Applying Black Holes as Cosmological Standard Rulers

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Standard rulers are astronomical objects with known intrinsic sizes whose apparent angular sizes can be used to determine their distance. Black holes (BHs) represent a potential standard ruler since their intrinsic sizes can be determined using their mass, and supermassive black holes (SMBHs) have observable angular sizes at cosmological scales. However, as far as I am aware, the use of BHs as standard rulers remains untested and has yet to be formally applied. Through my research, I present a formal application of this method to find the distance to the galaxy M87. I estimate the mass of M87's SMBH (M87*) using the distance independent M-Sigma relation, which relates SMBH mass to stellar velocity dispersion. Using this mass, I calculate the shadow radius of M87* to be 1.6 (+157%, -61%) e13 m, with uncertainties from scatter in the M-Sigma relation. I relate this intrinsic size to M87*'s angular radius of 21.15 microarcseconds, obtaining a distance of 4 (+6, -2) e23 m (rounded). Using this distance and M87's recessional velocity, I calculate the Hubble Constant (expansion rate of the universe) to be 125 (+190, -76) km/s/Mpc. My results exhibit large uncertainties and errors, with accepted distance values being +30% larger than what I obtained. I therefore conclude that currently, the use of SMBHs as standard rulers is experimental at best. Large intrinsic scatter in the M-Sigma relation, one of the only applicable distance-independent mass measuring methods, is the primary contributor to the uncertainties in my results, indicating that SMBH mass estimation is the most crucial practical issue. My conclusions highlight key flaws relating to this method, indicating a need for future development to improve practical feasibility.

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