on www.loop-doctor.nl describe the repair of Einstein's Relativity for Noether's theorem² in full detail. We hope you get as many "aha" experiences as we did,

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Maarten Palthe (MSc. editor). Schiedam, December 2019

² Noether E. "Invariant variation problems" translated by Tavel M. TTSP 1971 p. 186-207