Properties of a Torus-shaped Black Hole

Introduction and relevance

In a coordinated effort of several institutes, the "Event Horizon Telescope Collaboration" (EHTC), a beautiful picture emerges of a blurred ring around the black hole in M87. The authors commend the institute for its valuable work to "see" a black hole of massive proportions. The blurred ring has a diameter of about 41 micro arc-seconds (μas), ranging from about 25 to 60 μas. The EHTC explains the blurred ring as radiation from the accretion disk as it is curved by the black hole in ¾ of a full circle and observed as a ring of about 2.6 Schwarzschild radii, see figure 1.

The authors would like you to consider an alternative: could that blurred ring be the black hole which is directly observed with little curvature of the radio waves? That would mean a very massive torus rotating at a very high speed, see figure 2. A torus shaped black hole is not entirely black, it radiates radio waves as a consequence of its surface temperature and/or synchrotron radiation. Synchrotron radiation is caused by radially accelerating charged particles, as we observe in the Large Hadron Collider of CERN. Let us first look at what is wrong with the idea of a black hole as singularity with an "event horizon" at one Schwarzschild radius.

Black Hole in M87 according to EHTC

In figure 1, you see, according to the EHTC, the "event horizon" of the invisible black hole as the inner circle of one Schwarzschild radius (1.0Rs), which is equal to 19 billion [km]. The middle circle is the "photon sphere" (where light could orbit) of 1.5Rs or 29 billion [km]. The red to yellow blurred ring is not visible for the human eye, but represents the observed radio waves from 300 GHz (red) to 450 GHz (yellow).

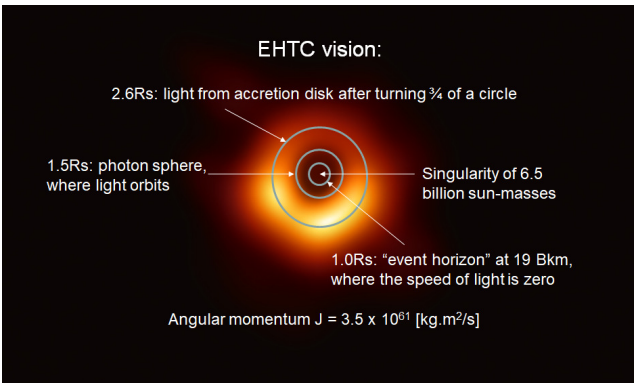

Figure 1: Top view M87 black hole as a sphere of 1.0 Rs = 7.8 μas = 19 Bkm

According to the EHTC this is blurred because of the low resolution of 25 micro-arc-seconds, but comes from the accretion disk radio waves which would be observable as a ring of 2.6Rs at a much higher resolution, the outer ring in figure 1. Note that the radio and other electro-magnetic waves must be curved between 253 to 297 degrees (since we look at 17 degrees from above) or about ¾ of a circle to be visible as a ring at 2.6Rs.

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A massive black hole as a "singularity" with an "event horizon"?

Everything is wrong with a black hole as a singularity with a spherical "event horizon". Firstly, the theory is wrong, Karl Schwarzschild *did not* predict an event horizon in 1916 as a consequence of any of his two exact solutions to Einstein's theory of General Relativity (GR), as EHTC writes in its introduction. Secondly, if this black hole would be a singularity with an "event horizon", it could not have (angular) momentum, there are no moving particles within a singularity.

Thirdly, there is no singularity in the GR-theory. The idea of a singularity comes from a badly copied Schwarzschild solution of Karl Schwarzschild that Eddington published years later. He confused Karl's auxiliary "R" with coordinate "r" of a polar coordinate system. Karl and only Karl has fully worked out the solution to a mass-point (singularity) of Einstein's GR. All others since then, start off with a formula that only looks like Karl's original, but replaced Karl's "R" by coordinate "r". Nobody since Karl has worked out the difficult tensor mathematics of a mass-point.

The Schwarzschild radius, the hot core, and its density

In summary, referring to Karl Schwarzschild as the origin of an "event horizon" is incorrect. Karl Schwarzschild also worked out a minimal radius of a sphere of incompressible liquid, his second solution. Neutron stars are close to such a model of a sphere, their density is very much the same everywhere. In other words, equal-density spheres have a minimal radius according to Karl, confirmed by Misner, Thorne, and Wheeler (MWT) in 1970. This minimal radius equals 9/8 times the Schwarzschild radius "Rs". This means no "event horizon" for equal-density spheres, spheres of neutrons only.

Some scientist believe that very massive spheres would collapse under its gravitational force, citing "neutron degeneracy pressure of *cold* dead matter at the core". Yes, neutrons can degenerate at the core of massive objects like neutron stars. However, there are no *cold* cores. Energy conservation requires cores to be hot. Cooled-off neutron stars have a core temperature of many trillions of degrees. Massive black holes as a sphere would have a temperature throughout the sphere which would cause near *total* neutron degeneracy.

Final nail in the coffin of a black hole as a sphere is its low density. When you work out the average density based on 6.5 billion sun-masses and a sphere of one Schwarzschild radius, you get a density of 0.44 kg/m^3. Our atmosphere on earth equals 1.2 kg/m^3. In other words, the average density of this black hole would be thinner than air! High rotation cannot prevent particles to stay in orbit either, all particles within the photon sphere would spiral towards the center. All particles would be concentrated in a tiny mass-point, the "singularity". However, what kind of particles would that be?

Going back into our universal history of superhot temperatures, cosmologists will tell you that there were no mass-particles at all, just radiation. A massive black hole as a sphere would be the most gigantic gamma ray burst ever seen in the universe. So the conclusion must be: A massive black hole cannot be a sphere, everything is wrong about that empty sphere with "singularity" and "event horizon", no mass-particles to hold together, no theory, no momentum.

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Massive Black Holes as Torus-shaped objects

Stellar black holes could still be near spherical, but *massive* black holes cannot. Suppose the blurred ring we see of the massive black hole in M87 *is* the black hole itself. Then we are talking about a torus-shaped black hole. Thanks to EHTC, we have its size! The radius is then about 50 billion [km]. Thanks to EHTC we have its mass too, about 6.5 billion sun-masses. Assuming the density of an atomic nucleus, the thickness radius of the torus then ends up as about 6.6 kilometer, small enough *not* to get too hot in its middle and explode in a gamma burst, see figure 2.

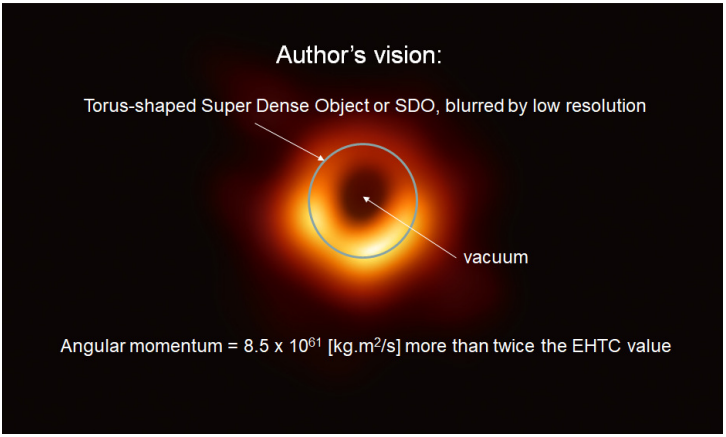

Figure 2: Top view M87 black hole as a torus instead of a sphere

The thickness radius is in the order of magnitude of neutron stars, small enough to be observable by radio waves. In other words, the ring we see is not coming from the accretion disk, but is the torus of the black hole itself!

Supporting evidence of a torus shape

Although the torus has a radius of 50 billion [km], the distance to the accretion disk is still an order of magnitude further away (up to 1800 billion km). The configuration of figure 2 does not invalidate the mass computations based on the size and speed of the accretion disk, which came to a mass between 3.3 and 6.6 billion sun-masses. The estimate of EHTC was on the high side of this range (6.5), May be, they were fitting the mass to the 2.6Rs assumption of the "event horizon" theory? The low thickness radius estimate comes down with a lower mass estimate (3.3) to as low as about 4.0 kilometer.

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The thickness radius of the torus is such that it is comparable to the radii of neutron stars. Neutron stars can emit radio waves. Therefore, it is likely that this black hole torus emits radio waves as detected by EHTC. The radio waves are then caused by the synchrotron radiation (radiation as caused by radially accelerating charged particles) and/or its surface temperature.

The most compelling evidence comes from the conservation of momentum. The compacter massive objects are, the faster these rotate. Both energy and momentum must be conserved. Some accretion disks reach half the speed of light.
The torus rotates as much as its energy-momentum dictates. Being able to take on any energy and momentum of in falling material is the charm of a torus. A singularity does not have that capacity, it does not even have any momentum. Unfortunately, there is no General Relativity solution to a torus, so how can we determine its rotational speed?

Torus rotational speed

How fast does this torus rotate? Using Newtonian mechanics we can state that the gravitational and centrifugal forces are in balance. The best we can do is assume that the torus behaves like an orbiting object. In that case, the total mass of the black hole gives us a first estimate of the rotational speed:

$v^2 = G.M / r$	$[m^2/s^2]$	speed squared of the torus
$v = 131{,}000{,}000$	[m/s]	rotational speed of the torus (first estimate)

This speed equals 44% of the speed of light, rotating in about 28 days! The speed of the torus might also be obtained from the difference in redshift between the two halves of the ring. We could also rely on the EHTC simulation, which provides the angular momentum. This would mean that the torus rotates with just 18% of the speed of light. However, those data are based on the Kerr solution with near maximum angular momentum (94% of its mathematical maximum). The authors cannot understand how a singularity can have angular momentum. In contrast, a torus does have angular momentum, which is not limited!

The jets

This black hole in M87 has two jets, where do these come from? Could the cause be electro-magnetic? Or could there also be an oblate spheroid in the middle of the torus rotating very fast? In that case, the very hot rotational axis of the oblate spheroid thermally ejects particles at relativistic speeds. We don't know, this is subject to further investigation.

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Our mission

We base ourselves on Noether's conservation laws of energy and momentum. We object to "dark energy" and singularities in physics based on Noether's work. We have slightly modified Einstein's Relativity where it is in conflict with Noether's laws. Emmy Noether signaled these failures to Einstein around 1920, but Einstein totally ignored her, although he praised her as a mathematical genius.
The result of Noether's theorems are slightly modified Schwarzschild and Robertson-Walker solutions, but with observable consequences: torus shaped black holes and eternal cosmic inflation, observed by NASA and ESA.

Our books and articles (www.loop-doctor.nl) describe the repair of Einstein's Relativity for Noether's theorem[1] in full detail.
We hope you get as many "aha" experiences as we did,

Rob Roodenburg (MSc. author),
Frans de Winter (MSc. coauthor),
Oscar van Duijn (MSc. coauthor),
Maarten Palthe (MSc. editor)

Schiedam, November, 2019

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