Astronomical error

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Measurement of distances in astronomy requires considering optical properties of media through which light propagates. We show that currently adopted method[1] of determining large distances in the Universe systematically overestimates astronomic distances and prevents properties of the intergalactic medium from being discovered. We show that distance measurement errors of the current method increase exponentially with the measured distance and that cosmological conclusions based on distances from high-red-shift supernovae, such as the conclusion that the Universe accelerates its expansion[1], are likely to be incorrect, because they are based on large systematic and exponentially growing errors. In view of presented findings many astronomic observations may need to be re-interpreted.

When we look at a local "sample" of the Universe, such as our Solar System or our Galaxy, we see mainly matter. And yet, after a few centuries of research, scientists on Earth conclude that the structure of the Universe is exactly the opposite: only 4% of the Universe seems matter and 96% remains a "mystery".

When the level of contradiction and mystery reaches 96% it may be wise to re-examine adopted methods and assumptions to see if there was a mistake somewhere. This letter aims to expose one such mistake.

Distances in astronomy are determined on the basis of measuring the intensity of light received from distant objects that emit a reproducible amount of energy and have reproducible intrinsic luminosity such as supernovae[1].

The method of measuring distances in astronomy is based on spherically symmetric light propagation that provides an inverse square relationship between intensity (luminosity) ratio I/I_o and the distance D_L.

$$\frac{I}{I_o} = \frac{1}{4\pi D_L^{\,2}} \tag{1}$$

Using this method, distance D_L of an object of known luminosity I_o is estimated using the measured luminosity I as follows[1]:

$$D_L = \sqrt{\frac{I_o}{4\pi I}} \tag{2}$$

In reality, intensity I of the light perceived by observer located at distance D from the source of light of intensity I_o depends on two phenomena: spherically symmetric light propagation and the absorption/attenuation of light by the media that light travels through. Adopting the simplest possible model of light absorption/attenuation in gas we have

$$\frac{I}{I_o} = \frac{e^{-\alpha D}}{4\pi D^2} \tag{3}$$

where α is the average absorption (attenuation) coefficient of the media over the propagation distance D. When propagation medium is disregarded ($\alpha = 0$) the value D_L estimated from measured luminosity ratio I/I_o is larger than true distance D, because luminosity loss due to absorption/attenuation is misinterpreted as a longer distance.

For small distances D and small α the exponent $\alpha D \approx 0$ and estimated D_L obtained from simplified relationship (1) is similar to D. As the distance D grows to billions of light years, the magnitude of the exponent αD grows and eventually becomes significant even for very small value of α. Systematic distance error arising from the assumption that $\alpha = 0$ grows exponentially with distance D , according to the relationship $D_L / D = e^{\alpha D/2}$.

If the intergalactic space contains, on average, just 1 atom of hydrogen or antihydrogen[2] per cubic kilometer, the corresponding attenuation coefficient α can be estimated to be $\alpha = 4.523893 \times 10^{-26}$. Transmittance of such space extending for the distance of 1 billion light years will be $e^{-\alpha D} = 0.6518137$ and the corresponding distance D_L error resulting from the assumption that $\alpha = 0$ will be about 23%: $D_L \approx 1.23D$. For the distance of 5 billion light years $D_L \approx 2.9D$. If light attenuation of space is ignored, the distance measurement error grows exponentially with distance, because the ratio $D_L / D \approx \exp(0.2139983x)$ where x is expressed in billions of light years (Fig 1).

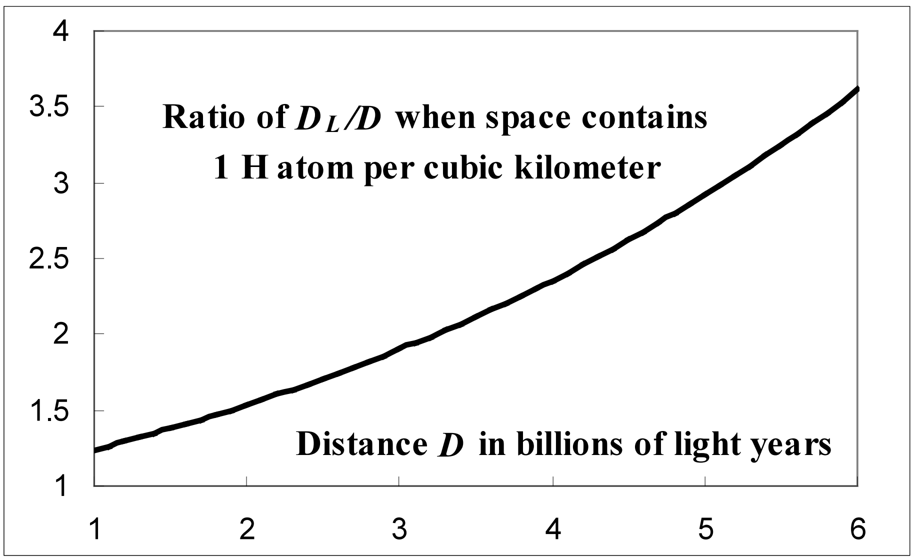

Fig 1. Ratio of D_L / D grows exponentially with distance when space contains just 1 H atom per cubic kilometer.

Cosmological conclusions that are based on large distance measurements using luminosity ratio should be critically re-examined. One such conclusion that should be re-examined is that the Universe accelerates its expansion[1]. The conclusion of accelerating expansion of the Universe is a result of distant supernovae proclaimed to be 10-15% farther away than expected in a low-mass density Universe without the cosmological constant. We have shown that distance errors much larger than 15% can arise from currently disregarded attenuation of light in space.

Relationship (3) contains two unknowns D and α. Additional information is required to determine realistic astronomic distances from luminosity measurement of distant supernovae and other suitable astronomical objects.

Admitting for consideration light absorption/attenuation by the intergalactic media as well as by space itself is important, because it allows us to determine their properties. Currently adopted assumption that $\alpha = 0$ actually prevents us from discovering what is the value α in our Universe.

In view of the considerations above, astronomic observations that include distance data may need to be re-interpreted.

Since some luminosity loss of distant astronomical objects is likely to be caused by attenuation of light in the intergalactic space, the Universe is likely to be smaller, younger and less mysterious than we currently believe.

References

1. Riess, A. et al. (1998). "Observational Evidence from Supernovae for an Accelerating Universe and a Cosmological Constant". The Astronomical Journal **116** (3): 1009–1038
2. Chalko T.J. "Does anti-matter matter?" NU Journal of Discovery Vol 7, Nov 2011 http://NUjournal.net