

Erwin T. Lau

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Education

- Ph.D., Astronomy & Astrophysics, University of Chicago, Chicago, IL, USA, 2010
- M.S., Astronomy & Astrophysics, University of Chicago, Chicago, IL, USA, 2006
- B.S., Astronomy and General Physics, University of Michigan, Ann Arbor, MI, USA, 2004
- B.S.E., Engineering Physics, University of Michigan, Ann Arbor, MI, USA, 2004

Professional Research Experience

- Smithsonian Astrophysical Observatory, High Energy Astrophysics
Visiting Scientist, Jan 2021–present
Advisor: Akos Bogdan
- University of Miami, Department of Physics
Postdoctoral Associate, Jan 2018–Dec 2020
Advisor: Nico Cappelluti
- Yale University, Department of Physics, Yale Center for Astronomy & Astrophysics
Associate Research Scientist, 2015–2017
Postdoctoral Associate, 2011–2015
Advisor: Daisuke Nagai
- Shanghai Astronomical Observatory, Key Laboratory for Research in Galaxies and Cosmology
Postdoctoral Fellow, 2010–2011
Advisor: Xiaohu Yang
- University of Chicago, Department of Astronomy & Astrophysics
Graduate Research Assistant, 2005–2010
Advisor: Andrey V. Kravtsov
- University of Michigan, Department of Physics
Undergraduate Research Assistant, 2003–2004
Advisor: Tim A. McKay

References

Prof. Nico Cappelluti (Postdoc Advisor)	University of Miami	ncappelluti@miami.edu
Prof. Daisuke Nagai (Postdoc Advisor)	Yale University	daisuke.nagai@yale.edu
Prof. Andrey V. Kravtsov (Thesis Advisor)	University of Chicago	andrey@oddjob.uchicago.edu
Prof. Paolo Coppi (Collaborator)	Yale University	paolo.coppi@yale.edu
Dr. Alexey Vikhlinin (Collaborator)	Smithsonian Astrophysical Observatory	alexey@cfa.harvard.edu

Research Interests

Computational and theoretical modeling of galaxy clusters and their observational signatures in X-ray and microwave. Statistical analysis of large data sets in simulations and observations. Astronomical software development. Physical processes in the intracluster medium. Diffuse emissions from the Large-scale Intergalactic Medium. Galaxy clusters as cosmological probes.

Awards

XSEDE Computing Research Allocation TG-AST190003, “Simulating Cosmic Weather in Galaxy Clusters”, 45k node hours

Professional Activities and Academic Services

Referee for:

- The Astrophysical Journal
- The Monthly Notices of the Royal Astronomical Society
- Astronomy & Astrophysics
- Research in Astronomy & Astrophysics

Peer Reviewer, *Chandra* Cycle 20 Peer Review, 2018

Organizer, Cosmology Seminar at Yale University, 2012–2014

Professional Societies

Member, American Astronomical Society

Member, International Astronomical Union

Selected Invited Talks

2019/6	INAF-OAS, Bologna, Italy, Cluster Talk
2017/9	Yale University, CT, USA, Astronomy Colloquium
2017/2	Rochester Institute of Technology, Rochester, NY, USA, Astrophysics Colloquium
2017/1	Kavli Institute for the Physics and Mathematics of the Universe, Kashiwa, Japan, Astrophysics Seminar
2017/1	Academia Sinica Institute of Astronomy and Astrophysics, Taipei, Taiwan, Special Seminar
2016/1	Shanghai Astronomical Observatory, Shanghai, China, Special Seminar
2016/1	Kavli Institute for Astronomy and Astrophysics, Peking University, Beijing, Lunch Seminar
2015/9	Kavli Institute for the Physics and Mathematics of the Universe, Kashiwa, Japan, Astrophysics Lunch Talk
2015/3	University of Hong Kong, Hong Kong, Physics Seminar
2014/3	University of Michigan, Ann Arbor, MI, USA, Cluster Seminar
2013/10	Brown University, Providence, RI, USA, Astrophysics Seminar
2012/8	Shanghai Astronomical Observatory, Shanghai, China, Cosmology Seminar
2012/4	Yale University, New Haven, CT, USA, Cosmology Seminar
2010/3	University of Colorado, Boulder, CO, USA, Cluster Seminar

Conference Presentations

2019/6	XMM Workshop on Extended X-ray Sources, ESAC, Madrid, Spain
2019/1	223th AAS meeting, Seattle, WA, USA
2018/12	“Miami 2018: Topical Physics Conference”, Fort Lauderdale, FL, USA
2018/10	“Accretion Histories of AGN Workshop”, Miami, FL, USA
2018/7	“Alpine Cosmology Workshop 2018”, Alagna Valsesia, Italy
2018/6	“AGN Feeding and Feedback”, Sesto, Italy
2017/8	“From Chandra to Lynx: Taking the Sharpest X-ray Vision Fainter and Farther”, Cambridge, MA, USA
2016/12	“Galaxy clusters: Physics Laboratories and Cosmological Probes”, Cambridge, UK
2015/6	“ICM Physics and Modelling”, Max Planck Institute for Astrophysics, Garching, Germany
2015/3	“Astroparticle View of Galaxy Clusters”, Hiroshima University, Hiroshima, Japan
2015/3	“SnowCluster 2015”, Snowmass, UT, USA
2014/6	“Cluster Paris 2014”, Paris, France
2013/3	“SnowCluster 2013”, Snowmass, UT, USA
2012/11	Galaxy Cluster Workshop, Ringberg, Germany
2012/8	28th IAU General Assembly, Beijing, China
2012/6	220th AAS Meeting, Anchorage, AK, USA
2012/3	“Turbulence in Cosmic Structure Formation”, ASU, Tempe, AZ, USA
2011/9	“Cosmology with X-ray and SZE Observations of Galaxy Clusters”, Huntsville, AL, USA
2011/3	“Astrophysics and Cosmology with Galaxy Clusters”, KITP, Santa Barbara, CA, USA
2010/7	“From Massive Galaxy Formation to Dark Energy”, IPMU, Kashiwa, Chiba, Japan
2010/6	10th “Great Lakes Cosmology Workshop”, Chicago, IL, USA
2010/1	215th AAS meeting, Washington, DC, USA
2007/2	“Clusters of Galaxies as Cosmological Probes”, Aspen, CO, USA

Mentoring and Teaching

Co-supervised undergraduate and graduate students with Prof. Daisuke Nagai at Yale University, and Prof. Nico Cappelluti at the University of Miami.

Luis Fernando Machado:

Post-Baccalaureate (2020-current) Project: “Modeling Gas Shapes in Galaxy Clusters and Groups”

Yale Undergrad (2016 - 2017) Project: “Modeling HST-COS Observations of Galaxy Cluster Outskirts”

Guanhua Chen: UMiami Undergrad (2019)

Project: “Semi-Analytic Modeling of X-ray and SZ Cross Power Spectra of Galaxy Clusters and Groups

Emil Öhman: Yale Undergrad (2015 - 2017)

Junior Project: “High resolution modeling of gas properties in galaxy cluster outskirts”

Senior Project: “Nature of gas streams and cold fronts in cosmological simulations of galaxy clusters”

Mari Kawakatsu: Yale Undergrad (2016 - 2017)

Senior Project: “Improving Galaxy Cluster Mass Measurements with Machine Learning Techniques”

Julia Menzel: Yale Undergrad (2015 - 2016)

Senior Project: “Streaming gas motions in galaxy clusters”

Joshua Burt, Yale Grad Student, Physics (2014-2015)

Summer Project: “Finding Gas Filaments in the Outskirts of Galaxy Clusters”

Christopher Cappiello: Yale Undergrad (2013 - 2015)

Awarded DeForest Pioneer Prize in Physics, Yale University, 2015

Senior Project: “Shapes of Galaxy Clusters”

Maya Fishbach: Yale Undergrad (2013 - 2015)

Awarded Howard L. Schultz Prize in Physics, Yale University, 2015

Senior Project: “Evolution of the filamentary gas flows in simulated galaxy clusters”

Junior Project: “Cluster Merger Simulations with Self-Interacting Dark Matter”

Hendrik Kits van Heyningen: Yale Undergrad (2013-2014)

Awarded DeForest Pioneer Prize in Physics, Yale University, 2014

Senior Project: “Modified Gravity & Dark Energy in Spherical Collapse Model”

Benjamin Elder, Yale Grad Student, Physics (2012-2013)

First Year Project: “Cosmological Simulations with Self-Interacting Dark Matter”

Dan Steinbrook: Yale Undergrad (Summer 2012)

Summer Project: “Effects of $f(R)$ gravity on the Shapes of Galaxy Clusters”

Elizabeth Peng: Yale Undergrad (2011-2012)

Senior Project: “Mock ASTRO-H Simulations of Galaxy Clusters”

Graduate Teaching Assistant, University of Chicago, 2004–2005, 2007

Refereed and Submitted Publications

1. Tchernin, C., Stapelberg, S., Hug, D., **Lau, E. T.**, Bartelmann, M. *Triaxiality in galaxy clusters: Mass versus Potential reconstructions*, 2020 A&A, submitted, arXiv:2012.13413
2. Aung, H., Nagai, D., **Lau, E. T.**, *Shock and Splash: Gas and Dark Matter Halo Boundaries around Λ CDM Galaxy Clusters*, 2020, MNRAS, submitted, arXiv:2012.00977
3. Machado Poletti Valle, L. F., Avestruz, C., Barnes, D. J., Farahi, A., **Lau, E. T.**, Nagai, D., *SHAPing the Gas: Understanding Gas Shapes in Dark Matter Haloes with Interpretable Machine Learning*, 2020, MNRAS, submitted, arXiv:2011.12987
4. Comparat, J., Eckert, D., Finoguenov, A., Schmidt, R., Sanders, J., Nagai, D., **Lau, E. T.**, Kaefer, F., Pacaud, F., Clerc, N., Reiprich, T. H., Bulbul, E., Ider Chitham, J., Chuang, C.-H., Ghirardini, Vi., Gonzalez-Perez, V., Gozaliasl, G., Kirkpatrick, C. C., Klypin, A., Merloni, A., Nandra, K., Liu, T., Prada, F., Ramos-Ceja, M. E., Salvato, M., Seppi, R., Tempel, E., Yepes, G., *Full-sky photon simulation of clusters and active galactic nuclei in the soft X-rays for eROSITA*, 2020, The Open Journal of Astrophysics, 3, 13, arXiv:2008.08404
5. Tchernin, C., **Lau, E. T.**, Stapelberg, S., Hug, D., Bartelmann, M., *Characterizing galaxy clusters by their gravitational potential: systematics of cluster potential reconstruction*, 2020, A&A, 644, A126, arXiv:2008.01107
6. **Lau, E. T.**, Hearin, A. P., Nagai, D., Cappelluti, N., *Correlations between Triaxial Shapes and Formation History of Dark Matter Haloes*, 2021, MNRAS, 500, 1029, arXiv:2006.09420
7. Shirasaki, M., **Lau, E. T.**, Nagai, D., *Probing Cosmology and Cluster Astrophysics with Multi-Wavelength Surveys I. Correlation Statistics*, 2020, MNRAS, 491, 235, arXiv:1909.02179
8. Chen, H., Avestruz, C., Kravtsov, A. V., **Lau, E. T.**, Nagai, D., *Imprints of mass accretion history on the shape of the intracluster medium and the $T_X - M$ relation*, 2019, MNRAS, 490, 2380 arXiv:1903.08662
9. Shi, X., Nagai, D., **Lau, E. T.**, *Multiscale analysis of turbulence evolution in the density-stratified intracluster medium*, 2018, MNRAS, 481, 1075 arXiv:1806.05056
10. Shirasaki, M., **Lau, E. T.**, Nagai, D., *Modelling Baryonic Effects on Galaxy Cluster Mass Profiles*, 2018, MNRAS, 477, 2804, arXiv:1711.06366
11. ZuHone, J. A., Kowalik, K., Öhman, E., **Lau, E.**, Nagai, D., *The Galaxy Cluster Merger Catalog: An Online Repository of Mock Observations from Simulated Galaxy Cluster Mergers*, 2018, ApJS, 234, 4, arXiv:1609.04121
12. Zinger, E., Dekel, A., Birnboim, Y., Nagai, D., **Lau, E.**, Kravtsov, A. V., *Cold Fronts and Shocks Formed by Gas Streams in Galaxy Clusters*, 2018, MNRAS, 476, 56, arXiv:1609.05308
13. Ota, N., Nagai, D., **Lau, E. T.**, *Constraining hydrostatic mass bias of galaxy clusters with high-resolution X-ray spectroscopy*, 2018, PASJ, 70, 51, arXiv:1507.02730
14. **Lau, E. T.**, Gaspari, M., Nagai, D., Coppi, P., *Physical Origins of Gas Motions in Galaxy Cluster Cores: Interpreting Hitomi Observations of the Perseus Cluster*, 2017, ApJ, 849, 54, arXiv:1705.06280
15. Tchernin, C., Eckert, D., Ettori, S., Pointecouteau, E., Paltani, S., Molendi, S., Hurier, G., Gastaldello, F., **Lau, E. T.**, Nagai, D., Roncarelli, M., Rossetti, M., *The XMM Cluster Outskirts Project (X-COP): Physical conditions to the virial radius of Abell 2142*, 2016, A&A, 595, A42, arXiv:1606.05657
16. Avestruz, C., Nagai, D., **Lau, E. T.**, *Stirred, not Clumped: Evolution of Temperature Profiles in the Outskirts of Galaxy Clusters*, 2016, ApJ, 833, 227, arXiv:1605.01723

17. Shirasaki, M., Nagai, D., **Lau, E. T.**, *Covariance in the Thermal SZ-Weak Lensing Mass Scaling Relation of Galaxy Clusters*, 2016, MNRAS, 460, 3913, arXiv:1603.08609
18. Shi, X., Komatsu, E., Nagai, D., **Lau, E. T.**, *Analytical model for non-thermal pressure in galaxy clusters - III. Removing the hydrostatic mass bias*, 2016, MNRAS, 455, 2936, arXiv:1507.04338
19. Sembolini, F., Yepes, G., Pearce, F. R., Knebe, A., Kay, S. T., Power, C., Cui, W., Beck, A. M., Borgani, S., Dalla Vecchia, C., Davé, R., Elahi, P. J., February, S., Huang, S., Hobbs, A., Katz, N., **Lau, E.**, McCarthy, I. G., Murante, G., Nagai, D., Nelson, K., Newton, R. D. A., Perret, V., Puchwein, E., Read, J. I., Saro, A., Schaye, J., Teyssier, R., Thacker, R. J., *nIFTy galaxy cluster simulations - I. Dark matter and non-radiative models*, 2016, MNRAS, 457, 2063, arXiv:1503.06065
20. **Lau, E. T.**, Nagai, D., Avestruz, C., Nelson, K., Vikhlinin, A., *Mass Accretion and its Effects on the Self-similarity of Gas Profiles in the Outskirts of Galaxy Clusters*, 2015, ApJ, 806, 86, arXiv:1411.5361
21. Avestruz, C., Nagai, D., **Lau, E. T.**, Nelson, K., *Non-Equilibrium Electrons in the Outskirts of Galaxy Clusters*, 2015, ApJ, 808, 176, arXiv:1410.8142
22. Rasia, E., **Lau, E. T.**, Borgani, S., Nagai, D., Dolag, K., Avestruz, C., Granato, G. L., Mazzotta, P., Murante, G., Nelson, K., Ragone-Figueroa, C., *Temperature Structure of the Intra-Cluster Medium from SPH and AMR simulation*, 2014, ApJ, 791, 96, arXiv:1406.4410
23. Zhuravleva, I., Churazov, E., Schekochihin, A. A., **Lau, E. T.**, Nagai, D., Gaspari, M., Allen, S. W., Nelson, K., Parrish, I. J. *The relation between gas density and velocity power spectra in galaxy clusters: qualitative treatment and cosmological simulations* 2014, ApJL, 788, L13, arXiv:1404.5306
24. Gaspari, M., Churazov, E., Nagai, D., **Lau, E. T.**, Zhuravleva, I., *The relation between gas density and velocity power spectra in galaxy clusters: high-resolution hydrodynamic simulations and the role of conduction*, 2014, A&A, 569, A67, arXiv:1404.5302
25. Nelson, K., **Lau, E. T.**, Nagai, D., *Hydrodynamic Simulation of Non-thermal Pressure Profiles of Galaxy Clusters*, 2014, ApJ, 792, 25, arXiv:1404.4636
26. Avestruz, C., **Lau, E. T.**, Nagai, D., Vikhlinin, A., *Testing X-ray Measurements of Galaxy Cluster Outskirts with Cosmological Simulations*, 2014, ApJ, 797, 117, arXiv:1404.4634
27. Wang, L., Yang, X., Shen, S., Mo, H. J., van den Bosch, F. C., Luo, W., Wang, Y., **Lau, E. T.**, Wang, Q. D., Kang, X., Li, R., *Measuring the X-ray luminosities of SDSS DR7 clusters from RASS*, 2014, MNRAS, 439, 611, arXiv:1312.7417
28. Harvey, D., Tittley, E., Massey, R., Kitching, T. D., Taylor, A., Pike, S. R., Kay, S. T., **Lau, E. T.**, & Nagai, D., *On the cross-section of Dark Matter using substructure infall into galaxy clusters*, 2014, MNRAS, 441, 404, arXiv:1310.1731
29. Nelson, K., **Lau, E. T.**, Nagai, D., Rudd, D. H., & Yu, L., *Weighing Galaxy Clusters with Gas. II. On the Origins of Hydrostatic Mass Bias in Λ CDM Galaxy Clusters*, 2014, ApJ, 782, 107, arXiv:1308.6589
30. Nagai, D., **Lau, E. T.**, Avestruz, C., Nelson, K., & Rudd, D. H., *Predicting Merger-Induced Gas Motions in Λ CDM Galaxy Clusters*, 2013, ApJ, 777, 137, arXiv:1307.2251
31. **Lau, E. T.**, Nagai, D., & Nelson, K., *Weighing Galaxy Clusters with Gas. I. On the Methods of Computing Hydrostatic Mass Bias*, 2013, ApJ, 777, 151, arXiv:1306.3993
32. Khedekar, S., Churazov, E., Kravtsov, A., Zhuravleva, I., **Lau, E. T.**, Nagai, D., & Sunyaev, R., *Bias from gas inhomogeneities in the pressure profiles as measured from X-ray and Sunyaev-Zeldovich observations*, 2013, MNRAS, 431, 954, arXiv:1211.3358

33. Zhuravleva, I., Churazov, E., Kravtsov, A., **Lau, E. T.**, Nagai, D., & Sunyaev, R., *Quantifying properties of ICM inhomogeneities*, 2012, MNRAS, 428, 3274, arXiv:1210.6706
34. **Lau, E. T.**, Nagai, D., Kravtsov, A. V., Vikhlinin, A., & Zentner, A. R., *Constraining Cluster Physics with the Shape of X-Ray Clusters: Comparison of Local X-Ray Clusters Versus Λ CDM Clusters*, 2012, ApJ, 755, 116, arXiv:1201.2168
35. Eckert, D., Vazza, F., Ettori, S., Molendi, S. Nagai, D., **Lau, E. T.**, Roncarelli, M., Rossetti, M., Snowden, S. L., & Gastaldello, F., *The Gas Distribution in the Outer Regions of Galaxy Clusters*, 2012, A&A, 541, A75, arXiv:1111.0020
36. **Lau, E. T.**, *Characterizing Galaxy Clusters with Gravitational Potential*, 2011, ApJ, 736, 145, arXiv:1009.2124
37. Nagai, D., & **Lau, E. T.**, *Gas Clumping in the Outskirts of Λ CDM Clusters*, 2011, ApJL, 731 L10, arXiv:1103.0280
38. **Lau, E. T.**, Nagai, D., Kravtsov, A. V., & Zentner, A. R., *Shapes of Gas, Gravitational Potential and Dark Matter in Λ CDM Clusters*, 2011, ApJ, 734, 93, arXiv:1003.2270
39. Shaw, L. D., Nagai, D., Bhattacharya, S., **Lau, E. T.**, *Impact of Cluster Physics on the Sunyaev-Zel'dovich Power Spectrum*, 2010, ApJ, 725, 1452, arXiv:1006.1945
40. **Lau, E. T.**, Nagai, D., & Kravtsov, A. V., *Effects of Baryon Dissipation on the Dark Matter Virial Scaling Relation*, 2010, ApJ, 708, 1419, arXiv:0908.2133
41. **Lau, E. T.**, Kravtsov, A. V., & Nagai, D., *Residual Gas Motions in the Intracluster Medium and Bias on the Hydrostatic Mass Profile*, 2009, ApJ, 705, 1129, arXiv:0903.4895
42. Becker, M. R., McKay, T. A., Koester, B., Wechsler, R. H., Rozo, E., Evrard, A., Johnston, D., Sheldon, E., Annis, J., **Lau, E.**, Nichol, R., & Miller, C., *The Mean and Scatter of the Velocity Dispersion–Optical Richness Relation for maxBCG Galaxy Clusters*, 2007, ApJ, 669, 905, arXiv:0704.3614

Unrefereed Publications

1. Simionescu, A.; Ettori, S.; Werner, N.; Nagai, D.; Vazza, F.; Akamatsu, H.; Pinto, C.; de Plaa, J.; Wijers, N.; Nelson, D.; Pointecouteau, E.; Pratt, G. W.; Spiga, D.; **Lau, E.**; Rossetti, M.; Gastaldello, F.; Biffi, V.; Bulbul, E.; den Herder, J. W.; Eckert, D. Fraternali, F.; Mingo, B.; Pareschi, G.; Pezzulli, G.; Reiprich, T. H.; Schaye, J.; Walker, S. A.; Werk, J., *Voyage through the Hidden Physics of the Cosmic Web*, 2019, White paper submitted in response to ESA's Voyage 2050 Call, arXiv:1908.01778
2. Walker, S.; Nagai, D.; Simionescu, A.; Markevitch, M.; Akamatsu, H.; Arnaud, M.; Avestruz, C.; Bautz, M.; Biffi, V.; Borgani, S.; Bulbul, E.; Churazov, E.; Dolag, K.; Eckert, D.; Ettori, S.; Fujita, Y.; Gaspari, M.; Ghirardini, V.; Kraft, R.; **Lau, E. T.**; Mantz, A.; Matsushita, K.; McDonald, M.; Miller, E.; Mroczkowski, T.; Nulsen, P.; Okabe, N.; Ota, N.; Pointecouteau, E.; Pratt, G.; Sato, K.; Shi, X.; Tremblay, G.; Tremmel, M.; Vazza, F.; Zhuravleva, I.; Zinger, E.; ZuHone, J., *Unveiling the Galaxy Cluster - Cosmic Web Connection with X-ray observations in the Next Decade*, 2019, Astro2020: Decadal Survey on Astronomy and Astrophysics, science white papers, no. 218; Bulletin of the American Astronomical Society, Vol. 51, Issue 3, id. 218, arXiv:1903.04550