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Luminosity distance dispersion in Swiss-cheese cosmology as a function of the hole size distribution

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The luminosity distance-redshift (D_L-z) relation of Type Ia supernovae (SNe Ia) yields evidence for a nonzero cosmological constant, i.e. 'dark energy'. SNe Ia analyses typically involve fitting the D_L and z to the functional form derived theoretically from the homogeneous and isotropic Friedmann-Lemaitre-Robertson-Walker (FLRW) metric. However, the metric in the epoch relevant to SNIa measurements deviates appreciably from FLRW due to gravitational clumping of mass into large-scale structures like filaments and voids, whose size distribution spans many orders-of-magnitude. Each line of sight to a SNe Ia passes through a random sequence of structures, so D_L differs stochastically from one line of sight to the next. Such dispersion in D_L may be dominated by a few large voids or many small voids, partly depending on the probability density function of the void size. In this work, we calculate the D_L dispersion in a Lemaitre-Tolman-Bondi Swiss-cheese universe with a power-law hole size distribution, as a function of the lower cut-off and logarithmic slope.

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