Dark Matter and Dark Energy explained by fix to vanishing of falling matter

Dmitri Martila

Institute of Theoretical Physics, Tartu University,

*4 Tähe Street, 51010 Tartu, Estonia**

(Dated: November 23, 2019)

Abstract

Considered motion in Kerr-Newman, Kerr, and Reissner-Nordström spacetimes. As an example, in Kerr spacetime, if you release from rest-state an electrically neutral test-particle (from any position outside the Black Hole, but not at equatorial plane $\theta = \pi/2$) it will end up in abrupt-end apart from the point of spacetime singularity. As solution to this problem the Dark Matter is used.

*Electronic address: `eestidima@gmail.com`

I. MOTIVATION OF THIS STUDY

The Kerr spacetime is partial case of Kerr-Newman spacetime. According to Stephen Hawking's "The Large Scale Structure of Space-Time" the Kerr spacetime is most common case in our Universe.

I follow my guiding star: "Guiding Star - Original Song" YouTube. Anyone can join me. I must be convinced (by me or others), that I have a mistake. This mistake must be found, and I must be convinced, that it is a mistake, and not an usual trolling and bullying, which comes from Truth Haters - the Nihilists. There are all good ones around me. I am not the God, but "must be a reason why I am king of my castle" YouTube.

I refer to the spirit of Presumption of Innocence: I am not having mistakes, until the moment the mistakes are found. But I often find people who disagree without any reasoning with my theories. A genius idea, which is 1000 years ahead of its time is not acceptable today. Even 4 years Einstein was rejected by all Science (the paper was published, but during 4 years it remained not understood despite of its logic).

II. NEUTRAL TEST-PARTICLE IN KERR-NEWMAN SPACETIME

From the [1] are presented the velocity components in the Kerr-Newman spacetime

$$u^r \equiv dr/d\tau = -\sqrt{B}/(r^2 + a^2 \cos^2\theta)\,, \tag{1}$$

$$u^\theta \equiv d\theta/d\tau = \sqrt{L - \cos^2\theta\,(a^2\,(\mu^2 - E^2) + L_z^2/\sin^2\theta)}/(r^2 + a^2 \cos^2\theta)\,, \tag{2}$$

$$u^\phi \equiv d\phi/d\tau = (-(a\,E - L_z/\sin^2\theta) + a\,P/\Delta)/(r^2 + a^2 \cos^2\theta)\,, \tag{3}$$

$$u^t \equiv dt/d\tau = (-a\,(a\,E \sin^2\theta - L_z) + (r^2 + a^2)\,P/\Delta)/(r^2 + a^2 \cos^2\theta)\,, \tag{4}$$

where $B := P^2 - \Delta\,(\mu^2\,r^2 + (L_z - a\,E)^2 + L)$, $P := E\,(r^2 + a^2) - L_z\,a - q\,Q\,r$, $\Delta := r^2 - 2\,M\,r + a^2 + Q^2$.

Here $\mu = 0$ for null-geodetics, and $\mu = 1$ for time-like ones, neutral test-particle has zero charge $q = 0$. The L_z, L, E - constants of geodetic motion; M, Q, a - three parameters of Black Hole. τ - geodesic parameter, e.g., the proper time of falling particle. t, r, θ, ϕ - coordinates of spacetime. The curvature physical singularity is placed at $r = 0$. Latter point requires the Quantum Gravity, unlike the $r \neq 0$ spacetime points, where General Relativity is applicable. However, there is no convincing inclusion of Dark Matter and Dark

Energy into General Relativity: [2]. I am adding to this the fallowing never seen effect: nonSingular-abrupt-end-geodetics. My own solution to the problem is in section VII.

III. THE FIRST SIGHT OF ABRUPT-END-GEODETICS

The velocity component of a test-particle is given by Eq.(1)

$$u^r \equiv \frac{d\,r}{d\tau} = -\frac{1}{r^2}\,\sqrt{B}\,, \tag{5}$$

where $B = E^2\,r^4 - (r^2 - 2\,M\,r + Q^2)\,r^2$.

In "geometrized" units (Q, M, r in meters) let us choose $Q = 1/5$ and $M = 1/2$. Zero initial velocity ($B = 0$ at $r = r_0 = 20$) requires a trajectory with

$$E = \frac{\sqrt{9501}}{100}\,. \tag{6}$$

Therefore

$$B = -\frac{499}{10000}\,r^4 + r^3 - \frac{1}{25}\,r^2\,, \tag{7}$$

which is negative in $r < r_m = 20/499$. Thus, at r_m the $u^r = 0$.

This can mean a termination of the falling body. My study in Section III.A. below shows that photons are being terminated as well; the terminations are present also in a Kerr spacetime (see Section III) as well as in naked singularity regimes: Section IV. Such termination was never found yet; e.g., it is not reported in Refs. [1, 3].

The value of E in Eq.(6) is slightly different for either slightly different parameter of spacetime (Q or M) or for slightly different initial velocity of the test-particle. Thus, my effect holds not for very specific parameters, but has a wide range of physically allowed parameters.

IV. THE ABRUPT-END IN NEUTRAL ($Q = 0$) KERR SPACETIME

The radial coordinate velocity of a test-body (falling from a large distance $r_0 = 20$ with zero initial velocity and the $\theta_0 = \pi/4$) in Kerr Black Hole with mass $M = 1/2$ and rotation $a = 1/4$ is Eq.(1)

$$u^r \equiv \frac{dr}{d\tau} = -\frac{\sqrt{B}}{r^2 + (1/16)\cos^2\theta}\,. \tag{8}$$

$$B = -\frac{640}{12801}\,r^4 + r^3 - \frac{742460}{155672961}\,r^2 + \frac{12481}{194576}\,r - \frac{62405}{622691844}\,. \tag{9}$$

Therefore, must be $B \geq 0$, but in $r < r_m = 1/640$ the $B < 0$, so there is no falling body in $0 \leq r < r_m$.

In a more realistic scenario in addition to the $a \neq 0$ also holds the $Q \neq 0$, so, the singular state will be reached way before the curvature singularity. The remainings of this crushed body will never reach the $r = 0$, because the trajectory is impossible in $r < r_m$. Note, what the Black Hole tidal forces do not stretch the body apart, but do compress it together into a perfect point-size: see Section VI.

A. Kinetics at the point of abrupt-end

What are the derivatives of the trajectory (the worldline), what are the values of space coordinates, is the time for reaching the abrupt-end finite? Such curious bold questions are subjects in this section of the paper.

Take the look at the start of the paper, the calculation with the rotating Black Hole of Kerr. At $r = r_m = 1/640$, $\theta = \theta_m = 3\,\pi/4$ the 4-velocity space components $u^r = u^\theta = u^\phi = 0$. At this abrupt-end the body is not moving. The time component is positive, finite and non-zero $u^t = (1/12161)\,\sqrt{155672961}$, so the body is the future directed. The proper time for reaching the abrupt-end is finite:

$$\Delta\tau = -\int \frac{dr}{u^r} < -2\int \frac{dr}{u^r} < -2\int_{1/640+0.02}^{1/640} 1/\sqrt{B}\,dr\,. \tag{10}$$

Latter inequalities hold because inside the Black Hole the $r < 1$ and because

$$B > \left(\frac{319475839}{4981145600} - 2\,\frac{8228483}{99630695040}\,(r - 1/640)\right)(r - 1/640) \tag{11}$$

at least when $1/640 < r < 1/640 + 0.02$. So, there holds

$$B > \left(\frac{319475839}{4981145600} - 2\,\frac{8228483}{99630695040}\,(1/640 + 0.02 - 1/640)\right)(r - 1/640) > 0.05\,(r - 1/640)\,.$$

. Thus,

$$\Delta\tau < -(2/\sqrt{0.05})\int_{1/640+0.02}^{1/640} 1/\sqrt{r - 1/640}\,dr \approx 2.5298\,. \tag{12}$$

Thus, however the instant velocity is zero in $r = r_m$, the displacement velocity from $r = r_m + 0.02$ into the abrupt-end at r_m is less than $2.5298/c \approx 84.32666667$ micro-seconds. By simple division $(0.02\,meters/(84.33\,mks) \approx 2.4$ millions meters in one second.

The position $\phi = \phi_m$ is the position of the abrupt-end. Hereby must be $|\phi_m| < \infty$, because allways holds $|d\phi/d\tau| < N =$ fixed, so

$$\phi_m = \int_0^{\tau_m} \frac{d\phi}{d\tau}\, d\tau < N\, \tau_m < \infty, \tag{13}$$

where τ_m is the proper time at the abrupt-end.

V. RANGE OF r_m

Analysis of the function $r_m = r_m(r_0, \theta_0, a, M)$ as the radial position of abrupt end. The central singularity is in $r = 0 < r_m$.

The r_m is the higher the closer the θ_0 to the axis of rotation. Also the r_m is the higher the higher is the a. The a is critical, when $a = M$. But if would be the naked singularity: $a > M$, then the abrupt-end will be in the $r_m \gg 0$.

Let us study the most dramatic case for r_m. It is taking the limits $\theta_0 \to 0+$ in the formulas for L_z, L, E, latter we have as solutions of the equations $u^r = u^\theta = u^\phi = 0$ at starting point (θ_0, ϕ_0, r_0). Turned out

$$L_z = 0\,, \quad L = a^2\, \frac{2\, M\, r_0 - Q^2}{r_0^2 + a^2}\,, \quad E = \frac{\sqrt{-2\, r_0^3\, M + r_0^4 + 2\, r_0^2\, a^2 + r_0^2\, Q^2 - 2\, M\, r_0\, a^2 + a^4 + a^2\, Q^2}}{r_0^2 + a^2}\,. \tag{14}$$

Now, let us work with $Q = 0$. Then, our $B = 0$, if holds

$$a^4\, r_m - a^4\, r_0 + a^2\, r_m^3 + a^2\, r_m\, r_0^2 - 2\, a^2\, r_0\, r_m^2 + r_m^3\, r_0^2 - r_0\, r_m^4 = 0\,. \tag{15}$$

As you see, the r_m is independent from the M.

Because the outer event horizon is placed at $r_s = M\,(1 + \sqrt{1 - \delta^2})$, where $a = \delta\, M$, then holding $r_s = 1$, we can adjust the M for any $0 \le \delta \le 1$ following way

$$M = \frac{1}{1 + \sqrt{1 - \delta^2}}\,. \tag{16}$$

Why? This way we can produce the convincing figures: Fig. 1.

Reissner-Nordström

The collapse of dust cloud, where each dust-particle has own electric charge. We expect, what the R.-N. spacetime will be produced. So the R.-N. solution is physical. The r_m is

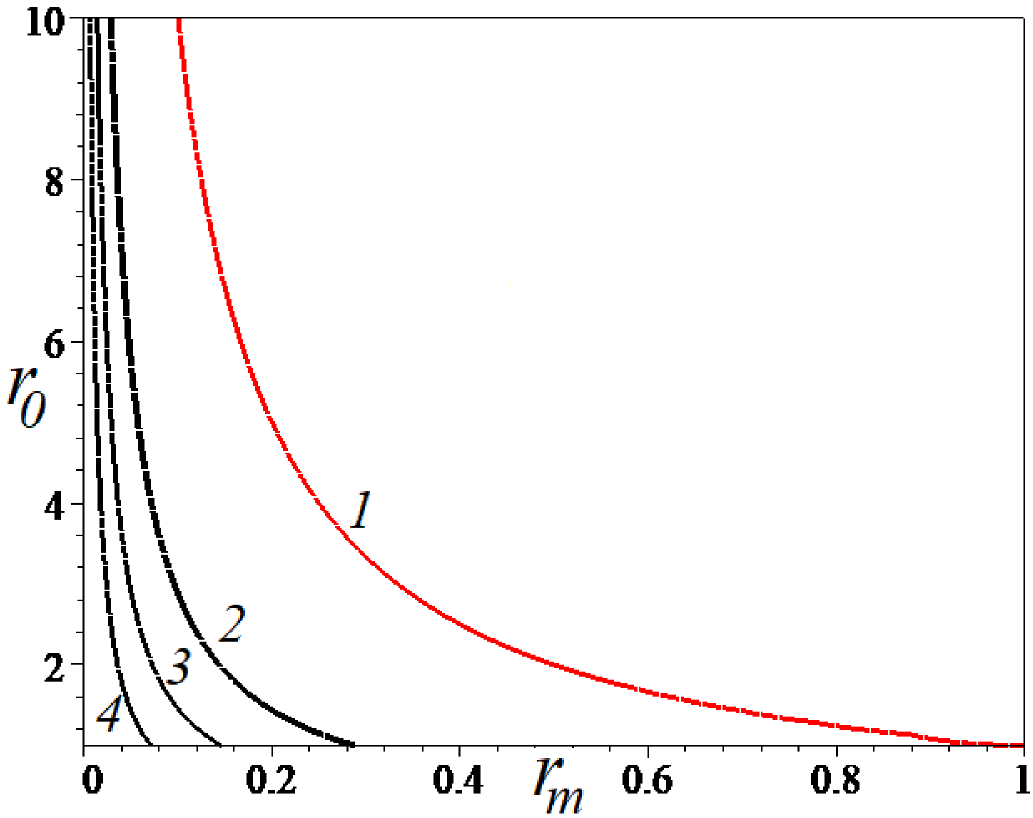

FIG. 1: The plot of r_m, curves (1): $\delta = 6/6$, (2): $\delta = 5/6$, (3): $\delta = 4/6$, (4): $\delta = 3/6$. The radius of BH is adjusted (through variation of M) to be the same for all curves: one meter.

practically independent from r_0. This is independence from the parameter of the test-object. Thus, the abrupt-end in the R.-N. case can have the status of the BH intrinsic parameter. The r_m is the higher, the higher is the total charge Q. We can read $Q^2/(2M) < r_m < M - \sqrt{M^2 - Q^2}$, however the r_m the faster tends to the $Q^2/(2M)$ the smaller the Q/M is. If r_0 is at the outer event horizon $r_0 \to M + \sqrt{M^2 - Q^2}$ then the r_m is at the inner event horizon: $r_m \to M - \sqrt{M^2 - Q^2}$. There is allways $Q^2/(2M) < M - \sqrt{M^2 - Q^2}$.

A. The case of null-geodesics (worldline of photons)

The effect is possible only for Kerr-Newman Black Hole, hereby (from Eq.(1) with $\mu = 0$)

$$r_m^4 + r_m^2\, a^2 + 2\, a^2\, M\, r_m - a^2\, Q^2 = 0\,.$$

For simplicity the $L_z = 0$, $L = 0$, $\theta_0 = 0$ was chosen.

VI. SMALL DROP OF PERFECT FLUID

Such drop has nearly the same velocity vector throughout the drop. The density ρ obbeys

$$d\rho/d\tau = -(\rho + p(\rho))\, u^{\mu}_{;\mu} \tag{17}$$

from [1], pages 226–227, where $p = p(\rho)$ is pressure. Here the covariant 4-divergence $u^{\mu}_{;\mu}$ uses the Christoffel symbols. Despite of our intuition the Black Hole can compress the drop to zero size: $u^{\mu}_{;\mu} \sim 1/u^r \to -\infty$ at the abrupt-end.

The r_m is $p(\rho)$ independent. But to make the point on disappearance dependent on the resistance of falling matter, the following idea can be useful: if the spatial density of energy-mass is $\rho < \rho_c$ then usual physics is applicable, but when $\rho \geq \rho_c$ the matter vanishes.

VII. HOW TO INCLUDE DARK MATTER IN GENERAL RELATIVITY?

The known

$$G^{\mu\nu} + \Lambda\, g^{\mu\nu} = 8\pi\, T^{\mu\nu}$$

runs into a problem, because of abrupt-end motion and the vanishing. So, the following mathematical extension of it is possible

$$G^{\mu\nu} + \Lambda\, g^{\mu\nu} = 8\pi(T^{\mu\nu} + K^{\mu\nu})\,,$$

where $K^{\mu\nu}$ can not be detected in our particle detectors, because it is just mathematical fix to General Relativity, not a new kind of (actual) matter. I call it virtual matter. In case if covariant divergence $K^{\mu\nu}_{;\mu} = 0$, I call it Dark Matter. In my opinion, the Dark Energy above $\Lambda\, g^{\mu\nu}$ is also a kind of mathematical fix, not a matter.

One should include such a concept as Virtual Terms – mathematical insertions into the equations and laws of nature, which are made not from fundamental premises, but “by hand” in order to fit the theory under observation. An example of such inserts is Dark Matter and Dark Energy, therefore, they cannot be directly detected, but to measure their effect on nature is possible. As a prime example, the Dark Matter anomaly has acted on the space-time grid so much that it created an additional force of attraction of stars to the center of their galaxy. By the way, the proton radius measured by many experimenters was different in different years. This riddle did not find yet a solution: Jean-Philippe Karr, Dominique Marchand, "Progress on the proton-radius puzzle", Nature 2019. I solve this with a virtual insert VT into the radius value: $r = R + VT$.

The demand to hold the "energy conditions" is not applicable to the Virtual Matter, because it is not subject to measure. So, one would not measure the negative energy.

---

[1] Lightman AP, Press WH, Price RH, Teukolsky SA. Problem Book in Relativity and Gravitation. Princeton, Princeton University Press, 1975.

[2] W. M. Keck Observatory: "A crisis in cosmology: New data suggests the universe expanding more rapidly than believed.", phys.org; H. Chen, M. Fishbach, D.E. Holz, "A two per cent Hubble constant measurement from standard sirens within five years", Nature 562, 545–547 (2018).

[3] Eva Hackmann, Hongxiao Xu, "Charged particle motion in Kerr-Newmann space-times", Phys. Rev. D **87**, 124030 (2013); Tim Adamo, E.T. Newman, "The Kerr-Newman metric: A Review", Scholarpedia **9**, 31791 (2014), arXiv:1410.6626; H. Cebeci, N. Özdemir, S. Sentorun, "Motion of the charged test particles in Kerr-Newman-Taub-NUT spacetime and analytical solutions", Phys. Rev. D **93**, 104031 (2016).