Three observations questioning classical GRT and preferring LI of GRT – EHT image of M87*, Spin, ALMA image of SGR A*

J. Brandes

2019-09-20 Preliminary version
last update: 2020-03-14

Content

1 Preliminary remarks

This contribution is a continuation of “Measuring results of M87* and Lorentz interpretation (LI) of GRT” [29] and discusses the EHT collaboration measurements of M87* [1]-[6].
The two main differences between classical GRT and LI of GRT are:

1.1 The philosophical difference

The spacetime philosophy of classical GRT differs from LI of GRT [30]. 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.
Everything that is falling into a black hole remains part of this world. There is no way into another universe. “How far can a dog run into the woods? Halfway, then it will be running out.” Within classical GRT the dog will run into another universe.
“We have seen the gates of hell at the end of space and time,” said astrophysicist Heino Falcke at a press conference in Brussels and he added: “What you’re looking at is a ring of fire created by the deformation of space-time. Light goes around, and looks like a circle.”[7]
Such fundamental differences in the philosophy of time and space should have observational consequences, as is shown e. g. with black holes.

1.2 The physical difference

Within LI of GRT there are no BH’s but instead SMO’s which own no event horizon. At the first sight this means a fundamental contradiction to GRT but this is not the case. SMO’s are calculated [26] using the TOV equation which is pure classical GRT. All the other formulas of LI of GRT remain the same but they are interpreted in different ways with measurable consequences for BH’s or SMO’s instead [30], p. 312. As is shown below, e.g. there are conflicting spin measurements which are rational within LI of GRT.
Up to now (March 2020) there are five observations preferring LI of GRT and questioning classical GRT: EHT image of M87* ch. 2, Spin ch. 3, ALMA image of SGR A* ch.4, Measurement of the period of the event horizon rotation ch. 5, conflicting measurements of the Hubble constant ch. 6.

2 Some open questions concerning the shadow of M87*

Updated 2020-03-08

BH’s own an event horizon and SMO’s not. BH’s get their luminosity by friction of the plunging matter at the innermost edge of an accretion disk but SMO’s get their luminosity mainly by accreting matter hitting the surface of SMO’s and only partly by friction at the innermost edge of an accretion disk. The matter hitting the surface of SMO’s is heated up and therefore it is called the fire ring of SMO’s.
An exciting question concerning the shadow of M87*is discussed by K. Nalewajko, M. Sikora and Agata Rózànskà in ‘On the orientation of the crescent image of M87*’[8]. They analyzed the crescent image of M87* with the result illustrated in Fig. 1. It shows how the spin or jet axis of M87* and the image of M87* of the EHT collaboration fit together. They state: “We strictly assume that (1) the BH spin vector is fixed to the jet axis, (2) the emitting regions are stationary and symmetric with respect to the BH spin, (3) the emissivities are isotropic in the local rest frames.”[8] with the result: “Within the constraints of our model, **we have not found a viable explanation for the observed brightness of the SEE sector.** The SEE ‘hotspot’ might have been produced by a non-stationary localised perturbation in the inner accretion flow. Alternatively, it could result from locally anisotropic synchrotron emissivities.”[8]

Table 1 Sketches of a BH with accretion disk and a SMO in different directions

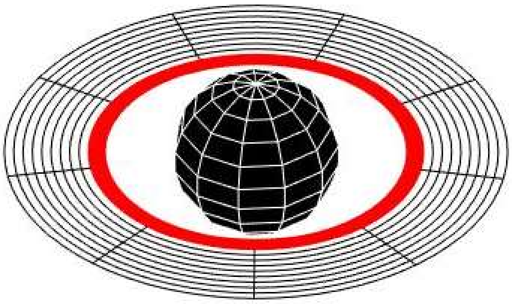

Abbildung 1 BH with accretion disk

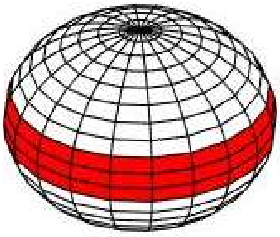

Abbildung 2 SMO with fire ring

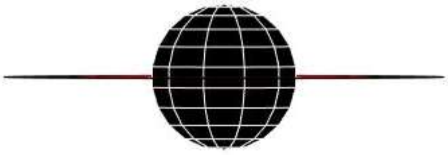

Abbildung 3 BH edge on

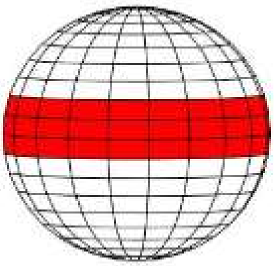

Abbildung 4 SMO edge on

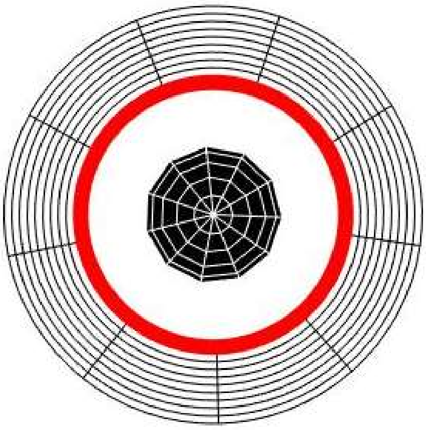

Abbildung 5 BH face on

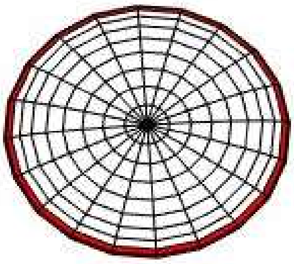

Abbildung 6 SMO face on

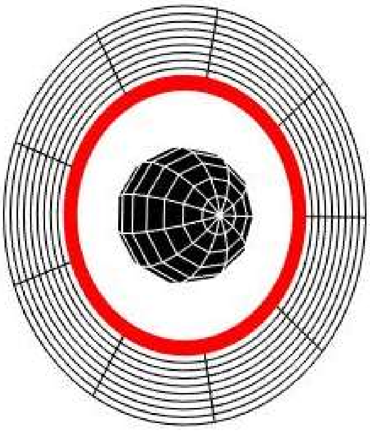

Abbildung 7 BH nearly face on

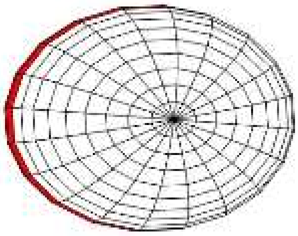

Abbildung 8 SMO nearly face on

Table 1 These sketches show some observable differences between BH's and SMO's. Looking edge on – Abbildung 3 and 4 – a BH is faint and a SMO bright. Looking face on – Abbildung 5 and 6 - there is 'no' difference between a BH or a SMO, you will see a ring in both cases but looking nearly face on – Abbildung 7 and 8 - a SMO has a bright edge and a accretion disk looks unchanged. This is important since this effect could correspond to the SEE region of fig. 1 in Ch. 2. (Doppler effects and gravitational lensing are not sketched. The heated up regions are red.)

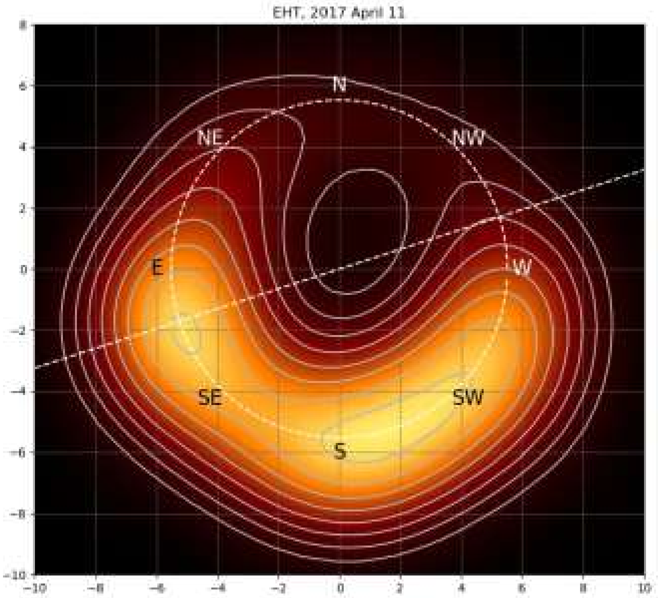

Fig. 1. Image of BH M87* at 1.3 mm wavelength obtained on April 11, 2017 by the Event Horizon Telescope (adapted from Fig. 3 in EHT Collaboration 2019a). The grey contour levels correspond to brightness temperature values. The white dashed lines indicate a photon ring of diameter 42 µas and the position angle of large-scale jet PA = 288◦ (NWW). The units of the grid are the angular size of the M87* gravitational radius θ_g = 3.8 µas. Taken from K. Nalewajko, M. Sikora and Agata Rózànskà [8]

The brightness of the crescent image (region from W to SE in fig. 1) is explained by the Doppler effect of the approaching plasma but the bright SEE sector is already receding and should be darker. The authors suggest perturbation in the inner accretion flow or anisotropic synchrotron emissivity as a reason. This looks reasonable for classical GRT as well as LI of GRT. But LI of GRT allows another explanation, see table 1. Assume that the dashed photon ring in fig. 1 is the inner edge of the accretion disk of a black hole (Abbildung 1 of table 1) or part of the surface of a SMO (Abbildung 2 of table 1). (Doppler effects are not sketched). The SEE sector in Fig. 1 is the nearest part to the observer of the disk with the SEE sector being above the image plane and the NWW sector is fastest away being below the image plane. This is the situation sketched by Abbildung 7 for BH's and Abbildung 8 for SMO's. For BH's there is no difference between looking face on or looking nearly face on but for SMO's there is a difference. In Abbildung 8 you will see that the left side of the SMO is brighter as the right side and this agrees with the SEE section and the NWW section in fig.1. So, as demonstrated by Abbildung 7 and 8, one has a brightness effect seen only for SMO's.
The paper [8] points to an open question concerning the shadow of M87*, weather this proves the fire ring model of LI of GRT can be further investigated. In the EHT papers [1]-[6] it was claimed that the round shape of EHT image proves that there is a photon ring. Within LI of GRT there is the additional explanation that the accreted material hitting the surface of a SMO is heated up and a fire ring arises. Similarly, light flashes are the result of tidal forces disrupting a stellar object (classical GRT as well as LI of GRT) or the additional explanation for LI of GRT: a stellar object or even clumped material is hitting the surface of a SMO creating a light flash. Concerning the SEE sector of fig. 1 a further test of a fire ring would be an image of some BH which is seen edge on (Abbildung 3 and 4). This is done by the ALMA VLBI measurements of SGR A*, [27] and ch. 4 below. So, looking at SGR A* there should be a bright spot at the nearest part to the observer of the fire ring and not at the point of the fire ring with the highest approaching velocity. As far as discussed in [27] the image of SGR A* shows a bright region and no shadow in agreement with this prediction of LI of GRT. The up to now (March 2020) unpublished results of SGR A* of the EHT collaboration should do better because the EHT measurements make use of the ALMA telescope, too. So, the EHT image of SGR A* could become a deeper test of LI of GRT if these results were released.

3 Conflicting spin measurements of M87* and SGR A*

Newest spin measurements of M87* and SGR A* show values a*<= 1 but there are others with a* = 0.2 up to a* = 0.6. Within LI of GRT there are no BH's but SMO's having no event horizon. Therefore, following LI of GRT the luminosity of these SMO's results from accreting matter hitting the surface of SMO's and only partly by friction at the innermost edge of an accretion disk. The high values of a* arise because the bright equatorial region of the SMO's is interpreted by classical GRT as the inner edge of the accretion disk which by this is seen as very close to the photon sphere. The conflicting spin measurements are discussed. It is a continuation of chapters 7 and 8 of [29]. There are two groups, those near a*>≈ 0.9 and those with a* < 0.6. Both groups are using several different methods. It is shown that all a*≈ 0.9 measurements get a wrong, too high value if there is a fire ring as demanded by LI of GRT. The lower values of a* are measured with methods which are independent of a fire ring.

High a* values

High a* values were measured by observing x-ray flares, Reynolds [11] 2013 , Aschenbach et al [12] and others, by looking for the brightest point, Dokuchaev [13], and by investigating twisted light, Tamburini et al. [16], [17]. The observed a * values are a* > 0.9, a*= 0.9939 + 0.0026 − 0.0074, a* = 0.75, a* = 0.9 respectively.

Low a* values are measured by Dokuchaev et al. 2013 [14], Denis Nikolaevich Sob'yanin [18], Rodrigo Nemmen [19], Genzel, R. et al. [20], Nokhrina et al.[21]. The observed a* values are a* = 0.65±0.05, a* = 0.15±0.05 up to a* = 0.5±0.3, |a∗|≥ 0.4 in the prograde case and |a∗|≥ 0.5 in the retrograde case, and a* = 0.1−0.3 respectively.
The measurement methods of the high a* values rely on the fact, that a* is a function of the innermost stable circular orbit r_{isco} of Kerr BH's, s. fig. 3 of [29] and r_{isco} is determined by several methods which **don't take into consideration that there might be a fire ring** of LI of GRT. So, for x-ray flares [10] - [12] the highest measured redshift of the iron line is connected directly with r_{isco} but the highest measurable redshift of the iron line is emitted from iron ions of the fire ring, e. g. from the surface of the SMO. This not taken into consideration. Some citations:
"Thus, the spin dependence of the ISCO directly translates into spin-dependent observables; as spin increases and the radius of the ISCO decreases, the disc becomes more efficient at extracting/radiating the gravitational binding energy of the accreting matter, the disc becomes hotter, temporal frequencies associated with the inner disc are increased, and the gravitational redshifts of the disc emission are increased." Page 3 and fig.1 of Reynolds 2013 [11].
"…we can determine the properties of the accretion disc itself (e.g., the ionization state of the surface layers and the elemental abundances of the disc) as well as the inclination of the disc and the location of the ISCO (hence the BH spin)." page 6 of [11]
"… **our method assumes that the accretion disc observables truncate at the ISCO; the spin constraint is almost entirely driven by this fact**." page 9 of [11].

The method of Dokuchaev et al. 2019 [13] to determine '*the brightest point in accretion'* is described by fig. 2. One can see immediately that a fire ring could change the position of the brightest point yielding a different r_{isco} and different spin. (But knowing the correct spin value then features of the fire ring can become determined with this method.)

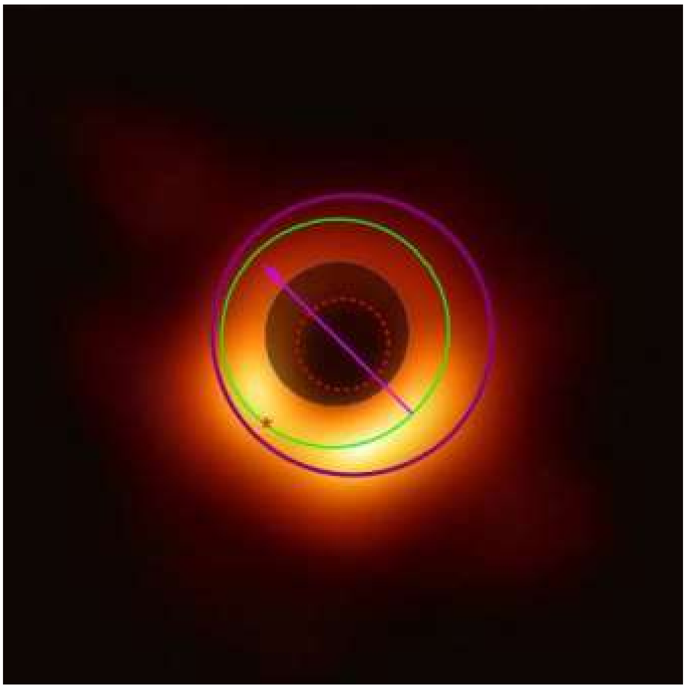

Fig. 2. Superposition of the M87* image, EHT [1–6], and the thin accretion disk model of [13] in the case of black hole spin $a = 0.75$. Star ⋆ marks the modelled position of the brightest point in the thin accretion disk at $r = r_{\rm ISCO}$ (green ring). The closed dark red curve is a border of the black hole shadow. The dashed red circle is the observed position of the black hole event horizon in the imaginary Euclidian space. The magenta arrow is the black hole rotation axes. Taken from [13]

The high spin values with Tamburini et al.[16], [17] rely on the '*Measurement of the spin of the M87 black hole from its observed twisted light'*. Some citations:
"The twisted-light/OAM method, complementary to black-hole shadow circularity analysis, allows a direct probing of Kerr metrics and shows that the M87* rotates clockwise with an estimated rotation parameter a~0.9±0.1."
"Our simulations show that the main contribution to the phase difference comes **from the inner stable orbits that approach the Sgr A* event horizon**."
This new and challenging method of Tamburini up to now leads to too high spin values if there is a fire ring. In this case the inner stable orbit appears to be at r_{smo}.

Low a* values

Low a* values were measured with methods independent of a fire ring. A first, very convincing one is presented by Dokuchaev et al. 2013 in '*Spin and mass of* Sgr A*'in fig.3. It is convincing because it consists of two independent measurements. $a^* = 0.65±0.05$.
Some citations:
"What is described below is the alternative QPO interpretation, related to the oscillation frequencies of the numerous hot spots in the accretion plasma [15,16,17,18,19,20], which are independent of the accretion model and defined completely by the properties of the black hole gravitational field." Page 2 of [14].

“For this reason a moderate spin value of the supermassive black hole Sgr A* is quite natural due to specific conditions in the Galactic Center. Note also that the value of spin parameter a= 0.65±0.05, derived here by dint of QPOs, is in a qualitative agreement with the corresponding quite independent estimation, a≃0−0.6, from the millimeter VLBI observations of Sgr A* [49,50 Broderick].” Page 10 of [14].

Some further low a* measurements:

Denis Nikolaevich Sob’yanin (Денис Николаевич Собьянин) *Black hole spin from wobbling and rotation of the M87 jet and a sign of a magnetically arrested disc [18]*
a* = 0.15±0.05 up to a* = 0.5±0.3
“In the case of a test-particle precession, the specific angular momentum is J/Mc= (2.7±1.5) × 1014cm, implying moderate dimensionless spin parameters a= 0.5±0.3 and 0.31±0.17 for controversial gas-dynamic and stellar-dynamic blackhole masses. However, in the case of a solid-body-like precession, the spin parameter is much smaller for both masses, 0.15±0.05. Rejecting this value on the basis of other independent spin estimations requires the existence of a magnetically arrested disc in M87” page 1 of [18].

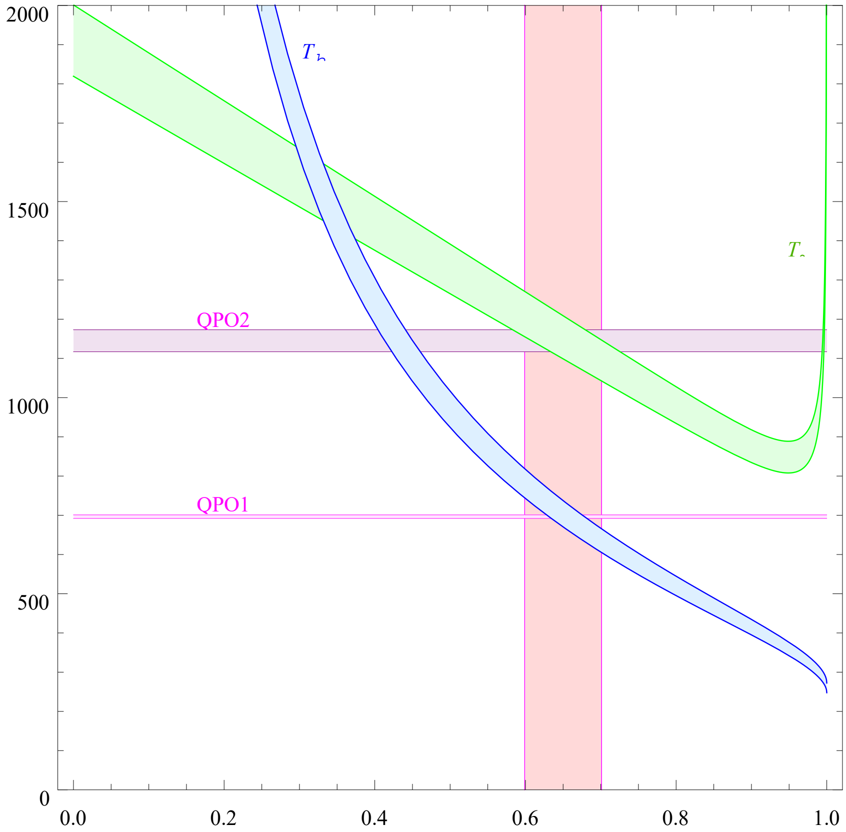

Fig. 3. *T(sec)* as a function of *a*. T_h and T_θ are blue and green respectively. “The observed QPOs with the mean periods 11.5 and 19 min (filled horizontal stripes QPO1 and QPO2) from the supermassive black hole Sgr A*, identified, respectively, with a period of the event horizon rotation T_h from (9) and a period of the latitudinal oscillation of the hot plasma clump at the near-circular orbit in the thin accretion disk with Ω_θ from (14). The filled region for T_θ corresponds to the numerically calculated permissible values of Q in (10) and (12), adjusted with the observational errors of QPO1 and QPO2 periods. The joint resolution of equations (9) and (14) with the observed values of QPO periods T_h and T_θ reveals the black hole spin, a = 0.65 ± 0.05 and mass, M = (4.2 ± 0.2)$10^6 M_\odot$, shown in Fig 7.” Taken from [14].

Rodrigo Nemmen *The Spin of M87* [19]*
|a∗|≥ 0.4 in the prograde case and |a∗|≥ 0.5 in the retrograde case.
“We find a lower limit on M87*’s spin and magnetic flux of |a∗|≥ 0.4 … in the prograde case, and |a∗|≥ 0.5 … in the retrograde case, otherwise the black hole is not able to provide enough energy to power the observed jet. These results indicate that M87* has a moderate spin at minimum …” [19]

Genzel, R. et al. [20]
Sgr A* a* = 0.52

"Two flares exhibit a 17-minute quasi-periodic variability. If the periodicity arises from relativistic modulation of orbiting gas, the emission must come from just outside the event horizon, and the black hole must be rotating at about half of the maximum possible rate." [20]

Nokhrina et al. *M87 black hole mass and spin estimate through the position of the jet boundary shape break [21]*
"Thus, we have obtained the moderate spin parameter of the order of 0.1−0.3 for M87 SMBH." [21]

Conclusion

Do we have an experimental proof of LI of GRT? Yes, perform a measurement of the Spin of M87* using a method not influenced by a fire ring and using another one which is influenced by a fire ring. If the measurement results agree, then there is no fire ring. The above discussed spin measurements prove the contrary.

4 ALMA and EHT measurements of SGR A*

A note added to the ALMA discussion which prove LI of GRT in [27], page 1. S. Issaoun and H. Falcke stated: "the radio jet is pointing almost at us" and we are looking at a bright emission center hiding the shadow. Following HAWTHORN et al [31], and their fig. 1 and 2, such a spin direction does not fit with observation.
The EHT measurements of SGR A* though made together with those of M 87* are not publicized up to now (March 2020). What is the reason? Making a guess, there is no difference to the ALMA results and no shadow of a BH is seen. No shadow and therefore no publication? But there is an argument of H. Falcke in the contribution Why didn't the Event Horizon Telescope team mention Sagittarius A*? [32]: It is "hard to photograph. It was easiest to take a picture of M87." "It is very difficult to photograph the black hole in our Milky Way, because the material around it moves very fast: the vortex rotates around its axis in 20 minutes. Compare it to a toddler who has to sit still for hours to be photographed: that's not possible. With M87, the matter revolves around the hole in two days, so it's easier to photograph". The counterargument: The shadow of a BH has no frequency of 20 minutes or two days but should be seen all the time. So, what is the result of the EHT measurements of SGR A*? The arousing suspicion is that the results might not fit with the predictions and therefore are being hold back.

5 Measurement of the period of the event horizon rotation

A further consequence from Fig.3. QPO1 is the measurement of the period of the event horizon rotation $T_{h.}$ Within LI of GRT T_h is the period of a SMO and such a period should be measurable. But within classical GRT the period of a BH is measured by signals from rotating objects near the event horizon and these signals have an infinite redshift, die away and are not measurable. If this argument is in order then the measurement of T_h alone proves LI of GRT.

6 Conflicting measurements of the Hubble constant

There are two different measurement results of the Hubble constant, see e. g. [33]: "The new estimate of the Hubble constant is 74.03 kilometres per second per megaparsec. The number indicates that the Universe is expanding at a rate about 9 percent faster than that implied by Planck's observations of the early Universe, which give a value for the Hubble constant of 67.4 kilometres per second per megaparsec."
This contradicts the idea of an expanding universal spacetime since two different Hubble constants

$$H(t) = a'(t) / a(t)$$

means two different scale factors *a(t)* and therefore two different expansion rates of the universe at the same time as well as two different redshifts for the same galaxy e.g. relative to us. Observable is always one value only. Within LI of GRT the expanding universe is described by an expanding dust star using similar formulas as classical GRT for the expanding universe [30, ch.19 and 22]. In this case different Hubble constants in different regions of the universe are not a fundamental problem since a dust star is only a rational approximation to exploding matter. Similar, a directional dependence of the Hubble constant would be no problem, too. For LI of GRT another problem might arise: At Big Bang the universe is extremely dense and it should become a BH at once. But then it could not expand like a dust star. Fortunately, this is no severe problem: LI of GRT postulates SMO's instead of BH's. At Big Bang there is a SMO and no BH. Classical GRT has no difficulty with BH's at Big Bang since the expansion of spacetime means resting galaxies and that is different from the expansion of a dust star with moving dust particles resp. galaxies. In the later case classical GRT gets a BH and no Big Bang.
So, there is the thesis: Two different estimates of the Hubble constant refute the idea of 'expansion of spacetime' and prove LI of GRT … and as a logical consequence refute BH's.
To get rid of this problem classical GRT must eliminate one of the Hubble constants. The latest help are the ideas of Maria Bergemann et al. discussed in [34]. Possibly, supernovae 1a are no longer suitable standard candles. The Hubble constant of 74.03 kilometres per second per megaparsec could become obsolete. But further considerations are necessary.
Some arguments why this wouldn't help: Measurement of the Hubble constant using gravitational lensing leads to high values near the above 74.03. Gravitational lensing observes supernova 1a as well but makes no use of them being standard candles. [35], [36]. So, the objections of [34] are not applicable. The next problem for classical GRT are the measurements using red giants [37], [38].

7 Summary

The brightness of sector SEE in fig. 1 of Krzysztof Nalewajko, Marek Sikora and Agata Rózànskà [8], and the ALMA VLBI measurements of SGR A* [9] present open questions concerning the shadow of M87* and of SGR A* which are explainable by LI of GRT – chapter 2 and 4. The same is true for the conflicting high and low spin measurements of M87* and SGR A* - chapter3. Since SGR A* is seen more edge on than M87* an EHT image of SGR A* should become a deeper test of LI of GRT. A possible direct measurement of the SMO/BH period - chapter 5 – as well as different Hubble constants – chapter 6 - might refute BH's.

8 Literature

[1] First M87 Event Horizon Telescope Results. I. The Shadow of the Supermassive Black Hole The Event Horizon Telescope Collaboration *et al.* 2019 *ApJL* **875** L1

[2] First M87 Event Horizon Telescope Results. V. Physical Origin of the Asymmetric Ring The Event Horizon Telescope Collaboration *et al.* 2019 *ApJL* **875** L5

[3] First M87 Event Horizon Telescope Results. IV. Imaging the Central Supermassive Black Hole The Event Horizon Telescope Collaboration *et al.* 2019 *ApJL* **875** L4

[4] First M87 Event Horizon Telescope Results. III. Data Processing and Calibration The Event Horizon Telescope Collaboration *et al.* 2019 *ApJL* **875** L3

[5] First M87 Event Horizon Telescope Results. II. Array and Instrumentation The Event Horizon Telescope Collaboration *et al.* 2019 *ApJL* **875** L2

[6] First M87 Event Horizon Telescope Results. VI. The Shadow and Mass of the Central Black Hole, Event Horizon Telescope Collaboration (Kazunori Akiyama (NRAO, Charlottesville & MIT, Haystack Observ. & Natl. Astron. Observ. of Japan & Harvard U.) et al.) Astrophys.J. 875 (2019) no.1, L6 (2019-04-10)

[7] Heino Falcke https://www.nature.com/articles/d41586-019-01155-0

[8] Krzysztof Nalewajko, Marek Sikora and Agata Rózànskà On the orientation of the crescent image of M87* arXiv:1908.10376v2 [astro-ph.HE] 3 Sep 2019

[9] S. Issaoun, M. D. Johnson, L. Blackburn, C. D. Brinkerink, M. Mo´scibrodzka, A. Chael, C. Goddi, I. Mart´ı-Vidal, J. Wagner, S. S. Doeleman, H. Falcke, T. P. Krichbaum, K. Akiyama, U. Bach, K. L. Bouman, G. C. Bower, A. Broderick, I. Cho, G. Crew, J. Dexter, V. Fish, R. Gold, J. L. G´omez, K. Hada, A. Hern´andez-G´omez, M. Janßen, M. Kino, M. Kramer, L. Loinard, R.-S. Lu, S. Markoff, D. P. Marrone, L. D. Matthews, J. M. Moran, C. M¨uller, F. Roelofs, E. Ros, H. Rottmann, S. Sanchez, R. P. J. Tilanus, P. de Vicente, M. Wielgus, J. A. Zensus, and G.-Y. Zhao: The Size, Shape, and Scattering of Sagittarius A* at 86 GHz: First VLBI with ALMA, arXiv:1901.06226v1 [astro-ph.HE] 18 Jan 2019

[10] C. S. Reynolds *Compton reflection and iron fluorescence in AGN and GBHCs* arXiv:astro-ph 9810018-iron-Reynolds.pdf

[11] C. S. Reynolds *The spin of supermassive black holes* 2013 Class. Quantum Grav. 30 244004 Online at stacks.iop.org/CQG/30/244004

[12] B. Aschenbach, N. Grosso, D. Porquet, and P. Predehl *X-ray flares reveal mass and angular momentum of the GalacticCenter black hole* https://arxiv.org/pdf/astro-ph/0401589.pdf

[13] Vyacheslav I. Dokuchaev and Natalia O. Nazarova *The brightest point in accretion disk and black hole spin: implication to the image of black hole M87** https://arxiv.org/pdf/1906.07171.pdf

[14] Vyacheslav I. Dokuchaev Spin and mass of the nearest supermassive black hole https://arxiv.org/pdf/1306.2033.pdf

[15] V.I. Dokuchaev, N.O. Nazarova Event horizon image within blackhole shadow,2018, https://arxiv.org/pdf/1804.08030.pdf

[16] Fabrizio Tamburini, Bo Thidé, Gabriel Molina-Terriza, Gabriele Anzolin *Twisting of light around rotating black holes* (Submitted on 15 Apr 2011) arXiv:1104.3099 [gr-qc]

[17] Fabrizio Tamburini, Bo Thidé, Massimo Della Valle *Measurement of the spin of the M87 black hole from its observed twisted light* (Submitted on 16 Apr 2019) arXiv:1904.07923 [astro-ph.HE]

[18] Denis Nikolaevich Sob'yanin (Денис Николаевич Собьянин) *Black hole spin from wobbling and rotation of the M87 jet and a sign of a magnetically arrested disc* Monthly Notices of the Royal Astronomical Society: Letters, Volume 479, Issue 1, September 2018, Pages L65–L69

[19] Rodrigo Nemmen *The Spin of M87** (Submitted on 6 May 2019 arXiv:1905.02143 [astro-ph.HE]

[20] Genzel, R. Schödel, T. Ott, A. Eckart, T. Alexander, F. Lacombe, D. Rouan & B. Aschenbach Near-infrared flares from accreting gas around the supermassive black hole at the Galactic Centre Nature volume 425, pages 934–937 (2003)

[21] E. .E. Nokhrina, L .I. Gurvits, V. S. Beskin, M. Nakamura, K. Asada, K. Hada *M87 black hole mass and spin estimate through the position of the jet boundary shape break* (Submitted on 11 Apr 2019) arXiv:1904.05665 [astro-ph.HE]

[22] Cosimo Bambi Testing black hole candidates with electromagnetic radiation https://arxiv.org/pdf/astro-ph/0401589.pdf

[23] Jiachen Jiang, Cosimo Bambi, and James F. Steiner Testing the Kerr Nature of Black Hole Candidates using Iron Line Spectra in the CPR Framework arxiv.1504.01970

[24] Cosimo Bambi, Katherine Freese, Sunny Vagnozzi, and Luca Visinelli Testing the rotational nature of the supermassive object M87* from the circularity and size of its first image arXiv.1904.12983

[25] *First steps in calculating supermassive objects (black holes) using TOV equation,* on the homepage of the author: http://www.grt-li.de

[26] *Supermassive objects (SMO's) calculated using the Tolman Oppenheimer Volkoff (TOV) equation and possible observation by gravitational waves (GW's) and by the event horizon telescope (EHT),* see homepage of the author: http://www.grt-li.de

[27] *Possible experimental proof of Lorentz interpretation (LI) of GRT - further arguments - Poster DPG 2019* see homepage of the author: http://www.grt-li.de

[28] *Possible experimental proof of Lorentz interpretation (LI) of GRT – M87*, see homepage of the author: http://www.grt-li.de

[29] *Measuring results of M87 and Lorentz interpretation (LI) of GRT,* see homepage of the author: http://www.grt-li.de

[30] Brandes, J.; Czerniawski, J. (2010): *Spezielle und Allgemeine Relativitätstheorie für Physiker und Philosophen - Einstein- und Lorentz-Interpretation, Paradoxien, Raum und Zeit, Experimente*, Karlsbad: VRI, 4. erweiterte Auflage

[31] JOSS BLAND-HAWTHORN, PHILIP R. MALONEY, RALPH SUTHERLAND & BRENT GROVES, MAGDA GUGLIELMO, WEN HAO LI & ANDREW CURZONS, GERALD CECIL, ANDREW J. FOX: THE LARGE-SCALE IONIZATION CONES IN THE GALAXY arXiv:1910.02225v1 [astro-ph.GA] 5 Oct 2019

[32] Why didn't the Event Horizon Telescope team mention Sagittarius A*?

[33] https://www.spacetelescope.org/news/heic1908/?lang

[34] „Wie ein Puzzleteil aus der Sternchemie Messungen der kosmischen Expansion beeinflussen könnte“ http://www.mpia.de/5067771/news_publication_14534752_transferred?c=2279

[35] „Kosmische Linsen liefern unabhängige Messung für die Ausdehnung des Universums“ https://www.mpa-garching.mpg.de/792204/news20200108

[36] K. C. Wong, S. H. Suyu, G. C.-F. Chen, et al., H0LiCOW XIII. A 2.4% measurement of H_0 from lensed quasars: 5.3σ tension between early and late-Universe probes accepted for publication by MNRAS

[37] „Rote Riesen vertiefen Rätsel um kosmische Expansion“ https://www.scinexx.de/news/kosmos/rote-riesen-vertiefen-raetsel-um-kosmische-expansion/

[38] Rachael L. Beaton, Mark Seibert, Dylan Hatt, Wendy L. Freedman, Taylor J. Hoyt, In Sung Jang, Myung Gyoon Lee, Barry F. Madore, Andrew J. Monson, Jillian R. Neeley, Jeffrey A. Rich, Victoria Scowcroft “The Carnegie-Chicago Hubble Program. VII. The Distance to M101 via the Optical Tip of the Red Giant Branch Method” https://arxiv.org/abs/1908.06120