# Automatic Generation of Caustic Maps to Enhance Microlensing Modeling of Lensed Quasars light curves

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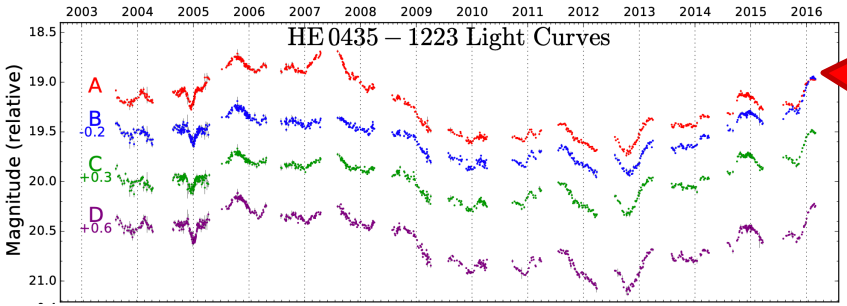
Aug 2023

# Modeling Microlensing in light curves of Lensed Quasars

Multiply-lensed Quasars

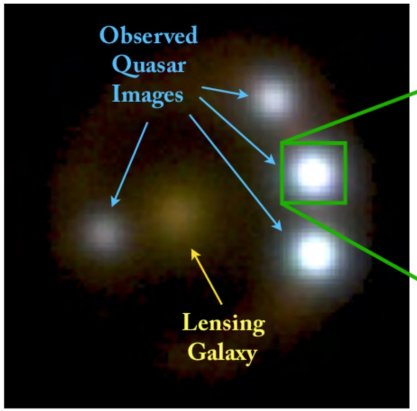

- The multiple images will be affected by the individual stars and objects in the lens galaxy along their line of sight, which is called "microlensing".
- Enhanced modeling of the microlensing variation in lightcurves of strong-lensed multiply-imaged quasars leads to more precise measurements of the cosmological time delays and the Hubble Constant.
- We can use it not only to get better measurements of $H_0$, but also to study quasars structure and the distribution of mass of stars in distant galaxies.

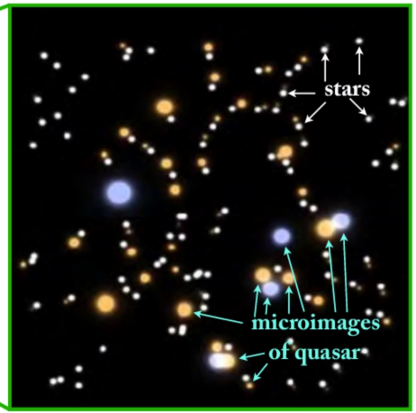


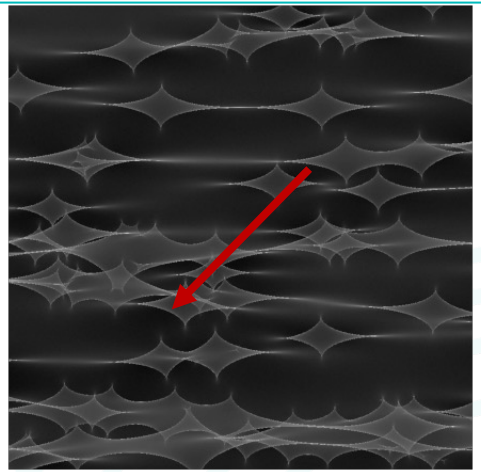

Time Delays → Hubble Constant

**Microlensing is a problem here!**

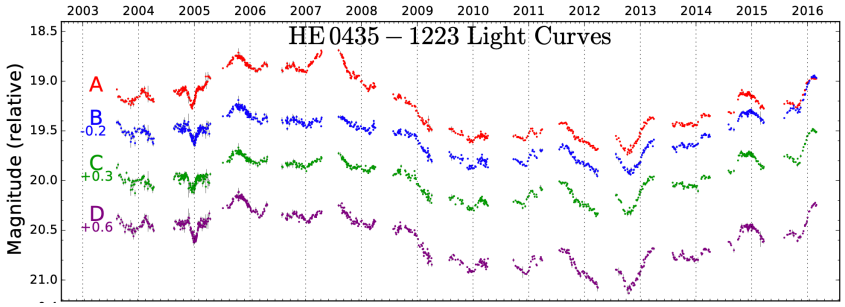
# Modeling Microlensing in light curves of Lensed Quasars



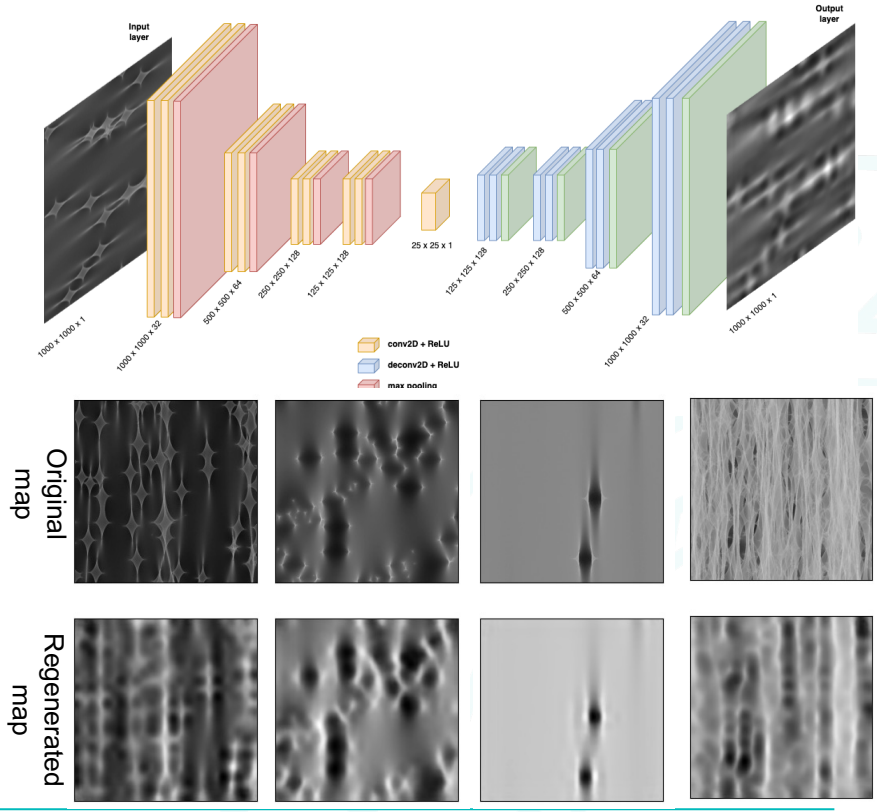



Magnification Maps



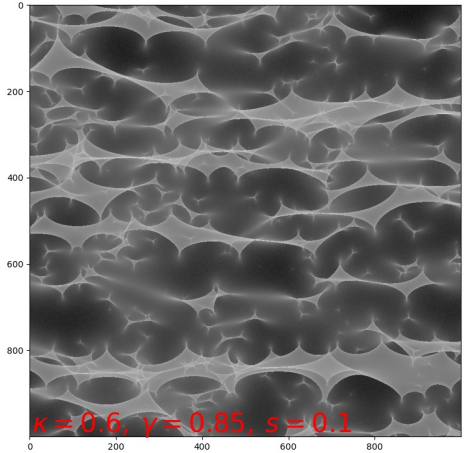
# Caustics Maps Generation using AI

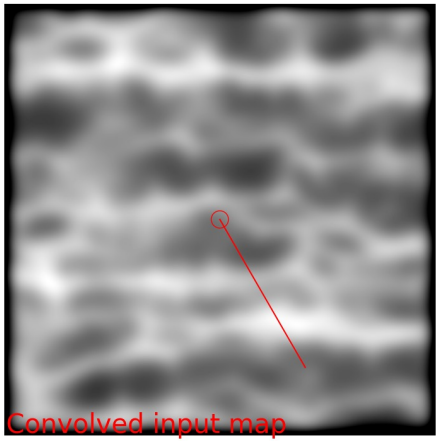
- We use variational autoencoders (VAE) **to compress magnification maps to speed up their generation or to even bypass maps altogether.**
- Our training set includes ~12000 pre-computed magnification maps (Vernardos et. Al. 2014).
- The structure of our VAE is inspired by the Unet[2] network that is used for image segmentation.
- The network is able to reduce the dimensions from 1000x1000 to 25x25 and back to the original dimensions and regenerate the patterns in the maps.
- Different parameters can generate maps that have significantly different patterns and statistical features. The VAE is able to capture all these differences.

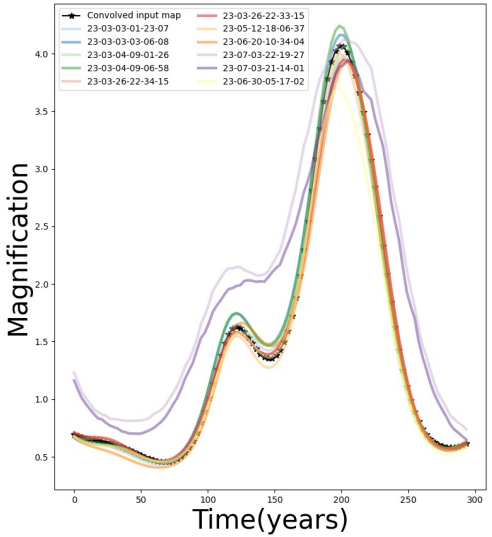


# Results

- The latent space representation is explored in 2D visualizations to see how maps with different ranges of initial parameters are distinguished. The reduced dimensions form a small meaningful parameter space that contain the most important features in the input.
- We generate light curves from the predicted maps and compare with the true light curves to find how details of the maps are reproduced.
- Next step is to make this dimension reduction part of the lightcurve analysis and help automate the process.



# Thanks for listening!