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Comment on "Is space really expanding? A counterexample" by Michał J. Chodorowski [Concepts of Physics V. 4 No. 1 (2007) 15]

D.L. Khokhlov
Sumy State University
R.-Korsakov St. 2, Sumy 40007 Ukraine
e-mail:dlkhokhl@rambler.ru

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Author of [1] addresses one of the key question in cosmology, interpretation of the cosmological redshift (Hubble law). The standard cosmology, the Friedman model, gives interpretation of the cosmological redshift in terms of the expanding universe. Recall that the Friedman model describes the evolution of the scale factor of the universe with time, i.e. stretching of the space of the universe with time. The question arises relative to what the universe expands. Quoting reference in [1], "but why is then, say, Brooklyn, not expanding?" In the Friedmann model the universe expands at the large scale relative to the gravitationally bound scale. Then, in the Friedmann model, the Hubble law is valid for distances which are larger than the size of the cell of homogeneity, 100-150 Mpc or more. But observations [2] tell us that the Hubble law is seen not only at large distances but at distances from 1.5-2 to 20 Mpc as well. Putting aside confrontation of the theory against observation, the Friedmann model regards in fact two universes, static for bound structures and expanding for the whole universe. One can see different bound structures in the universe from the electron scale 10^{-13} cm to the supercluster scale 100 Mpc. These structures behave such if there is no expansion. The question arises how the two universes, static and expanding, may coexist. Yet, it is reasonable to have a unique universe which follows universal laws of scale invariance.

Instead of the idea of the stretching space, another interpretation is discussed elswhere, e.g. [3], that locally recession velocities associated with the cosmological redshift are kinematic. Author of [1] also follows this idea. The interpretation signifies that we proceeds from the Friedmann model to the Milne model wherein the particles fly away in the empty space. Then, the cosmological redshift is treated within special relativity as a Doppler effect. Nonetheless, the question relative to what the universe expands (particles move) remains unanswered. A particle in the Milne model, on the one hand, belongs to some bound (static) structure, on the other hand, is involved in the cosmological motion. In the Milne model we also have two universes, static and expanding, hence the problem of coexistence of the two universes remains unresolved.

Interpretation of the cosmological redshift in the static universe is proposed in [4]. Consider the static universe in the background Euclidean space and the absolute time. Let the universe have a finite size R. Suppose that the rest frame at the distance r is equivalent to the frame receding with the velocity

$$v = \frac{cr}{R} \tag{1}$$

where c is the speed of light. Write down the relativistic shift for the wavelength of light between two frames. The wavelength of light coming from the distance r is shifted in the frame of receiver as

$$\lambda_r = \lambda(1 + v/c) = \lambda(1 + r/R). \tag{2}$$

This shift of the wavelength of light may be interpreted as the Hubble law

$$z \equiv \frac{\lambda_r - \lambda}{\lambda} = \frac{r}{R} = \frac{Hr}{c} \tag{3}$$

where $H = c/R$ is the Hubble parameter. Thus, the shift for the wavelength of light between two rest frames at the distant r is the same as that between two moving frames with the velocity of recession given by eq. (1).

One can interpret the redshift depending on distance in terms of the relative velocity between two frames that seems to contradict to the static universe. But one should consider the effect relative to the whole universe. Since the velocity is relative one can take the frame at the distance r as a rest frame and the laboratory frame as a moving frame. Then, an observer in the laboratory frame determines the velocity $-v$ with respect to the rest frame at the distance r and the velocity v with respect to the opposite rest frame at the distance $-r$. The total velocity of the laboratory frame with respect to the both rest frames at the distance r is equal to zero. Hence, the laboratory frame has the null velocity with respect to the whole (static) universe.

In conclusion, the standard cosmology has no reasonable answer to the question relative to what the universe expands. Interpretation considered by author of [1] which treats the cosmology in terms of moving particles in the empty space (Milne model) instead of the space stretching with time (Friedman model) also gives no plausible answer to the question. A possible resolution of the problem is to consider the relativistic effect depending on distance [4] which explains cosmological redshift in the static universe. The relativistic shift depending on distance mathematically explains the cosmological redshift in a similar way as a conventional Doppler effect however the interpretation is different. We come to the static universe whereas the expansion of the universe due to the cosmological redshift turns out to be mere an illusion.

References

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