Inst. for Computational Cosmology
Department of Physics
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Mark C. Neyrinck
Resumé

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Born in Colorado; Citizen of USA

Principal Achievements

- Pioneered methods for **feature detection** and **classification** in 3D **images** or point sets (the spatial large-scale structure of matter in the Universe). I **developed the standard void detector** in use currently, the publicly released ZOBOV, essentially a **watershed image-analysis** and **segmentation** technique. Developed methods to detect linear filamentary and planar wall structures
- Discovered why Gaussianization, the image-analysis technique, works so well to increase the information available in 2D and 3D images
- Discovered physical connections between the **network** of the cosmic web (the cellular spatial structure in the universe), origami, and architectural structures such as trusses and spiderwebs. Related to tessellations and segmentations of spatial images and spatial **graph theory**.
  - The Cosmic Spiderweb on All Dark-Matter-Haloes' Eve, *The Huffington Post*
  - Interviewed, work featured in the NOVA program "The Origami Revolution", contributing visualizations
    http://www.dailymotion.com/video/x5li34h
    http://www.pbs.org/wgbh/nova/physics/origami-revolution.html
  - "How to Make an Origami Universe," Battersby, Stephen, *New Scientist*
  - "The Origami Cosmic Web," OrigamiUSA magazine *The Paper*, Autumn 2016
  - "The Origami Cosmic Web of Galaxies," invited blog post, *The Huffington Post*

Education

Ph.D. Astrophysical and Planetary Sciences, University of Colorado at Boulder
Ph.D. Thesis: "Illuminating the Tips of Dark-Matter Icebergs" **(Thomas Award)**
M.S. Astrophysics, University of Colorado at Boulder
B.A. Physics, w/spec. in Astr, **University of Chicago (Honors; Lewis Prize)**
Mathematics, Part IB, Pembroke College, **Cambridge University**

Other Expertise

- Image analysis, information theory, feature detection, graph theory, creative visualization, data analysis, mathematical modeling, sonifications
- 3D printing and modeling
- Developed several software packages: the publicly available cosmological halo-finders VOBOZ and ORIGAMI; the CosmicEmuLog emulator; CosmoPy, Python toolkit for cosmology; and the "Fold Your Own Universe" origami cosmology NASA SpaceApp
- Highly proficient in Python, C, IDL, Mathematica, HTML, FORTRAN
- Experienced with Java, Perl, Lisp, SQL and Inform, C++
- Have given over 100 presentations, seminars, and classes as instructor of record at Johns Hopkins University and the University of Colorado
- Have supervised several students

Selected Awards, Grants, and Professional Service

- Invited participant, Institute of Physics, London,
  "Bringing Physics into the Human Experience" Symposium *Oct 2017*
- NASA proposal review panels *2011-2014*
- "The Bridge" fellowship, SciArt Center, New York *2016-2017*
- JHU Digital Media Center Creative Use of Technology Grant,
  funding a "folding lab" in my "Origami Mathematics and Cosmology" class *2015*
- **PI, Templeton New Frontiers in Astronomy and Cosmology Award, $200,000**
  "Information Flowing and Folding into Complexity" *2012-2014*
- **Richard N. Thomas Award**, annual award for outstanding research by a graduating
  University of Colorado Astrophysics PhD student *Dec 2005*
- **Lewis Prize**, for the "**best graduating senior in physics," University of Chicago**

Employment

Postdoctoral Researcher, Institute for Computational Cosmology,
Durham University, UK *Summer 2016-Present*
Associate Research Scientist, Johns Hopkins University Physics and Astronomy Dept
Institute for Data-Intensive Engineering and Science (IDIES) *Fall 2014-Summer 2016*
Course Instructor, "Origami Mathematics and Cosmology", JHU *Winter 2015*
Assistant Research Scientist, Johns Hopkins University *Summer 2011-Fall 2014*
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", Astrophysics Dept., U. of Colorado *Summer 2005*

Selected Academic Papers (Google Scholar overview: over 80 entries, over 2500 citations, h-index 24)
Papers about my spatial feature-detection algorithms:

Ivkin, … Neyrinck et al 2017, Scalable Streaming Tools for Analyzing N-body Simulations: Finding Halos and Investigating Excursion Sets in One Pass
Neyrinck, Falck & Szalay 2015, ORIGAMI: Delineating Cosmic Structures with Phase-Space Folds
Liu, … Neyrinck et al 2015, Streaming Algorithms for Halo Finders
Falck, Neyrinck & Szalay 2012, ORIGAMI: Delineating Halos Using Phase-space Folds
Neyrinck 2008, ZOBOV: a parameter-free void-finding algorithm
Neyrinck 2005, VOBOZ: an almost-parameter-free halo-finding algorithm

Comparison projects of feature-detection algorithms, including my own:

Tracing the cosmic web (cosmic web classifier/feature detection comparison project)
Subhaloes going Notts: the subhalo-finder comparison project
Structure finding in cosmological simulations: the state of affairs
Haloes gone MAD: the halo-finder comparison project
The Aspen-Amsterdam void finder comparison project

Other selected papers:

Neyrinck et al 2017, The cosmic spiderweb: equivalence of cosmic, architectural, and origami tessellations
Paper about the geometry of the spatial graph of the cosmic web

Neyrinck et al 2009, Rejuvenating the Matter Power Spectrum: Restoring Information with a Logarithmic Density Mapping
Discovery paper of the Gaussianization approach in large-scale structure statistics, essentially explaining why altering the "histogram" in an image works so well in improving information content