# Relativistic Distance-Luminosity Relation

Pavlo Danylchenko*

*Scientific-production enterprise "GeoSystem", Vinnytsia, Ukraine*

Anisotropy of the luminous intensity of distant astronomical objects of expanding Universe in intrinsic space of the observer is shown. The relativistic distance-luminosity relation, by which radial coordinate of astronomical object is being determined taking into account Hubble anisotropy of its luminous intensity, is received. As it follows from this relation, values of radial coordinates of distant astronomical objects in intrinsic space of the observer are much smaller than values of their coordinates, calculated by classical distance-luminosity relation. This makes the presence of such hypothetical components of the Universe as dark matter and dark energy unnecessary in principle.

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Only relativistic shift of radiation frequency is usually being taken into account during the analysis of the results of astronomical observations, while relativistic anisotropy of luminous intensity of distant objects of expanding Universe is being ignored. This, as it is shown here, substantially overrates values of radial coordinates of these objects in the intrinsic space of the observer. That's why taking into account of the anisotropy of luminous intensity of distant astronomical objects, proposed here, can make the presence of dark matter and dark energy in the Universe excessive.

The following relativistic transformation of angular coordinate of propagation direction of the light, at the transition from intrinsic frame of references of time and coordinates (FR) of object, moving at the velocity *v*, to the FR of observer of this motion, is well known [1, 2]:

$$\cos\breve{\varphi}_r = \frac{\cos\varphi_R + v/v_c}{1+(v/v_c)\cos\varphi_R}.$$

Here, velocity of light in the point, where object is, determined by coordinate clock [2] of the observer, according to Schwarzschild solution of the equations of gravitational field, is the function of Schwarzschild radial coordinate *r*:

$$v_c = c\sqrt{1-r_g/r-\lambda r^2/3},$$

where: $c$ – constant of the velocity of light; $r_g$ – gravitational radius of the astronomical body, from the surface of which the observation of object takes place; $\lambda$ – cosmological constant, which corresponds [3] to the presence of antigravitational field in observer FR and for the accelerated expansion of the Universe, caused by this field. According to all this, transformation of numerical apertures of the beam of light, which propagates in the direction, opposite to the object motion, ($\alpha_R = \varphi_R - \pi$), is the following:

$$\sin\breve{\alpha}_r = \sin\alpha_R\sqrt{1-v^2/{v_c}^2}\,[1-(v/v_c)\cos\alpha_R]^{-1}.$$

Here $\alpha_R$ and $\breve{\alpha}_r$ metrical values of aperture angles of registered beam of light in moving object FR and in observer FR correspondingly.

According to Schwarzschild solution, in non-Euclidean observer space metrical value of numerical aperture of the beam of light ($\sin\breve{\alpha}_r$) can be expressed via its observed value ($\sin\alpha_r$) the following way [2]:

$$\sin\breve{\alpha}_r = (dr/d\breve{r})\sin\alpha_r = \sin\alpha_r\sqrt{1 - r_g/r - \lambda\, r^2/3}\,,$$

where: $d\breve{r}$ and $dr$ – increments of metrical radial distance and Schwarzschild radius in observer FR correspondingly. According to Hubble relation in space-time continuum (STC) of the observer [4]:

$$v/v_c = Hr/c\sqrt{1 - r_g/r}\,,$$

where: $H = c\sqrt{\lambda/3}$ – Hubble constant. Taking all this into account, equivalent nonrelativistic value of the radial coordinate of astronomical object, which corresponds to classical distance-luminosity relation:

$$R = \frac{r}{\sqrt{1 - r_g/r} - (Hr/c)\cos\alpha_R} \approx \frac{r}{1 - Hr/c} \approx \frac{rr_c}{r_c - r} \approx \frac{zc}{H} >> r \approx \frac{zc}{(z+1)H}\,,$$

may be received from the condition of invariance of the aperture diameter $D = 2r\sin\alpha_r = 2R\sin\alpha_R = \text{inv}$ of recording instrument to coordinates' transformation. Here, taking into account $r_g << r$ and $\cos\alpha_R \approx 1$, radius of observer horizon $r_c \approx c/H$ and combined Doppler-antigravitational redshift of the radiation spectrum of astronomical object [5, 6]:

$$z = (c/v_c)(v_c + v)^{1/2}(v_c - v)^{-1/2} - 1 \approx Hr/(c - Hr)\,.$$

According to this, relativistic relation between luminosity of distant astronomical object, luminous intensity of which is isotropic in its intrinsic FR, brightness (illuminance

*E*, created by this object in the aperture plane of recording instrument) and Schwarzschild radial coordinate of the object in observer FR is the following:

$$L = 4\pi R^2 E \approx 4\pi r^2 \left(1 - r / r_c\right)^{-2} E .$$

This radial coordinate of luminous astronomical object can be expressed via the difference between its absolute *M* and apparent *m* stellar magnitudes by the relativistic distance-luminosity relation:

$$r = (10^{\xi / 5} + H / c)^{-1}$$

where: $\xi = M - m - 5$.

Clearly, evolutional process [4-6], which causes the Universe expansion, forms not only antigravitational field, but also global antigravitational lens, which corresponds to this field, in observer STC. This lens has Hubble negative lens power:

$$\varphi_H = -1 / r_c = 1 / R - 1 / r \approx -H / c$$

and forms virtual image of infinitely far Universe objects on the spherical surface of observer horizon.

So, radial coordinates of distant astronomical objects of expanding Universe are much smaller than it follows from the classical distance-luminosity relation, which doesn't take into account anisotropy of luminous intensity of these objects in observer STC. Therefore, the presence of dark matter in the Universe may be unnecessary. Taking into account the absence of expenditure of energy in the process of infinitely long free fall of distant astronomical objects on the observer horizon [4 – 6], the presence of dark energy in the Universe is also excessive. However, the presence of nonenergetical antigravitational field in the observer STC is doubtless.

The presence of fictitious necessities of dark matter and dark energy and the possibility of relativistic substantiation of the absence of these necessities are the one more convincing proof of the correspondence of special and general relativities to physical reality.

*Email address: pavlo@vingeo.com

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