Ikerbasque Fellow
Dept of Theoretical Physics
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Mark C. Neyrinck

Curriculum Vitæ

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Born in Colorado, USA

Principal Achievements

- I discovered an engaging **"origami" analogy for structure formation**, which helps to understand information loss in the cosmos, and how angular momentum in a galaxy is related to its environment.
- I pioneered **techniques to detect and analyze cosmic voids** for cosmological constraints. With my premier void-finder ZOBOV, we made the **first detection of the cold imprints of voids** on the **cosmic microwave background**, a **sign of dark energy**.
- I discovered a simple way to enhance the power of conventional large-scale-structure studies: Gaussianizing transforms. This will lead to a **deeper understanding, and tighter constraints, on cosmic structure formation and the cosmological and galaxy-formation physics** driving it.

Popular Media Attention for Work

Interview and segment about origami and cosmology in "The Origami Revolution," (aired 2/15/2017)
http://www.pbs.org/video/nova-origami-revolution-episode/, http://www.dailymotion.com/video/x5yma3d
"The Cosmic Spiderweb on Dark-Matter-Haloes' Eve" invited blog post, *The Huffington Post*
"The Origami Cosmic Web" article, *The Paper* (OrigamiUSA magazine, circ. 1800), Autumn 2016
Quoted in "Vast cosmic voids merge like soap bubbles", Cowen, Ron, *Nature*, Oct 15, 2015
"How to Make an Origami Universe," Battersby, Stephen, *New Scientist*, 20 Dec 2014
Quoted in "Shadow of a Supervoid," Maria Temming, *New Scientist*, 24 June 2014
"The Origami Cosmic Web of Galaxies," invited blog post, *The Huffington Post*
"Dark energy 'imaged' in best detail yet," Merali, Zeeya, *New Scientist*
"Dark Energy's Early Fingerprints," Carlisle, C. M., *Sky & Telescope* online

Education

Ph.D. Astrophysics, University of Colorado at Boulder (Thomas Award) *Dec 2005*
Ph.D. Thesis: "Illuminating the Tips of Dark-Matter Icebergs"
Advisors: Andrew J. S. Hamilton, Nickolay Y. Gnedin
M.S. Astrophysics, University of Colorado at Boulder (High Pass)
B.A. Physics, w/spec. in Astr, University of Chicago (Honors; Lewis Prize)
Mathematics, Part IB, Pembroke College, **Cambridge University**

Selected Awards and Grants

PI, Templeton New Frontiers in Astronomy and Cosmology Award/Grant
Only non-faculty recipient. "Information Flowing and Folding into Complexity"
Recipient, JHU Digital Media Center Creative Use of Technology Grant, funding a "folding lab" in my "Origami Mathematics and Cosmology" class
Collaborator, NASA Grants, "Reconstructing Information in Large-Scale Structure via Logarithmic Mapping," "Detecting Dark Energy from WMAP and Pan-STARRS1 Cross-correlations"
Richard N. Thomas Award, annual award for the most outstanding research by a graduating University of Colorado Astrophysics PhD student
Supercomputer Allocations, NCSA/XSEDE
Lewis Prize, for the "**best graduating senior in physics," University of Chicago**
Donnelley Fellowship for one year at Cambridge University, awarded to one undergraduate per year at the University of Chicago

Employment

Ikerbasque Fellow, Univ of the Basque Country, Spain	*Spring 2018-Present*
Postdoctoral Researcher, Durham University	*Aug 2016-Winter 2017*
Visiting Scientist, Institut d'Astrophysique de Paris	*Jan-July 2016*
Course Instructor, "Origami Mathematics and Cosmology", JHU	*Intersession, Jan 2015*
Asst, Assoc. Research Scientist with PI status, Johns Hopkins	*Summer 2011-June 2016*
W. M. Keck Fellow, Johns Hopkins University	*Fall 2008-Summer 2011*
Postdoctoral Researcher, Institute for Astronomy, U. of Hawaii	*Fall 2005-Summer 2008*
Course Instructor, "Black Holes", APS Dept., U. of Colorado	*Summer 2005*
Research Assistantship, JILA, Univ. of Colorado	*Summer 2000-Fall 2004*
Teaching Assistantship, APS Dept., U. of Colorado	*Fall 2000, Fall 2002, Spring 2005*
Teaching Assistantship, Math Dept., U. of Chicago	*1997-1998, 1999-2000*

Selected Presentations and Invitations

Inst of Physics Symposium, London, "Bringing Physics into the Human Experience"	*Oct 2017*
Seminar: Vorticity in Large-Scale Structure, Aspen Center for Physics meeting, "Vorticity in the Universe"	*Sep 2017*
Seminar: Origami-Folding the Local Universe, Paper Studio, Northumbria University	*Apr 2017*
Talk, Virgo Consortium Meeting	*Dec 2016*
Seminar, Institute of Theoretical Astrophysics, University of Oslo	*Nov 2016*
Invited speaker, BAO & RSD: Dark Light on Obscure Acronyms, Sexten Center for Astrophysics, Sesto, Italy	*July 2016*
Talk at Statistical Challenges in 21st Century Cosmology, Chania, Greece	*May 2016*
Invited speaker, Statistics of Extrema in Large Scale Structure, Leiden	*March 2016*
Talk, "Local Group Astrostatistics" workshop, Ann Arbor, MI	*June 2015*
Invited speaker, "Advanced Workshop on Cosmological Structures from Reionization to Galaxies: Combining Efforts from Analytical and Numerical Methods," Trieste, Italy	*May 2015*
Invited speaker, National Society of Black Physicists conference, Baltimore, MD	*Feb 2015*
Sloan 3 BOSS meeting	*Dec 2014*
Invited CITA Seminar	*November 2014*
"The Galaxy-Halo Connection Across Cosmic Time" workshop, Aspen Center for Physics	*September 2014*
Plenary talk, co-organizer of "Cosmic Voids in the Next Generation of Galaxy Surveys" workshop, Ohio State University	*August 2014*
Talk at 6OSME: The 6th International Meeting on Origami in Science, Mathematics, and Education, Tokyo	*August 2014*
Seminar, University of Nagoya, Japan	*August 2014*
Seminar, Institute for Astronomy, Hawaii	*August 2014*
Invited talk, Collisionless Fluids Workshop, IAP, Paris	*July 2014*
Invited talk, IAU Symposium 308: The Zel'dovich Universe, Tallin, Estonia	*June 2014*
LSST Dark Energy Science Collaboration meeting, Philadelphia	*June 2014*
Invited talk, IAU Symposium 306: Statistical Challenges in 21st Century Cosmology, Lisbon, Portugal	*May 2014*
Invited talk, "Tracing the Cosmic Web," Lorentz Center, Leiden, the Netherlands	*Feb 2014*
SDSS BOSS collaboration meeting, Berkeley	*Dec 2013*
CASA/JILA Astrophysics Lunch Seminar, U of Colorado, Boulder	*Aug 2013*
Talk, Ripples in the Cosmos, Durham, UK	*Jul 2013*
Invited Talk, Darklight Dark Energy/Matter Workshop, Varenna, Italy	*June 2013*

Professional and Departmental Service

LSST-Dark Energy Science Collaboration full member *2014-Present*
JHU Cosmology Journal Club (Cosmojo) founding and weekly organization *2009-2015*
SOC, "Cosmic Voids in the Next Generation of Galaxy Surveys"
workshop, Ohio State University *Aug 2014*
NASA Astrophysics Theory and Data Analysis Program panels (ATP, ADAP) *2011, 2012, 2014*
Head Organizer for IDIES (Institute for Data-Intensive Engineering and Science) *Aug 2009*
Inaugural Symposium/Alex Szalay's 60th Birthday "Szalaybration"
Colloquium Committee, UH Institute for Astronomy *2007-2008*

Outreach Activities (hyperlinks in blue)

Involvement in NOVA program "The Origami Revolution" *2017*
Involvement in "Celebrate Science," Durham University *2016-2017*
JHU Physics & Astronomy Dept Physics Fair contributions and volunteering *2010-2015*
"The Bridge" Resident, SciArt Center *2016-2017*
Involvement in "The Origami Code" documentary: interview and making animations *2015*
JHU Physics & Astronomy Dept Physics Fair contributions and volunteering *2009-2014*
Development of "Fold Your Own Galaxy" origami activity, and
"Fold Your Own Universe" NASA SpaceApp
USA Science & Engineering Festival (Wash, DC) contributions and volunteering *Oct 2010*
UH Institute for Astronomy Open Houses *2006-2008*
Supervising the "Astronomy" and "Reach for the Stars" events for *2001, 2003, 2004, 2005*
Colorado Science Olympiad (middle and high school) competitions
Running open houses at Boulder's Sommers-Bausch Observatory

Publications: H-index 25, over 2500 total citations (according to Google Scholar)

Selected Paper in Preparation

1. **Neyrinck**, Mark C., invited review article to Physics Reports, in prep.
"Optimizing the information extracted from non-Gaussian fields using nonlinear transforms"

Submitted and Accepted Refereed Publications (blue text is linked to ADS abstracts)

2. Raccanelli,… **Neyrinck** et al., 2018, Physics of the Dark Universe, in press
Doppler term in the galaxy two-point correlation function: wide-angle, velocity, Doppler lensing and cosmic acceleration effects
3. **Neyrinck** et al., 2017, Roy Soc Open Science, submitted
The cosmic spiderweb: equivalence of cosmic, architectural and origami tessellations
4. Libeskind, … **Neyrinck**, et al., 2018, MNRAS, 473, 1195
Tracing the cosmic web
5. **Neyrinck** et al., 2017, MNRAS, submitted
Density-dependent clustering: I. Pulling back the curtains on motions of the BAO peak
6. Ivkin, … **Neyrinck**, Szalay et al., 2018, Astronomy & Computing, submitted,
Scalable Streaming Tools for Analyzing N-body Simulations: Finding Halos and Investigating Excursion Sets in One Pass
7. Falck, …, **Neyrinck**, et al., 2017, ApJ, 837, 181
The Effect of Corner Modes in the Initial Conditions of Cosmological Simulations
8. Cai, **Neyrinck**, Mao, Peacock, Szapudi & Berlind, 2016, MNRAS, 466, 3364
The lensing and temperature imprints of voids on the Cosmic Microwave Background
9. Aragon-Calvo, M., **Neyrinck**, Mark C., Silk, J., 2016
How Cosmic Web Detachment Drives Galaxy Quenching
10. Mao, Berlind, Scherrer, **Neyrinck**, et al., 2017, ApJ, 835, 160

Cosmic Voids in the SDSS DR12 BOSS Galaxy Sample: The Alcock-Paczynski Test

11. Mao, Berlind, Scherrer, **Neyrinck**, et al., 2017, ApJ, 835, 161
    A Cosmic Void Catalog of SDSS DR12 BOSS Galaxies
12. Kitaura, F-S, … **Neyrinck**, Mark, et al., 2016, MNRAS, 456, 4156
    The clustering of galaxies in the SDSS-III Baryon Oscillation Spectroscopic Survey: mock galaxy catalogues for the BOSS Final Data Release
13. McCullagh, N., **Neyrinck**, Mark, Norberg, P., Cole, S., 2016, MNRAS, 457, 3652
    Recovering dark-matter clustering from galaxies with Gaussianization
14. **Neyrinck**, Mark C. 2016, MNRAS, 460, 816
    Tetrahedral collapse: a rotational toy model of simultaneous dark-matter halo, filament and wall formation
15. Zaoxing, L., … **Neyrinck**, Mark, et al. (4th of 10) 2015 IEEE 11th International Conference on e-Science, pp.342-351, Aug. 31 2015-Sept. 4 2015, doi: 10.1109/eScience.2015.73
    Streaming Algorithms for Halo Finders
16. **Neyrinck**, Mark C. 2016, MNRAS Letters, 455, 11
    Truthing the stretch: Non-perturbative cosmological realizations with multiscale spherical collapse
17. Alam, Shadab, … **Neyrinck**, Mark C., et al. 2015, ApJS, 219, 12
    The Eleventh and Twelfth Data Releases of the Sloan Digital Sky Survey: Final Data from SDSS-III
18. Achitouv, Ixandra, **Neyrinck**, Mark; Paranjape, Aseem, 2015, MNRAS, 451, 3964
    Testing spherical evolution for modelling void abundances
19. Aragon-Calvo, M., **Neyrinck**, Mark C., Silk, J., 2014, MNRAS, submitted
    Star Formation Isochrone Surfaces: Clues on Star Formation Quenching in Dense Environments
20. Yang, F. Y., **Neyrinck**, Mark C., … Silk, J., 2014; MNRAS, 451, 360
    Warmth Elevating the Depths: Shallower Voids with Warm Dark Matter
21. **Neyrinck**, Mark C., 2015; MNRAS Letters, 452, 26
    Kolmogorov complexity in the Milky Way and its reduction with warm dark matter
22. **Neyrinck**, Mark C., 2015; accepted after refereeing to Origami^6: Proceedings of the 6th International Meeting on Origami in Science, Mathematics, and Education.
    Cosmological Origami: Properties of Cosmic-Web Components when a Non-Stretchy Dark-Matter Sheet Folds
23. Hoffmann, K.; … **Neyrinck**, Mark C., et al. (17 authors), 2014, MNRAS, 442, 1197
    Subhaloes gone Notts: subhaloes as tracers of the dark matter halo shape
24. **Neyrinck**, Mark C.; Aragon-Calvo, M. A.; Jeong, D.; Wang, X., 2014, MNRAS, 441, 646
    A halo bias function measured deeply into voids without stochasticity
25. Cai, Y-C; **Neyrinck**, Mark C.; et al. (5 authors), 2014, ApJ, 786, 110
    A Possible Cold Imprint of Voids on the Microwave Background Radiation
26. Cai, Y-C; ... **Neyrinck**, Mark C.; et al. (5 authors), 2014, MNRAS, 439, 2978
    The Integrated Sachs-Wolfe effect in f(R) gravity
27. Wang, Xin, ... **Neyrinck**, Mark et al. (5 authors), 2014, ApJ, 793, 58
    Kinematic Morphology of Large-Scale Structure: Evolution from Potential to Rotational Flow
28. Pujol, A., ..., **Neyrinck**, Mark C., et al., 2014, MNRAS, 438, 3205
    Subhaloes gone Notts: the clustering properties of subhaloes
29. Knebe, A., ..., **Neyrinck**, Mark C., et al. (21 of 35 authors), 2013, MNRAS, 435, 1618
    Structure finding in cosmological simulations: the state of affairs
30. **Neyrinck**, Mark C. & Yang, L. F., 2013, MNRAS, 433, 1628
    Ringing the initial Universe: the response of overdensity and transformed-density power spectra to initial spikes
31. Onions, J., ..., **Neyrinck**, Mark C., et al. (12th of 18 authors), 2013, MNRAS, 429, 2739.
    Subhaloes gone Notts: spin across subhaloes and finders
32. Hernandez-Monteagudo, C., ..., **Neyrinck**, Mark C., et al. (7th of 15 authors), MNRAS, 438, 1724.
    The SDSS-III Baryonic Oscillation Spectroscopic Survey: Constraints on the Integrated Sachs Wolfe effect
33. McCullagh, N., **Neyrinck**, Mark C., et al. (4 authors), ApJ Letters, 763, 14.
    Removing BAO-peak shifts with local density transforms
34. **Neyrinck**, Mark C., 2013, MNRAS, 428, 141

Quantifying distortions of the Lagrangian dark-matter mesh in cosmology

35. **Neyrinck**, Mark C., 2012, MNRAS, 427, 494.
Origami constraints on the initial-conditions arrangement of streams and caustics
36. Onions, J., ... **Neyrinck**, Mark C. et al. (17 authors), 2013, MNRAS, 429, 2739
Subhaloes gone Notts: Spin across subhaloes
37. Falck, B., **Neyrinck**, Mark C., & Szalay, A, 2012, ApJ, 754, 126
ORIGAMI: Delineating haloes using phase-space folds
38. Onions, J., ... **Neyrinck**, Mark C. et al. (17 authors), 2012, MNRAS, 423, 1200
SubHaloes Going Notts: The SubHalo-Finder Comparison Project
39. Carron, J., & **Neyrinck**, Mark C., 2012, ApJ, 750, 28
On the inadequacy of N-point correlation functions to describe nonlinear cosmological fields: Explicit examples and connection to simulations
40. Falck, B., **Neyrinck**, Mark C., Lavaux, G, Aragon-Calvo, M. & Szalay, A, 2012, ApJ, 745, 17.
Straightening the Density-Displacement Relation with a Logarithmic Transform
41. **Neyrinck**, Mark C., 2011, ApJ, 742, 91
Rejuvenating the Matter Power Spectrum III: The Cosmology Sensitivity of Gaussianized Power Spectra
42. **Neyrinck**, Mark C., 2011. ApJ, 736, 8.
Removable Matter-power-spectrum Covariance from Bias Fluctuations
43. Wang, X., **Neyrinck**, Mark C., et al. (8 authors), 2011. ApJ, 735, 32.
Perturbation Theory of the Cosmological Log-density Field
44. Knebe, A., … **Neyrinck**, Mark C., et al. (37 authors), 2011. MNRAS, 415, 2293.
Haloes gone MAD: The Halo-Finder Comparison Project
45. Tian, H.J., **Neyrinck**, Mark C., Budavári, T., & Szalay, A.S., 2011. ApJ, 728, 34.
Redshift-Space Enhancement of Line-of-Sight Baryon Acoustic Oscillations in the SDSS Main-Galaxy Sample
46. **Neyrinck**, Mark C., Szapudi, I., & Szalay, A.S., 2011. ApJ, 731, 116.
Rejuvenating Power Spectra II: the Gaussianized galaxy density field
47. Granett, B. R., Szapudi, I., & **Neyrinck**, Mark C., 2010. ApJ 714, 825.
Galaxy Counts on the Cosmic Microwave Background Cold Spot
48. Granett, B. R., **Neyrinck**, Mark C., & Szapudi, I., 2009. ApJ 701, 414.
A Map of the Integrated Sachs-Wolfe Signal from Luminous Red Galaxies
49. **Neyrinck**, Mark C., Szapudi, I., & Szalay, A. S., 2009. ApJ 698, L90.
Rejuvenating the Matter Power Spectrum: Restoring Information with a Logarithmic Density Mapping
50. Granett, B. R., **Neyrinck**, Mark C., & Szapudi, I., 2008. ApJ 683, L99.
An Imprint of Superstructures on the Microwave Background due to the Integrated Sachs-Wolfe Effect
51. Colberg, J. M., … **Neyrinck** M. C., et al., 2008. MNRAS 387, 933.
The Aspen-Amsterdam void finder comparison project
52. **Neyrinck**, Mark C., 2008. MNRAS 386, 2101.
ZOBOV: a parameter-free void-finding algorithm
53. **Neyrinck**, Mark C. & Szapudi, I., 2008. MNRAS 384, 1221.
Baryon oscillations in galaxy and matter power-spectrum covariance matrices
54. **Neyrinck**, Mark C. & Szapudi, I., 2007. MNRAS 375, L51.
Information content in the halo-model dark-matter power spectrum - II. Multiple cosmological parameters
55. **Neyrinck**, Mark C., Szapudi, I., & Rimes, C. D., 2006. MNRAS 370, L66.
Information content in the halo-model dark-matter power spectrum
56. **Neyrinck**, Mark C., Hamilton, A. J. S., & Gnedin, N. Y., 2005. MNRAS 362, 337.
A galaxy-halo model of large-scale structure
57. **Neyrinck**, Mark C., Gnedin, N. Y., & Hamilton, A. J. S., 2005. MNRAS 356, 1222.
VOBOZ: an almost-parameter-free halo-finding algorithm
58. **Neyrinck**, Mark C., Hamilton, A. J. S., & Gnedin, N. Y., 2004. MNRAS 348, 1.

Understanding the PSCz galaxy power spectrum with N-body simulations

59. Gnedin, N. Y., … **Neyrinck**, M. C., et al., 2003. ApJ 583, 525.
Linear Gas Dynamics in the Expanding Universe

Leniently Refereed Conference Proceedings

1. Aragon-Calvo, **Neyrinck** & Silk, 2016, Proceedings of "The Zel'dovich Universe: Genesis and Growth of the Cosmic Web," 23-28 June 2014, Tallinn, Estonia.
The origin of the galaxy color bimodality
2. **Neyrinck**, Proceedings of "The Zel'dovich Universe: Genesis and Growth of the Cosmic Web,"
An origami approximation to the cosmic web
3. **Neyrinck**, Mark C., 2014, Proceedings for "Statistical Challenges in 21st Century Cosmology," IAU Symposium No. 306, Lisbon, May 2014.
Transformationally decoupling clustering and tracer bias
4. **Neyrinck**, Mark C.; Falck, Bridget L.; Szalay, Alex S., 2015, proceedings of the 13th Marcel Grossmann Meeting, ORIGAMI: Delineating Cosmic Structures with Phase-Space Folds
5. **Neyrinck**, Mark C., & Shandarin, S.F., 2015, proceedings of "The World a Jigsaw: Tessellations in the Sciences."
Tessellating the cosmological dark-matter sheet: origami creases in the universe and how to find them
6. **Neyrinck**, Mark C., 2011. "Statistical Challenges of Modern Astronomy V" conf. proc.
Gaussianization: Enhancing the Statistical Power of the Power Spectrum
7. **Neyrinck**, Mark C., Hamilton, Andrew J. S., & Gnedin, Nickolay Y., 2003. ASSL 281, 203.
The PSCz Galaxy Power Spectrum Compared to N-Body Simulations

Software-Development Accomplishments

Expertise with *N*-body simulations, parallelization and running highly parallel applications
Developed CosmicEmuLog, a Python emulator of the cosmological log-density power spectrum
Developed CosmoPy, a package of Python code for cosmology
Developed the publicly available cosmological halo-finders VOBOZ and ORIGAMI, and the void-finder ZOBOV
Highly proficient in Python, C, FORTRAN, IDL, Java, Mathematica, and HTML
Have also used C++, Perl, Lisp, and Inform

Non-Astronomical Interests

Music composition, piano, creative writing, mathematics, origami

Professional References

1. **Prof. Alexander Szalay**, Alumni Professor of Physics and Astronomy, Johns Hopkins University, 3400 N. Charles St., Baltimore, MD 21218, szalay@jhu.edu, (410) 516-7217
2. **Prof. István Szapudi**, Institute for Astronomy, University of Hawaii, 2680 Woodlawn Drive, Honolulu, HI 96822, szapudi@ifa.hawaii.edu, (808) 956-6196
3. **Prof. Joe Silk**, Department of Physics and Astronomy, Johns Hopkins University, 3400 N. Charles St., Baltimore, MD 21218, jsilk@pha.jhu.edu, (410) 516-2881
4. **Prof. Shaun Cole**, Institute for Computational Cosmology, Department of Physics, University of Durham, shaun.cole@durham.ac.uk, +44-191-334-3593
5. **Prof. Sergei Shandarin**, Department of Physics and Astronomy, 6070C Malott Hall, 1251 Wescoe Hall Dr., Lawrence, KS 66045, sergei@ku.edu, (785) 864-5274
6. **Prof. Andrew J. S. Hamilton**, JILA and Dept of Astrophysical and Planetary Sciences, Univ of Colorado; Campus Box 440, Boulder, CO 80309, Andrew.Hamilton@colorado.edu, (303) 492-7833

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