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Uncovering Mass Distributions through Gravitational Time Delays

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Changes in the brightness of fast transients, observed over hours to months, can reveal the mass distribution of galaxies that lie along the line of sight. These galaxies deflect light from the source via gravitational microlensing. The difference in path length of individual rays, paired with variations in gravitational potential, change the arrival time of lensed light. These microlensing time-delays are imprinted in the lightcurves of the source and reflect the internal structure of the intermediate galaxy. These patterns can be recovered by simulating how light rays travel through the lensing galaxies. However, such a process is computationally expensive. We use the Python library JAX to enable fast, efficient computation through just-in-time compilation and GPU acceleration. In light of upcoming observations, the accelerated microlensing computation that we present here will be key in unveiling the large-scale structure of the Universe.

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