Curriculum Vitae, Boryana Hadzhiyska

Contact Information

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Collaborations member: DESI, LSST-DESC

Academic Interests

My research blends the distinct fields of cosmology, galaxy formation, particle physics, and statistics to reveal the answers to some of the most puzzling enigmas of our Universe: dark matter, dark energy, and neutrinos. In particular, I compare predictions from powerful numerical simulations with observations from cutting-edge galaxy experiments, jointly analyze early Universe probes (e.g., cosmic microwave background) and galaxy observations, and develop analytical approaches, in an effort to provide competitive constraints on galaxy formation and cosmology.

Building healthy relationships with our peers and the wider community is integral to science, so I devote many efforts to community service, mentoring, and outreach.

Education

PhD in Astrophysics and Astronomy 2018 - present
Harvard University, expected April 2022
Thesis: Forging precise tools in anticipation of large galaxy surveys
Advisors: Prof. Daniel Eisenstein, Prof. Lars Hernquist

MASt in Applied Mathematics 2017 - 2018
University of Cambridge, Pass with distinction
Thesis: Improving small-scale CMB lensing reconstruction
Advisor: Prof. Blake Sherwin

BA in Astrophysics, Minor in Linguistics 2013 - 2017
Princeton University, *summa cum laude*
Thesis: Constraining self-interacting neutrinos with CMB data
Advisors: Prof. David Spergel, Prof. Jo Dunkley

Awards and Grants

Interdisciplinary Ashford Fellowship Stipend, Harvard 2018 - 2021
Awarded to ∼10 grad students who form a close-knit group

Peirce Fellowship Stipend, Harvard 2018
Additional financial support to selected graduate students

Benefactors' Scholarship, St John's College, Cambridge 2017 - 2018
Prestigious fully funded scholarship for completing Master's degree; awarded to ∼15 students yearly in any discipline

Sigma Xi and Phi Beta Kappa Society Awards, Princeton 2018
Best undergraduate thesis; top 5% of the graduating class

Selected Talks

Forward modeling in the era of cosmological surveys
Cosmology seminars, invited talks by Berkeley & BNL; Oxford Oct. 2021
Galaxy lunch, Yale Sept. 2021
Cosmology lunch, Princeton & IAS Sept. 2021

Tristate Cosmology x Data Science, Flatiron Institute — Sept. 2021
Scheduled invited talks: Stanford, Ohio State, IPMU Tokyo — Nov. 2021
Limitations to the "basic" HOD and beyond
Cosmology seminar, invited by Berkeley & BNL — Feb. 2020
Cosmology seminar, University of Santa Cruz — Feb. 2020
Improving Small-Scale CMB Lensing Reconstruction — March 2021
CMB-S4 conference, invited talk
HEFTy improvements to cosmological constraints — April 2021
Large-scale structure seminar, invited by Cambridge

Mentoring

Polygence research program, Online — 2020 - present
Advised an international high-school student (40 weeks, 2 hrs/week)
Project title: Galaxy assembly bias and large-scale distribution: a comparison between IllustrisTNG and a semi-analytic model

Science Research Mentoring Program, Harvard & MIT — 2019 - 2020
Advised 2 students from public high school (30 weeks, 6 hrs/week)
Project title: Exploring halo finders in dark-matter simulations

Non-resident tutor for undergraduates, Harvard — 2018 - present
Organized monthly astronomy-related events; engaged weekly in community-building events; advised on LGBTQ+ issues

Teaching

Introduction to Cosmology, Harvard Summer School — Summer 2021
Solo designed and led intense two-week course for high school students; received an overall students' evaluation of 5.0/5.0

Intro to astronomy (Ast1); Planetary life (GE1070), Harvard — 2019 - 2020
Teaching fellow: led weekly sections and telescope observations

Natural sciences and mathematics, Prison Teaching Initiative — 2016 - 2017
Visited weekly incarceration facilities and worked in small groups

Community Service

Grievance committee, Harvard Graduate Student Union — 2020 - present
Committee chair: resolved ∼200 workplace issues (∼15 hrs/week); mediated faculty-student communication; led mutual aid efforts

Family Meals and FoodCycle, Cambridge, MA and UK — 2017 - 2019
Weekly volunteer: packed and prepared food, delivered surplus food

Bulgarian Society in England, Cambridge, UK — 2017 - 2018
Vice President: organized fundraisers, mentored incoming students

Outreach

APS Inclusion, Diversity, and Equity Alliance, Harvard — 2020 - 2021
Founding member: organized department-wide climate and wellness surveys, participated in several diversity and sustainability efforts

LGBTQ+ in Academia, Equity & Inclusion Journal Club — Summer 2020
Panel speaker: presented a systemized summary of challenges LGBTQ+ individuals in academia face and led discussion session

Cambridge Science Festival, Cambridge, MA — Summer 2019
Volunteer: led public tours, held "Ask an Astronomer" table

Publication List, Boryana Hadzhiyska

19 publications, **11** of which **first-author**, and **5** second- and third-author

In-press Journal Publications

19. Ana Maria Delgado, D. Wadekar, **BH**, S. Bose, L. Hernquist, S. Ho, *Modeling the galaxy-halo connection with machine learning*, submitted MNRAS, arXiv *My role: contributed key ideas about assembly bias; mentored first-year graduate student; supplied halo data for the hydro simulation IllustrisTNG*

18. Sownak Bose, Daniel Eisenstein, **BH**, Lehman Garrison, Sihan Yuan, *Constructing high-fidelity halo merger trees in AbacusSummit*, submitted to MNRAS, arXiv:2110.11409

    My role: helped in the development and testing process of the merger trees, which are used to clean the halo catalogs and report halo history statistics.

17. Sihan Yuan, Lehman Garrison, **BH**, Sownak Bose, Daniel Eisenstein, *AbacusHOD: A highly efficient multi-tracer HOD framework and its application to BOSS data*, submitted to MNRAS, arXiv:2110.11412

    My role: helped in the development, optimization and testing of the HOD framework; included different galaxy tracers targeted by future galaxy surveys.

Refereed Journal Publications

16. **BH**, Daniel Eisenstein, Sownak Bose, Lehman Garrison, Nina Maksimova, *CompaSO: A new halo finder for competitive assignment to spherical overdensities*, MNRAS.tmp.2718H, arXiv:2110.11408

    My role: developed new optimized algorithm for finding halos in N-body simulations and applied it to the AbacusSummit suite of simulations.

15. **BH**, Lehman Garrison, Daniel Eisenstein, Sownak Bose, *The halo light cone catalogs of AbacusSummit*, MNRAS.tmp.2780H, arXiv:2110.11413

    My role: produced publicly available halo light cones for AbacusSummit, which will be used in the analysis of current and future observational data.

14. Nina Maksimova, Lehman Garrison, Daniel Eisenstein, **BH**, Sownak Bose, *AbacusSummit: A Massive Set of High-Accuracy, High-Resolution N-Body Simulations*, MNRAS.tmp.2270M, arXiv:2110.11398

    My role: generated initial conditions for the largest-yet N-body simulation suite AbacusSummit and accompanying software products.

13. **BH**, Carlos García-García, David Alonso, Andrina Nicola, Anže Slosar, *Hefty enhancement of cosmological constraints from the DES Y1 data using a Hybrid Effective Field Theory approach to galaxy bias*, JCAP, 2021, 020, arXiv:2103.098
    My role: applied novel method combining N-body simulations and effective field theory to obtain better constraints on cosmological parameters S_8, Ω_m.

12. **BH**, Sonya Liu, Rachel S. Somerville, Austen Gabrielpillai, Sownak Bose, Daniel Eisenstein, Lars Hernquist, *Galaxy assembly bias and large-scale distribution: a comparison between IllustrisTNG and a semi-analytic model*, MNRAS, 508, p. 698-718, arXiv:2108.00006

    My role: compared the galaxy distribution predicted by a hydro simulation and a SAM, providing useful information for constructing galaxy-halo models.

11. **BH**, Sandro Tacchella, Sownak Bose, Daniel Eisenstein, *The galaxy-halo connection of ELGs in IllustrisTNG*, MNRAS, 502, p. 3599-3617, arXiv:2011.05331
    My role: extracted emission-line galaxies from a hydro simulation and modeled their galaxy-halo connection, which is useful for future experiments.

10. Sihan Yuan, **BH**, Sownak Bose, Daniel Eisenstein, Hong Guo, *Evidence for galaxy assembly bias in BOSS CMASS redshift-space galaxy correlation function*, MNRAS, 502, p. 35825-3598, arXiv:2010.04182

    My role: helped in developing a model incorporating secondary assembly bias parameters (e.g., environment) into the analysis of observational data.

9. **BH**, Sownak Bose, Daniel Eisenstein, Lars Hernquist, *Extensions to models of the galaxy-halo connection*, MNRAS, 501, p. 1603-1620, arXiv:2008.04913

    My role: studied other frequently used galaxy-halo models and constructed an augmented HOD model that captures well basic and alternative statistics.

8. **BH**, David Alonso, Andrina Nicola, Anže Slosar, *Analytic marginalization of $N(z)$ uncertainties in tomographic galaxy surveys*, JCAP, 2020, 056, arXiv:2007.14989

    My role: applied a novel theoretical model to observational data that reduces the number of nuisance parameters in the analysis of weak lensing data.

7. **BH**, Sownak Bose, Daniel Eisenstein, Lars Hernquist, David N. Spergel, *Limitations to the 'basic' HOD model and beyond*, MNRAS, 493, 5506-5519, arXiv:1911.02610

    My role: showed that one of the most popular galaxy-halo models (mass-only HOD) underestimates the galaxy clustering by 15%, well beyond the subpercent precision requirement for current and future galaxy surveys.

6. **BH**, Blake Sherwin, Mathew Madhavacheril, Simone Ferraro, *Improving Small-Scale CMB Lensing Reconstruction*, PRD, 100 (2019) 023547, arXiv:1905.04217

    My role: developed a method for reconstructing the small-scale lensing power, which is relevant for future cosmic microwave background experiments.

5. Minsu Park, Christina D. Kreisch, Jo Dunkley, **BH**, Francis-Yan Cyr-Racine, *ΛCDM or self-interacting neutrinos?*, PRD, 100 (2019) 063524, arXiv:1904.02625

    My role: studied the dependence of the bimodal posterior distribution on the assumed prior for the strength of the hypothesized neutrino interactions.

4. **BH**, David N. Spergel, *Measuring the Duration of Last Scattering*, PRD, 99 (2019) 043537, arXiv:1808.04083

    My role: made the first measurement of the thickness of the last scattering surface 380,000 years after the Big Bang, which can constrain exotic models.

3. **BH**, David N. Spergel, Jo Dunkley, *A Small-Scale Modification to the Lensing Kernel*, PRD, 97 (2018) 043521, arXiv:1711.03168

    My role: considered the effect of treating the last scattering event more carefully as non-instantaneous and estimated its effects on future CMB surveys.

2. David Alonso, **BH**, Michael A. Strauss, *Recovering the Tidal Field in the Projected Galaxy Distribution*, MNRAS, 460, p. 256-272, arXiv:1512.03402

    My role: constructed a two-dimensional all-sky map of the cosmic web from the 2MASS galaxy survey and studied the properties of galaxies in it.

1. Daniel P. Meerburg, Renee Hložek, **BH**, Joel Meyers, *Multi-wavelength constraints on the inflationary consistency relation*, PRD, 91 (2015) 103505, arXiv:1502.00302

    My role: ran chains that put the tightest constraints on the primordial power tensor from a combination of gravitational wave detectors (LIGO, pulsars).