Review of: "A Robust Assessment of the Local Anisotropy of the Hubble Constant"

Hirokazu Fujii

Potential competing interests: No potential competing interests to declare.

This article aims at assessing the degree of anisotropy in the local Universe. The author considered several univariate cosmological models parametrised by the Hubble constant and fitted the models to the m-z relation of supernovae taken from the Pantheon+ compilation. All of the cosmological models considered (the concordance LCDM model, the Einstein-de Sitter model, flat and open coasting FLRW models, and three tired-light static models) are based on the assumption of the large-scale homogeneity of the Universe. Imposing different low-redshift cutoffs ($0 < z_{cut} < 0.15$) to the sample, the author found that 1) even the concordance LCDM model cannot explain the m-z relation over the entire redshift range (i.e. $z_{cut} = 0$) due to large scatters seen locally, and 2) two independent models, i.e. the LCDM model and one of the tired-light models (called the ncTL model), are consistent with the data for $z_{cut} > 0.035$, while the other models are rejected based on large chi-squared residuals. From the second result, he argues that the redshift of 0.035 be related to the scale of homogeneity, which is in agreement with previous works based on different observational data and methods. The author also studied whether there is a direction in the sky where the Hubble flow is quiet, i.e. both low-redshift ($z < 0.05$) and high-redshift ($z > 0.05$) supernovae show a consistent m-z relation with the predictions of LCDM and ncTL models. He found such directions for both of the models, which are roughly coincident with the CMB dipole direction, without giving any discussions on this result.

In general, I find this study interesting, but also feel that there are several points that the author should address before publishing the paper. My comments are as follows.

1. The author should elaborate on his originality as to the result that the LCDM model is not consistent with observations when $z_{cut} < 0.035$. Popovic et al. (2023, cited as [53]) already mention that they “require $z > 0.03$ to avoid difficulties modeling Hubble scatter with significant contributions from peculiar velocities”, which is essentially the same as what the author states in this paper. Indeed, given the typical peculiar velocity of galaxies $v_{pec} \sim 400$ km/sec, one may conclude, without the need to analyse data, that a redshift cutoff of 0.03--0.05 be needed to ensure $v_{pec} \ll cz$, which validates the homogeneity assumption.
2. The author may give a more detailed discussion on the result that the direction in the sky where the supernovae m-z relation is ‘consistent’ over the entire redshift range roughly coincides with the CMB dipole direction. For instance, is this what is expected if the nearby ($z < 0.05$) supernovae are moving toward in that direction together with our own Galaxy and Local Group? If so, is such a bulk motion consistent with the prediction of the standard cosmological model?
3. Aluri et al. (2023, cited as [12]) should not be cited in the context of saying that the homogeneity assumption has been

well confirmed, since this paper rather reviews observational anomalies that may indicate the violation of this assumption.

4. The author states that he retrieved cosmological redshifts data from the Pantheon+ GitHub server, but the term ‘cosmological redshift' must be avoided since it usually refers to the redshift due entirely to the expansion of the universe, while the redshift data available in such database are mostly observational, which are ‘polluted’ by various effects (e.g. Davis et al. 2011[1]).
5. The author should add some justification to consider tired-light static universe models since the measurements of time dilation effect have already rejected this class of cosmological models (e.g. Blondin et al. 2008[2]). Moreover, stating that these models are ‘backed by Nobel laureates’ should be avoided, as it may give the impression that the author considers the validity of a model is reinforced by the authority supporting it.
6. In Conclusion section, the author states that the cutoff redshift of 0.035 corresponds to the homogeneity scale 100 / h Mpc and it is significantly above most previous estimates. I would not agree with this statement because he compares numbers that are derived from different populations, which are biased differently and must have different homogeneity scales unless the biasing effect is corrected.

References

1. ^*Tamara M. Davis, Lam Hui, Joshua A. Frieman, Troels Haugbølle, et al. (2011).THE EFFECT OF PECULIAR VELOCITIES ON SUPERNOVA COSMOLOGY. ApJ, vol. 741 (1), 67. doi:10.1088/0004-637x/741/1/67.*
2. ^*S. Blondin, T. M. Davis, K. Krisciunas, B. P. Schmidt, et al. (2008).Time Dilation in Type Ia Supernova Spectra at High Redshift. ApJ, vol. 682 (2), 724-736. doi:10.1086/589568.*