Measuring results of M87 and Lorentz interpretation (LI) of GRT

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2019-05-12 Preliminary version
last update: 2019-09-25

1 Preliminary remarks

This was the prediction of the M87* observation by LI of GRT before 10.4.2019, [17]:
"So, r_{M87+NS} is seen under $10*22/53\,\mu as$. Assuming gravitational lensing having the same enlargement of 2.5 as for SGR A* one gets

(1) $$d_{M87} = 2*1.56*10*22/53*2{,}50\,\mu as$$
$$= 32\,\mu as"$$

Taking a better enlargement factor for gravitational lensing, formula (1) of [2], but the same radius of 1.56 rsm one gets:

(2) $$d_{M87} = 2*\sqrt{27}*r_g*1{,}56/1.5$$
$$= 41{,}1\,\mu as$$

In words: The diameter of the photon sphere 2*1.5 r_{sm} = 2* 3 r_g is enlarged by gravitational lensing by a factor $\sqrt{3}$. The factor 1.56/1.5 adapts to the real radius of the SMO. r_g = 3.8 µas.
Both values fit together with the measuring result of 42 µas, table I of [1].

And this are some preliminary, first comments from [17] on the M87* image after presenting the black hole shadow, [1]-[6].
1.) This very important observation of the EHT collaboration opens the door for many other helpful experiments. It's deeply impressing to see the photon ring for the first time.
2.) LI of GRT becomes less convincing but it is not rejected. If there are SMO's without event horizon then their radius *Rsmo* is restricted, *Rsm* < *Rsmo* ~< *Rphotonring*.
3.) One should not forget, *Rsmo* is calculated using standard physics. It needs TOV and some degenerated equations of state of QM, only. So, if LI of GRT is rejected then there remains some contradiction within GRT or QM.
4.) The next important event of EHT is the shadow of SGR A*. Please present it yesterday.

Quite interesting are the statements of two well known astrophysicists questioning the existence of black holes:
"Ganz streng genommen wissen wir noch immer nicht, ob es sich bei dem zentralen Objekt in M87 wirklich um ein Schwarzes Loch handelt", so sagt es Karl Schuster vom Iram in der SZ vom 10.04.2019. Fast gleichlautend hat sich auch Reinhard Genzel, MPI, in einer Fernsehsendung ~April, Mai 2019 geäußert

2 Press Conference on First Result from the Event Horizon Telescope 10.4.2019

Since the press conference on first results from the Event Horizon Telescope on 10.4.2019 everybody knows;
1.) In the galactic centers are supermassive objects, SMO's
2.) They are black holes, BH's – light cannot escape, their shadow is visible, s. fig. 1.
3.) Time and space are ending, curved, distorted. E. g. Der Spiegel Nr. 16/ 13.4.2019: „Am Ende von Raum und Zeit.“ „Zusammen mit dem Raum wird auch die Zeit verzerrt.“
But what is proven?
1.) SMO's are accepted by classical GRT and LI of GRT. SMO's bend even light into a circular orbit – the bright ring in fig. 1 consists of circulating light and plasma.
2.) BH's are not proven for sure. LI of GRT explains the shadow of fig.1 as the polar cup of the SMO which is dark because it is not illuminated by the surrounding plasma.
3.) The philosophical differences with classical GRT and LI of GRT remain. But there is a new argument from cosmology challenging classical GRT, s. next chapter.

3 More to 3.) curved spacetime: A cosmological argument preferring LI of GRT

The spacetime philosophy of classical GRT differs from LI of GRT [17]. Some examples: Time expands versus clocks run slower in gravitational fields, space is curved versus measuring rods contract in gravitational fields, space between galaxies expands and the galaxies are resting versus galaxies remove from each other with a certain velocity.
This curved spacetime concept of classical GRT gets severe difficulties in cosmology. Riess et al. [11] proved that there are two different Hubble constants. CMB (cosmic microwave background) observation data yield

(3) $$H_1(t_0) = 67{,}15\ km/s/Mpc$$

Observations with the HST (Hubble space telescope) using calibration with cepheids in the Large Magellanic Cloud (LMC) deliver

(4) $$H_2(t_0) = 74,03 \text{ km / s / Mpc}$$

The differences are not explainable by observation errors [8] – [11].

The Hubble constant at present time, t_0, is defined by classical GRT as

(5) $$H(t_0) = a'(t_0) / a(t_0)$$

$a(t)$: scale factor of the universe
$a'(t)$: expansion rate of the universe
$t = t_0$: present time

With $H_1(t_0)$ and $H_2(t_0)$ and with formula (5) you get two different expansion rates of the universe at the same time what is impossible if the universe is isotropic and homogenous. A newer remark [24]
LI of GRT is not harmed by different Hubble constants, see ch. 9 of [18].

4 Measuring results of M87*

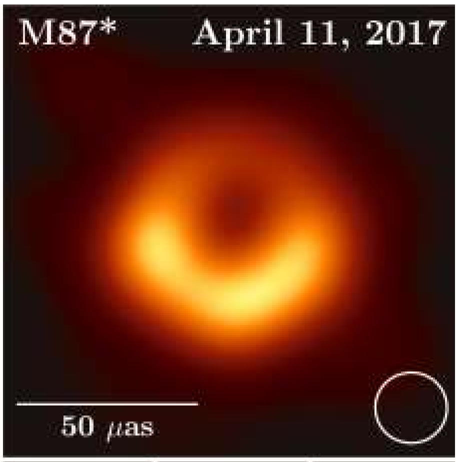

Fig. 1 The Shadow of the Supermassive Black Hole M87*. Taken from [1], fig 3
The right circle is the beam size and shows the measuring uncertainty of ~20 μas.

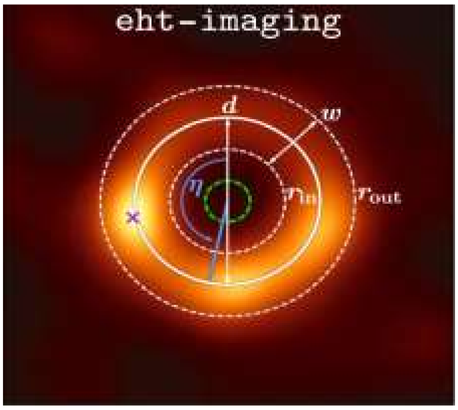

Fig. 2 The same as fig. 1 but visualizing the measured parameters. Taken from [3], fig.26.

The image of M87*, fig. 1, is described quantitatively by the parameters visualized in fig.2. The measured values are:
Ring diameter d: 42 μas
Ring width w: <20 μas
Gravitational radius $r_g = GM / Dc^2$
$= 3.8 \mu\text{as}$
Masse M of M87* $(6.5 \pm 0.7) \times 10^9 M_\odot$
Distance D of M87* (16.8 ± 0.8) Mpc
Very important is what is not visible. There is no r_{isco}, normally twice as large than the photon ring. The conclusion of classical GRT is that the BH is maximal rotating. See fig.3.

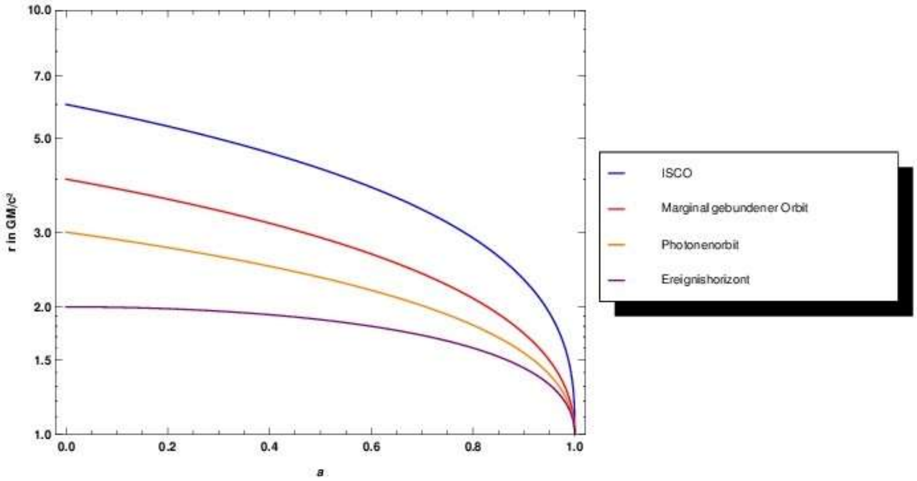

Fig. 3 Radii of ISCO, of photon ring, and of event horizon as a function of spin *a*. Taken from [12].

5 Classical GRT explains fig. 1 + 2 as follows:

d is the measured photon ring diameter.
The innermost stable circular orbit r_{isco} is not seen to be different from the photon ring. This is explainable by the spin *a* of the black hole. $a = 0$ means $r_{isco} = 3\ r_{sm}$ and $a \sim 1$ means maximal rotating. In this case r_{isco} and $r_{photoring}$ become equal, see fig. 3. So, the bright ring in fig.1 is a mixture of photons and plasma circulating around a black hole just before being captured. The existence of r_{isco} is necessary to explain the brightness of M87*. A rational solution is to assume that r_{isco} and $r_{photoring}$ are near together and that $a \approx 1$ and $r_{isco} \approx r_{photoring} \approx r_g$
$r_{photoring} \approx r_g$ is enlarged by gravitational lensing. Regardless of the value of spin *a* one gets [13]:

(6) $$r_{photoring,observable} = \sqrt{27} * r_g = 19.8 \mu as$$

The enlargement is not circular as for $a = 0$ but a little flattened if $a \approx 1$, s. [13]. This is unimportant in the moment on account of the measuring errors.

The interior of $r_{photoring,\ observable}$ is the shadow of the black hole. Only its inner part is black, the outer part is not black on account of the finite beam size and the thickness of the photon ring. The size of this effect is $\approx w \approx 20\ \mu$as. Now, one has to compare

(7) $$d \cong 2 * r_{photoring,observable}$$

Since $d = 42\ \mu$as is comparable to 2* 19.8 = 39.6 μas both values match well.

6 LI of GRT explains fig. 1 + 2 as follows:

Using TOV equation, LI of GRT predicts instead of a BH a supermassive object (SMO) with radius r_{SMO} ,[14] –[17].

(8) $$r_{SMO} = 1.56 * r_{SM}$$

All applied formulas agree with those of classical GRT [18], especially this is true for the TOV equation.

The ring of fig.1 is a mixture of the photon ring and the accreting matter hitting the surface of the SMO. Similar to meteorites, the matter is heated up when hitting the SMO. The ring in fig. 1 is the enlarged image by gravitational lensing of r_{SMO}, formula (1) of [2]:

(9) $$r_{SMO,observed} = \sqrt{27} * r_g * 1.56 / 1.5$$

(10) $$d_{SMO,observed} = 41,1 \mu as$$

Formula (9) applies to all values of spin *a*, s. comment of (6).

This fits quite nice to the observed $d = 42\ \mu$as. The observation belongs to all values of spin *a*, $0 <= a <= 1$. Normally, one should see bright rings at r_{isco} and $r_{photoring}$ but a missing r_{isco} is in the case of LI of GRT a problem to accretion disk theory, only. There are different accretion models available and nearly all of them should work with LI of GRT. The energy transfer necessary for the jets as well as the radiation emission can be done by accretion over the surface of the SMO.

LI of GRT explains the shadow of fig.1 as the polar cup of the SMO which is dark because it is not illuminated by the surrounding plasma.

7 More to 2.) black hole

A maximal rotating object confirming the Kerr metric - $a \approx 1$ - means there is a black hole and light cannot escape. But this is not observably different from a maximal rotating SMO in the sense of LI of GRT. In this case r_{SMO} is only a little bit larger than r_g. but with the consequence that light can escape. So, if one has maximal rotating objects a decision between both interpretations by observing d is impossible.
But there is a nice consequence. If there is an independent measurement of $a < 1$ than a missing $r_{\mathrm{isco}} > r_{photoring}$ proves LI of GRT.
Two further comments to the measurement of spin:
First, assume the prediction of r_{isco} using the theory of a thin accretion disk is correct then there always will exist one r_{isco} but only fainter than predicted. Though not visible in the image of fig.1, perhaps, there is a measurable faint emission bump. This is equivalent to a measurement of spin a. No bump means $a \approx 1$ and that is necessary for a BH of M87*, but $a < 1$ prefers LI of GRT. The bright ring at r_{SMO} in fig.1 is not explainable for a BH with $a < 1$.
Second, there is no TOV equation for rotating objects. By rotation the centrifugal forces will expand the star, the higher velocity will contract it on account of Lorentz contraction. Following fig. 3 it is rational to assume that contraction is the larger effect. The radius of the SMO should follow $r_{photoring}$ in fig.3.

8 The spin of M87*

There are different predictions of the spin a* of M87* in the literature. Sob'yanin [19], Nokhrina et al. [20] predict a M87* spin a* < 0.5, Nemmen [21] a*> 0.4 where as Tamburini et al. [22],[23] predict a spin a*≈ 0.9. Assuming a* < 0.5 then one should see two different bright regions at r_{isco} and $r_{photoring}$ in fig. 1. Since this is not the case LI of GRT would be proven.
Assuming a*≈ 0.9 then from fig. 3 one gets:

$$r_{\mathrm{isco}} = 2.6\ r_g.$$
$$r_{photoring} = 1.8\ r_g.$$
$$r_{eventhorizon} = 1.4\ r_g.$$

but on account of gravitational lensing these differences would not be visible in an image of M87* like fig. 1. So, if a* of M87* < 0.5 then one can decide between classical GRT and LI of GRT, if a*≈ 0.9 then SMO's without event horizon remain possible, after all.

9 Summary

Spin $a < 1$ prefers LI of GRT if there is no visible $r_{\mathrm{isco}} > r_{photonring}$.
$a \approx 1$ fits with both interpretations.
The shadow in fig. 1 fits with both interpretations but this is not discussed in detail.

10 Literature

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