

26th International Microlensing Conference

January 31–February 1-2, 2023



Disentangling the Black Hole Mass Spectrum with Photometric Microlensing Surveys

Scott E. Perkins
Postdoctoral
Researcher



LLNL-PRES-859989

This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under contract DE-AC52-07NA27344.
Lawrence Livermore National Security, LLC.

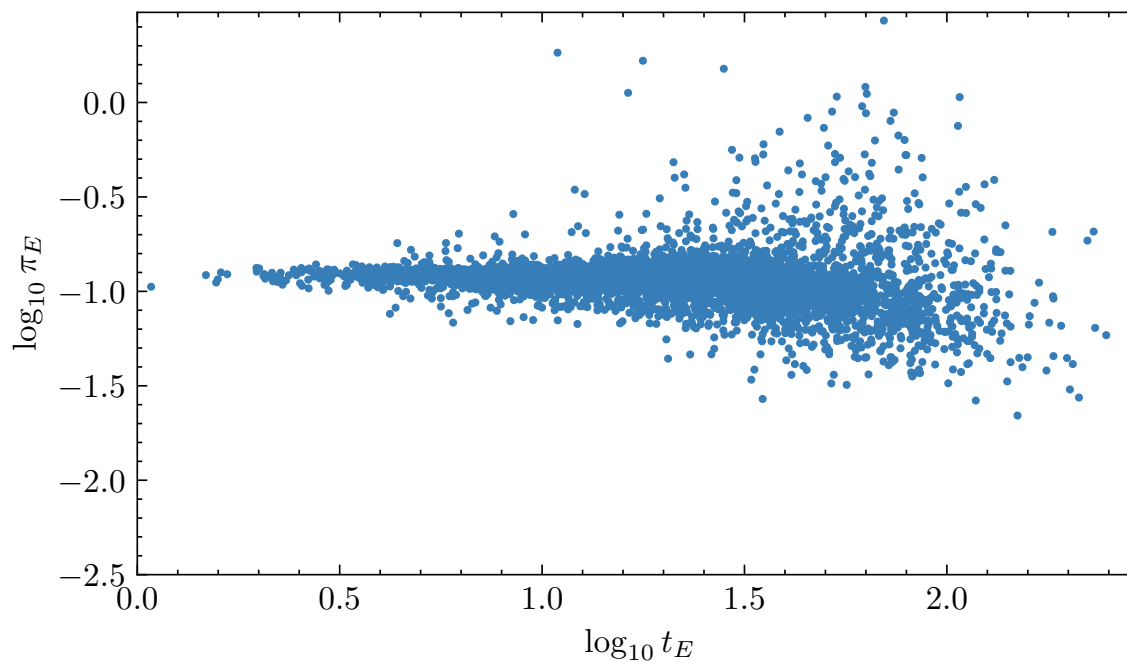
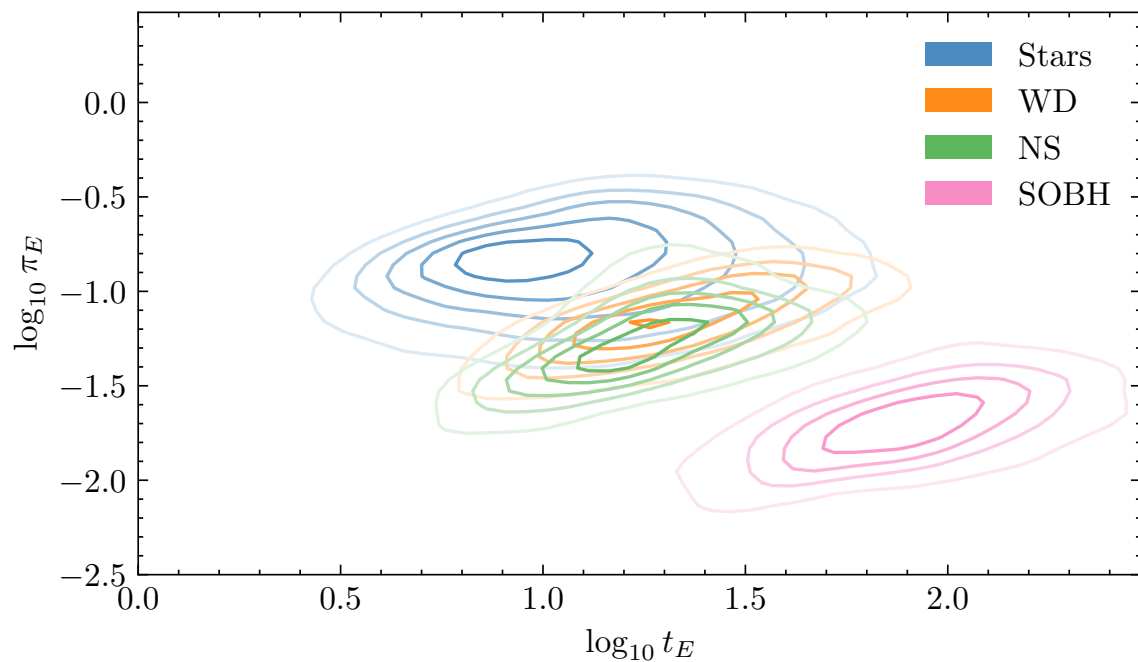
This work was supported by the LLNL-LDRD Program under Project 22-ERD-037.

Based on
Perkins et al 2024 ApJ 961 179
(arXiv:2310.03943)



Motivation - Detectability in Parameter Distributions

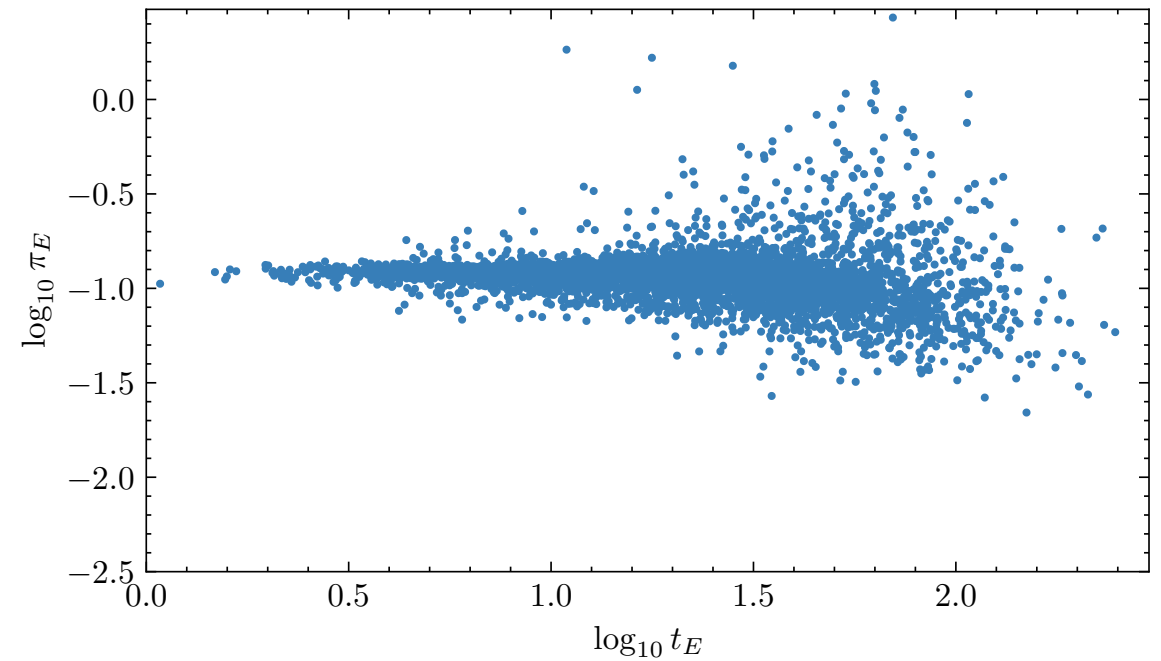
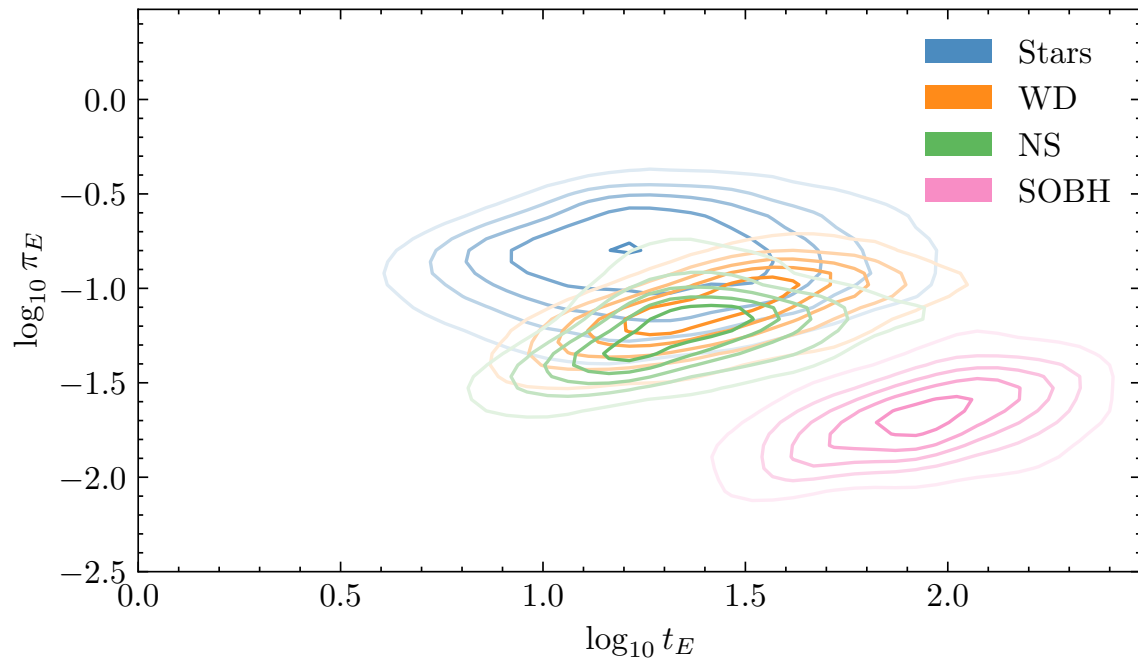
Lam + 2020
Golovich + 2022



Separation in distributions of observable parameters \Rightarrow Possibility of informative inference, despite uncertainty and selection bias

Motivation - Detectability in Parameter Distributions

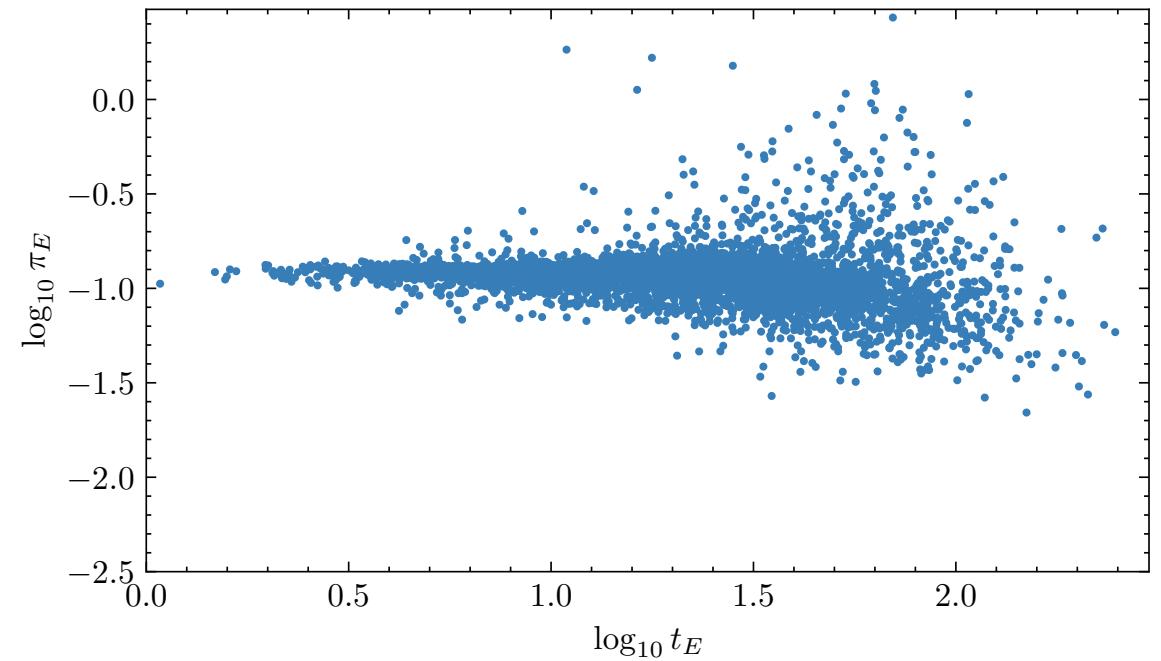
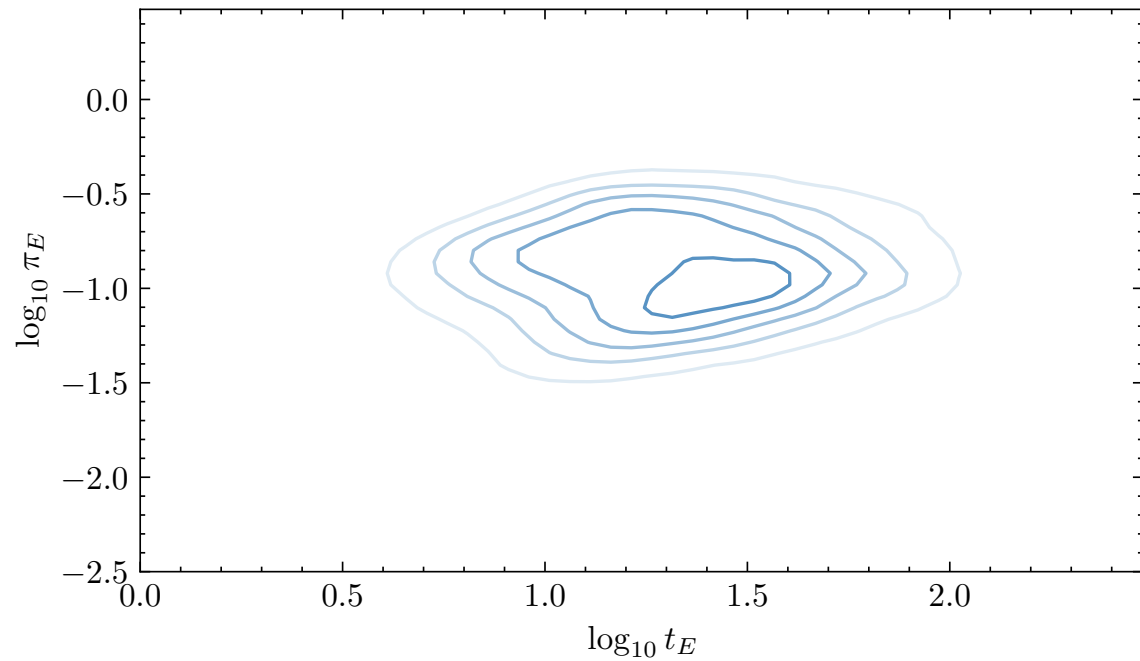
Lam + 2020
Golovich + 2022



Separation in distributions of observable parameters \Rightarrow Possibility of informative inference, despite uncertainty and selection bias

Motivation - Detectability in Parameter Distributions

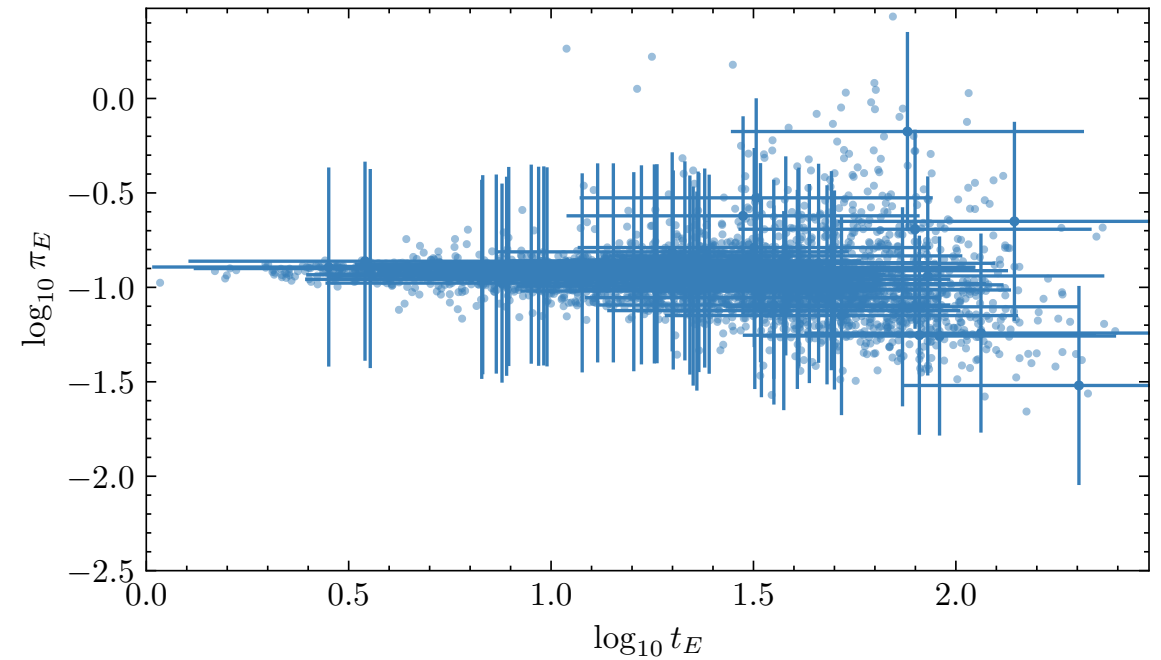
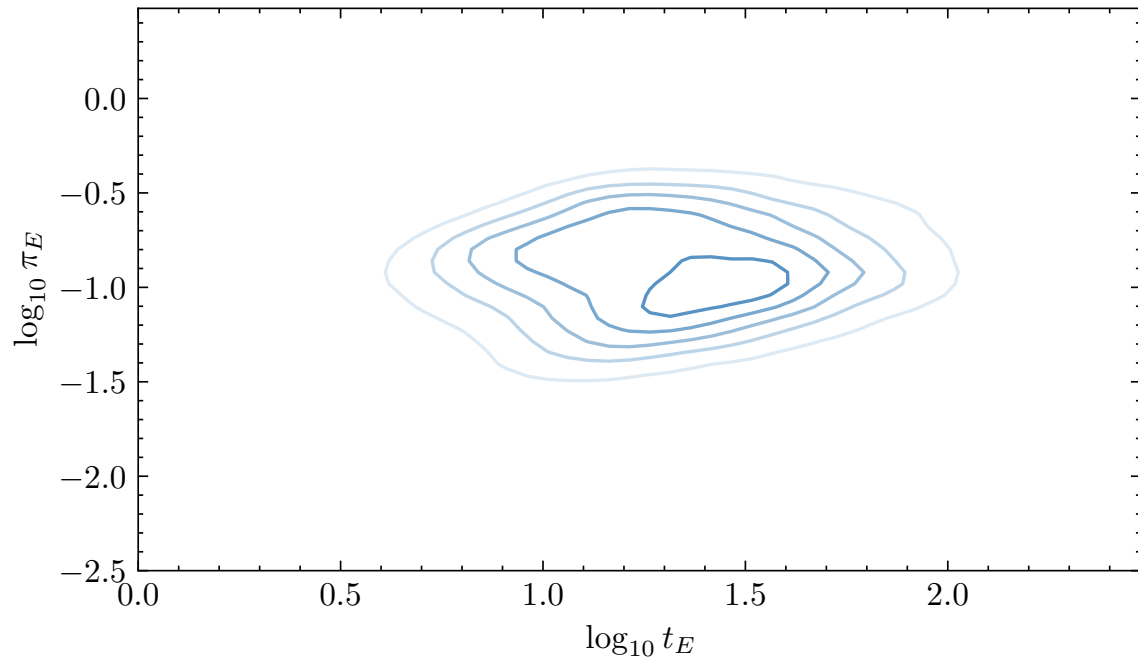
Lam + 2020
Golovich + 2022



Separation in distributions of observable parameters \Rightarrow Possibility of informative inference, despite uncertainty and selection bias

Motivation - Detectability in Parameter Distributions

Lam + 2020
Golovich + 2022

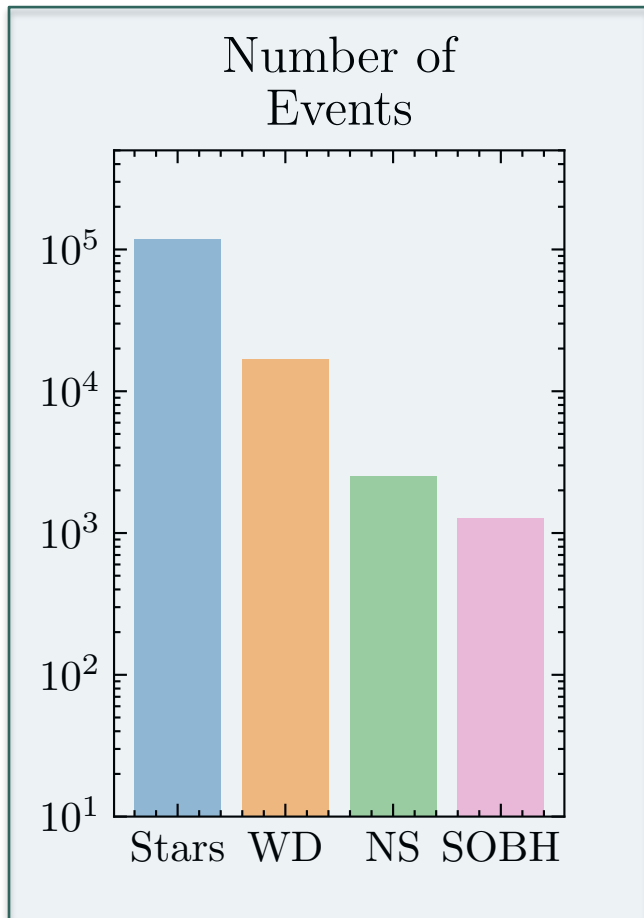


Separation in distributions of observable parameters \Rightarrow Possibility of informative inference, despite uncertainty and selection bias

Methodology - Fully Bayesian Hierarchical Inference

$$p(d_1 \dots d_N | \text{Model}) \propto p(N | \text{Model}) \times \prod_i p(d_i | \text{Model})$$

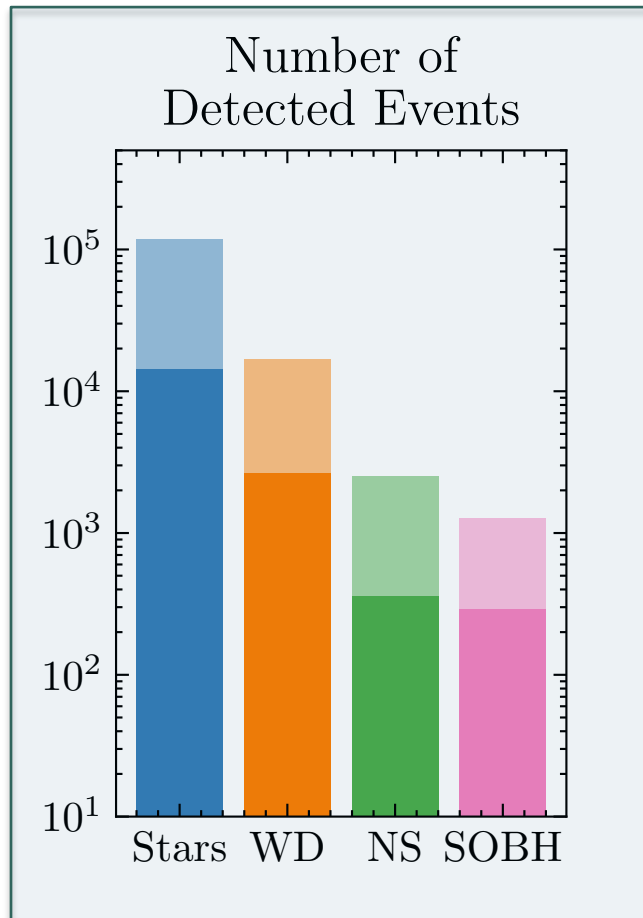
Loredo 2004
Vitale + 2020
Mandel + 2019
Taylor, Gerosa 2018



Methodology - Fully Bayesian Hierarchical Inference

$$p(d_1 \dots d_N | \text{Model}) \propto p(N | \text{Model}) \times \prod_i p(d_i | \text{Model})$$

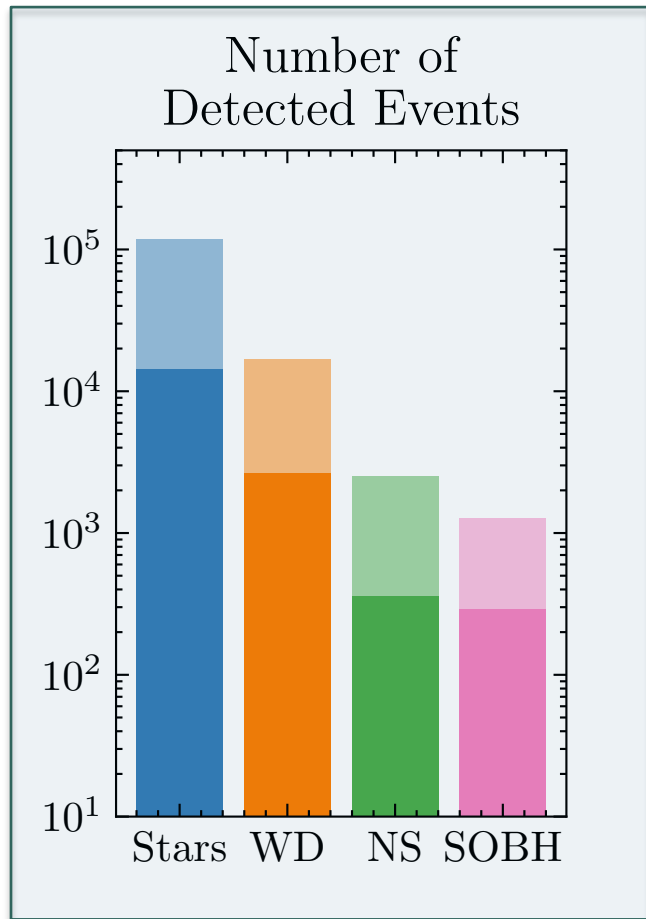
Loredo 2004
Vitale + 2020
Mandel + 2019
Taylor, Gerosa 2018



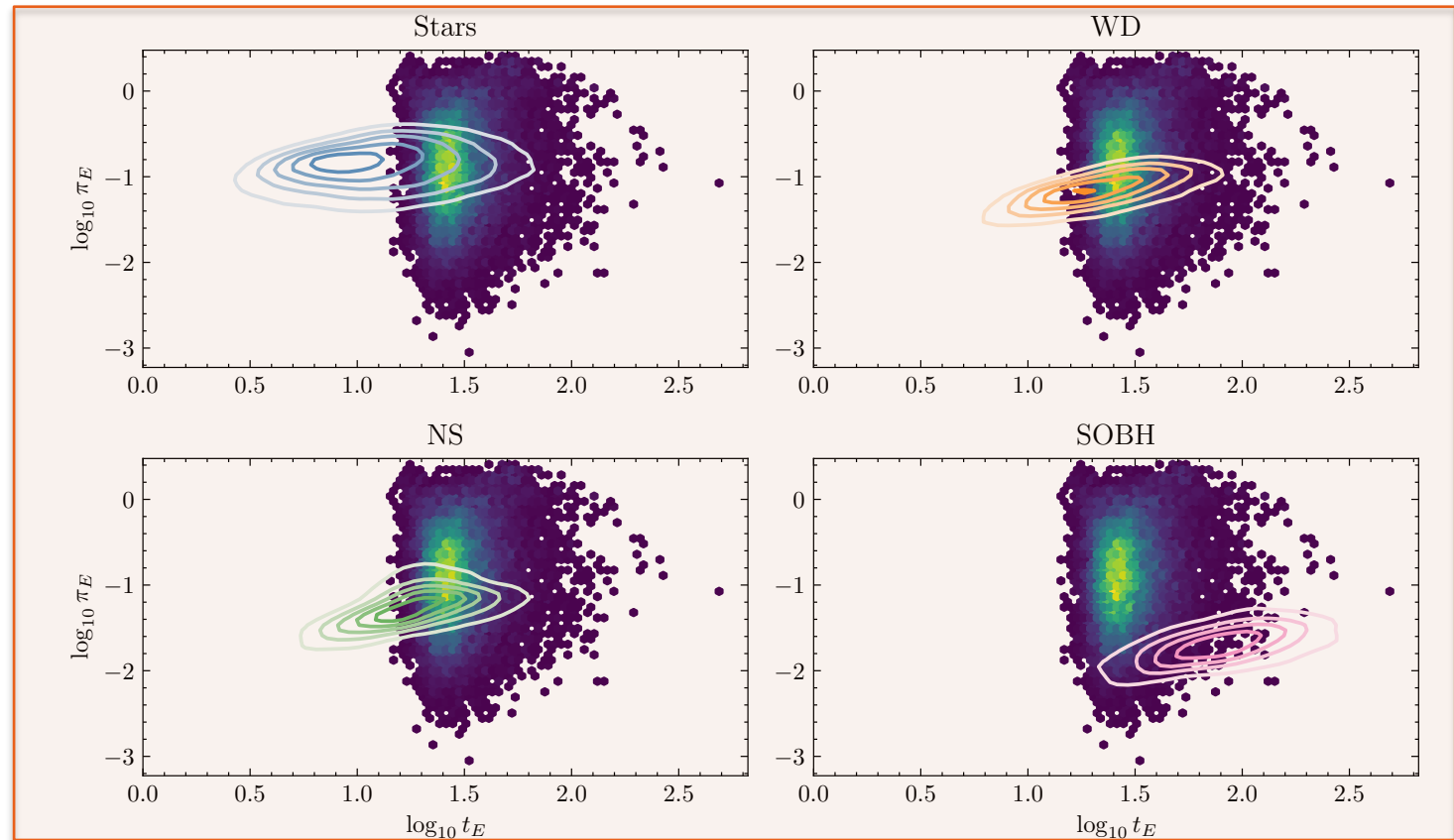
Methodology - Fully Bayesian Hierarchical Inference

$$p(d_1 \dots d_N | \text{Model}) \propto p(N | \text{Model}) \times \prod_i p(d_i | \text{Model})$$

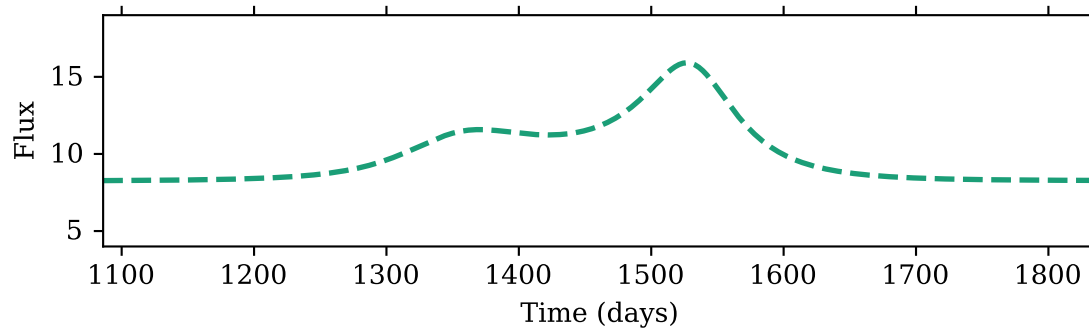
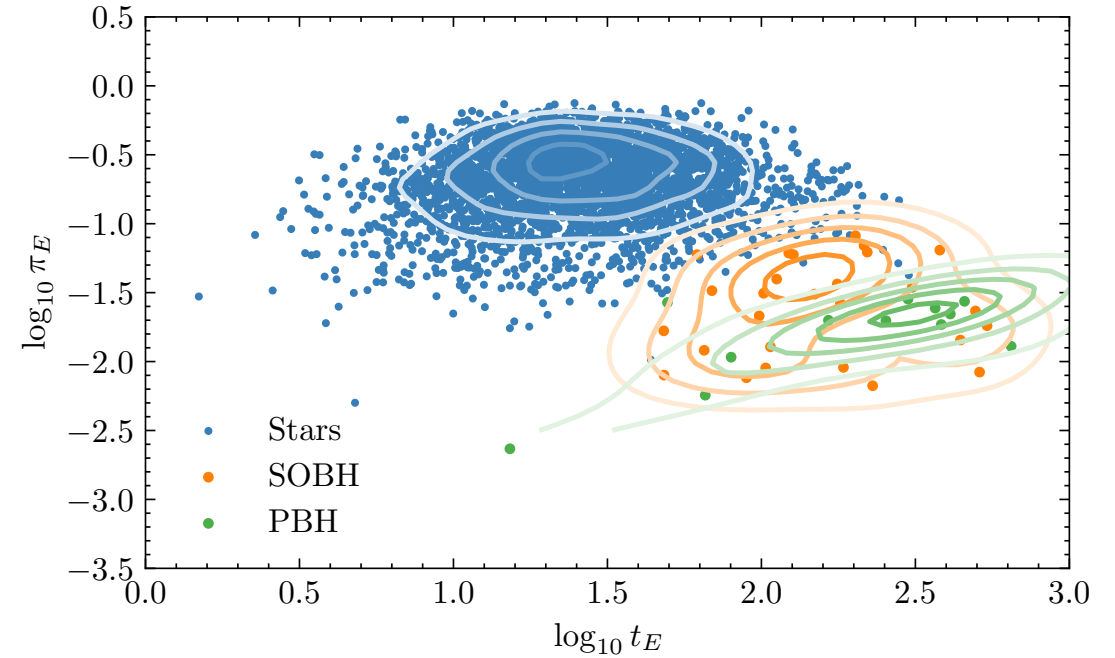
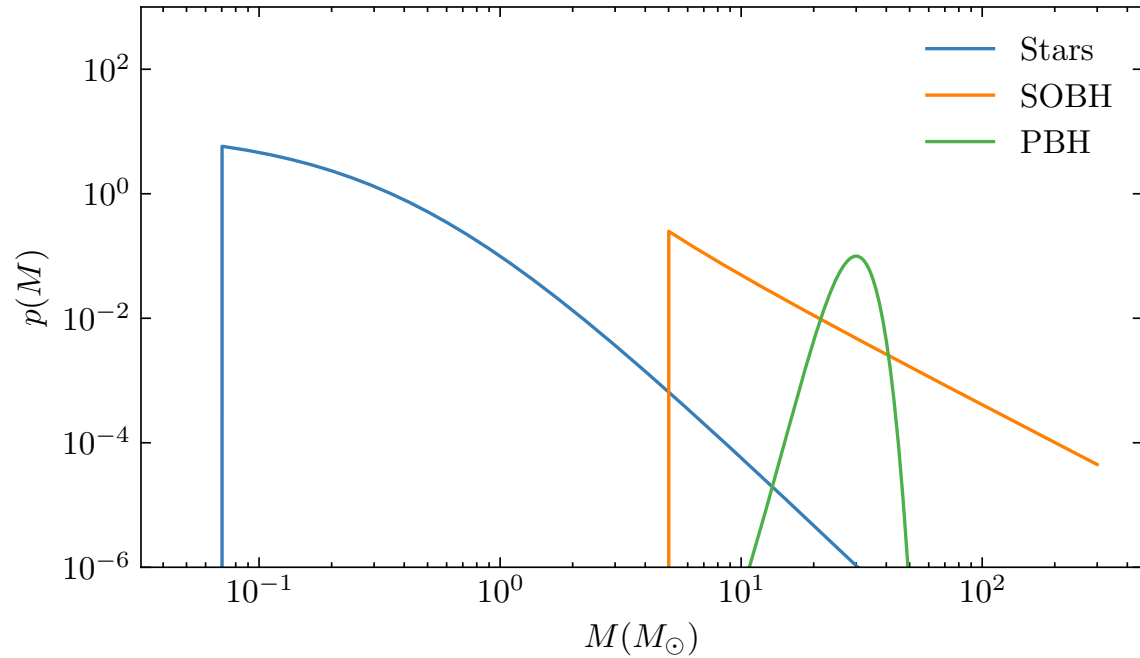
Loredo 2004
 Vitale + 2020
 Mandel + 2019
 Taylor, Gerosa 2018



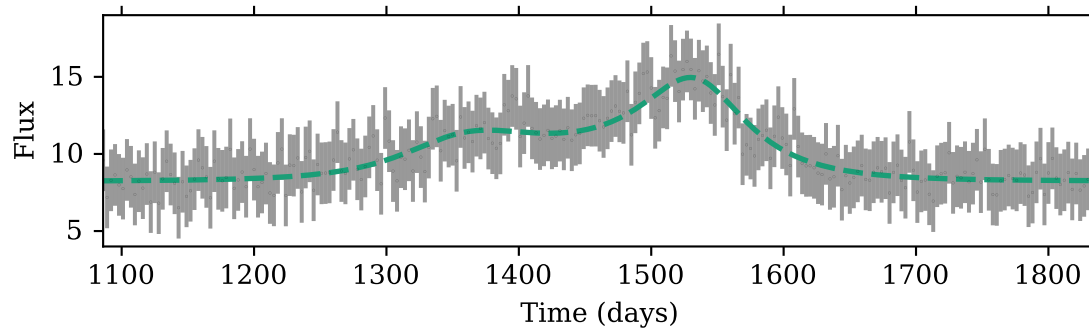
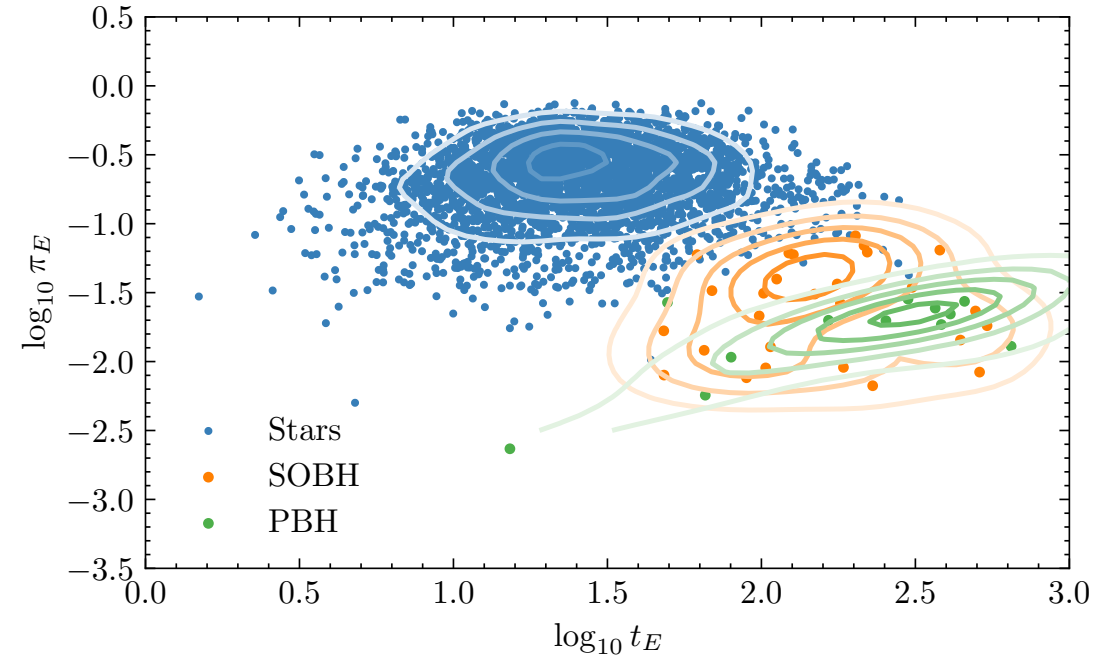
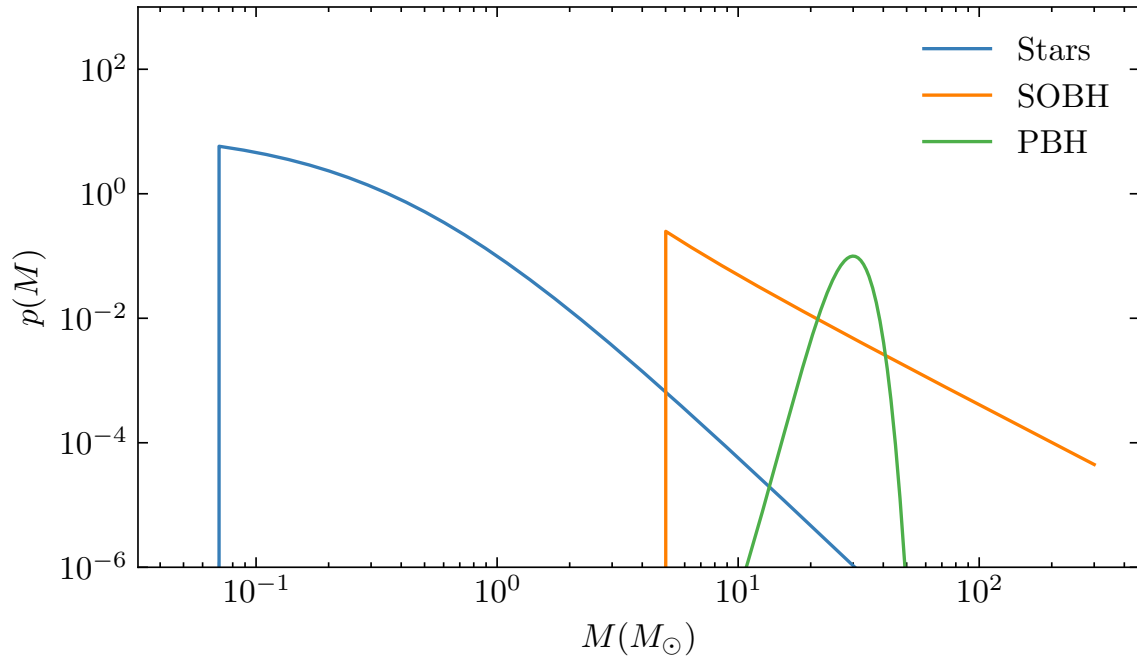
×



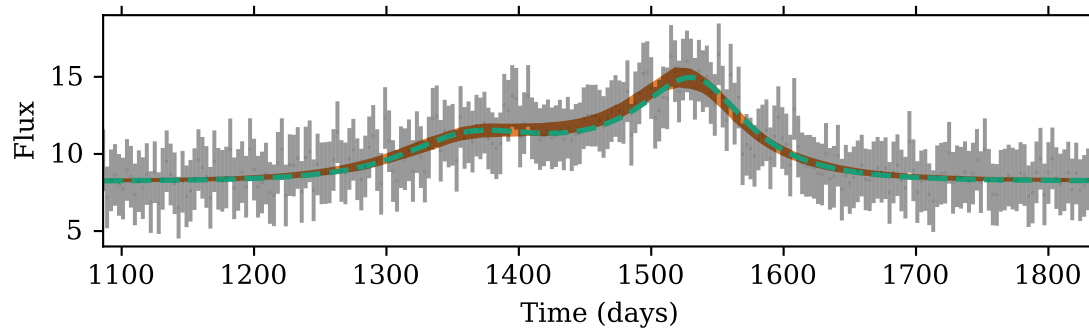
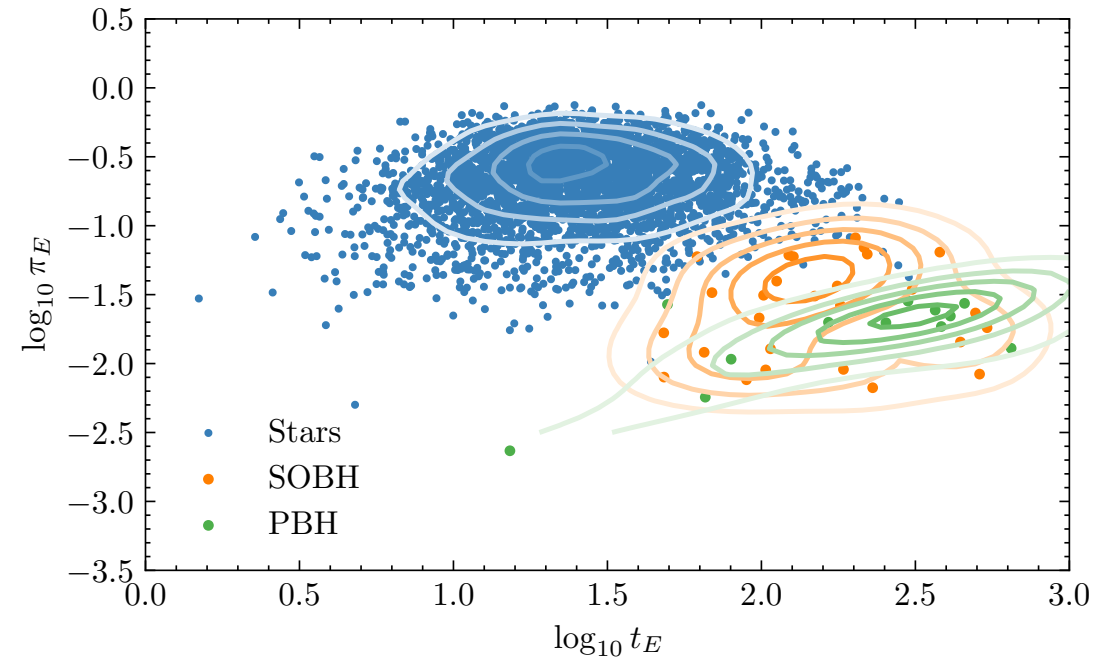
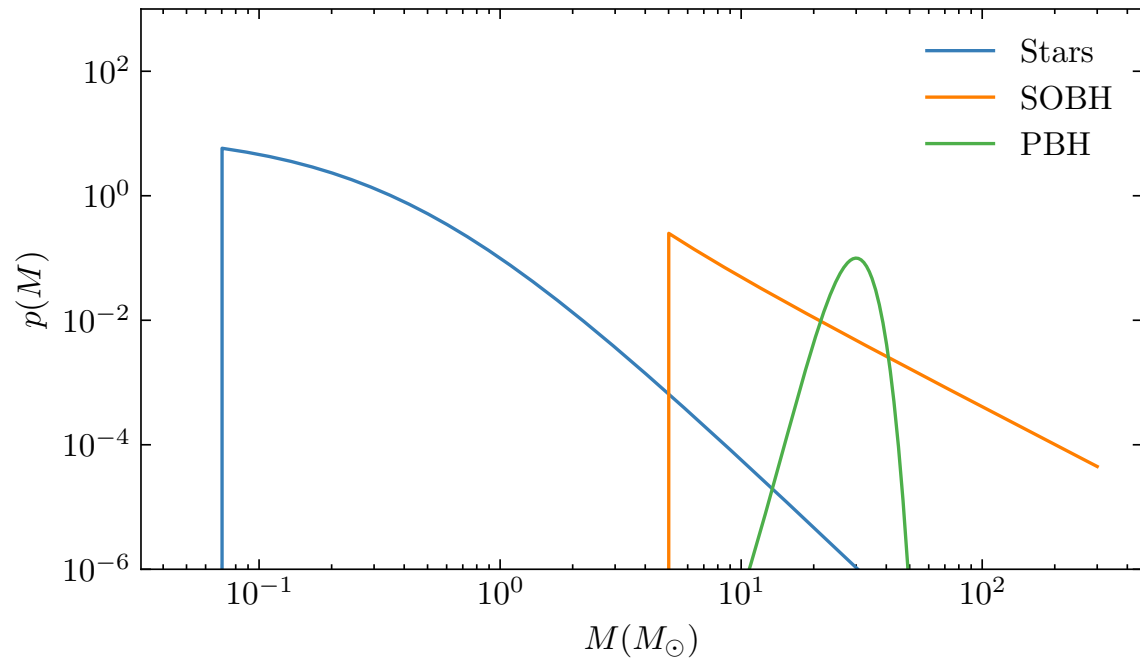
Validation Through Simulation



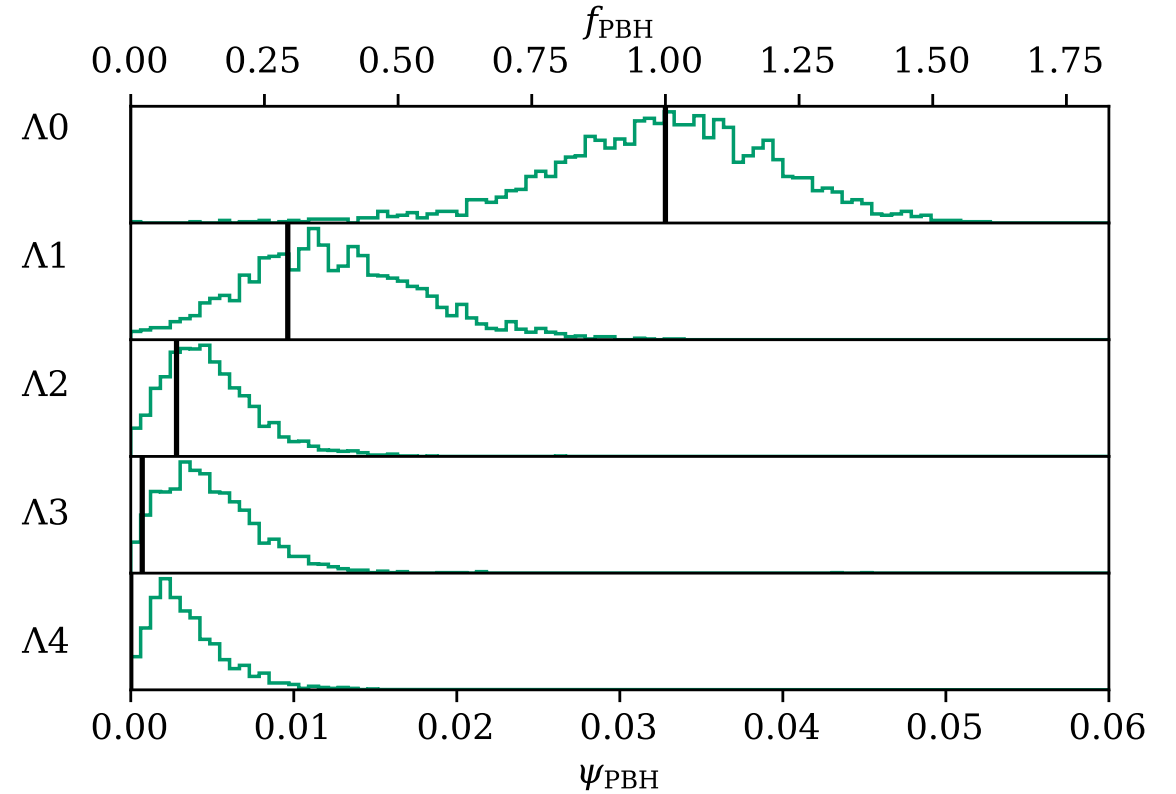
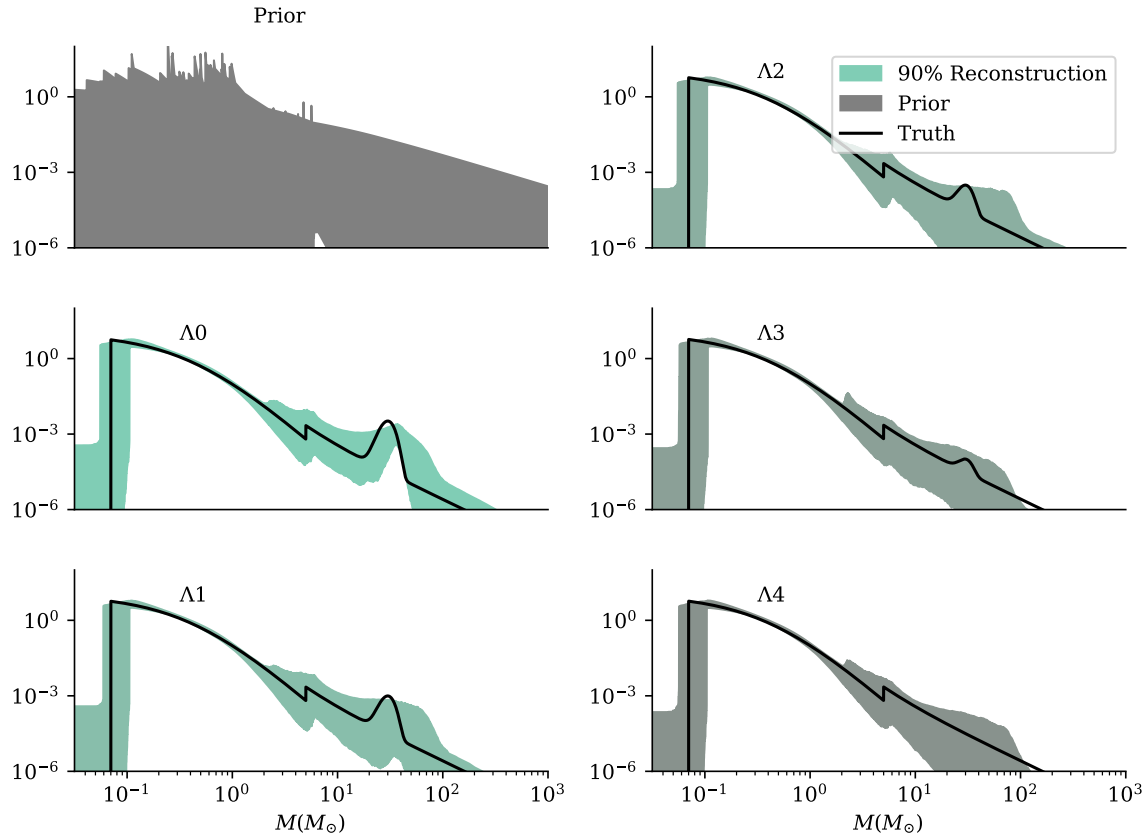
Validation Through Simulation



Validation Through Simulation



Predicted Constraints on PBH Abundance and Lens Mass Distribution - Posteriors



Hierarchical inference seems very likely to produce informative constraints on PBH abundance, while marginalizing over many sources of uncertainty



Disclaimer

This document was prepared as an account of work sponsored by an agency of the United States government. Neither the United States government nor Lawrence Livermore National Security, LLC, nor any of their employees makes any warranty, expressed or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States government or Lawrence Livermore National Security, LLC. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States government or Lawrence Livermore National Security, LLC, and shall not be used for advertising or product endorsement purposes.