SS 2023 Advanced Cosmology Seminars: Presentation Topics

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(including material originally presented by C. Pfrommer and J. Hennawi)

-1. Supernovae and cosmology
- 2. Cold Dark Matter and numerical cosmology
- 3. From dark matter halos to galaxies
- 4. Alternatives to a cosmological constant
- 5. Cosmic Microwave Background
- 6. Gravitational Lensing
- 7. Emerging cosmological probes (review 2201.07241)
- 8. CMB polarisation and GW from inflation
- 9. Galaxy clusters as cosmological probes
- 10. The Sunyaev-Zel'dovich effect
- 11. Strong gravitational lensing
- 12. Non-einsteinian gravity
- 13. Gravitational waves and cosmology
- 14. Galaxy clustering and baryon acoustic oscillations
- 15. The Lyman-alpha Forest & the Intergalactic Medium
- 16. First Light & Cosmic Reionization
- 17. Cosmological tests of gravity
- 18. Reheating in inflation
- 19. Primordial black holes

1. Supernovae and Cosmology

Nobel Prize: http://www.nobelprize.org/nobel_prizes/physics/laureates/2011/#

SCP Website: http://supernova.lbl.gov

Popular Article: *Supernovae, Dark Energy, and the Accelerating Universe*
Perlmutter, S. 2003, Physics Today, 56, 040000
http://supernova.lbl.gov/PDFs/PhysicsTodayArticle.pdf

Review Article: *Measuring Cosmology with Supernovae*

Perlmutter, S., & Schmidt, B.~P. 2003, Supernovae and Gamma-Ray Bursters, 598, 195
http://www.springerlink.com/content/9116g28114206078/fulltext.pdf
http://arxiv.org/abs/astro-ph/0303428

Article: *Observational Evidence from Supernovae for an Accelerating Universe and a Cosmological Constant*
Riess, A. G., Filippenko, A. V., Challis, P., et al. 1998, AJ, 116, 1009
http://adsabs.harvard.edu/abs/1998AJ....116.1009R

Article: *Measurements of Omega and Lambda from 42 High-Redshift Supernovae*
Perlmutter, S., Aldering, G., Goldhaber, G., et al. 1999, ApJ, 517, 565
http://adsabs.harvard.edu/abs/1999ApJ...517..565P

Review Article: *The Cosmological Constant*
Carroll, S. M. 2001, Living Reviews in Relativity, 4, 1
http://adsabs.harvard.edu/abs/2001LRR.....4....1C

2. Cold Dark Matter & Numerical Cosmology

Millennium simulation web site:
http://www.mpa-garching.mpg.de/galform/virgo/millennium/

Mare Nostrum simulation web site:
http://astro.ft.uam.es/marenostrum/universe/index.html

Review Article:
Numerical simulations of the dark universe: State of the art and the next decade
Kuhlen, Michael; Vogelsberger, Mark; Angulo, Raul, 2012 Physics of the Dark Universe, Volume 1, Issue 1, p. 50-93.
http://adsabs.harvard.edu/abs/2012PDU.....1...50K

Article for the millennium simulation:
Springel, V., White Simon, et al. 2005, Nature, 435, 629
http://adsabs.harvard.edu/abs/2005Natur.435..629S

Seminal Article: *The evolution of large-scale structure in a universe dominated by cold dark matter*
Davis, M., Efstathiou, Frenk C., White S.D.M, 1985, ApJ, 292, 371
http://adsabs.harvard.edu/abs/1985ApJ...292..371D

3. From Dark Matter Halos to Galaxies

Seminal paper: *Core condensation in heavy halos - A two-stage theory for galaxy formation and clustering*
White, S.D.M & Rees M., 1978, MNRAS, 183, 341
http://adsabs.harvard.edu/abs/1978MNRAS.183..341W

Seminal paper: *Galaxy formation through hierarchical clustering*
White S.D.M & Frenk, C., 1991, ApJ, 379, 52

http://adsabs.harvard.edu/abs/1991ApJ...379...52W

Review Article: *A primer on hierarchical galaxy formation: the semi-analytical approach* C.M. Baugh, 2006, Rep. Prog. Phys. 69, 3101 http://adsabs.harvard.edu/abs/2006RPPh...69.3101B

Review Article: *Understanding Galaxy Formation and Evolution*
Avila-Reese, 2007, Ap&SS, 115
http://arxiv.org/abs/astro-ph/0605212

Review Article: *Galaxy Formation Theory*
Benson, A. J. 2010, Phys. Rep, 495, 33
http://adsabs.harvard.edu/abs/2010PhR...495...33B

Review Article: *Physical Models of Galaxy Formation in a Cosmological Framework*
Somerville, R. S. & Dave, R. 2015, ARAA, 53, 51
http://adsabs.harvard.edu/abs/2015ARA%26A..53...51S

4. Alternatives to a Cosmological Constant

Note: All articles are quite technical and theory oriented. We do not expect you to master the complex math of this field but to give a general overview of the alternatives to simple cosmological constant and their possible effect on structure formation.

Review Article: *The Cosmological Constant*
Carroll, S. M. 2001, Living Reviews in Relativity, 4, 1
http://adsabs.harvard.edu/abs/2001LRR.....4....1C

Review Article: *Dark matter and dark energy proposals: maintaining cosmology as a true science?*
George Ellis 2009, EAS Publications Series, Volume 36, 2009, pp.325-336
http://adsabs.harvard.edu/abs/2009EAS....36..325E

Journal Article: *Dark energy and inhomogeneity*
George Ellis 2008, Journal of Physics: Conference Series, Volume 189, Issue 1
http://adsabs.harvard.edu/abs/2009JPhCS.189a2011E

Review Article: *Dark energy and dark gravity: theory overview*
Ruth Durrer, Roy Maartens, 2008,
General Relativity and Gravitation, Volume 40, Issue 2-3, pp. 301-328
http://adsabs.harvard.edu/abs/2008GReGr..40..301D
(very technical, look mainly to page 314 tp 320)

Review Article: *Dark Energy simulations*
Marco Baldi 2012, Physics of the Dark Universe, Volume 1, Issue 1, p. 162-193
http://adsabs.harvard.edu/abs/2012PDU.....1..162B

5. Cosmic Microwave Background

WMAP Website: http://map.gsfc.nasa.gov

Movies: Sensitivity of CMB power spectrum to cosmological parameters, Martin White
http://astro.berkeley.edu/~mwhite/movies.html

CMB Tutorial: Introduction to the CMB Tutorial, Wayne Hu
http://background.uchicago.edu/~whu/beginners/introduction.html

Online Notes: Wayne Hu's Notes on CMB Fundamentals
http://background.uchicago.edu/~whu/Papers/cmbfun_hr.pdf

Popular Article: *The Cosmic Symphony*
M. White & W. Hu, Scientific American, 2003
http://astro.berkeley.edu/~mwhite/sciam03_short.pdf

Review Article: *Cosmic Microwave Background Anisotropies* Hu, W., & Dodelson, S. 2002, ARAA, 40, 171
http://adsabs.harvard.edu/abs/2002ARA%26A..40..171H

Review Article: *The Cosmic Microwave Background*
Jones, A., & Lasenby, A. 1998, Living Reviews in Relativity, 1, 11
http://adsabs.harvard.edu/abs/1998LRR.....1...11J

Article: *First-Year Wilkinson Microwave Anisotropy Probe (WMAP) Observations: Determination of Cosmological Parameters*
Spergel, D. N., Verde, L., Peiris, H. V., et al. 2003, ApJS, 148, 175
http://adsabs.harvard.edu/abs/2003ApJS..148..175S

Article: *Three-Year Wilkinson Microwave Anisotropy Probe (WMAP) Observations: Implications for Cosmology*
Spergel, D. N., Bean, R., Dore, O., et al. 2007, ApJS, 170, 377
http://adsabs.harvard.edu/abs/2007ApJS..170..377S

Article: Planck 2013 results. XVI. Cosmological parameters
Planck Collaboration, arXiv:1303.5076
http://www.aanda.org/index.php?option=com_article&access=doi&doi=10.1051/0004-6361/201321591

6. Weak Gravitational Lensing

Euclid mission (ESA web site):
http://sci.esa.int/science-e/www/area/index.cfm?fareaid=102
http://sci.esa.int/science-e/www/object/index.cfm?fobjectid=46661

Euclid consortium web page:
http://www.euclid-imaging.net/

Book (really long!): *Euclid Imaging Consortium Science Book*
Refregier et al. 2010
http://arxiv.org/abs/1001.0061

Review Article: *Weak Gravitational Lensing and its Cosmological Applications*
Hoekstra H. & Jain B., 2008, 85, 93
http://www.annualreviews.org/doi/abs/10.1146/annurev.nucl.58.110707.171151

Review Article: *Weak Gravitational Lensing*
Bartelmann, M. & Schneider P. 2001, 340, 291
http://xxx.lanl.gov/abs/astro-ph/9912508

Review Article: Cosmology with weak lensing survey Dipak M, et al.
2008, PhRv, 462, 67 http://adsabs.harvard.edu/cgi-bin/bib_query?arXiv:astro-ph/0612667

7. Emerging cosmological probes (review 2201.07241)

Choose two probes among the ones presented in this review
https://ui.adsabs.harvard.edu/abs/2022LRR....25....6M/abstract

8. CMB Polarization, and Gravity Waves from Inflation

Online Tutorial on CMB Polarization, by Wayne Hu:
http://background.uchicago.edu/~whu/polar/webversion/polar.html

Review Article: *A CMB Polarization Primer*
White, M. & Hu, W.
http://arxiv.org/pdf/astro-ph/9706147.pdf
http://ads.ari.uni-heidelberg.de/abs/1997NewA....2..323H

Article: *Signature of Gravity Waves in the Polarization of the Microwave Background*
Seljak, U & Zaldarriaga, Matias, 1997, Physical Review Letters, 78, 2054 http://ads.ari.uni-heidelberg.de/abs/1997PhRvL..78.2054S

Article: *Planck* 2013 results. XXII. Constraints on inflation, Planck Collaboration
Planck Collaboration, 2013, arXiv:1303.5082
http://www.aanda.org/articles/aa/pdf/forth/aa21569-13.pdf

See in particular the "Lighting Review of Inflation" in Section 2Article: *Detection of B-Mode Polarization at Degree Angular Scales by BICEP2*
Planck Collaboration
http://ads.ari.uni-heidelberg.de/abs/2014PhRvL.112x1101A

Article: *Planck intermediate results. XXX. The angular power spectrum of polarized dust emission at intermediate and high Galactic latitudes*
Planck Collaboration, arXiv: 1409.5738
http://arxiv.org/abs/1409.5738

Commentary: *Big Bang blunder bursts the multiverse bubble*
Steinhardt, P. 2014, Nat, 510, 9
http://www.nature.com/news/big-bang-blunder-bursts-the-multiverse-bubble-1.15346
http://adsabs.harvard.edu/abs/2014Natur.510....9S

Article: *A joint analysis of Planck and BICEP2 B modes including dust polarization uncertainty*
Mortonson, M. J., & Seljak, U. 2014, arXiv:1405.5857
http://ads.ari.uni-heidelberg.de/abs/2014arXiv1405.5857M

Article: *Toward an understanding of foreground emission in the BICEP2 region*
Flauger, R, Hill, J. C., & Spergel, D. N, 2014, JCAP, 8, 39 http://ads.ari.uni-heidelberg.de/abs/2014JCAP...08..039F

9. Galaxy Clusters as Cosmological Probes

X-ray Satellites
Chandra satellite: http://chandra.si.edu/about/
XMM-Newton satellite: http://sci.esa.int/science-e/www/area/index.cfm?fareaid=23

Review Article: *Tracing cosmic evolution with clusters of galaxies* Voit, G. M. 2005, Reviews of Modern Physics, 77, 207
http://rmp.aps.org/abstract/RMP/v77/i1/p207_1

Review Article: *Cosmology with Clusters of Galaxies*
Borgani, S.: 2008, LNP, 740, 287
http://adsabs.harvard.edu/abs/2008LNP...740..287B

Review Article: *Formation of Galaxy Clusters* Kravtsov, A. V. & Borgani, S. 2012, ARAA, 50, 353
http://adsabs.harvard.edu/abs/2012ARA%26A..50..353K

Review Article: *Cosmological Parameters from Observations of Galaxy Clusters* Allen, S. W., Evrard, A. E., & Mantz, A. B. 2011, ARAA, 49, 409
http://adsabs.harvard.edu/abs/2011ARA%26A..49..409A

Article: *Chandra Cluster Cosmology Project III: Cosmological Parameter Constraints*
Vikhlinin, A., et al. 2009, ApJ, 692, 1060

http://adsabs.harvard.edu/abs/2009ApJ...692.1060V

10. The Sunyaev-Zel'dovich Effect

South Pole Telescope: http://pole.uchicago.edu

Atacama Cosmology Telescope: http://www.physics.princeton.edu/act

Planck Satellite: http://sci.esa.int/planck/

Review Article: *Cosmology with the Sunyaev-Zel'dovich Effect* Carlstrom, J. E., Holder, G. P., & Reese, E. D. 2002, ARAA, 40, 643
http://adsabs.harvard.edu/abs/2002ARA%26A..40..643C

Review Article: *Formation of Galaxy Clusters* Kravtsov, A. V. & Borgani, S. 2012, ARAA, 50, 353
http://adsabs.harvard.edu/abs/2012ARA%26A..50..353K

Review Article: *Cosmological Parameters from Observations of Galaxy Clusters* Allen, S. W., Evrard, A. E., & Mantz, A. B. 2011, ARAA, 49, 409
http://adsabs.harvard.edu/abs/2011ARA%26A..49..409A

Article: *The Atacama Cosmology Telescope: Cosmology from Galaxy Clusters Detected via the Sunyaev-Zel'dovich Effect*
Sehgal, N., Trac, H., Acquaviva, V., et al. 2011, ApJ, 732, 44
http://adsabs.harvard.edu/abs/2011ApJ...732...44S

Article: *A Sunyaev-Zel'dovich-selected Sample of the Most Massive Galaxy Clusters in the 2500 deg2 South Pole Telescope Survey*
Williamson, R., Benson, B. A., High, F. W., et al. 2011, ApJ, 738, 139
http://adsabs.harvard.edu/abs/2011ApJ...738..139W

Article: *Discovery and Cosmological Implications of SPT-CL J2106-5844, the Most Massive Known Cluster at z>1*
Foley, R. J., Andersson, K., Bazin, G., et al. 2011, ApJ, 731, 86
http://adsabs.harvard.edu/abs/2011ApJ...731...86F

Article: *Planck 2013 results. XX. Cosmology from Sunyaev-Zeldovich cluster counts*
Planck Collaboration 2013, arXiv:1303.5080
http://adsabs.harvard.edu/abs/2013arXiv1303.5080P

11. Strong Gravitational Lensing

Book: *Gravitational Lensing: Strong, Weak, and Micro* Schneider, P, Kochanek, C., Wambsganss, 2006
http://link.springer.com/book/10.1007/978-3-540-30310-7/page/1

Saas-Fee Advanced Course. Entire book available for download. Lots of theoretical details, but instead focus on Part 2 by C.S. Kochanek, on the different types of lenses observed, and primary observational results.

Review Article: *Cluster Lenses*
Kneib, J. P., Natarajan, P. 2011, A&ARv, 19, 47
http://link.springer.com/article/10.1007/s00159-011-0047-3

Review Article: *Arc Statistics*
Meneghetti, M., Bartelmann, M., Dahle, H., & Limousin, M. 2013, SSRv, 177, 31
http://link.springer.com/article/10.1007%2Fs11214-013-9981-x

Review Article: *Applications of Gravitational Lensing in Cosmology*
Bartelmann, M. 2006, Astrophysics Update 2, 213
http://link.springer.com/chapter/10.1007/3-540-30313-8_7

Article: *Characterizing the Cluster Lens Population*
Hennawi, J. F., Dalal, N., Bode, P., & Ostriker, J. P. 2007, ApJ, 654, 714
http://adsabs.harvard.edu/abs/2007ApJ...654..714H

Article: *CLASH: The Concentration-Mass Relation of Galaxy Clusters*
Merten, J., Meneghetti, M., Postman, M., et al. 2015, ApJ, 806, 4
http://adsabs.harvard.edu/abs/2015ApJ...806....4M

Review Article: *Strong Lensing by Galaxies*
Treu, T. 2010, ARA&A 48, 87
http://www.annualreviews.org/doi/full/10.1146/annurev-astro-081309-130924

12. Non-Einsteinian Gravity

Book: *Dark Energy. Theory and Observations.* L. Amendola & S. Tsujikawa (2010)

13. Gravitational waves and cosmology

https://arxiv.org/pdf/1807.09241.pdf
https://phys.org/news/2018-10-gravitational-dark.html
https://arxiv.org/pdf/1710.05893.pdf
https://arxiv.org/pdf/1801.06683.pdf

14. Galaxy Clustering & Baryon Acoustic Oscillations

SDSS Web Site: http://www.sdss.org

Martin White's BAO Page: http://astro.berkeley.edu/~mwhite/bao/

Review Article: *Baryon Acoustic Oscillations*
Basset, B. & Hlozek, R., chapter contributed to the book "Dark Energy", Ed. P. Ruiz-Lapuente, Cambridge University Press
http://arxiv.org/abs/0910.5224

Review Article: *Dark Energy and Cosmic Sound*
Eisenstein, D. J. 2005, NAR, 49, 360
http://adsabs.harvard.edu/abs/2005NewAR..49..360E

Article: *Detection of the Baryon Acoustic Peak in the Large-Scale Correlation Function of SDSS Luminous Red Galaxies*
Eisenstein, D. J., Zehavi, I., Hogg, D. W., et al. 2005, ApJ, 633, 560
http://adsabs.harvard.edu/abs/2005ApJ...633..560E

Review Article: *Measuring our Universe from Galaxy Redshift Surveys*
Lahav, O., & Suto, Y. 2004, Living Reviews in Relativity, 7, 8
http://adsabs.harvard.edu/abs/2004LRR.....7....8L

15. The Lyα Forest & the Intergalactic Medium

Review Article: *The physics of the intergalactic medium*
Meiksin, A. A. 2009, Reviews of Modern Physics, 81, 1405
http://adsabs.harvard.edu/abs/2009RvMP...81.1405M

Review Article: *The Lyman Alpha Forest in the Spectra of QSOs*
Rauch, M. 1998, ARAA, 36, 267
http://adsabs.harvard.edu/abs/1998ARA%26A..36..267R

Review Article: *The Lyα Forest as a Cosmological Tool*
Weinberg, D. H. et al. 2003, The Emergence of Cosmic Structure, 666, 157
http://arxiv.org/abs/astro-ph/0301186

Article: *Can Sterile Neutrinos Be the Dark Matter?*
Seljak, U., Makarov, A., McDonald, P., & Trac, H. 2006, PRL, 97, 191303
http://adsabs.harvard.edu/abs/2006PhRvL..97s1303S

Article: *Cosmological parameters from combining the Lyman-α forest with CMB, galaxy clustering and SN constraints*
Seljak, U., Slosar, A., & McDonald, P. 2006, JCAP, 10, 14
http://adsabs.harvard.edu/abs/2006JCAP...10..014S

Article: *The Thermal Memory of Reionization History*
Hui, L., & Haiman, Z. 2003, ApJ, 596, 9
http://adsabs.harvard.edu/abs/2003ApJ...596....9H

Article: *Constraints from the Lyα Forest Power Spectrum*
Zaldarriaga, M., Hui, L., & Tegmark, M. 2001, ApJ, 557, 519
http://adsabs.harvard.edu/abs/2001ApJ...557..519Z

Review Article: *The Evolution of the Intergalactic Medium*
McQuinn, M. 2015, ARAA, https://arxiv.org/abs/1512.00086

16. First Light & Cosmic Reionization

Popular Article: *The First Stars in the Universe and Cosmic Reionization*
Barkana, R. 2006, Science, 313, 931
http://www.sciencemag.org/content/313/5789/931.full.pdf

Review Article: *Observational Constraints on Cosmic Reionization* Fan, X., Carilli, C. L., & Keating, B. 2006, ARAA, 44, 415
http://adsabs.harvard.edu/abs/2006ARA%26A..44..415F

Review Article: *In the beginning: the first sources of light and the reionization of the universe*
Barkana, R., & Loeb, A. 2001, Phys. Rep., 349, 125
http://adsabs.harvard.edu/abs/2001PhR...349..125B

Review Article: *The physics and early history of the intergalactic medium*
Barkana, R., & Loeb, A. 2007, Reports on Progress in Physics, 70, 627
http://adsabs.harvard.edu/abs/2007RPPh...70..627B

Article: *A luminous quasar at a redshift of z = 7.085*
Mortlock, D. J., Warren, S. J., Venemans, B. P., et al. 2011, Nature, 474, 616
http://adsabs.harvard.edu/abs/2011Natur.474..616M

Article: *Lower-Luminosity Galaxies could reionize the Universe: Very Steep Faint-End Slopes to the UV Luminosity Functions at z>=5-8 from the HUDF09 WFC3/IR Observations*
Bouwens, R. J., Illingworth, G. D., Oesch, P. A., et al. 2011, arXiv:1105.2038
http://adsabs.harvard.edu/abs/2011arXiv1105.2038B
New JWST data: https://arxiv.org/pdf/2211.02607.pdf

Review Article: *The Evolution of the Intergalactic Medium*
McQuinn, M. 2015, ARAA, https://arxiv.org/abs/1512.00086

Book Chapter: *Observing the Epoch of Reionization with the Cosmic Microwave Background*
Reichardt, C. L., 2016, https://arxiv.org/abs/1511.01117

Article: *HERA Phase I Limits on the Cosmic 21 cm Signal: Constraints on Astrophysics and Cosmology during the Epoch of Reionization*
The HERA collaboration, Abdurashidova, Z., Aguirre, J. E., Alexander, P., et al., ApJ 924, 2, 30, 2022, https://arxiv.org/abs/2108.07282

Review Article: *Quasars and the Intergalactic Medium at Cosmic Dawn*
Fan, X., Banados, E., Simcoe, R. A., ARAA 2023, https://arxiv.org/pdf/2212.06907.pdf

Book recommendation: The cosmic 21-cm revolution. Charting the first billion years of our universe. Mesinger, Andrei, 2020. Bristol: IOP Publishing

17. Cosmological tests of gravity

Review Article: *Measuring gravity at cosmological scales*
Amendola, L. et al. 2019
http://inspirehep.net/record/1720827

18. Reheating in inflation

Review: *Lectures on Reheating after inflation*
K. Lozanov
https://arxiv.org/pdf/1907.04402.pdf

Review*: The Physics of inflation*
D. Baumann
https://www.icts.res.in/sites/default/files/baumann_icts_dec2011.pdf

Article: *Reheating after inflation*
Kofman, Linde, Starobinski
http://adsabs.harvard.edu/abs/1994PhRvL..73.3195K

19. Primordial black holes

Massive Primordial Black Holes as Dark Matter and their detection with Gravitational Waves
Juan Garcia-Bellido, arXiv:1702.08275.

Constraints on Primordial Black Holes with Extended Mass Functions
F.Kühnel, K. Freese, Phys.Rev. D95 (2017) no.8, 083508, arXiv:1701.07223.

Review: PBHs as dark matter candidates
Carr and Kuhnel
https://arxiv.org/abs/2110.02821