

Caustics: A Differentiable, GPU Accelerated, Gravitational Lensing Simulator



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We present Caustics, a tool to accelerate the analysis of gravitational lensing systems for the next generation of astronomical data. Caustics will enable precision measurements of dark matter properties, the expansion rate of the Universe, lensed black holes, the first stars, and more. In this talk I will the benefits and challenges of how we used PyTorch (a differentiable and GPU accelerated scientific python package) to allow for fast development without sacrificing numerical performance. I will detail our development process as well as how we encourage users of all skill levels to engage with our documentation/tools. Caustics is already shaping new exciting discoveries in the search for dark matter, which I will detail in this talk. I will demonstrate how a differentiable gravitational lensing code can seamlessly interface with machine learning models to provide state of the art source reconstruction and lens modelling in strong gravitational lenses. Specifically score based models allow for principled posterior sampling in a previously unsolved problem in astrophysics, we are now able to perform precision cosmology using gravitational lenses without the bias of oversimplified models. Further, with GPU acceleration we can explore parameter space at an unprecedented rate, making Caustics the ideal tool for gravitational lensing analysis.

Biography:

I am a postdoctoral fellow at the Université de Montréal in Canada. I apply statistics to astronomical problems and I'm not afraid to develop some open source software along the way! I study Galaxies, strong gravitational lensing, and machine learning.