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COSMOLOGICAL DISTANCES SURPRISINGLY ACCURATE

Precision distances to galaxies and the cosmological scale based on them are surprisingly solid, and free from unknown systematic effects (unless such effects cancel exactly), reports Ian Steer, retired curator of NASA's database of precision distances for galaxies, in *The Astronomical Journal*, released October 7, 2020.

Half a dozen diverse methods commonly used to calculate mean values for cases with multiple values, when applied to extragalactic distances, agree to a greater degree than expected in all cases studied. This proves the diverse estimates may be scattered individually. Surprisingly however, when taken together, estimates are more accurate in their mean than scatter alone would suggest.

Multiple estimates are like multiple darts. Both can be tight or scattered, and on or off target. Scatter measures random imprecision verses precision. Target miss distance measures non-random or systematic inaccuracy verses accuracy. Diverse extragalactic distances are imprecise individually. Taken together and in their means however, they are impressively accurate.

The new study bolsters confidence that the true errors in extragalactic distances are surprisingly small, both in terms of their random and internal precision, as well as their non-random and external accuracy.

This is good news for the validity of estimates of the universe's size and expansion rate. Hubble expansion rate estimates have seen a significant reduction in scatter over the last four decades, by about a factor of four, as shown in the article's Figure 2.

Regarding the current controversy over the Hubble constant, a graph of nearly a thousand Hubble constant estimates published since 1980 strongly favors a mean of around 68 km s^{-1} Mpc^{-1} and rules out any values greater than 73 km s^{-1} Mpc^{-1}, as shown in the article's Figure 2.

The study gives us a poor man's way of estimating the accuracy of multiple measurements, which normally can only be determined using external and independent means. Here, accuracy is inferred from the estimates themselves, based on the fact that no matter how estimates are weighted or not weighted and/or selected or not selected, all mean estimating methods give consistently the same value again and again in case after case.

One result of the research is an unsurprising answer to an old question. What is the best way to estimate the mean of multiple data points? If the data is "well behaved", defined as imprecise individually but accurate in the mean, then all mean estimating methods will result in the same mean answer. In essence, all roads lead to Rome in galaxy mean distances.

The finding supports the idea that inclusiveness and respect for diverse data and methods results in better, more viable and more valid information than the normal approach that excludes most data, and takes only the most pristine, cherry picked choices. Extragalactic distances data, like the life forms gathering it, are stronger together than expected and work better together than apart.

Better distances will lead to better cosmological parameters including the Hubble expansion rate, better 3D maps of the universe, as shown in the article's Figure 5, and better advance catalogs of galaxies with better odds of identifying gravitational wave cross-matches, as were referenced to discover the first optical counterpart of a gravitational wave in 2017, GW170817.

A record number of galaxies with multiple precision distances were involved. Around ~12,000 galaxies with ~78,000 individual distance estimates were analyzed, as tabulated in the NASA/IPAC Extragalactic Database (NED) of Distances (NED-D).

The new data also shows how super-clusters of galaxies make up most of the 3D structure of our universe. Many galaxy super-clusters are clearly visible in the 3D image of the whole sky, in which the ~12,000 galaxies identified are plotted in galactic coordinates, as shown in the article's Figure 5.

See also: http://ned.ipac.caltech.edu/Library/Distances/

and: https://iansteer.com

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Reference:
"Mean Estimate Distances for Galaxies with Multiple Estimates in NED-D," Ian Steer, 2020 Oct. 7, Astronomical Journal [https://doi.org/10.3847/1538-3881/abafba].

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