

# Daniel Grin

Curriculum Vitæ

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## PERSONAL INFORMATION

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## RESEARCH INTERESTS

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- Early universe cosmology: Inflation, the curvaton model, hydrogen recombination, cosmic microwave background anisotropies and spectral distortions, cosmological phase transitions, primordial initial conditions (non-Gaussianity, isocurvature).
- Particle phenomenology: Axions & sterile neutrinos, neutrino mass, dark energy.
- Gravitational physics: Primordial gravitational waves, stellar dynamics of astrophysical gravitational-wave sources, gravitational lensing.
- Large-scale structure: 21-cm cosmology, baryon acoustic oscillations, galaxy clusters, astrophysical tests of dark-sector physics, cold dark-matter halo profiles, bias, and halo models of large-scale structure.

## EDUCATION

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CALIFORNIA INSTITUTE OF TECHNOLOGY (CALTECH) 2004-2010  
Ph. D. in Astrophysics  
Thesis topic: "The lukewarm frontier: some cosmological consequences of low-energy physics."  
Advisor: Prof. Marc Kamionkowski.

UNIVERSITY OF OXFORD 2003-2004  
M. Stud. in Philosophy  
Examination Topics: *Philosophy of Physics*, *The Rise of Modern Logic*.  
Supervisors: Dr. Harvey Brown, Dr. Simon Saunders, Dr. Jan Westerhoff.

PRINCETON UNIVERSITY 1999-2003  
A.B. in Physics, *magna cum laude*  
Senior thesis topic: "Galaxy bias in the halo model," Advisor: Prof. Uroš Seljak.

## EMPLOYMENT

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HAVERFORD COLLEGE 8/2016-present  
Assistant Professor of Physics.

UNIVERSITY OF CHICAGO 2013-2016  
NSF Astronomy and Astrophysics Postdoctoral Fellow, Department of Astronomy & Astrophysics,  
Associate Fellow, Kavli Institute for Cosmological Physics

INSTITUTE FOR ADVANCED STUDY, PRINCETON, NJ 2010-2013  
Postdoctoral Member, Astrophysics

## AWARDS & HONORS

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- KITP Scholar, 2017-2020, Kavli Institute for Theoretical Physics, University of California, Santa Barbara.
- Dan David Prize Fellowship, May 2009, Past Time Dimension in the field of Astrophysics: History of the Universe, (\$15,000 USD cash award).
- George Ellery Hale Fellow, Gordon Moore Foundation, Caltech Astronomy Dept (2004-2008).
- Kusaka Memorial Prize in Physics, Princeton University, June 2003.
- Member, Phi Beta Kappa, since June 2003.
- Member, Sigma Xi Scientific Research Society, since June 2003.
- The Shapiro Prize for Academic Excellence (Princeton University), 2001.

## PUBLICATIONS

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- T. L. Smith, J. Muñoz, R. Smith, K. Yee, and **D. Grin**, *Baryons still trace dark matter: probing CMB lensing maps for hidden isocurvature*, submitted to Physical Review D, arXiv:1704.03461.
- CMB-SIV collaboration, *CMB-S4 Science Book, First Edition*, arXiv:1610.02743.
- R. Hložek, D. J. Marsh, D. Grin, R. Allison, J. Dunkley, and E. Calabrese, *Future CMB tests of dark matter: ultra-light axions and massive neutrinos*, Phys. Rev. D 95, 123511, arXiv:1607.08208.
- R. Emami, **D. Grin**, J. Pradler, A. Raccanelli, and M. Kamionkowski, *Cosmological tests of an axiverse-inspired quintessence field*, Physical Review D 93, 123005 (2016), arXiv:1603.04851.
- C. He, Heinrich, **D. Grin**, W. Hu, *Lensing Bias to CMB Measurements of Compensated Isocurvature Perturbations*, Physical Review D 94, 043534 (2016), arXiv:1605.08439.
- T. L. Smith & **D. Grin**, *Probing a panoply of curvaton-decay scenarios using CMB data*, Physical Review D 94, 103517 (2016), arXiv:1511.07431.
- Julián Muñoz, **D. Grin**, L. Dai, M Kamionkowski, and E. Kovetz, *A search for Compensated Isocurvature Perturbations with Planck power spectra*, Physical Review D 93, 043008 (2016), arXiv:1511.04441.
- C. He, **D. Grin**, and W. Hu, *Compensated isocurvature perturbations in the curvaton model*, Physical Review D 92, 063018 (2015), arXiv:1505.00639.

- R. Hložek, **D. Grin**, D. J. E. Marsh, P. Ferreira, *A search for ultralight axions using precision cosmological data*, Physical Rev D91, 103512 (2015), arXiv:1410.2896.
- J. Chluba, L. Dai, **D. Grin**, M. Amin, and M. Kamionkowski, *Spectral distortions from the dissipation of tensor perturbations*, MNRAS, 446, 2871-2886 (2014), arXiv:1407.3653.
- M. Amin and **D. Grin**, *Probing early-universe phase transitions with CMB spectral distortions*, Physical Review D90, Issue 8, 083529 (2014), arXiv:1405.1039.
- D. J. E. Marsh, **D. Grin**, R. Hložek, P. Ferreira, *Tensor Detection Severely Constrains Axion Dark Matter*, Physical Review Letters 113, 011801 (2014), arXiv:1403.4216.
- **D. Grin**, D. Hanson, G. Holder, O. Doré, and M. Kamionkowski, *Baryons DO trace dark matter in the early universe: a constraint to compensated isocurvature perturbations using WMAP 9-year data*, Physical Review D89, 023006 (2014), arXiv:1306.4319.
- J. Chluba and **D. Grin**, *CMB spectral distortions from small-scale isocurvature fluctuations*, MNRAS, 434, 1619 (2013), arXiv:1304.4596.
- D. J. E. Marsh, **D. Grin**, R. Hložek, and P. Ferreira, *Axiverse cosmology and the energy scale of inflation*, Physical Review D 87, 121701(R) (2013), arXiv:1303.3008.
- T. L. Smith, **D. Grin**, and M. Kamionkowski, *An improved estimator for non-Gaussianity in cosmic microwave background observations*, Physical Review D87, Issue 6, id. 063003 (2013), arXiv:1211.3417.
- **D. Grin**, M. Kamionkowski, and O. Doré, *Compensated Isocurvature Perturbations and the Cosmic Microwave Background*, Physical Review D 84:123003 (2011), arXiv:1107.5047.
- **D. Grin**, M. Kamionkowski, and O. Doré, *Do baryons trace dark matter in the early universe?*, Physical Review Letters 107:261301 (2011), arXiv:1107.1716.
- Yacine Ali-Haïmoud, **D. Grin**, and C. Hirata, *Radiative transfer effects in primordial hydrogen recombination*, Physical Review D82:123502, (2010), arXiv:1009.4697.
- **D. Grin** and C. Hirata, *Hydrogen recombination: the effect of high- $n$  states*, Physical Review D81:083005 (2010), arXiv:0911.1359.
- **D. Grin**, T. L. Smith and M. Kamionkowski, *Axion constraints in non-standard thermal histories*, Physical Review D 77:085020 (2008), arXiv:0711.1352.
- R. R. Caldwell and **D. Grin**, *Lower Limit to the Scale of an Effective Theory of Gravitation*, Physical Review Letters 100:031301 (2008), astro-ph/0606133.
- **D. Grin**, G. Covone, M. Kamionkowski, J-P. Kneib, A. Blain, E. Jullo, *Telescope search for decaying relic axions*, Physical Review D75, 105018 (2007), astro-ph/0611502.

## SOFTWARE

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- Developed publicly available **AXIONCAMB**: modified version of CMB Boltzmann code CAMB that includes ultra-light axions as dark matter or dark energy, and outputs theoretical cosmological power spectra in ultra-light axion models for use in data analysis.

## CONFERENCE PROCEEDINGS

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- *Testing the ultra-light axion hypothesis using cosmic microwave background and galaxy clustering data*, IAU General Assembly, Meeting # 29, Honolulu, Hawaii, Aug. 2015.
- *Cosmological search for ultra-light axions*, Axion-WIMP Patras Workshop, Zaragoza, Spain, June 2015.
- *Thermal axions: telescope searches/cosmological constraints in non-standard thermal histories*, Proceedings of Axions 2010 workshop.
- *Thermal axion constraints in non-standard thermal histories*, AIP Conf. Proc. 1166:119-125, 2009, UCLA Dark Matter '08 Conference, Marina Del Rey, CA, Feb. 2008.

## TEACHING EXPERIENCE

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INSTRUCTOR Fall/Spring 2017

Physics 308/302, Haverford College, course on classical and fluid mechanics, advanced undergraduate quantum mechanics.

CO-INSTRUCTOR AND CURRICULUM CONSULTANT Spring 2015

AST 282 (undergraduate), University of Chicago, *The Dark Universe*:  
Co-taught course on dark matter and dark energy with Prof. Michael Turner. Gave lectures, coached students on their presentations, composed problem sets and solutions, ran problem sessions, graded final paper, and facilitated classroom discussion.

SUBSTITUTE LECTURER Spring 2015

PHYS 152 (undergraduate), Chicago State University, *Electricity and Magnetism*:  
Assisted and substituted in an introductory class based on active learning techniques in a SCALE-UP classroom. Supervised by Prof. Kim Coble.

SUBSTITUTE LECTURER 2014-2015

NTSC 10200 (undergraduate) & AST 40600/40800 (graduate), University of Chicago, *Evolution of the Universe & Gravitational Lensing/Cosmological Perturbation Theory*:  
Prepared and delivered 3 lectures on the interstellar medium, gravitational lensing & spectral distortions in the cosmic microwave background.

INSTRUCTOR 2011-2012

Princeton Prison Teaching Initiative, *College Algebra* (undergraduate):  
Volunteer instructor in New Jersey correctional system at Garden State and Albert Wagner Youth Correctional facilities. Supervised by Prof. Jill Knapp.

TEACHING ASSISTANT 2006-9

Ay 20 (undergraduate), Ay 124 & 127 (graduate), Ph 136abc (graduate), Caltech, Prof. Andrew Blain, Prof. Sterl Phinney & Prof. Kip Thorne, *Galactic and extra-galactic Astronomy, Galactic Dynamics, Cosmology and Galaxy Formation, Applications of Classical Physics*:  
Graded problem sets, held office hours, composed problem solutions, gave substitute lectures.

## PUBLIC OUTREACH

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CREATOR, ORGANIZER, LECTURER 2013-2016

*KICP lifelong learning program*, University of Chicago & Chicago Area Agency on Aging:  
Developed astronomy curriculum with focus on older adult enrichment, met regularly with gerontologist to build awareness of best practice, made contacts at senior-citizen centers throughout Chicago to attract audiences for talks, recruited and coached University of Chicago volunteers to give 34 general-interest lectures, gave 7 cosmology lectures, conducted 8 field trips to the Adler planetarium. Applied for and obtained NSF AAFP Fellowship funding for effort. Presented results at American Society on Aging Conference. Managed site logistics for all talks.

COURSE ORGANIZER/LECTURER 2012-2013

Princeton Evergreen Forum, *Cosmology & Astrophysics* (older adults):  
Organized a series of 6 lectures on supernovae, cosmology, galaxies, and exoplanets, given by Princeton-area postdocs to local Evergreen Forum senior lifelong learning organization. Gave a lecture on history of cosmic expansion to Evergreen cosmology lecture series.

## RESEARCH SUPERVISION/MENTORSHIP

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HAVERFORD COLLEGE 2016-present

Supervised undergraduate students Jonathan Cookmeyer (*the WKB approximation in axion cosmology*), Emery Trott (*LSS sensitivity to axion dark matter*), and Ching Li (*Charged Lepton Flavor Violation*, co-supervised with Prof. Alexey Petrov, Wayne State University).

JOHNS HOPKINS UNIVERSITY DEPARTMENT OF PHYSICS & ASTRONOMY 2014-2015

Remotely mentored graduate students Razieh Meibody (*axion dark energy, CMB physics*) and Julián Muñoz (*compensated isocurvature perturbations*).

UNIVERSITY OF CHICAGO DEPARTMENT OF ASTRONOMY AND ASTROPHYSICS 2013-2015

Mentored graduate student Chen He: *Cosmic microwave background, curvaton scenarios, compensated isocurvature perturbations*.

PRINCETON ASTROPHYSICS REU PROGRAM 2012-2013

Mentored undergraduate student D. Martindale & K. Z. Khor: *intracluster light, axion decay constraints from clusters*.

## INVITED TALKS

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- **Department colloquia:** Villanova University (2017): *Searching for axions using the cosmic microwave background*, University of Washington (2015): *The microwave sky and the dark universe*, CUNY Queens (2015): *The microwave background and the dark universe*
- **Seminars:**
  - *Entropy fluctuations are no spectator sport, Institute for Advanced Study Informal Seminar (2016)*.
  - *Entropy fluctuations are no spectator sport, FermiLab Particle Astrophysics Seminar (2016)*.

- *Axionic dark matter*, University of Chicago (2014/2015), MIT/Harvard/Tufts joint cosmology Seminar (2014).
- *New Sources of CMB spectral distortions*, Perimeter Institute (2014).
- *Some new isocurvature directions*, FermiLab (2014), Dartmouth College (2014).
- *New windows on cosmic initial conditions and dark matter properties*, Stanford (2012), LBNL (2012), UC Irvine (2012), Harvard CfA (2012), University of Chicago (2012), FermiLab (2012), MIT/Harvard Tufts joint cosmology seminar (2012).
- *Do baryons trace dark matter in the early universe? Compensated Isocurvature Perturbations and the Cosmic Microwave Background*, University of Pennsylvania (2011).
- *Cosmological consequences of  $\sim eV$ -scale physics*, UBC Vancouver (2009).
- *Cosmological hydrogen recombination: The effect of extremely high- $n$  states and forbidden transitions*, Harvard Center for Astrophysics (2010), UW Madison (2009), University of Michigan (2009), University of Waterloo (2009), Ohio State University (2009), UC Berkeley, Fermilab (2009), University of Chicago (2012), (2009), UCLA (2009), Yale (2009), UT Austin (2009), CITA cosmology seminar (2009), Columbia University (2009), University of Pennsylvania (2009), Princeton University (2009), UNM Albuquerque (2008).
- *A telescope search for decaying relic axions*, Lawrence Berkeley National Labs/Stanford University (2007).

## **CONFERENCE PRESENTATIONS & SUMMER SCHOOLS**

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- *American Society on Aging Annual Conference*, Chicago, Illinois, March 2017.
- 231<sup>th</sup> meeting of the American Astronomical Society, Grapevine, TX, Jan. 2017.
- 229<sup>th</sup> meeting of the American Astronomical Society, Kissimmee, FL, Jan. 2016.
- *IAU focus meeting on Planck's legacy*, Honolulu, Hawaii, Aug. 2015.
- *DPF APS Meeting*, Ann Arbor, Michigan, Aug. 2015.
- *Axion-WIMP Patras Workshop*, Zaragoza, Spain, June 2015.
- *"Dark matter: off the beaten track" workshop*, ICTP, Trieste, Italy, April 2015.
- *American Society on Aging Annual Conference*, Chicago, Illinois, March 2015.
- 225<sup>th</sup> meeting of the American Astronomical Society, Seattle, WA, Jan. 2015.
- *MIAPP workshop on cosmology after Planck*, Garching, Germany, Sept. 2014.
- *Cosmo 2014 conference*, Chicago, IL, Aug. 2014.
- *New Perspectives on Dark Matter*, FermiLab, May 2014.
- *Cosmology after Planck workshop*, Ann Arbor, MI, Sept. 2013.
- *International School of Physics "Enrico Fermi", New Horizons for Observational Cosmology*, Varenna, Italy, July 2013.

- *Aspen Center for Physics winter workshop on inflation and the CMB*, Aspen, CO, Jan. 2012.
- *PASCOS Cosmology Conference*, Cambridge, UK, July 2011.
- Cosmo 2011 conference, Porto, Portugal, Aug. 2011.
- Axions 2010 conference, University of Florida, Gainesville, June 2015.
- Paris workshop on cosmological recombination, University of Paris-Sud, Orsay, July 2009.
- 213<sup>th</sup> meeting of the American Astronomical Society, Long Beach, CA, Jan. 2009.
- TASC Meeting- *Theoretical Astrophysics in Southern California*, Fall 2004, 2005, 2006, 2007, 2008.
- UCLA *Dark Matter '08* Conference, Marina Del Rey, CA, Feb. 2008.
- SLAC Summer Institute- *Gravity in the Quantum World and the Cosmos*, Palo Alto, CA, July 2005.
- 3rd Irvine Cosmology Workshop- *Astrophysical Probes of the Nature of Dark Matter*, UC Irvine, Irvine, CA, March 2007.
- Les Houches Summer School Session 86- *Particle Physics and Cosmology: The Fabric of Spacetime*, Les Houches, France, Aug. 2006.

## **SERVICE & OTHER PROFESSIONAL ACTIVITIES**

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- Referee for peer-reviewed journals: Phys. Rev. D, Phys. Rev. Lett., Astronomy and Astrophysics, Astrophysical Journal, and Journal of Cosmology & Astroparticle Physics.
- Formal seminar organizer & Monday cosmology lunch seminar organizer, Institute for Advanced Study, Princeton, NJ.
- Friday cosmology seminar organizer: KICP, University of Chicago.
- Workshop proposer and co-organizer: *CMB Spectral Distortion Workshop* (May 2015), Kavli Institute for Cosmological Physics & *The Dark Matter Paradigm: Status and Challenges* (October 2013), Princeton Center for Theoretical Science.
- Leader, University of Chicago HEP-Theory BICEP discussion on polarized dust.
- Member, American Astronomical Society.
- Member, American Physical Society.
- Member, KNAC consortium (Keck Northeast Astronomy Consortium).

## **COLLABORATORS**

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M. Kamionkowski (Johns Hopkins University), C. Hirata (Ohio State University), T .L. Smith (Swarthmore College), R. Hložek (Princeton University), D. J. E. Marsh (King's College), K. Z. Khor (Princeton University), E. Jullo (Laboratoire d'Astrophysique de Marseille), G. Covone (Università di Napoli), A. Benson (Carnegie Observatories), M. Amin (Rice University), P. G. Ferreira (Oxford University), O. Doré (Jet Propulsion Laboratory), W. Hu (University of Chicago), J. Bryan (UC Irvine), A. Cooray (UC

Irvine), J. P. Kneib (EPFL Lausanne), A. Blain (Leicester University), R. R. Caldwell (Dartmouth College), J. Muñoz (Johns Hopkins University), R. Meibody (Hong Kong University), A. Raccanelli (Johns Hopkins University), J. Pradler (Technical University of Vienna), J. Ruderman (NYU), T. T. Yu (SUNY Stonybrook)