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# The Gaia and HST Cepheid Scales, Galactic Reddening, and the $H_0$ Tension

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The latest SH0ES results claim that the distance scale route to  $H_0$  is accurate to  $\pm 1\%$  which creates a 9% or 5% discrepancy with the Planck  $H_0$  value. Here we study the SH0ES error budget in the 3 rungs of their distance ladder. After checking the validity of the suggested correction to the Gaia distances using  $\approx 1000$  open clusters, we confirm that the previous Milky Way HST calibration of the Cepheid Period-Luminosity (PL) relation is discrepant at the 9% level with the new Gaia Cepheid PL calibration, or  $3\times$  the error originally quoted by SH0ES. Secondly, using open clusters we find evidence for significant variations in the Galactic reddening law that can move the ratio of total to selective absorption from  $R_V = 3.3$  to  $R_V \approx 4$  and this source of error is not included in the SH0ES error budget. Thirdly, using a maximum likelihood technique, we find that photometric incompleteness in the PL relations in the SH0ES SNIa calibrating galaxies can cause underestimation of their distances, resulting in an  $\approx 3\%$  reduction in the  $H_0$  value. Finally, we find that the inclusion of a peculiar velocity correction for the 'Local Hole' may cause a further 2.6% reduction in the SH0ES  $H_0$  measurement. We conclude that the SH0ES 1% overall error may be an underestimate. For example, applying just our Cepheid incompleteness and 'Local Hole' corrections would already result in a SH0ES  $H_0$  value no higher than  $70 \text{ km s}^{-1} \text{ Mpc}^{-1}$ .

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