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Strong Lensing Science from Current and Future Astronomical Surveys

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Strong gravitational lenses are cosmic magnifying glasses that can be used as a probe of cosmic phenomena, like dark energy and dark matter. However, strong lensing systems are rare and complex, which means they are both hard to find and analyze. We present two important results in strong lensing science: 1) new deep learning techniques for finding and measuring strong lenses; and 2) dark energy forecasts for future surveys that will find hundreds of thousands of lensing systems. Current surveys, like DES, are predicted to discover thousands of galaxy-scale strong lenses, while future surveys, like LSST will increase that number by 1-2 orders of magnitude. The large number of strong lenses discoverable in future surveys will make strong lensing a highly competitive and complementary cosmic probe, but only if they can be analyzed on realistic time-scales. We demonstrate a novel deep learning regression analysis which can infer strong lensing observables from ground-based imaging for thousands of lenses to within 10-15% of their true values in a fraction of the time conventional modeling techniques take. We then use these uncertainties to inform how well we can constrain cosmology with galaxy-scale lenses in the DES and LSST era, demonstrating the statistical power of this probe in relation with other conventional probes of cosmology.

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