Scientific Justification *Be sure to include overall significance to astronomy. For standard proposals limit text to one page with figures, captions and references on no more than two additional pages.*

Strong gravitational lensing (SL) is a powerful tool in astrophysics and cosmology, enabling precise measurements of galaxy structure, dark matter distribution, and cosmological parameters. The upcoming Vera C. Rubin Observatory Legacy Survey of Space and Time (LSST) is expected to identify tens of thousands of lensing systems, presenting great opportunities to do science, but also new challenges. Current methods of lens modeling are not suitable to handle this massive influx of data, prompting the development of artificial intelligence (AI) models for fast and automated parameter inference. Observations of known lensing systems are critical for training and validating these AI models, as they provide high-quality data on the key physical parameters of the lens and source galaxies.

Zaborowski et al. recently identified a sample of strong lensing candidates in images from the DELVE survey, obtained using DECam. Among these, approximately 60 Grade A candidates are considered highly likely to be genuine lenses. While DECam's wide field of view and sensitivity enabled the initial identification of these candidates, its relatively low spatial resolution limits the ability to resolve detailed features of the lensing arcs and their associated galaxies. In order to better characterize these systems, we propose using SOAR's Goodman spectrograph perform spectroscopic observations to determine the redshifts of the lens and source galaxies and measure the velocity dispersion of the lens galaxy. These parameters are key components of the Singular Isothermal Ellipsoid (SIE) lensing model, widely used in lensing analyses. By constraining these parameters, we can refine lens models and improve the accuracy of inferred quantities such as the total mass distribution of the lens.

Furthermore, the proposed observations will provide useful data on a diverse set of strong lensing systems, aiding in the creation of training sets for the development of AI-based lens modeling techniques. These methods will play a central role in analyzing the high number of lensing systems anticipated from LSST. Currently, one of the biggest challenges in the development of AI-based modeling techniques is validating the performance of models trained on simulated Strong Lensing data. The spectroscopic measurements proposed in this work would be highly applicable to the validation of these algorithms. Moreover, the data will contribute to a deeper understanding of galaxy evolution, dark matter properties, and the interplay between baryonic and dark matter components in massive galaxies.

In summary, the proposed observations will enhance our understanding of strong lensing phenomena, support the development of AI models for automated lens modeling, and help prepare the community for the lensing discoveries to come from LSST.

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Experimental Design *Describe your overall observational program. How will these observations contribute toward the accomplishment of the goals outlined in the science justification?*

We plan to conduct spectroscopic observations of the strong lensing (SL) systems using SOAR's Goodman High Throughput Spectrograph (GHTS). We will use Goodman in long-slit mode with a 1.0" slit and a 400 l/mm grating, covering the spectral range 300–900 Å. The primary goals of spectroscopy are to measure the redshifts of the lens and source galaxies and derive the velocity dispersion of the lens galaxy, a key input for Singular Isothermal Ellipsoid (SIE) models.

Exposure times for each object are calculated to achieve S/N $\approx$ 10 for the source galaxy of each system, and are available in the target list. Since we plan to observe the lensed features as well, extra time needs to be allocated to each object. Due to magnification effects, the magnitude of the lensed arcs are not available in the data released by Zaborowski et al., but we estimate that an exposure time equal to the one used for the lens galaxy should be enough since the lensed features have comparable magnitudes to the lens galaxy. An average time of 1300 seconds per target will be sufficient under typical seeing conditions ($\approx$1.0"). This estimate factors in time for Target acquisition and centering, Instrument calibration, readout Time, and exposure times for both the lens galaxy and the lensed arcs, as well as a factor of 30% for contingency, but it does not include the time required for calibration using Dome Flats, which should be done in the afternoon before the observations.

We plan to observe 17 Grade A SL candidates identified in prior work and calculated to have exposure times under 600 seconds. Observations will be conducted under dark or grey moon conditions with seeing $<$ 1.0" to optimize spectral resolution. These constraints are consistent with SOAR's typical observing conditions, ensuring the feasibility of the program. The estimated time for all observations is 6.5 hours, so we request one night.

Spectroscopic data will be reduced using the Goodman Data-Reduction pipeline for bias subtraction, flat-fielding, and wavelength calibration. Redshifts will be measured by cross-correlating the observed spectra with template galaxy spectra, and velocity dispersions will be derived using standard line-fitting techniques. We will validate these results against known measurements where available to ensure reliability.

These observations will provide the high-quality data needed to refine SL models and help validate the results obtained by AI algorithms for automated lens modeling.