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Improved Weak Lensing Photometric Redshift Calibration via StratLearn and Hierarchical Modeling

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Discrepancies between cosmological parameter estimates from cosmic shear surveys and from recent Planck cosmic microwave background measurements challenge the ability of the highly successful ΛCDM model to describe the nature of the Universe. To rule out systematic biases in cosmic shear survey analyses, accurate redshift calibration within tomographic bins is key. In this work, we improve photo-z calibration via Bayesian hierarchical modeling of full galaxy photo-z conditional densities, by employing StratLearn, a recently developed statistical methodology, which accounts for systematic differences in the distribution of the spectroscopic training/source set and the photometric target set. Using realistic simulations that were designed to resemble the KiDS+VIKING-450 dataset, we show that StratLearn-estimated conditional densities improve the galaxy tomographic bin assignment, and that our StratLearn-Bayesian framework leads to nearly unbiased estimates of the target population means. This leads to a factor of ~ 2 improvement upon often used and state-of-the-art photo-z calibration methods. Our approach delivers a maximum bias per tomographic bin of $\Delta\langle z\rangle = 0.0095 \pm 0.0089$, with an average absolute bias of 0.0052 ± 0.0067 across the five tomographic bins.

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