

# He Jia

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## EDUCATION

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**Peking University** | School of Physics Sept. 2016 – Present

- B.S. in Physics (expected in July 2020)
- Overall GPA 3.79/4.00, Major GPA 3.87/4.00, Junior GPA 4.00/4.00 (WES scale); GRE Physics 990/990
- Core Courses: Basics of Cosmological Physics (100), General Relativity (90), Theoretical Mechanics (99), Equilibrium Statistical Physics (96), Advanced Quantum Mechanics (91), Quantum Statistical Physics (98), Methods of Mathematical Physics I (100), Methods of Mathematical Physics II (97), Scientific Software (97), Computational Physics A (93), Numerical Methods B (93), Probability Theory and Statistics B (93)

**University of California, Berkeley** | Berkeley Center for Cosmological Physics July – Aug. 2018 | Feb. – Sept. 2019

- Visiting Research Assistant (Supervisor: Prof. Uroš Seljak)

## PUBLICATIONS

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- **He Jia** and Uroš Seljak, *Normalizing Constant Estimation with Gaussianized Bridge Sampling*, accepted by AABI 2019 Proceedings, PMLR, [arXiv:1912.06073](https://arxiv.org/abs/1912.06073).
- **He Jia** and Uroš Seljak, *BayesFast: A Fast and Scalable Method for Cosmological Bayesian Inference*, in prep for JCAP.

## SOFTWARE DEVELOPMENT

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**BayesFast** | Author and Maintainer [github.com/HerculesJack/bayesfast](https://github.com/HerculesJack/bayesfast)

- Next generation Bayesian analysis tools for efficient posterior sampling and evidence estimation.

**CosmoFast** | Author and Maintainer [github.com/HerculesJack/cosmofast](https://github.com/HerculesJack/cosmofast)

- Cosmology add-ons for the BayesFast package.

## RESEARCH EXPERIENCE

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**Berkeley Center for Cosmological Physics, University of California, Berkeley** | Supervisor: Prof. Uroš Seljak

***DES Reanalysis with BayesFast and Improved Photo-z Modeling*** (with Dr. Sukhdeep Singh) Nov. 2019 – Present

- Currently implementing an improved modeling of photometric redshifts beyond the photo- $z$  shift parameters used in DES analysis. This will lead to a likelihood with hundreds of dimensions, which is formidable for traditional samplers, while we plan to solve it with the BayesFast package.

***Normalizing Constant Estimation with Gaussianized Bridge Sampling*** June 2019 – Oct. 2019

- Designed Iterative Neural Transform (INT), a novel Normalizing Flow, which Gaussianizes the samples of the target distribution with bijective transformations and therefore provides probability density estimation as a by-product.
- Developed an adaptive strategy to determine sample allocation in Bridge Sampling, which allows users to prioritize between posterior sampling or evidence estimation.
- Proposed a black-box Bayesian evidence (normalizing constant) estimator on top of standard MCMC samplers, which exploits adaptive Bridge Sampling with its proposal distribution estimated from the posterior samples using INT.
- Tested the proposed approach on four synthetic examples and demonstrated that it is orders-of-magnitude more efficient than state-of-the-art methods including Annealed Importance Sampling and Nested Sampling.
- Integrated the whole algorithm into the public BayesFast package.
- Led to a first-author paper accepted by AABI 2019 (2nd Symposium on Advances in Approximate Bayesian Inference).

***BayesFast: A Fast and Scalable Method for Cosmological Bayesian Inference*** Apr. 2019 – Present

- Designed and implemented a lightweight symbolic computation framework, which allows user-defined modules and computes analytic gradient of the likelihood using the chain rule.
- Developed a sparse polynomial surrogate model with various extrapolation schemes.
- Leveraged No-U-Turn Sampler for fast posterior sampling, with expensive and/or intractable modules replaced by the polynomial surrogate model, and an optional Importance Sampling step to correct the bias. Enabled parallelization with dask.
- Rewrote Planck 2018 and JLA likelihoods as BayesFast modules with analytic Jacobians available. Also developed wrappers to call CAMB codes and CosmoSIS modules from BayesFast.

- Tested the proposed approach on JLA, Planck and DES likelihoods, showing that it typically requires only  $10^2$ - $10^3$  likelihood evaluations to achieve the desired accuracy, in contrast to  $10^5$ - $10^6$  calls required by traditional MCMC samplers.
- Integrated the algorithms into the public BayesFast and CosmoFast packages.
- Led to a first-author paper in prep for JCAP (Journal of Cosmology and Astroparticle Physics).

**Classification Using Flow Based Density Estimator** (with Xuheng Luo) July 2019 – Aug. 2019

- Explored image classification using flow based density estimator on MNIST, Fashion-MNIST and CIFAR-10 datasets.
- Implemented signal-background classification on Higgs dataset, and compared it with kNN, BDT and MLP.

**Posterior Inference Using EL<sub>2</sub>O** June 2018 – Apr. 2019

- Implemented the EL<sub>2</sub>O Variational Inference approach, which fits the target distribution with transformed Gaussian.
- Applied the EL<sub>2</sub>O approach to state-space estimation and demonstrated that it achieves state-of-the-art performance.
- Obtained perfect posterior samples from Planck 2015 likelihoods for the  $\Omega_K$  model, using only  $10^2$  likelihood evaluations.
- Explained the limitation of the EL<sub>2</sub>O approach on more sophisticated examples such as the DES likelihood.

**School of Physics, Peking University** | Supervisor: Prof. Siguang Wang

**Signal-Background Classification on PandaX-III Dataset Using ROOT TMVA** Mar. 2019 – Present

- Conducted signal-background classification on PandaX-III dataset with CNN, ResNet and DenseNet in PyTorch.
- Currently implementing ResNet and DenseNet algorithms in ROOT TMVA.

**Kavli Institute for Astronomy and Astrophysics, Peking University** | Supervisor: Prof. Zuhui Fan

**CMB Lensing Simulation and CMB Data Analysis** Dec. 2017 – Mar. 2018

- Simulated lensed CMB temperature and polarization maps with CAMB and LensPix.
- Conducted cosmological parameter estimation with CosmoMC using Planck 2015 likelihoods.

## CONFERENCE EXPERIENCE

**BCCP Spectroscopic Surveys Workshop** | University of California, Berkeley Jan. 13-15, 2020 (expected)

- (Oral Presentation) *BayesFast: A Fast and Scalable Method for Cosmological Bayesian Inference*

**NAOC Workshop** | Beijing, China Dec. 29, 2019 (expected)

- (Oral Presentation) *Efficient Bayesian Methods for Posterior Sampling and Evidence Estimation*

**2nd Symposium on Advances in Approximate Bayesian Inference** | Vancouver, Canada Dec. 8, 2019

- (Poster Presentation) *Normalizing Constant Estimation with Gaussianized Bridge Sampling*

## HONORS

- Weiming Elite Student Scholarship, Peking University (top 10%, CNY 5,000) Sept. 2019
- Award for Scientific Research, Peking University (top 10%) Dec. 2018
- Weiming Elite Student Scholarship, Peking University (top 5%, CNY 5,000) Nov. 2018
- Shouren Chen Scholarship, Peking University (top 1%, CNY 30,000) June 2018
- Yuting Wu Scholarship, Peking University (top 10%, CNY 5,000) Dec. 2017
- National First Prize, China Physics Olympiad (top 0.05%) Sept. 2014

## OUTREACH

**PKU Orienteering Association** | Director of Competition Department Sept. 2017 – Sept. 2018

- Organized monthly orienteering competitions on the campus. Devoting to promotion of orienteering.
- Leader of a 15-student outdoor camping team.

## TECHNICAL SKILLS

- **Programming:** Proficient in Python, C++,  $\LaTeX$  and Mathematica. Working knowledge of ROOT, Matlab, Origin, Qt and Fortran.
- **Software:** CAMB, CosmoSIS, Cython, dask, dynesty, emcee, MultiNest, PyMC3, PyStan, PyTorch, scikit-learn, SymPy.
- **Technique:** Experience of running massive parallel computing jobs on NERSC Cori supercomputer.
- **Languages:** Mandarin (Native), English (Fluent, GRE General 325+4, TOEFL iBT 109).

*Last updated on Dec. 16, 2019*