The Real Fairytale

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Abstract

©There can not be a single contradiction in reality, because we have one God. Two or more gods (with contradictive opinions about matters) are imperfect, because are limited by each other, thus they are not gods. So, the solution might be: "the Book of Life is the real fairytale, with the God and us as the authors. Nobody expects from a fairytale the total absence of contradictions. The contradictions is in the definition of a fairytale." The song "you must believe in fairytale" youtu.be/io3vYgTHO2U

The compression of the falling bodies in the strongly curved spacetime manifolds

I am working strictly within the General Relativity. Considered the rotational black hole and falling of a test-body. The singular state inside the body will be reached way before the curvature singularity. Moreover, the remains of this crushed body will never reach the famous singularity in $r = 0$, because the trajectory is impossible in $r < r_m$. Despite the establishment, it is clear, what the Black Hole (BH) tidal forces do not stretch the body apart, but do compress it together into a perfect point-size: the collapsing star means the collapsing state of the body. This compression holds even outside the BH, starting from $r \approx 3\,r_0/4$, whereby at the $r = r_0$ the body was released with zero initial velocity. Is interesting, what the same effects has the simple case: the Reissner-Nordström BH, provided, what there is no the accretion disk: so latter can not eliminate the electric charge of the BH.

Epigraph

Your own,
Personal,
Squeezing.
Something,
what really feels,
Something, what kills.
(cf., "Your own, personal, Jesus", the song)

I. INTRODUCTION

Dear friends, the motion of prolong bodies in a curved spacetime is very interesting theme, because the point-like particles are way too simple idealization. However, the large bodies do loose the interest of a reader, because of tremendous number of details. Remains the golden area of study: the small object, but not a microscopic – a drop of liquid. There are waters in heaven, look: [1]. I am sure, what the complicated algorithms, often with extensive use of the Deviation Equation (in its higher approximation terms) are written, e.g.: [2]. But in the present manuscript we expect to present the easily accessible way to study any spacetime of interest.

The BHs are observationally verified (e.g., the recent detection of gravity wave's BH patterns, and the media NEWS: "2007 MASTER Team discovered the Black Hole Ergosphere, surrounding event horizon" [3]).

The M, a, Q, r are being measured in meters: they are "geometrised".

The main result of the paper is the solution to the following problems of Black Hole (read the article "Black Hole" in Wikipedia):

1. Information loss paradox, with proposed solutions: "In quantum mechanics, loss of information corresponds to the violation of vital property called unitarity, which has to do with the conservation of probability. It has been argued that loss of unitarity would also imply violation of conservation of energy."

2. The firewall paradox, with proposed solution: "In order to resolve the paradox, physicists may eventually be forced to give up one of three time-tested theories: Einstein's equivalence principle, unitarity, or existing quantum field theory. One possible solution, which violates the equivalence principle, is that a "firewall" destroys incoming particles at the event horizon."

The solution is: exceptions to the Energy Conservation Law: "density regularization" below. So, it is the exceptions to "unitary" principle.

II. THE TERMINATION OF THE TRAJECTORY AT $r = r_m$

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 BH with mass $M = 1/2$ and rotation $a = 1/4$ is (see Appendix A)

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

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

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 BH tidal forces do not stretch the body apart, but do compress it together into a perfect point-size. This compression holds even outside the BH, starting from $r \approx 3r_0/4$.

In case of Reissner-Nordström BH, let us take the $a = q = 0$, $Q = 1/5$, $\theta_0 = \pi/2$, $r_0 = 20$ in the Appendix A. Then the zero initial velocity require the trajectory with $E = \sqrt{9501}/100$, $L = 0$, $L_z = 0$ and, thus, our $B = -(499/10000)\, r^4 + r^3 - (1/25)\, r^2$, which is negative in $r < r_m = 20/499$.

III. ANALYSIS OF THE FUNCTION $r_m = r_m(r_0, \theta_0, a, M)$

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 personal singularity 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

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

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

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

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

$$M = \frac{1}{1 + \sqrt{1-\delta^2}}\,. \tag{5}$$

Why? This way the 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

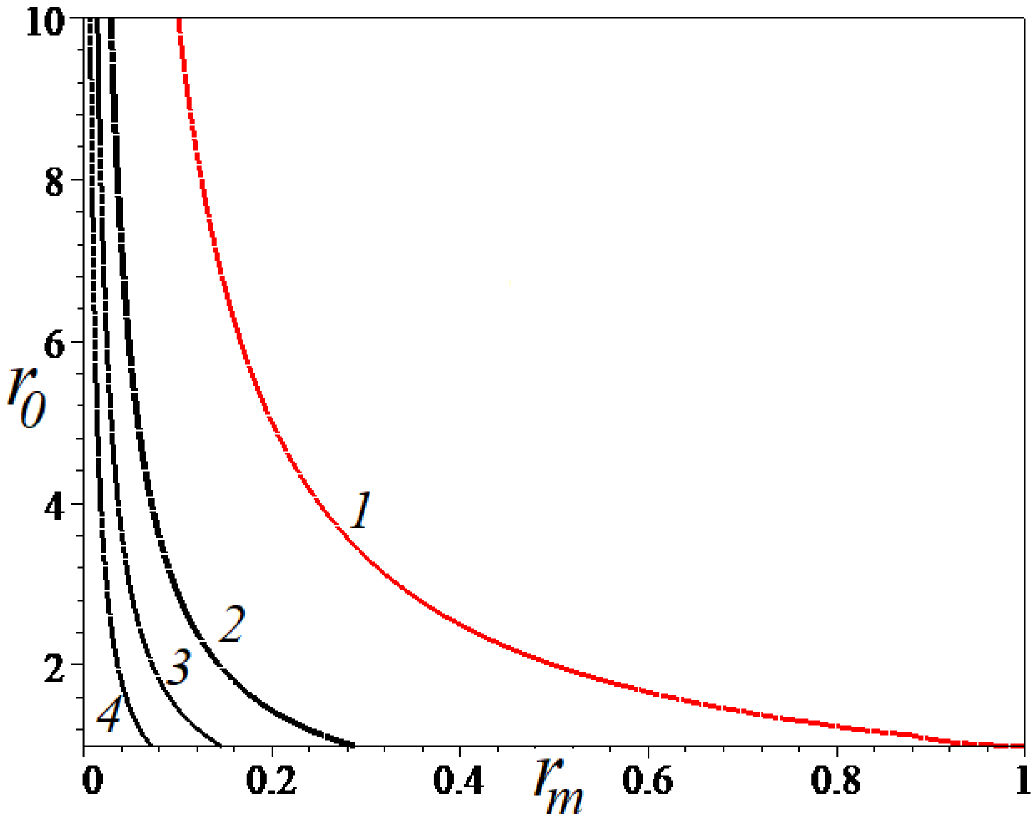

FIG. 1: The plot of r_m, curves (1): $\delta = 6/6$, (2): $\delta = 5/6$, (3): $\delta = 4/6$, (4): $\delta = 3/6$. The radius of BH is adjusted (through variation of M) to be the same for all curves: one meter.

is practically independent from r_0. This is independence from the parameter of the test-object. Thus, the personal singularity 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 $Q^2/(2M) < M - \sqrt{M^2 - Q^2}$.

IV. THE POINT OF NOTHINGNESS

What are the derivatives of the trajectory, what are the values of space coordinates, is the time for reaching the Nothingness 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 BH 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 singularity 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 personal singularity is finite:

$$\Delta\tau = -\int \frac{dr}{u^r} < -2\int \frac{dr}{u^r} < -2\int_{1/640+0.02}^{1/640} 1/\sqrt{B}\,dr\,. \tag{6}$$

Latter inequalities hold because inside the BH the $r < 1$ and because

$$B > \left(\frac{319475839}{4981145600} - 2\,\frac{8228483}{99630695040}\,(r - 1/640)\right)(r - 1/640) \tag{7}$$

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,

$$\Delta\tau < -(2/\sqrt{0.05})\int_{1/640+0.02}^{1/640} 1/\sqrt{r - 1/640}\,dr \approx 2.5298\,. \tag{8}$$

Thus, however the instant velocity is zero in $r = r_m$, the displacement velocity from $r = r_m + 0.02$ into the personal singularity at r_m is less than $2.5298/c \approx 84.32666667$ microseconds. By simple division $(0.02\,meters/(84.33\,mks) \approx 2.4$ millions meters in one second. The more trustful speed calculation shall be made in the stationary ON tetrad at the personal singularity.

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

$$\phi_m = \int_0^{\tau_m} \frac{d\phi}{d\tau}\,d\tau < N\,\tau_m < \infty, \tag{9}$$

where τ_m is the proper time at the personal singularity.

V. THE COMPRESSION TO ZERO AS PROVEN EXPLANATION OF TERMINATION OF THE TRAJECTORY

A. Models of fall

1. Small drop of liquid

It can have all attributes of the real liquid. The velocity of the drop at given space point is the velocity of free-fall, because the drop is small.

2. Let it snow!

Consider near mass-less snowflakes, each one of them starts the fall from $r = r_0$ from the spherical cloud all around the BH. Let it snow so long, what the snowflakes have almost reached the surface of the BH. Then the velocity at any spacetime point is the velocity of the free-fall from the $r = r_0$.

Conclusion

In all these cases our formula $d\rho/d\tau = -(\rho + p)\, u^{\nu}_{;\nu} > 0$ applies and, so the BH does not strach the falling bodies into all directions, but compresses them.

B. Density rate

Is known, what the rate of compression of a perfect fluid behaves as

$$d\rho/d\tau = -(\rho + p(\rho))\, u^{\mu}_{;\mu} \tag{10}$$

from [4], pages 226–227, see Appendix E. Here the $u^{\mu}_{;\mu}$ is the tensor of the zero rank – the scalar, because the derivative in the 4-divergents is the covariant (one, which uses the Christoffel symbols). Case of the viscous fluid is in Appendix B.

If you insert the velocity in appendix A into the divergence, you get to know, that $u^{\mu}_{;\mu} \sim 1/u^r \to -\infty$, as example, in case of $a = Q = q = 0$ the

$$D := u^{\mu}_{;\mu} = M\, \frac{4\, r - 3\, r_0}{\sqrt{2\, M\, r_0\, r^3\, (r_0 - r)}} \tag{11}$$

With the zero at $r = 3r_0/4$ as the start of the compression. The plot shows, what at initial moment (i.e. $r = r_0$) the $D > 0$ and infinite (behaves like $1/\sqrt{r_0 - r}$), the density of the drop drops, but the integration is finite, so the physically is O.K. Then at $r = 3\, r_0/4$ the $D < 0$ and the drop begins to shrink. Notably, this happens at infinite distance from the BH, if the r_0 in infinite. This doesn't fit into the common-day intuition, where the gravity deviation forces are trying to rip apart the astronaut body. Such the unexpected result is hardly can be found in Newton's age (however we do try it in Appendix D), even while we still have weak field at $r = (3/4)r_0 \gg 2M$. The deadly ripping $D \gg 0$ never begins, however at $r = 0$ the $D < 0$ is infinite. Hereby the D behaves like $-1/r^{3/2}$, which integral is diverging at the curvature singularity $r = 0$.

VI. ALTERNATIVE DERIVATION OF THE COMPRESSION: DEVIATION

Information about the Christoffel symbols

The

$$\frac{d\,v^\alpha}{d\tau} = \frac{v^\alpha(\tau_2) - v^\alpha(\tau_1)}{\tau_2 - \tau_1} \tag{12}$$

is meant the pure mathematical procedure. But the result of that is not the invariant, because the transformation matrix is applied only at one point. The invariant is the covariant derivative:

$$\frac{D\,v^\alpha}{d\tau} = \frac{d\,v^\alpha}{d\tau} + \Gamma^\alpha_{\mu\nu} v^\mu\, u^\nu\,. \tag{13}$$

How one would calculate the $D\,u^\alpha/d\eta$?

$$\frac{D\,u^\alpha}{d\eta} = \frac{d\,u^\alpha}{d\eta} + \Gamma^\alpha_{\mu\nu} u^\mu\, v^\nu \tag{14}$$

P.S. The x^α is not a vector, but the vector is the dx^α.

A. Alternative to the known Deviation Equation

The derivation of Deviation Equation [4], pages 58, 291 shall be made more clear, because the starting from the bundle of trajectories $x^\alpha = x^\alpha(\lambda, \eta)$ and definition of a tangent to the geodesic line $u^\alpha = \partial x^\alpha/\partial\lambda$ one can not come to the wrong assertion $\mathrm{grad}\, u^\alpha \equiv \partial_u\, u^\alpha \neq 0$. Here

$$\mathrm{grad}\, u^\alpha := \frac{\partial u^\alpha}{\partial x^\nu} = \frac{\partial}{\partial x^\nu}\Big(\frac{\partial x^\alpha}{\partial\lambda}\Big) = \frac{\partial}{\partial\lambda}\Big(\frac{\partial x^\alpha}{\partial x^\nu}\Big) = \frac{\partial}{\partial\lambda}\,\delta^\alpha_\nu\,. \tag{15}$$

One shall rewrite the derivation using the alternative denotations $u^\alpha(\lambda,\eta) = U^\alpha(\{x^\nu(\lambda,\eta)\})$ with

$$U^\alpha_{,\nu} \equiv \frac{\partial U^\alpha(x^0, x^1, x^2, x^3)}{\partial x^\nu} \neq 0. \tag{16}$$

But with such simple-looking moderation of the proof, the proof might become inconceivable. But this was done and result coincides with the accepted Science; moreover, my computer-test on example of Schwarzschild black hole has proven the validity of the Deviation Equation (hereby the test on Eq.(65) has used the formula (18) (and latter derivatives) below). But now let us take the more easy way.

Because mathematically speaking

$$\frac{\partial^2 x^\alpha}{\partial\eta\,\partial\lambda} = \frac{\partial^2 x^\alpha}{\partial\lambda\,\partial\eta}\,, \tag{17}$$

then obviously holds [5]

$$\frac{\Delta\eta\,\partial v^\alpha}{\partial\lambda} = \Delta\eta\,\frac{\partial u^\alpha}{\partial\eta}\,, \tag{18}$$

where $v^\alpha = \partial x^\alpha/\partial\eta$ and $\Delta\eta = \text{const}$. With $v^\alpha = v^{\hat{u}}\,e_{\hat{u}}{}^\alpha$, where $v^{\hat{u}}$ is the projection of the vector v^α on the free-falling ON reference frame with $e^{\hat{q}}_\alpha e^{\hat{u}\,\alpha} = \eta^{\hat{q}\,\hat{u}} = \text{diag}(-1,1,1,1)$ it turns into

$$\frac{d\,S^{\hat{u}}}{d\lambda}\,e_{\hat{u}}{}^\alpha = \Delta\eta\,\frac{\partial u^\alpha}{\partial\eta} - S^{\hat{u}}\,\frac{\partial e_{\hat{u}}{}^\alpha}{\partial\lambda}\,. \tag{19}$$

with $S^{\hat{u}} := \Delta\eta\,v^{\hat{u}}$. Multipliyng Eq.(19) with $e^{\hat{z}}{}_\alpha$, we get

$$\frac{d\,S^{\hat{z}}}{d\lambda} = \Delta\eta\,e^{\hat{z}}{}_\alpha\,\frac{\partial u^\alpha}{\partial\eta} - S^{\hat{u}}\,e^{\hat{z}}{}_\alpha\,\frac{\partial e_{\hat{u}}{}^\alpha}{\partial\lambda}\,. \tag{20}$$

Now, because we have realized the necessity of the Eqs.(15), (16), holds

$$\frac{\partial u^\alpha}{\partial\eta} \equiv U^\alpha_{,\nu}\,\frac{\partial x^\nu}{\partial\eta}\,, \tag{21}$$

where

$$\frac{\partial x^\nu}{\partial\eta} = v^\nu = S^{\hat{u}}\,e^\nu_{\hat{u}}/\Delta\eta \tag{22}$$

and the $\partial U^\alpha/\partial\eta$ is written as zero, because at given spacetime position, there is no freedom of the choice of the geodetic line.

Results for Schwarzschild BH

The most special places in such world are the event horizon and the central singularity. The area of event horizon is a wonderful place, because the General Relativity and the Special Relativity are put there to their limits: a falling particle approaches the light-speed and the curvature of the space seems to be unlimitly high, because even photons can not escape the BH trap, [4].

The velocity one finds using integral of motion $u_t = -E$, and the norm $u^\nu\,u_\nu = -1$, the non-zero components are

$$u_t = -E, \qquad u_r = -\frac{\sqrt{E^2 - 1 + 2M/r}}{1 - 2M/r}, \qquad E = \sqrt{1 - 2M/r_0}\,. \tag{23}$$

In our case let $\eta = r_0$, what makes the trajectories different, and the $\lambda = \tau$, the proper time along each curve. The $M = 1/2$. Insert the $d\,S^{\hat{0}}/d\tau = S^{\hat{0}} = 0$, into the Eqs.(19). They can always be satisfied. Hereby at the $r = 3r_0/4$ the density rate can be zero:

$$\frac{d\rho}{d\tau} = \frac{d}{d\tau}\Big(\frac{K}{S^{\hat{1}}(\tau)\,r^2(\tau)}\Big)\,. \tag{24}$$

Here the $K = \text{const}$. That means, what the body starts to shrink while approaching the BH.

Please note, what the azimuthal size of the dust cloud does shrink as $1/r$ while approaching the curvature singularity. This azimuthal contraction increases the density of the dust cloud as $1/r^2$, because the geometry shows $\rho \sim 1/(S^{\hat{1}}\,r^2)$. Because this solution has $S^{\hat{0}} = 0$, then the $S^{\hat{1}}$ can be recognized as the distance between the dust-particles (as well as the Strong Equivalence principle suggests, what the same time shall be in the locality of the observer, namely $S^{\hat{0}} = 0$).

Please note, what unlike the Deviation Equation, our Eq.(18) includes the property of the bundle of geodesics: the η. The calculation with Deviation equation is much more complicated, because includes the second order derivatives: Appendix C.

From the Eq.(19) and Eq.(24) with $M = 1/2$ has appeared

$$\frac{d\rho}{d\tau} = \rho\,\frac{3\,r_0 - 4\,r}{2\,\sqrt{r_0\,r^3\,(r_0 - r)}} \tag{25}$$

which is exactly the Eq.(10), which was derived from the first method.

Reissner-Nordström

The Reissner-Nordström black hole with the above parameters was taken, both methods (through the four-divergents in Eq.(10) and through the alternative deviatsioon) gave exactly the same answer. Whereby the radial size $S^{\hat{1}}$ becomes zero at the personal singularity in the $r = r_m = 20/499$.

VII. WAYS TO STUDY THE PROBLEM FURTHER

“Best before” of the space

The spacetime is the material, because is measured by the standart instruments. So, as any material, it has the “best before” margins: the n_1 into the future, and the $-n_2$ into the past. The stationary observer measures the maximum available age of the given space, so the Universe is within

$$-n_2 < t\sqrt{1-2m/r} < n_1 \,. \tag{26}$$

Let us input these curves into the Penrose diagramm in the Kruskal Coordinates of Schwarzschild BH. We expect, what the falling body (including the matter of the collapsing star) can reach the personal singularity within the range of the Universe. And indeed, that is the fact: Fig. 2.

A. Falling of the thick layer of matter

Let $T^{\nu\mu} = (\rho + p)\, u^\nu\, u^\mu + p\, g^{\nu\mu}$, then $T^{\nu\mu}_{;\mu} = 0$. This is the first-order diff. equations for finding the $\rho(t, r)$ and the $u^r(t, r)$, starting from $u^r(t = 0) = 0$, $\rho(t = 0) = \rho_0 \exp(-(r - r_0)^2/\epsilon^2)$, where ϵ is fixed, but should be small. Let the $p \approx A\,\rho$, the A is fixed. Use the numerical method and the Kruskal coordinates. Look the final result in Fig.3.

Joonisel on näidatud vaid mõni milli-mikro-sekund peale kukkumise alguse. Kukkumine kuni $r = r_m$ on raske näidata (mul pole super-arvuti). Alguseks on kõver 1 kahel scenariumil, mis on $v = v_0 = 0$ ja $v = v_0 = \sqrt{2M/r}$.

Curve 2 is the density of the same body, but in the future. As you see, it has grown, because at initial moment (curve 1) the body has such velocity profile ($v = \sqrt{2M/r}$) as it would have been released from inifity with zero velocity. But curve 3 (the future of curve 1) has lower density, than curve 1, because curve 1 has then the zero velocity destribution: $v = 0$.

Kuna ma näitasin üleval, et vahemikus $r_m < r < 3\,r_0/4$ on tiheduse kasv, siis kui lasta $r_0 \to \infty$ (see on tehtud omistades $v = \sqrt{2M/r}$ kõverale 1), siis kasv on kogu ruumis, ka koha $r = 20$ juures, kus on tehtud Joonise 3 kõverad 1 ja 2.

Kuna vahemikus $3\,r_0/4 < r < r_0$ on tiheduse langus, siis langus on ka koha $r = 20$ juures,

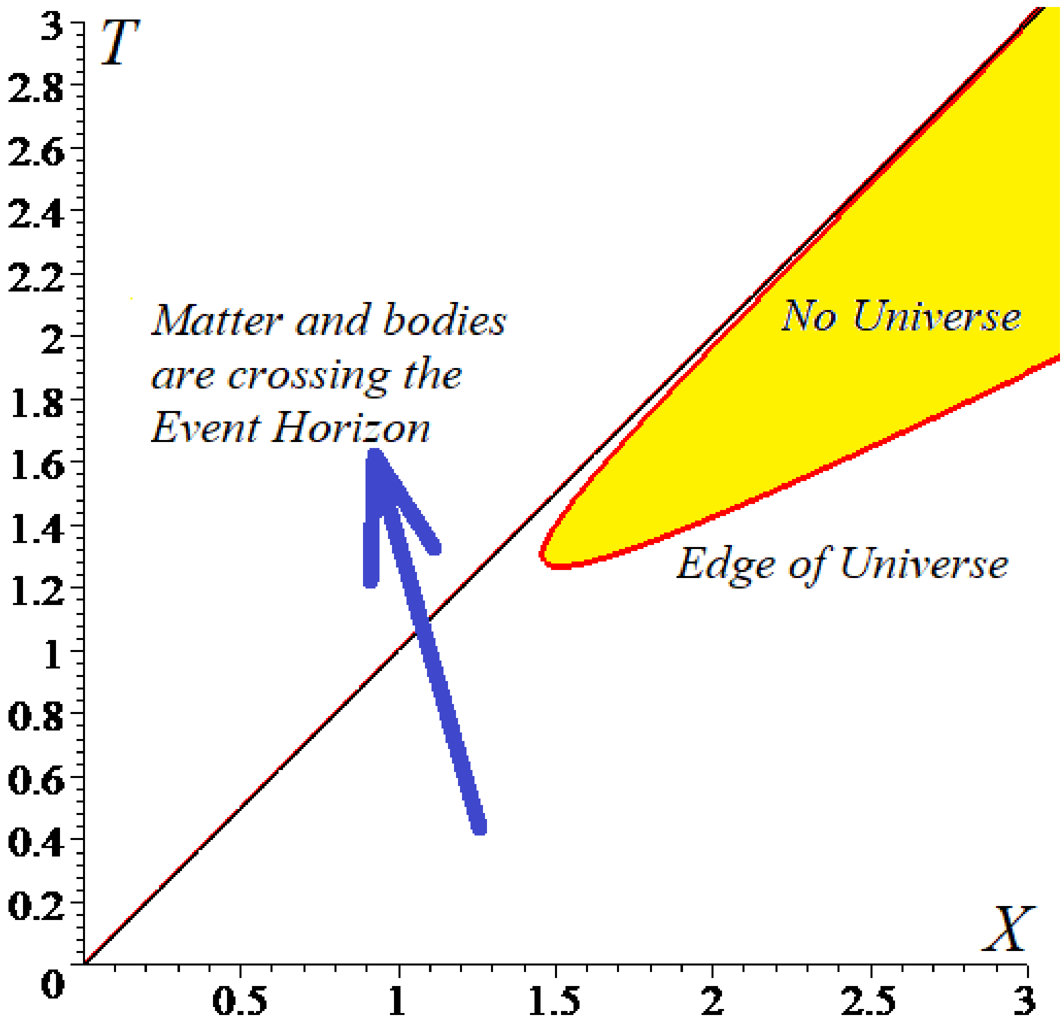

FIG. 2: The plot of Schwarzschild solution in the Kruskal coordinates (T, X). Used the $n_1 = 1$, $M = 1/2$ and ploted is only the first quarter.

kus on tehtud Joonise 3 kõverad 1 ja 3. Sel juhul kõverale 1 on omistatud $v = 0$.

We have optimised our algorithm, so can look much more deeper into the compression progress: the record is 10^{-8} seconds from the start of the evolution, see Fig.4.

This shows, what our talk of the compression applies also to the large bodies.

B. Riemann curvature tensor in personal singularity

Is expected, what the local curvature around the falling body will be singular at the personal singularity. Let us check it, but remember, that the mathematical programs like Maple can give a wrong result due to bugs in the imperfect programs.

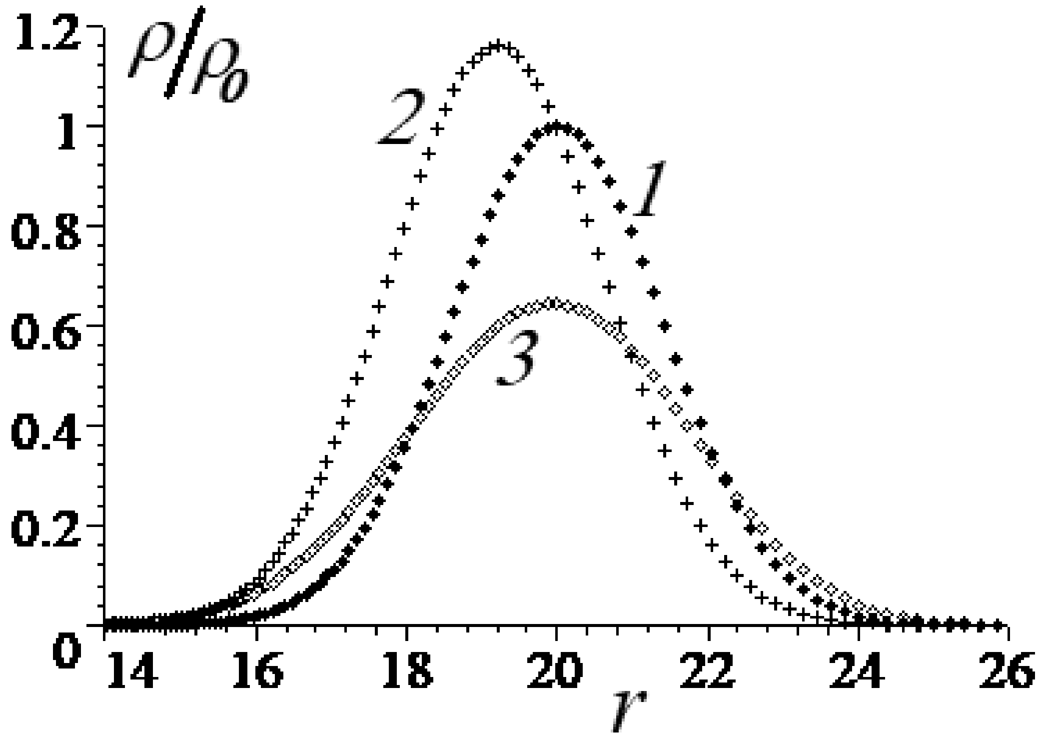

FIG. 3: Evolution of the body density, the curve 1 is the initial state in two cases: $v = 0$ and the $v = \sqrt{2M/r}$. The progress of this common initial condition is shown in curve 2 (then the curve 1 has $v = \sqrt{2M/r}$ velocity profile), and the curve 3 for the $v = 0$ as the initial state. The A=1/3, M=1/2. On the veritical axis is plotted the dimension-less density, which is ρ/ρ_0. The coordinate time $\Delta\, t$ of transition between curves 1 and 2 is $2\,\mathrm{x}\,10^{-9}$ seconds; transition between curves 1 and 3 happens during $9\,\mathrm{x}\,10^{-9}$ seconds. So, the plotted is $0 \leq t \leq 9\,\mathrm{x}\,10^{-9}$ second gap of coordinate time (latter is not the proper time τ)

$$R_{(\nu)(\mu)(\alpha)(\beta)} = R_{\nu\mu\alpha\beta}\, e^{\nu}_{(\nu)}\, e^{\mu}_{(\mu)}\, e^{\alpha}_{(\alpha)}\, e^{\beta}_{(\beta)}$$

Hereby the ON thetrad $e^{\nu}_{(\nu)}$ is taken from R.-N. metric. Turned out, what the Riemann curvature tensor components are finite at the personal singularity, measured in the local, in-falling ON thetrad in case of $r_m \neq 0$. This can hardly be explained intuitively. But the facts with the tensors, as the measurable quantities, are: $R_{(\nu)(\mu)(\alpha)(\beta)} < \infty$, $u^{\nu}_{;\nu} \to \infty$. Thus, the singularity, which is connected with space-time [due to invariance of the nature of the falling body: the personal singularity is indifferent of: 1) of the equation of state $p = p(\rho, T)$, 2) viscous or perfect fluid], is there. The position of it depends on the orbital parameters

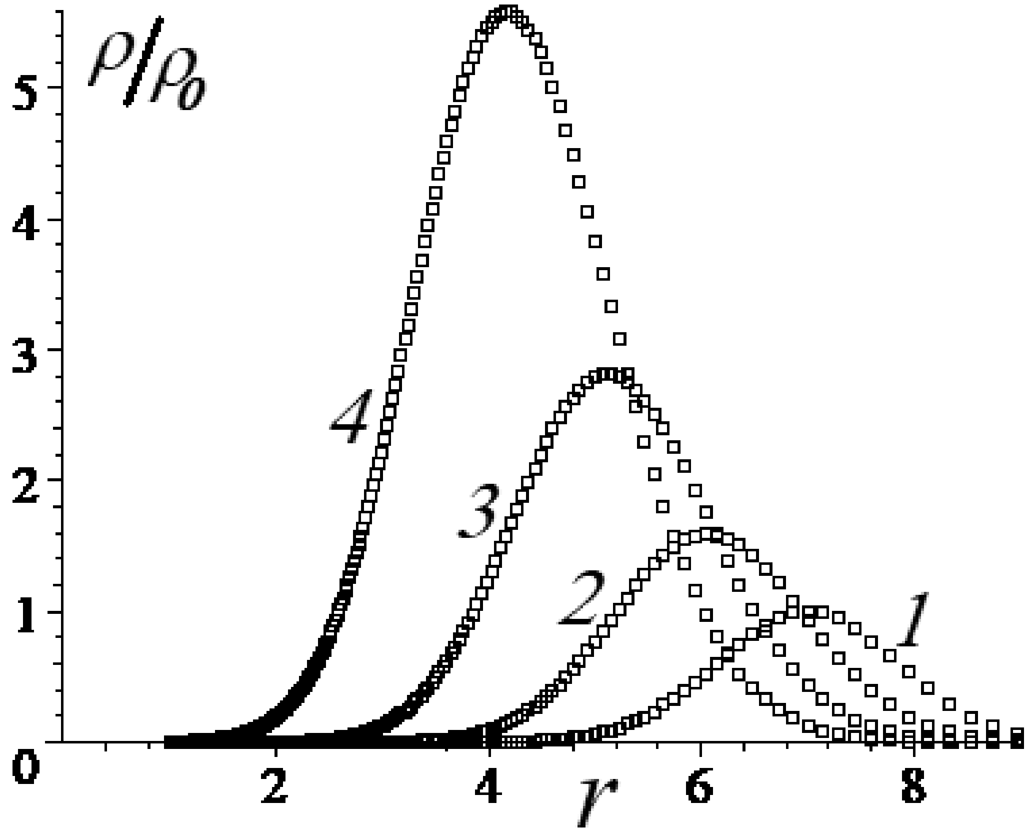

FIG. 4: Evolution of the body density, the curve 1 is the initial state with initial velocity $v_0 = \sqrt{2M/r}$. The progress of this initial condition is shown in curves 2, 3, and 4. The $A = 1/3$, $M = 1/2$, $Q = 1$, $a = 0$, $q = 0$, then the personal singularity is expected to be in $r_m = Q^2/(2M) = 1$. Curves correspond to the following values of the coordinate time: $t = 0/c,\ 1/c,\ 2/c,\ 3/c$ seconds, where $c = 3\,\mathrm{x}\,10^8$ meters/sec. Is shown, what the density diverges as $r \to r_m$

E, L_z, L.

Note, that the Richi tensor does not describe in full the curvature singularity: $R^{\nu\mu} = 0$ even in $r = 0$. So, perhaps the Riemann Curvature tensor is either not the full description.

C. The density regulator

I am sure, what we have found the natural mechanism for density regulation, which is meant to avoid the curvature singularity occurrence.

Look: the density is measured by "density-meter", the space is measured by the ruler, the time is measured by the clock, etc. The Nature is that, what is measured by the Standard

Instruments and the Standard Instruments are what measure the Nature. Look at it as the (closed in well-meant, benign loop) definition of Nature. The infinite values can not be measured, so the Nature is finite in size, in past time, in future time, in velocity (the maximum is the c), and the mass-density. The Standard Instruments can not be changeable [6], because any change is measured by The non-changeable Standard Instrument. The existence of Nature refers to the non-changeability of the Standards: I am sure, what our head will not shrink to perfect point-size, when we arrive at the Mars. Because our head does naturally exist. However, I am sure, what the shrinking to the point-size at the personal singularity r_m is the exceptional mechanism to regulate the mass-density of the collapse.

Look at the stationary star solution: [4], which is Tolman-Oppenheimer-Volkoff hydrostatic equilibrium formula in curved spacetime:

$$\frac{dp}{dr} = -\frac{(\rho + p)(m + 4\pi\, r^3\, p)}{r^2\,(1 - 2\, m/r)}\,, \tag{27}$$

where

$$m = \int_0^r 4\pi\, r^2\, \rho\; dr\,. \tag{28}$$

We have concluded, what the dp/dr starts to diverge way before the BH formation (latter is when $r = 2m$), namely when $m/r^2 \to \infty$, at the $r = 0$.

But, above is revealed, what holds

$$\rho \leq W\,, \tag{29}$$

where $W = \text{const}$ is the fundamental constant for given Universe, the W is to be found from the smallest BH to be discovered. Because the smaller the BH, the higher is its density of the collapsing matters.

So, there is no possibility of central curvature singularity:

$$\frac{m}{r^2} \leq 4\pi\, W \frac{\int_0^r r^2\, dr}{r^2} = 4\pi\, W\, r/3 \to 0, \quad r \to 0. \tag{30}$$

Law of step and exponent

So, we have right to suggest the following law in Nature

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

here step-function $\Theta = \Theta(W - \rho) = 0$, if $W - \rho < 0$ and $\Theta = 1$, if $W - \rho > 0$. The $\rho = \mathrm{MIN}\,(T^{\mu\,\nu}\,u_\mu\,u_\nu)$ is the minimum of energy, which the observer locally measures. The ψ is inserted for possibility not only of numerical, but also of analytic calculation, we suggest $\psi = \exp(-n\,\rho/W)$ with simplest choice: $n = 1$. This way the step function Θ may never become zero during the evolution of the matter, but slight regulation of density will save the spacetime from singularity.

Such exponential law predicts the vanishing of some small portion of objects even at the normal densities and energies. And look, such effects are there: the news from 28.05.2010 (the "vanishing rings of Jupiter", http://evilearth.ru/
zagadochnoe-ischeznovenie-kolca-yupitera.html): science does not know, what happened to the ring of Jupiter. Three months ago it was there and this is not a single case. Also in terrestrial experiments the particles were anomalously disappeared (possibly); I have read about the loss of neutrons and of a certain abnormal weakening of the particle beam in the LHCollider: "Two separate detectors near a nuclear reactor in France found 3 % of anti neutrinos missing. They suggested the existence of a 4th neutrino of mass 0.7 Kev. [11]". And there are the YouTube reports of vanished – from the physical reality – the water: “UFO Caught Sucking Water Out Of California Lake, May 2015”, “UFOs Sucking Up Water From Oceans Around The Globe! 1/23/17”, and the buildings: “How to Disappear Completely - A Short Film About Dustification ”.

The Dark Matter $(-1/(8\pi))\,D^{\mu\,\nu}$ and Dark Energy $\Lambda\,g^{\mu\,\nu}$ are not matter, but a modification of gravitation. However recent study [7] suggests, what the Dark Energy can be explained by non-homogeneity of matter. Analogously the study [8] proposes the Law, which rigidly links the Matter distribution to the Dark Matter distribution.

Shortly about the mistery of Quantum Mechanics

The double slit experiment in Quantum Mechanics can not be explained by the pilot-wave theory of David Bohm [10], but the trajectory of the particles must have the determined momentum and the position: the uncertainty principle allows to think about the particle as having the certain position in every moment of time (with no information about the momentum, however latter information is extracted from the positions of the particle). Moreover, one can think about the particle as having the definite position (without information about momentum) and the definite momentum (with no information about position) at any time moment. So, at any moment one can think of the particle as having definite position and momentum: just connect the two thoughts together! So, the explanation are the mini-wormholes, which is the form of Dark Matter, which link the source with the screen or the slits. This explains why the particles can not be observed at the slits, while the interference in the screen.

Note, that the Delayed Choice quantum eraser experiment [9] suggests to provide information, what a photon was at the slits. However the interference in the screen remains. However, the photon from the source is being splitted into two photons, which in fact are not the photons, but the wave-function: there are no photons at the slits. The photon appears at the detector from the wormhole (without information of the slit where the splitting of wave-function accured). But another set of detectors made it clear, where the splitting has occured, so it collapses the original wave-function, then the photons were at the slits.

All this suggests, what the elementar particles do hate to travel through the spacetime.

The Quantum Field Theory has some formulas, which have no physical meaning, as example the negative energy particles, the energy of empty space, and the virtual particles. The mathematical description is larger, than the physical reality.

D. Is there personal singularity for photons?

Yes! And this suggests, that the photon has intrinsic structure, which is becoming therminated in $r = r_m > 0$. Hereby the effect is possible only for Kerr-Newman BH, because holds

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

For simplicity chosen was $L_z = 0$, $L = 0$.

VIII. CONCLUSION

The extremely dramatic spacetime effects are expected, when a supernova produces the collapsing remnant. Which is going to be a Black hole with point-size matter bulb (within the short proper future of falling matters). So, is expected, what any kind of falling body will feel the compression. That contradicts the established "fact", that the falling astronaut would be ripped into pieces. But how the latter is possible, if the end-state of the cosmonaut is a singular point $r = 0$? So, the expected is, what the cosmonaut will be transformed into a large cloud of elemental particles, which, thus, do stop the motion at the $r_m \neq 0$. So there shall be this r_m even within the establishment. But we shall go into the right direction, proving, what this cloud is a point-size "nothingness" with terminated trajectory at the r_m.

We have demonstrated, what even such well established thing as ripping death of falling astronaut is not correct. So, we have gained the knowledge: we know, what I am sure, what we have demonstrated that within the General Relativity. And we shall be avoided of baseless criticism, until a disproof would come. If you do not know a theorem, then you truly don't know the theorem. If you are sure, what the $2 = 1 + 1$, then you are truly sure. If you doubt, what Darwinism is correct, then you truly doubt it. So, there is always the Verity. There is no limit of getting knowledge. Let us call a man, who got to know all, as "Champion". Think about the Champion. The Champion knows also, what he exists. So, the Champion really exists, because even such a knowledge is out to get there.

I am the champions,
Got time for lost ones,
Cause I am the champions...
For the Good!

(cf., "I am the champions", the song).

A. The law of the conservation of Matter

Our "density regulator" can violate the baryon and lepton number conservations (which are not yet violated, according to Russian Wikipedia 2017). I am glad, that the laws of these conservations are only phenomenological, not the theoretical (according to Russian Wikipedia 2017): they are not ruing any vital theory, even while we found their rare violation (the "density regulator" above).

The conducted experimental tests of these conservation laws were using the detector technics, which –we assume– in case of success require the energy-momentum conservation (as in case of search for proton decay), or the breaking of the total "electric charge conservation" in the system. However in the case of present paper neither of these accommodating events is necessary to occur.

The law of the matter conservation (which we define as the baryon and lepton number conservations) is required, because the Standard Instruments of Metrology (meter, thermometer, ampermeter, voltmeter, etc.) must not be corrupted by any changes. Thus, naturally, the law of conservation takes place. But we have found the exceptional way (outside the natural laws) to regulate the matter, in order to prevent their divergency – the density regulator.

B. Let us add:

on arvutatud Riemani kõveruse tensor ON tetraadis. Ta pole singulaarne isiklikus singulaarsuses. Kuid isiklikus singulaarsuses keha suurus pressitakse ideaalseks nulliks. Seega kõverus ei saa olla lõplik. Kuid ta on. Järelikult, kui mitte tuua sisse minu "Density Regulator" (vt. vastav peatükk), Einsteini ÜRT on sisemiselt vastuoluline. Seega oletades, ei maailm ei vtta vastu Density Regulator, minu saame kuulsuse kui Einsteini ümber-lükkajad? Kas minu oleme riskidega nõus?

The density regulator is energy destruction. This star has no explanation within Physics, so we propose the energy-conservation violation: "The most mysterious star in the universe — Tabetha Boyajian" youtu.be/gypAjPp6eps T.S.Boyajian, et al., Planet Hunters X, KIC 8462852: Where's the flux? 2016.

Mul on arvutused, kus ma näitasin, et musta augu ekvaatori pikkus on lõpmata suur (täpsemalt see on nn. ergosfääri perimeeter, ergosfäär langeb kokku sündmuste horisondiga, kui on pöörlemine $a \approx 0$). Kuna aga lõpmatus pole füüsiline (teda ei saa mõõta isegi mõtteliselt), siis ÜRT sees on vastuolu. Üks vastuolu on avastatud (minu poolt) see on isiklik singulaarsus ja parandatud tuues sisse uus seadus "Density Regulator". Kuid lõpmata ergosfäär ei saa olla parandatud, kuna teda kaudselt "nägiti" teleskoopides: mustade aukude kokkupõrked ja neist tulevad gravitatsiooni lained.

There can not be a single contradiction in reality, because we have one God. Two or more gods (with contradictive opinions about matters) are imperfect, because are limited by each other, thus they are not gods. So, the solution might be: "the Book of Life is the real fairytale, with the God and us as the authors. Nobody expects from a fairytale the total absence of contradictions. The contradictions is in the definition of a fairytale." The song "you must believe in fairytale" youtu.be/io3vYgTHO2U

Please recall, that we have found the contradiction in the perfect fluid and in the viscous fluid theory. Because is shown, that the fluid's current must conserve also in the General Relativity. But these theories are derived from physical laws. Then, the contradiction in Nature itself means, that we live in the real fairytale.

Proof of infinite ergosphere. The physical things one measures in local ON thetrad with the Minkowski local metric. Let us calculate this thetrad. It satiesfies the ON-conditions: $e^{\hat{\mu}}_{\nu}\, e^{\hat{\alpha}\,\nu} = \mathrm{diag}(-1,1,1,1)$, and 4-velocity of a stationary test body $u^{\nu} = (u^0,0,0,0)$ with norm $u^{\nu}u_{\nu} = -1$ must have following projection on ON-thetrad $u^{\hat{\nu}} = (1,0,0,0) = e^{\hat{\nu}}_{\mu}\, u^{\mu}$. The displacement vector dr^{μ} on the equatorial plane has two nonzero components: dr^t and dr^{ϕ}. One calculates its components in ON-thetrad: $dr^{\hat{\nu}} = e^{\hat{\nu}}_{\mu}\, dr^{\mu}$. Then the $dr^{\hat{\phi}}$ is the distance along the ergosphere, if condition $dr^{\hat{t}} = 0$ is imposed. Then the integration over the circle $\Delta\phi = 2\pi$, gives $L := \int dr^{\hat{\phi}}\, d\phi = \infty$.

IX. NAVIER STOCKES EQUATION, INTEGRALS OF MOTION AND GENERALIZATION OF THE EQUATION OF CONTINUITY OF THE FLOW OF MATTER TO THE THEORY OF RELATIVITY

The use of N-S equation is of outmost important for everyday life: airplanes, ships, underwater ships, etc. So, the Clay Institute promises 1 000 000 dollars for a good solution. Present paper is about Estonian author confidence, that he have solved the problem.

Areas of physics: mathematical physics, the science of matter, field theory. A new formula for the continuity of the flow of matter is derived. The existing theory suffers from the "problem of uniqueness": it is not always clear what states of matter are real.

Intuitively, I think that if you throw a handful of balls from the bearing, the number of balls is invariably preserved. No matter how strong gravity would be observed. Therefore, in addition to the Einstein equations, an additional law must be fulfilled that keeps the number of balls unchanged. Looking ahead, I will say that it has a simple appearance:

$$\sum_{\nu=0}^{3} J^{\nu}_{;\nu} = 0\,, \qquad J^{\nu} = \rho\, u^{\nu}\,. \tag{3f}$$

Here the density of matter is multiplied by its four-dimensional velocity, and the resulting flux has a zero covariant divergence

$$\sum_{\nu=0}^{3} J^{\nu}_{;\nu} = \sum_{\mu=0}^{3} \frac{\partial J^{\mu}}{\partial x^{\mu}} + \sum_{\alpha=0}^{3} \sum_{\nu=0}^{3} \Gamma^{\nu}_{\nu\,\alpha} \, J^{\alpha} \, ,$$

where $\Gamma^{\nu}_{\mu\,\alpha}$ denotes the “connectivity coefficients”, also known as the “Christoffel symbols”. They are calculated according to the “metric” of space-time in a known way. In the case of Minkowski space-time, the metric has the form of the diagonal matrix $g_{\nu\mu} = \mathrm{diag}(-1,\, 1,\, 1,\, 1)$, so that the square of the linear element is $ds^2 = -dt^2 + dx^2 + dy^2 + dz^2$. This is the interval between two very close points. Recall that by the Pythagorean theorem $dL^2 = dx^2 + dy^2 + dz^2$.

Therefore, in the case of choosing a flat Minkowski space-time (or, alternatively: [2]), there is a simple and well-known formula for the continuity of the flow of matter:

$$\sum_{\nu=0}^{3} J^{\nu}_{,\nu} = \sum_{\nu=0}^{3} \frac{\partial J^{\nu}}{\partial x^{\nu}} = 0 \, , \tag{1f}$$

it is well known that in the case of such a space-time, all $\Gamma^{\nu}_{\mu\,\alpha} = 0$. However, here I give a generalization to high velocities of ”balls” (for example, protons in a particle accelerator), and not only the well-known classical theory that gives

$$\frac{\partial \rho}{\partial t} + \nabla\left(\rho\, \vec{u}\right) = 0 \, .$$

So, our innovation is the preservation of not only the number of balls, but also the total energy of the system. This innovation is a relativistic generalization of the law of continuity to the Special Theory of Relativity. Let us now generalize it to the General Theory of Relativity.

It can be shown from the energy-momentum tensor of the “ideal fluid” [1] that there is

$$\sum_{\nu=0}^{3} J^{\nu}_{;\nu} = -p \sum_{\nu=0}^{3} u^{\nu}_{;\nu} \, , \tag{2f}$$

where the fluid pressure is multiplied by the divergence from the fluid velocity. Recall that by choosing Minkowski space, I have zero Christoffel symbols and therefore

$$\sum_{\nu=0}^{3} J^{\nu}_{,\nu} = -p \sum_{\nu=0}^{3} u^{\nu}_{,\nu} \, .$$

However, in the Minkowski space the formula (1f) is known. Therefore, I must assume that the mathematically verified state of an ideal fluid has zero pressure, $p = 0$, and then from

(2f)

$$\sum_{\nu=0}^{3} J^{\nu}_{;\nu} = 0\,.$$

So, our assumption was confirmed.

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

[2] By transforming the coordinates at any chosen point, you can reset all the Christoffel symbols (see "Theory of the Field" by Landau-Lifshitz), so at this point the formula will give a restriction on the state of matter.

X. "PERFECT FLUID" MODEL IS NOT MATHEMATICALLY CONSISTENT

Derived the integral of motion for perfect fluid. It reduces the number of valid equations of state: must be $p = 0$. This can be regarded as part of the solution of more general problem: the fluid with viscosity, which is also showing $p = 0$ by another approach.

The energy-momentum tensor of the perfect fluid is

$$T^{\nu\mu} = (\rho + p)\, u^{\nu}\, u^{\mu} + p\, g^{\nu\mu}\,. \tag{31}$$

with $u^{\nu}\, u_{\nu} = -1$. Then the $T^{\nu\mu}_{;\nu} = 0$ means

$$0 = u_{\mu}\, T^{\nu\mu}_{;\nu} = \frac{d\rho}{d\tau} + (\rho + p)\Theta\,, \tag{32}$$

where

$$\Theta = u^{\nu}_{;\nu}\,, \qquad \frac{d\rho}{d\tau} = \frac{\partial\rho}{\partial x^{\nu}}\, u^{\nu}\,. \tag{33}$$

Let us denote

$$J^{\mu} = -T^{\nu\mu}\, u_{\nu} = \rho\, u^{\mu}\,. \tag{34}$$

Then

$$J^{\mu}_{;\mu} = \frac{d\rho}{d\tau} + \rho\,\Theta\,, \tag{35}$$

and so from Eq.(46)

$$J^{\mu}_{;\mu} = -p\,\Theta\,. \tag{36}$$

While solving the problems in Special Relativity one holds the background spacetime fixed: Minkowskian, no need of General Relativity Equation $G^{\nu\mu} = 8\pi T^{\nu\mu}$ then. Such method, applied to Dark Matter, can solve even it: [4]. If in a model the spacetime is flat and fixed Minkowskian, then holds exactly

$$J^{\mu}_{,\mu} = -p\,\Theta\,, \tag{37}$$

where $\Theta = u^{\nu}_{,\nu}$.

But is known, that in flat spacetime $J^{\mu}_{,\mu} = 0$. Therefore holds 1) $p = 0$ or 2) $\Theta = 0$ with $\rho = \text{const}$. And so in addition to the known $T^{\nu\mu}_{;\nu} = 0$, by fact holds for the perfect fluid following formula:

$$J^{\mu}_{;\mu} = 0\,. \tag{38}$$

One can demonstrate (viXra:1711.0272, viXra:1304.0086), that in latter case holds

$$\int J^{t}\,\sqrt{-g}\,dV = \text{const}\,,$$

where $J^{t} = \rho\,u^{t}$. Therefore, the conserved is not the rest-mass ρ, but the energy $\rho\,u^{t} = \rho\,c^{2}/\sqrt{1-(v/c)^{2}}$. Therefore, the $\rho \neq \text{const}$, so the Θ can not be zero, and the only one mathematically consistent possibility remains: the pressure-free dust with $p = 0$.

XI. THE ANSWER TO MILLENNIUM PRIZE PROBLEM

One might argue, that between a planet and the vacuum is discontinuity of measurements. Thus, that place violates the strong equivalence principle, to avoid it, one must understand that there are no discontinuities in Nature. The problematic places are having the thin transitional areas. So, there are regular functions $f(t,x,y,z)$, their derivations are all continuous. Then, the Taylor series at initial moment $t = 0$ imply, that the Navier Stockes equations can not be the source of divergency:

$$|\sum f^{(k)}\,\frac{t^{k}}{k!}| < \sum |f^{(k)}|\,\frac{t^{k}}{k!} < M \sum \frac{t^{k}}{k!} < \infty\,, \tag{39}$$

where M is the maximum derivative at initial moment. Then, if the measurable-s (velocity, density, etc) are regular at initial moment (thus, the physical), then it is regular and smooth all the future and satisfies the N-S equations:

The NS equation has form $N(t,x,y,z) = 0$ for all t, look Eq.(43). Therefore, I have following equations at $t = 0$

$$n_k := \frac{\partial^k N}{\partial t^k}\Big|_{t=0} = 0\,, \tag{40}$$

for all $k = 1, 2, 3, \ldots$. On the other hand, one inserts the Taylor series

$$f = \sum f^{(k)}\,\frac{t^k}{k!}\,, \tag{41}$$

where f can be density ρ, pressure p, velocity $\vec{v}$, viscosity μ etc. One inserts them all into NS equation $N(t,x,y,z) = 0$, and collects the terms with the same power of the t

$$N = N_0 + N_1\,t + N_2\,t^2 + N_3\,t^3 + \ldots\,. \tag{42}$$

It turned out, what the structure of NS equation is so lucky (obviously in contrary to [1]), what all $N_k \sim n_k = 0$, thus all $N_k = 0$.

A. The form of NS equation

Is well known, what Navier-Stokes equations are derived to have such simple form [2]

$$0 = N(t,x,y,z) := -\rho\Big(\frac{\partial\vec{v}}{\partial t} + (\vec{v}\,\nabla)\vec{v}\Big) + \rho\vec{F} - \nabla\,p + (\gamma+\mu)\,\nabla\,(\mathrm{div}\,\vec{v}) + \mu\,\triangle\vec{v}\,, \tag{43}$$

with equation of state $p = p(\rho, T)$, the dissipative constants γ, μ are assumed to be constant while derivation of latter case of NS equation.

Let's now the γ and μ are functions of space and time. Then the NS equation $N = 0$ has becomes [3]

$$\begin{aligned} N := -\rho\Big(\frac{\partial\vec{v}}{\partial t} + (\vec{v}\,\nabla)\vec{v}\Big) + \\ +\rho\vec{F} - \nabla\,p + (\gamma+\mu)\,\nabla\,(\mathrm{div}\,\vec{v}) + \mu\,\triangle\vec{v} + \\ +A\,\nabla v^i + B^i\,\mathrm{div}\,\vec{v} + C_k\,\nabla v^k\,, \end{aligned} \tag{44}$$

where $A := \nabla\mu$, $B := \nabla\gamma$, the vector k-th component is $C_k := (\nabla\mu)_k$.

XII. ON GENERAL SOLUTION

Let the viscous coefficients are time and space functions, e.g. $\eta = \eta(t,x,y,z)$. If the fluid is electrically neutral, then the potential field, which acts on the fluid is zero: $\vec{U} = 0$, nevertheless the fluid can experience the pushing from the sides of the fluid (the wings of airplane are pushing air around the plane).

The norm of 4-velocity is $u^\nu u_\nu + 1 = 0$. Then by taking the covariant gradient, one gets

$$0 = (u^\nu u_\nu + 1)_{;\alpha}\, u^\alpha = a^\nu u_\nu + u^\nu a_\nu = 2\, a^\nu u_\nu \,, \tag{45}$$

where 4-acceleration $a^\nu = u^\nu_{;\alpha}\, u^\alpha$.

The 4-current density is

$$J^\nu = -T^{\nu\mu}\, u_\mu = \rho\, u^\nu \,, \tag{46}$$

where the energy-momentum tensor $T^{\nu\mu}$ of viscous fluid is from book of Lightman. Then the

$$J^\nu_{;\nu} = d\rho/d\tau + \rho\,\Theta \,, \tag{47}$$

where $\Theta = u^\nu_{;\nu}$. If holds Eq.(55), then the relative density rate $((d\rho/d\tau)/\rho)$ is the 4-divergence Θ, that is in perfect accordance with divergence physical meaning (the counter of the field sources).

But on the other hand, because $T^{\nu\mu}_{;\nu} = 0$

$$(-T^{\nu\mu}\, u_\mu)_{;\nu} = -T^{\nu\mu}\, u_{\mu\,;\nu} = -\beta + \eta\, a^\nu a_\nu \,, \tag{48}$$

where

$$\beta = p\,\Theta + (2\eta/3 - \zeta)\,\Theta^2 - 2\,\eta\, u_{\nu\,;\mu}\, u^{(\nu\,;\mu)} \,, \tag{49}$$

where $2\, u^{(\nu\,;\mu)} = u^{\nu\,;\mu} + u^{\mu\,;\nu}$.

$$u_\mu\, T^{\nu\mu}_{;\nu} = -d\rho/d\tau - \rho\,\Theta - \beta = 0 \tag{50}$$

While the derivations the following facts were used:

$$0 = (u^\beta u_{\beta\,;\alpha})^{;\alpha} = u^{\beta\,;\alpha} u_{\beta\,;\alpha} + u^\beta u^{;\alpha}_{\beta\,;\alpha} \,, \tag{51}$$

$$a^{;\alpha}_\alpha = (u^\beta u_{\alpha\,;\beta})^{;\alpha} = u^{\beta\,;\alpha} u_{\alpha\,;\beta} + u^\beta u^\alpha_{;\beta\,;\alpha} \,. \tag{52}$$

Thus, from Eqs.(46)–(50) holds $a^\nu a_\nu = 0$. From the Special relativity (the Dr. Teet Örd's lectures) is known, that $a^\nu a_\nu$ is zero only if the 3-acceleration is zero: $a = (0,0,0)$. Latter imply, that motion is force-free, the lines of fluid are geodetic $a^\nu = 0$ at every point of spacetime. So, without experiencing any acceleration, even the acceleration of circular orbit, then the fluid is totally static and experiences no non-compensated pushing from the edges (no flying airplane then). In conclusion, the general solution (which is consistent with mathematics) of N-S equation is the pressure-free dust, $p = 0$.

A. Case of zero viscosity

It has $\eta = \zeta = 0$. Then from Eqs.(46)–(50)

$$d\rho/d\tau + (\rho + p)\,\Theta = 0\,. \tag{53}$$

Then from Eq.(47) I have

$$J^{\nu}_{;\nu} = -p\,\Theta\,, \tag{54}$$

Because in weak gravity limit $J^{\nu}_{;\nu} \to J^{\nu}_{,\nu} = 0$, but $\Theta \to u^{\nu}_{,\nu}$ does not turn to zero, then must be $p = 0$.

XIII. ON THE COVARIANT DIVERGENCE OF CURRENT DENSITY

As you have seen, the mathematically consistent solution in case of zero viscosity must have

$$J^{\nu}_{;\nu} = 0\,, \tag{55}$$

But the N-S equations does not satisfy it. Then let us agree, that latter condition is necessary also for viscous fluid.There is Gauss theorem in curved spacetime (viXra:1711.0272, viXra:1304.0086), latter produces formula, which is easy to demonstrate by a math-software. In case $A^{\nu}_{;\nu} = 0$ and isolated field $A^{\nu} = 0$, $r > r_0$ it simplifies

$$\int A^t\,\sqrt{-g}\,dxdydz = \text{const}\,, \tag{56}$$

Applying to current density in non-relativistic case this constant is the conservation of the fluid mass-energy: $\int \rho\,dxdydz = \text{const}$. This law of (energy) conservation is very important result, because there is the problem of Energy concept in General Relativity: viXra:1306.0012.

Where $\sqrt{-g} = 1$ for Minkowski as fixed background spacetime, notably the variation principle can be used following way: to fix spacetime and let matter assume the optimal energy level: [4], vixra.org/abs/1512.0347. Let us study one obvious solution of above integral equation, in educational purposes

$$A^t\,\sqrt{-g} = b(x, y, z)\,. \tag{57}$$

Thus, in addition to above formulas holds

$$J^t = \rho\, u^t = b(x, y, z)\,. \tag{58}$$

Because $u^t = c/\sqrt{1-(v/c)^2} \approx c$, then in non-astrophysical situations one can write $\rho = b(x, y, z)$. Remember, that the ρ measures the co-moving observer, so, there can be $d\rho/d\tau \neq 0$. The non-changing ρ means the non-changing u^ν, so the general solution of N-S is stationary. However the $a^\nu = D\,u^\nu/d\tau$ can be non-zero. Please note, that latter consideration holds also for the collapse of dust cloud, and to the dynamics of Universe (viXra:1304.0086).

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[1] Terence Tao, Finite time blowup for an averaged three-dimensional Navier-Stokes equation, 2015, arXiv:1402.0290; Nets Hawk Katz, N. Pavlović, Finite time Blow-up for a dyadic model of the Euler Equations, Trans. Amer. Math. Soc. 357, 695–708, 2004.

[2] L.D. Landau, E.M. Lifshitz, Fluid Mechanics: Course of Theoretical Physics, Vol. 6, Pergamon Press Verlag, 1966, 47–53; J.N. Reddy, An Introduction to Continuum Mechanics, Cambridge 2008, 212–214.

[3] G.G. Stokes, On the theories of internal friction of fluids in motion, and of the equilibrium and motion of elastic solids, Trans. Cambridge Philos. Soc, Vol. 8, 1845; Poisson, Mémoire sur les équations générales de l'équilibre et du mouvement des corps solides élastiques et des fluides, Journal de l'École Polytechnique, Vol. 13, 1831; de Saint-Venant, Note á joindre au Mémoire sur la dynamique des fluides, Comptes rendus, Vol. 17, 1843.

[4] Dmitri Martila, "Simplest Explanation of Dark Matter and Dark Energy", 2013, LAP LAMBERT www.amazon.com/author/dmitrimartila

XIV. APPENDIX A

From the [4] are presented the velocity components in the Kerr spacetime

$$dr/d\tau = -\sqrt{B}/(r^2 + a^2\cos^2\theta)\,, \tag{59}$$

$$d\theta/d\tau = \sqrt{L - \cos^2\theta\,(a^2\,(1-E^2) + L_z^2/\sin^2\theta)}/(r^2 + a^2\cos^2\theta)\,, \tag{60}$$

$$d\phi/d\tau = (-(a\,E - L_z/\sin^2\theta) + a\,P/\Delta)/(r^2 + a^2\cos^2\theta)\,, \tag{61}$$

$$dt/d\tau = (-a\,(a\,E\sin^2\theta - L_z) + (r^2+a^2)\,P/\Delta)/(r^2 + a^2\cos^2\theta)\,, \tag{62}$$

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

Here the charge of BH is $Q = 0$, rotation $a = 1/4$, mass $M = 1/2$. The e is the electric charge of the falling body. The system of three equations $d\phi/d\tau = 0$, $d\theta/d\tau = 0$, $dr/d\tau = 0$ taken at $r = 20$ and $\theta = \pi/4$ are giving us the three constants: $L = 249620/155672961$, $L_z = -80/\sqrt{155672961}$, and the $E = (1/12801)\sqrt{155672961}$.

XV. APPENDIX B

The matter tensor of viscose fluid was taken, turned to be

$$-d\rho/d\tau - (\rho + p)\,D + (\zeta - 2\eta/3)\,D^2 + \eta\,H = 0\,, \tag{63}$$

where $H := u^\alpha_{;\mu}\,u^\mu_{;\alpha}$. One can show, what $H = (u^\alpha\,u^\mu_{;\alpha})_{;\mu} - d\,D/d\tau \approx -d\,D/d\tau$. So, looking at the perfect fluid solution, one could conclude, that the $H > 0$ in the vicinity of the central singularity. Hereby, if the $\zeta - 2\eta/3 > 0$, then the catastrophic compression is inevitable. If the $\zeta - 2\eta/3 < 0$ the density ρ still behaves as the $\exp|D|$ (looking at the perfect fluid case). Then, the D^2 term can not compensate the compression.

The density is

$$\rho \sim \exp(-D + (\zeta - 2\eta/3)\,D^2/\rho)\,. \tag{64}$$

Then, if $-D + (\zeta - 2\eta/3)\,D^2/\rho \to \infty$ at $r = r_m$, then the compression happens. Is known, what the $D \to -\infty$. In the case of finite compression, must be $\rho \to |(\zeta - 2\eta/3)\,D|$. But, nevertheless, the density diverges, because is known, what $D \to -\infty$.

XVI. APPENDIX C

The known is [4]

$$\frac{D^2\, n^\alpha}{d\tau^2} = -R^\alpha_{\mu\,\rho\,\nu}\, u^\mu\, u^\nu\, n^\rho\, . \tag{65}$$

But less known is

$$\frac{D\, n^\alpha}{d\tau} = \frac{D\,(S^{\hat u}\, e^\alpha_{\hat u})}{d\tau} = \frac{d\, S^{\hat u}}{d\tau}\, e^\alpha_{\hat u} + S^{\hat u} \frac{d\, e^\alpha_{\hat u}}{d\tau} + \Gamma^\alpha_{\mu\,\nu}\, u^\mu\, e^\nu_{\hat u}\, S^{\hat u}\, , \tag{66}$$

$$\frac{D^2\, n^\alpha}{d\tau^2} = \frac{D}{d\tau}\Big(\frac{d\, S^{\hat u}}{d\tau}\, e^\alpha_{\hat u} + S^{\hat u} \frac{d\, e^\alpha_{\hat u}}{d\tau} + \Gamma^\alpha_{\mu\,\nu}\, u^\mu\, e^\nu_{\hat u}\, S^{\hat u}\Big) =$$

$$= \frac{d^2\, S^{\hat u}}{d\tau^2}\, e^\alpha_{\hat u} + 2\frac{d\, S^{\hat u}}{d\tau}\, \frac{d\, e^\alpha_{\hat u}}{d\tau} + S^{\hat u} \frac{d^2\, e^\alpha_{\hat u}}{d\tau^2} + \frac{d}{d\tau}\Big(\Gamma^\alpha_{\mu\,\nu}\, u^\mu\, e^\nu_{\hat u}\Big)\, S^{\hat u} +$$

$$+\Gamma^\alpha_{\mu\,\nu}\, u^\mu\, e^\nu_{\hat u}\, \frac{d\, S^{\hat u}}{d\tau} + \Gamma^\alpha_{\mu\nu}\, u^\mu\, \frac{D\, n^\nu}{d\tau}\, , \tag{67}$$

where $S^{\hat u}$ is the projection of the vector n^α on the free-falling ON reference frame with $e^{\hat q}_\alpha e^{\hat u\,\alpha} = \eta^{\hat q\,\hat u} = \mathrm{diag}(-1, 1, 1, 1)$. Hereby must be zero of the reference time-component $S^{\hat 0} = n^\alpha\, e^{\hat 0}_\alpha = 0$.

Thus, there is open, what the body shrinks: the $d(S_{\hat u}\, S^{\hat u})/d\tau < 0$.

The Schwarzschild BH was taken with radial falling with zero initial velocity. If $S^{\hat 0} = 0$ during the fall, then the falling observer does measure the density of the dust at the same time $\hat x_0 = \tau =$ fixed, because locally the Physics must be classical. The result confirms the paper, because there can not be inconsistency in Nature, due to its real existence.

XVII. APPENDIX D: WHAT WOULD SIR NEWTON SAY?

Tilgu saab mõtteliselt jagada ülemiseks osaks ja alumiseks. Ülemise osa mass on m, alumise osa on samuti m. Osad on vastas-mõjus. Selle vastasmõju mudelina on esitatud vedru. Ehk, minu mudel on reaalse tilgu üli-lihtsustatud ja jämedaim mudel. Kuid juba sel tasemel ülesanne on väga keeruline ja lubab uusi efekte.

So, let model the drop with two masses m connected through the spring. First mass is closer to BH, than the second one. Thus, the gravity force $f_1 > f_2$, and so the tidal force tries to rip apart the drop. But the spring acts on the masses with rigid force $F = k\,(r_2 - r_1 - h_0)$, which fights against the tidal force. Thus, there is opposite effects in the system, and so the interesting results are expected. The drop falls from $r_1 = r_0$, and the total energy for the Hamiltonian Mechanics is

$$H = (p_1^2 + p_2^2)/(2m) + k(r_2 - r_1 - h_0)^2/2 - Mm/r_1 - Mm/(r_2)\,. \tag{68}$$

Holds $\partial H/\partial q_1 = -dp_1/dt$, where $q_1 = m\,r_1$. The further progress would be numerical methods. However, this is promising, because the system has a complex behavior, as you see in the following.

Because there is no temporal dependence, then

$$H = E = const. \tag{69}$$

Well, $p_1 = m\,r_1$, $p_2 = m\,(r_1 + h)$, $r_2 = r_1 + h$, then

$$m(2(v_1)^2 + 2v_1\,(dh/dt) + (dh/dt)^2)/2 + k(h - h_0)^2/2 - 2\,Mm/r_1 + Mm\,h/(r_1)^2 = E. \tag{70}$$

The $E = -Mm/r_0 - Mm/(r_0 + h_0) < 0$. Therefore,

$$m\,v_1\,(dh/dt) = E - k(h - h_0)^2/2 + 2\,Mm/r_1 - Mm\,h/(r_1)^2 - m(dh/dt)^2/2 - m(v_1)^2\,. \tag{71}$$

Because $h/r_1 \ll 1$, and the $(dh/dt)/v_1 \ll 1$ then

$$m\,v_1\,(dh/dt) \approx E - k(h - h_0)^2/2 + 2\,Mm/r_1 - m(v_1)^2\,. \tag{72}$$

At initial moment the $h = h_0$ and $v_1 = 0$. Thus, the $dh/dt > 0$, the spring becomes longer, until comes the $dh/dt = 0$ at

$$E - k(h - h_0)^2/2 + 2\,Mm/r_1 - m(v_1)^2 = 0\,. \tag{73}$$

While the fall, the (dh/dt) can several times to change the sign, because the latter equation includes not strictly monotonic terms, so it can have one or more solutions.

XVIII. APPENDIX E

Consider a drop of "perfect fluid" falling into BH. Because the drop is small, then velocity of every part of it is the velocity of the fall. The equation of matter is $T^{\mu\nu}_{;\nu} = 0$, thus $u_\mu\,T^{\mu\nu}_{;\nu} = 0$, where

$$T^{\mu\nu} = (\rho + p)u^\mu u^\nu + p\,g^{\mu\nu}\,. \tag{74}$$

Thus,

$$-(\rho+p)_{,\nu}\, u^\nu - (\rho+p)\, u^\nu_{;\nu} + (\rho+p)\, u^\nu\, u^\mu_{;\nu} u_\mu + p_{,\nu}\, u^\nu = 0\,, \tag{75}$$

where $u^\mu_{;\nu} u_\mu = 0$, because $(u^\mu u_\mu)_{;\nu} = (-1)_{;\nu} = 0$. We have $u^\nu = dx^\nu / d\tau$, then

$$-\frac{d(\rho+p)}{d\tau} - (\rho+p)\, u^\nu_{;\nu} + \frac{dp}{d\tau} = 0\,. \tag{76}$$

This has no solution, unless the fluid is compressible. Let the equation of state is $p = p(\rho)$, then

$$\frac{d\rho}{d\tau} = -(\rho + p(\rho))\, u^\nu_{;\nu}\,. \tag{77}$$

Now the rate (and sign) of density change depends on the $D := u^\nu_{;\nu}$.

This holds for any spacetime (wormholes, Universe, any kind of BH, etc).

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