ROSATOM

FEDERAL NUCLEAR ORGANIZATION FSUE "MINING AND CHEMICAL COMBINE"

THE MOVEMENT OF PARTICLES AND OBJECTS IN THE UNIVERSE UNDER THE INFLUENCE OF THE MASSIVE BODY GRAVITATION

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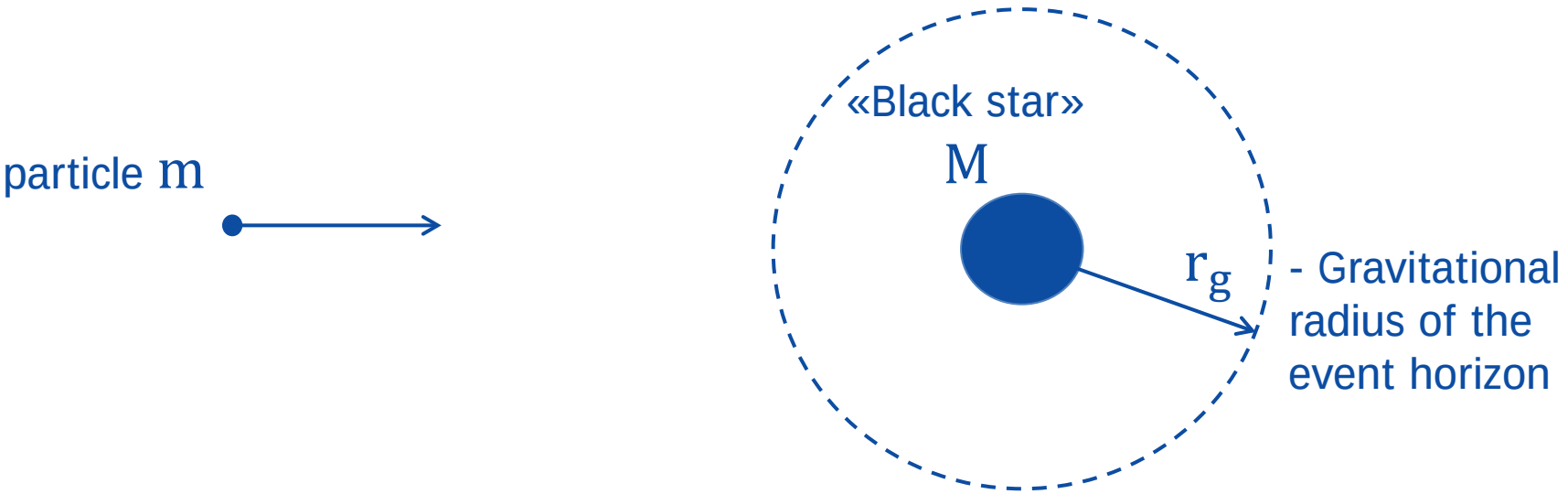
Michell's Model (1784)



The "Black star" (black hole (BH)) weighing M creating gravitational field to which the particle with mass m progressively moves has a gravitational radius r_g of the "event horizon".

Michell's "Black star" (black hole) of the year 1784.

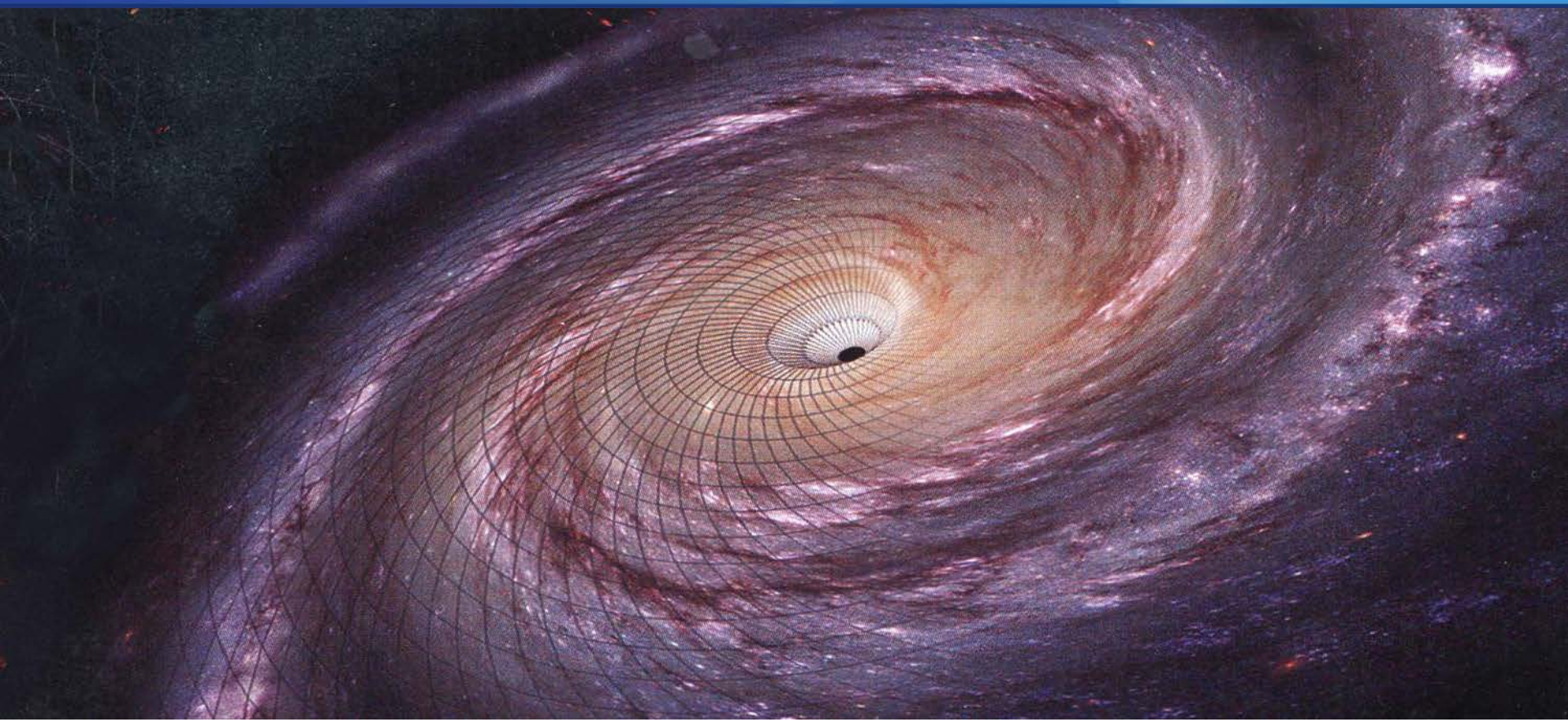
$$-\frac{GmM}{r}+\frac{m\cdot v^2}{2}=0$$

i.e. $v=\sqrt{\frac{2GM}{r}}$ or $v\sim r^{-\frac{1}{2}}$. (1)

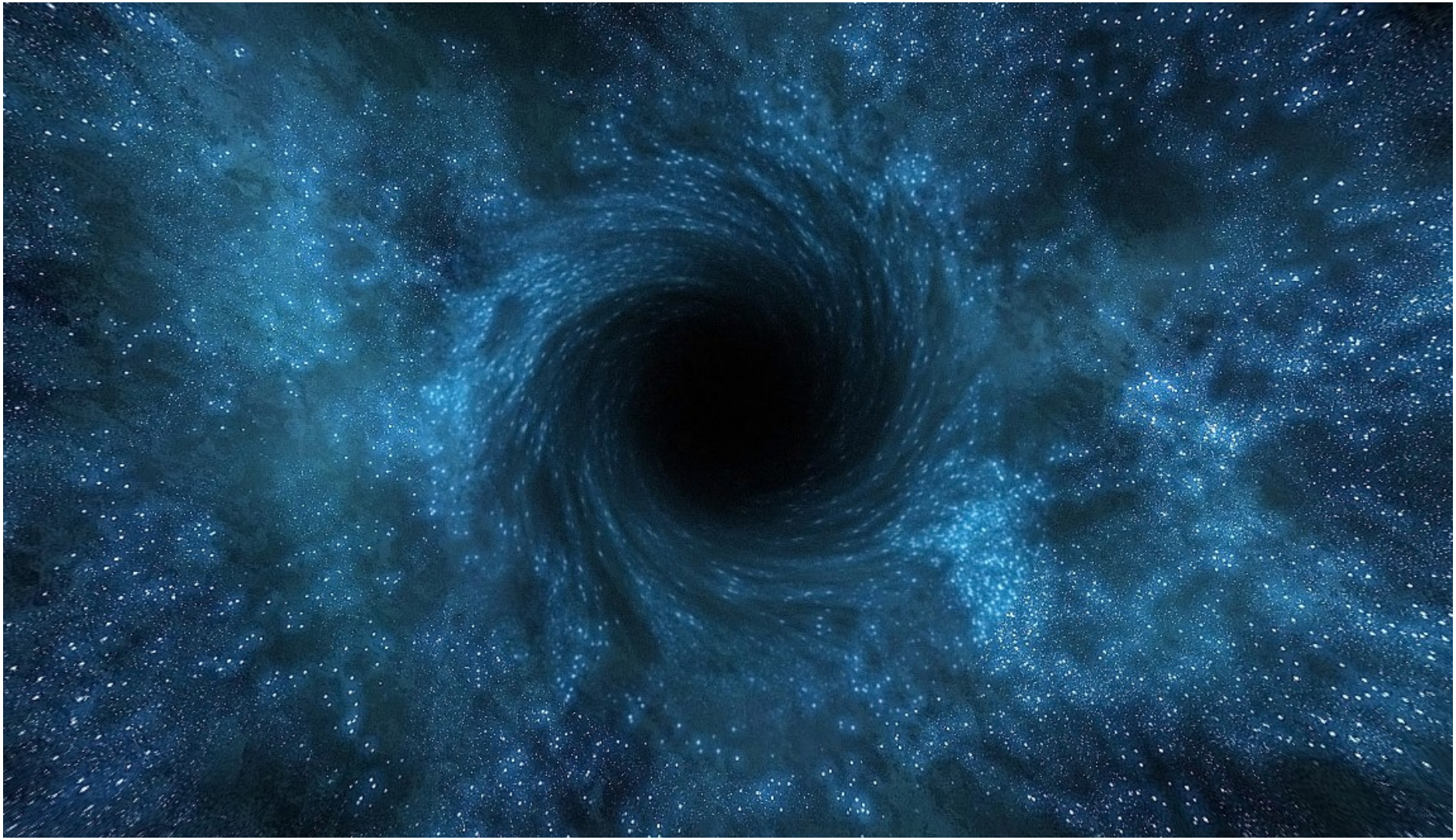
where $v = c$, the gravitational radius of Michell-Schwarzschild for the "event horizon" has the value:

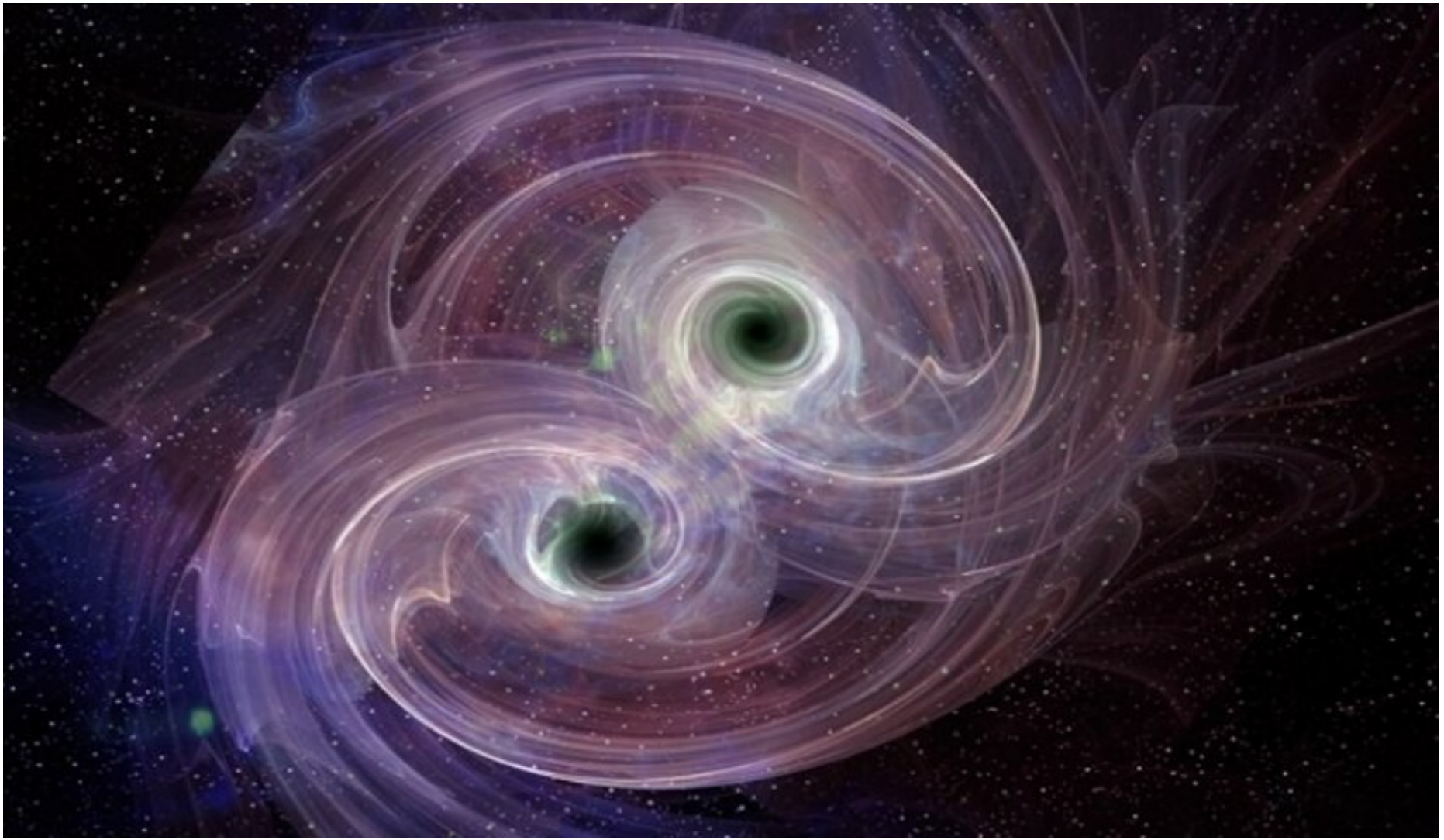
$$r_g=\frac{2GM}{c^2} \ . \qquad (2)$$

M – mass of the "black star" (black hole).



However, observations via modern telescopes (Hubble's telescope) show movements of particles to the black holes creating powerful gravitational fields occur, as a rule, on a spiral.





In 1937 Fritz Zwicky in his study [1] in which on the basis of observations of **relative** speeds of galaxies via telescope of Palomar Observatory obtained "paradoxical" result: the observed cluster mass (obtained according to the total luminosities of galaxies and their red shift) appeared much lower than the cluster mass calculated proceeding from own speeds of cluster members (obtained according to dispersion of red shift): the total cluster mass occurred 500 times lower than the estimated one, i.e. insufficient to keep the galaxy components from "dispersion".

"Dark energy" in cosmology is the hypothetical type of energy caused by presence of a certain "dark weight", entered into mathematical model of the Universe for the sake of an explanation of its observed expansion at first with delay and then as earlier it was supposed with acceleration (2011's physics study based on the late 1990s observations of Ia type supenovae).

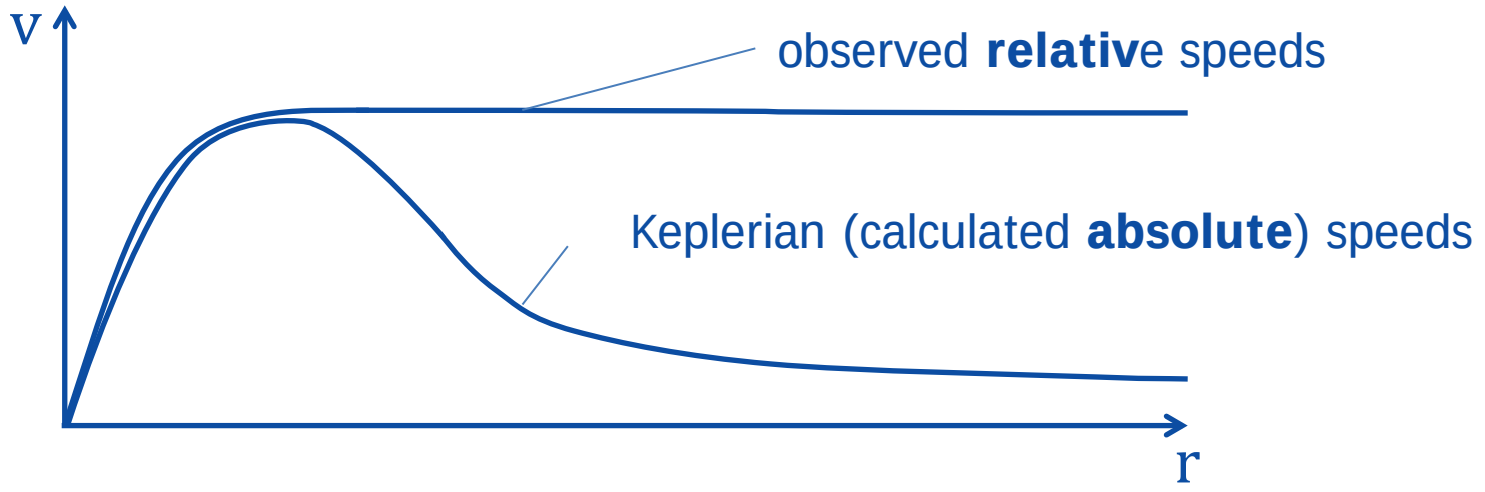


Fig. 1. “Dispersion” speeds for galaxy objects at the distance r from the center

Let's consider L.D.Landau's non-stationary equation of the movement [2] in the following form:

$$m\frac{dv}{dt} = -\frac{\partial U}{\partial r} - m\,W + m\left[r\dot{\Omega}\right] + 2m\,[v\Omega] + m\,[\Omega[r\Omega]]$$

Gravitation force

Force field

inertia forces (Coriolis's strength, centrifugal force, unevenness of rotation).

Taking into account "by contradiction" method we shall believe that the force field is absent ("dark energy" does not exist), then:

$$-m\,W = 0\,.$$

The self-similar solution of the non-stationary equation of the movement [2] taking into account force of gravitation, inertia forces (centrifugal and Coriolis) and in the assumption of "dark energy" lack, with method "by contradiction" applied, has a dimensionless appearance [3]:

$$\tilde{a} = \frac{1}{\tilde{r}} - \frac{1}{\tilde{r}^2} \quad , \qquad (3)$$

where dimensionless Functionals $\tilde{a} = a/(3v^2/r_e)$, $\tilde{r} = r/r_e$.

a – acceleration of a particle, v – speed of a particle, radius of gravitation and inertia forces balance $r_e = GM/(3v^2)$.

with $v = c$ we obtain $r_g/r_e = 6$.

The equation (3) explains the known "contradiction": why there is a delay of a particle with energy surpassing the gravitation force which is flying by the black hole with mass M creating gravitation; and then there is an acceleration of the particle moving away from a black hole with mass M. Apparently, at the same time there is no need to introduce "dark energy" as a concept.

In study [4] on the basis of the equation (3) analysis the extreme values of particle acceleration are obtained. At the same time graphical representation of dimensionless functionality of acceleration of $\tilde{a}$ depending on dimensionless functionality of distance of $\tilde{r}$ in the range from 0 to ∞, is presented at Fig. 2.

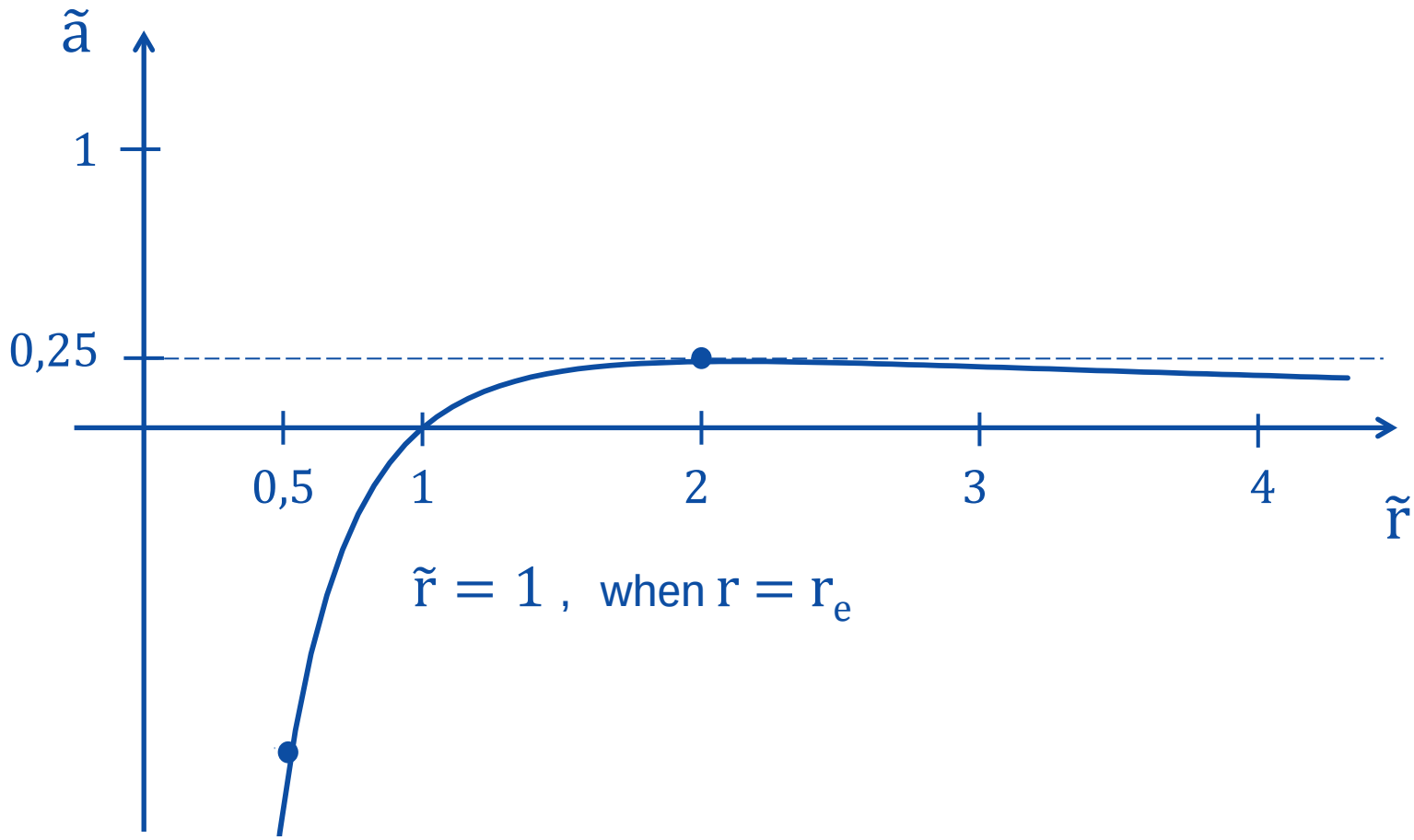


Fig. 2. Change of dimensionless functionality of acceleration ã depending on dimensionless functionality of distance r̃

In an explicit form the equation (3) has an appearance:

$$\frac{\partial^2 r}{\partial t^2} = \frac{3r^2 - t^2 \cdot G \cdot M}{r^2 \cdot t^2 \cdot GM}, \qquad (4)$$

where t – time.

For the constant speed of the particle $v = const$, particle acceleration $a = \frac{\partial^2 r}{\partial t^2} = 0$, what as appears from fig. 1 corresponds to $\tilde{r} \geq 1$, then the solution of the equation (4) will take a form [5]:

$$r = t^{2/3} \cdot \sqrt[3]{\frac{GM}{3}} \quad . \qquad (5)$$

Differentiating the equation (5) we obtain the following

$$v(t) = \frac{\partial r}{\partial t} = \frac{2}{3}\sqrt[3]{\frac{GM}{3}} \cdot t^{-1/3},$$

or

$$v(t) = \frac{2}{3} \cdot \sqrt{\frac{GM}{3}} \cdot \frac{1}{\sqrt{r}} \quad . \qquad (6)$$

Thus, the equation (6) confirms a conclusion of the equation (1) for **absolute** speed $v(t) \sim r^{-1/2}$ represented at Fig.1 and does not explain F. Zwicky's "paradox".

In the equation (3) automodel dimensionless functionality of acceleration $\tilde{a}$ does not depend on t, but depends on $\tilde{r}$ only, then we will obtain dimensionless functionality of speed $\tilde{v}$, which depends on $\tilde{r}\left(r; v(t)\right)$ only:

$$\tilde{v}(\tilde{r}) = \int \tilde{a}(\tilde{r})\, d\tilde{r} = \ln \tilde{r} + \frac{1}{\tilde{r}} \ . \qquad (7)$$

In this case physical sense of **absolute** speed v(t) (the observer is out of the Universe) and functionality of dimensionless **relative** speed $\tilde{v}(\tilde{r}\left(r; v(t)\right))$ (the observer is in the Universe) should be understood by analogy with observer's location difference in A. Einstein's study [6] (the observer is located on an embankment and watches the train moving; and the observer located directly in the train).

Proceeding from this fig. 1 will take a form

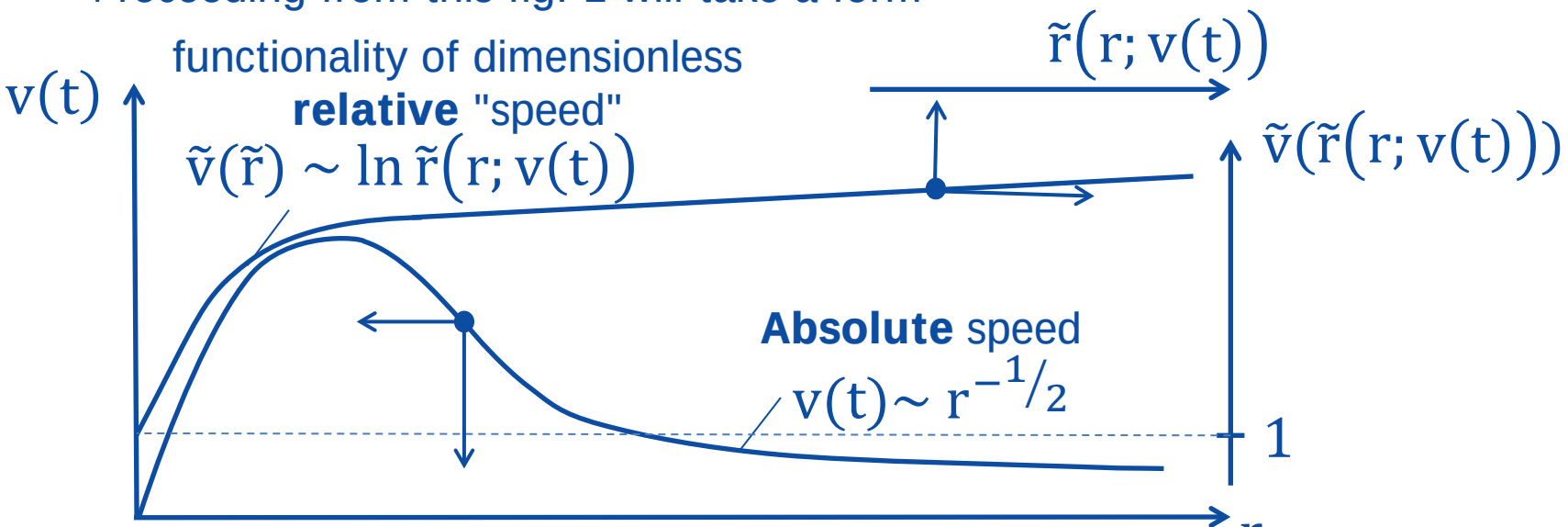


Fig. 3. Dependencies of $v(t)$ on r; and $\tilde{v}(\tilde{r})$ on $\tilde{r} \geq 1$.

A certain "feature" of the result (7) presented in fig. 3 is that for the observer who is in the Universe when $\tilde{r} \gg 1$ $\tilde{a}(\tilde{r}) \longrightarrow 0$, while the functionality of dimensionless **relative** "speed" $\tilde{v}(\tilde{r})$ rises $\tilde{v}(\tilde{r}) \sim \ln \tilde{r}$. This "feature" of self-similarity apparently explains the distinction in experimental results of different observers: some fix the increase in **relative** speed of the scattering bodies, others fix the lack of **relative** acceleration of those bodies.

Thus, the analysis of the equation (2) shows that if the energy of a particle, for example, presumably obtained as a result of "Big Bang", allows to overcome the M body's gravitational field, and that looks possible as the energy of "Big Bang" has to cause a powerful impulse of maximum dynamic pressures [7], then the further movement of particle (object) being removed happens at the **relative** speed of functionality $\tilde{v}(\tilde{r}) \sim \ln \tilde{r}$. This model is applicable for the movement of particles and bodies as well [3], in the gravitation it is well coordinated with an experiment [8] and offers an explanation of the known contradiction: why the Universe originally extended with delay, and then extended with insignificant acceleration, at the same time there is no need to enter the concept "dark energy" for an explanation of this contradiction.

This conclusion [8] was confirmed by researchers from Oxford at the end of 2016 who analysed 740 supernovae type Ia and called into question the "dark energy" existance as the distinction of the distances obtained by means of Ia supernovae and Hubble's law does not exceed three sigmas.

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