

# Dr. Robyn E. Sanderson

Kapteyn Astronomical Institute  
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## Education

Massachusetts Institute of Technology, Cambridge, Massachusetts, USA, 2004–2011

Ph.D., Physics, 25 January 2011.

Thesis advisor: Edmund Bertschinger. Thesis Committee: Alan Guth, Paul Schechter.

University of Maryland, College Park, Maryland, USA 1999–2003

B.S., Physics, High Honors and magna cum laude

B.S., Astronomy, High Honors and magna cum laude

Centre International d'Études Françaises, Université de Bourgogne, Dijon, France, January–May 2002

Diplome d'Études Langue Française, deuxième degré, mention Très Bien

## Research Experience

**Postdoctoral researcher, Kapteyn Astronomical Institute** April 2011–March 2014.

Supervisor: Amina Helmi.

- Developed a new method for constraining the Milky Way potential by simultaneously fitting multiple tidal streams. The method exploits the clustering of the streams in the action space of the correct potential and does not require stream membership information.
- Extended thesis research on tidal shells to include model velocity profiles, and demonstrated the use of integrated-light spectra or pointwise velocity measurements of tidal shell components to measure the dynamical mass of external galaxies.
- Studied the heating of tidal streams around galaxies by dark subhalos, developing analytical predictions for the diffusion coefficients to be compared with simulated stellar halos.
- Assessed capabilities of current data analysis software and database options for working with the forthcoming Gaia catalog (at the request of CU9, the Gaia catalog access unit). An image from our results was selected as Gaia Picture of the Week for 9-16 October 2012.
- Helped supervise two graduate students and one master's student.

**Ph.D. Thesis research, MIT** 2007–2011. Supervisor: Edmund Bertschinger.

- Established a simple theoretical description of minor mergers with low angular momentum, which produce a distinctive type of tidal debris (tidal shells) that is observed around nearby galaxies including M31. Showed that one can jointly constrain the masses of the merging galaxies using only an image of a shell, without resorting to N-body modeling.

- Calculated the expected gamma-ray signal due to self-annihilation expected from tidal shells of dark matter in the Andromeda galaxy, and evaluated the prospect of observing this signal with Fermi.
- Supervised an undergraduate student through the MIT Summer Research Program, dedicated to increasing the fraction of underrepresented minorities in research. The student presented a poster on his project at the Joint Fall 2010 Meeting of APS, AAPT, SPS, and the National Society of Hispanic Physicists.

**Graduate Research, MIT 2004–2007.** Supervisor: Edmund Bertschinger.

Developed a theoretical framework to extend the intuitive analogies between general relativity and electromagnetism using the tetrad or vierbein, which describes the orientations of local inertial frames in terms of the coordinate basis vectors. In addition to its pedagogical value, the formalism may be used to compare satellite-based measurements of the gravitomagnetic field performed in different local inertial frames and to analyze atom-interferometric measurements of post-Newtonian gravity.

**Undergraduate Honors Thesis Research, University of Maryland 2003.**

Supervisor: Derek Richardson.

Studied the dynamical stability of Jupiter’s moon Amalthea as a rubble pile, based on new results from Galileo, and set an upper limit on the size of the moon’s constituent pieces. Awarded High Honors in Physics and Astronomy.

## Teaching Experience

**Graduate Student Teaching Certificate, MIT Teaching and Learning Laboratory** Awarded May 2010.

One-year program including lectures, readings, and teaching assessment. Full description at <http://web.mit.edu/tll/programs-services/ta-certificate/index-ta-certificate.html>.

**Teaching Assistant, MIT Department of Physics** September 2006–May 2008; September–December 2009

8.01 (Fall 2009): Introduction to Mechanics.

First-semester physics course required of all MIT undergraduates; taught in Technology-Enabled Active Learning (TEAL) format based on recent research in physics teaching, emphasizing problem-solving, group work, and interactive demonstrations. Managed classroom operation; supervised 3 undergraduate TAs; provided in-class assistance to students during group problem-solving and labs; lectured one two-hour class. Graded quizzes and exams; held office hours and weekend tutoring sessions.

8.282 (Spring 2008 half-time): Introduction to Astronomy.

Undergraduate survey course in astronomy and astrophysics. Gave two one-hour lectures on cosmology. Ran a nighttime observing session with 8” telescopes. Graded homework and exams; held office hours.

8.284 (Spring 2008 half-time): Astrophysics.

Advanced undergraduate course in quantitative astrophysics. Graded homework and exams; held office hours.

8.902 (Fall 2007 part-time): Astrophysics II.

Graduate course in extragalactic astrophysics. Graded homework and exams; wrote problem set solutions.

8.224 (Spring 2007): Exploring Black Holes: General Relativity and Astrophysics.

Gave introductory lecture; reviewed new sections of the course textbook for a new edition. Graded homework and exams; held office hours.

8.287 (Fall 2006): Observational Techniques of Optical Astronomy.

Conducted weekly  $\geq 3$ -hour laboratories at Wallace Astrophysical Observatory on data-taking and analysis.

**Teaching Assistant, UMCP Department of Astronomy** 2001–2003 (4 semesters; 1 summer)

ASTR100 (all spring and fall semesters except Spring 2002): Introduction to Astronomy.

Taught weekly 1-hour discussion section. Graded homework and exams.

ASTR101 (Summer 2003): Introduction to Astronomy Laboratory.

Conducted two 2-hour laboratories weekly for a 6-week course.

**Undergraduate Teaching Assistant, UMCP Department of Physics** Spring 2001 (1 semester)

PHYS170: Introduction to Mechanics for Physics Majors.

Concurrent with a course for undergraduate teaching assistants through the Center for Teaching Excellence. Graded homework and exams, developed exam problems, and led weekly problem-solving sessions.

## Prizes and Grants

**IAU** grant of €280 (cost of registration) to attend IAU Symposium 298

**Leids Kerkhoven Bosscha Fonds** grant of €750 to attend IAU Symposium 298

**Henry Kendall Teaching Award** 2010

**Whiteman Graduate Fellowship** 2004–2006

**Student speaker** University of Maryland Commencement Ceremony, 12/2003

## Research Visits and Schools

**Max-Planck-Institut für Astronomie** 13-16 August 2013. Guest of David Hogg.

**Institut d'Astrophysique de Paris** February-April 2011. Guest of Roya Mohayee.

**University of California, San Diego** 7–11 December 2009. Guest of Adam Burgasser.

**Oxford University** Rudolph Peierls Centre for Theoretical Physics, 4–12 July 2009. Guest of James Binney.

**Summer School in Cosmology** Abdus Salam International Centre for Theoretical Physics, Trieste, Italy, 21 July–1 August 2008.

## Refereed Publications

- R.E. Sanderson**, A. Helmi, & D. W. Hogg, in prep. “Action-space clustering of tidal streams to infer the Galactic potential.”
- R.E. Sanderson** & A. Helmi, 2013. “An analytical phase-space model for tidal caustics”. *MNRAS* 435, 378.
- R.E. Sanderson**, R. Mohayaee, & J. Silk, 2011. “Enhancements to velocity-dependent dark matter interactions from tidal streams and shells in the Andromeda galaxy”. *MNRAS* 420, 2445.
- R.E. Sanderson** & E. Bertschinger, 2010. “Seen and unseen tidal caustics in the Andromeda galaxy”. *ApJ* 725, 1652.
- N. Kallivayalil, G. Besla, **R.E. Sanderson**, C. Alcock, 2009. “Revisiting the Role of M31 in the Dynamical History of the Magellanic Clouds”. *ApJ* 700, 924.
- A.J. Burgasser, S. Witte, C. Helling, **R.E. Sanderson**, J.J. Bochanski, P.H. Hauschildt, 2009. “Optical and Near-Infrared Spectroscopy of the L Subdwarf SDSS J125637.13-022452.4”. *ApJ* 697, 148.
- M.C. Cushing, D. Looper, A.J. Burgasser, J.D. Kirkpatrick, J. Faherty, K.L. Cruz, A. Sweet, **R.E. Sanderson**, 2009. “2MASS J06164006–6407194: The First Outer Halo L Subdwarf”. *ApJ* 696, 986.
- D.C. Richardson, P. Elankumaran, **R.E. Sanderson**, 2005. “Numerical experiments with rubble piles: equilibrium shapes and spins”. *Icarus* 173, 349.

## Invited Talks

**ASTRON colloquium** 14 May 2013

**Netherlands Astronomy Conference** 23 May 2012

**Observatoire Astronomique de Strasbourg** Séminaire, 17 February 2012

**Netherlands Research School for Astronomy** Network I Meeting, 2 November 2011

**5th Groningen Theory Meeting** Rijksuniversiteit Groningen, 29 September 2011

**Institut d’Astrophysique de Paris** Galaxies Journal Club, 17 March 2011

**Universität Zurich** Institute of Theoretical Physics, Particle and Astrophysics Seminar, 23 February 2011

**Kapteyn Astronomical Institute** Monday Lunch Talk, 7 February 2011

**Northwestern University** CIERA Astrophysics Seminar, 30 November 2010

**Brown University** Journal Club, 22 September 2010

NASA, Goddard Spaceflight Center SEAL Lunch Talk, 17 February 2010

University of California, San Diego CASS Journal Club, 8 December 2009

## Contributed Talks

- “Action-space clustering to map the Galactic potential.” IAU Symposium 298, Setting the Scene for Gaia & LAMOST, Lijiang, China, 20-24 May 2013. In *Proceedings of IAU Symposium 298, Setting the Scene for Gaia and LAMOST*, S. Feltzing, G. Zhao, N.A. Walton & P.A. Whitelock, eds.
- “Diffusion of tidal streams in clumpy halos.” Virgo Consortium Meeting, Institute for Computational Cosmology, Durham, UK, 12-14 December 2012
- “Constraining Milky Way models with action clustering.” Large Area Optical Spectroscopic Surveys: Science with 4MOST, AIP, Potsdam, Germany, 13-15 November 2012
- “Measuring galaxy masses using tidal shells.” Multi-object spectroscopy on the European Extremely Large Telescope, UvA, Amsterdam, Netherlands, 25 October 2012
- “Galactic dynamics with dwarfs.” Cool Stars 17, 26 June 2012. *Astronomische Nachrichten* 334(1-2), 93-96.
- “Understanding dark matter halos with tidal caustics.” Dissertation talk, AAS Spring Meeting, 22–26 May 2011.
- “Galaxy mergers in phase space.” APS April Meeting, 14 February 2010.
- “Galactic archaeology in action space.” APS April Meeting, 2–5 May 2009.
- “Gamma rays from neutralino self-annihilation in a caustic in M31.” Small-Scale Structure of Dark Matter Workshop, Perimeter Institute, Waterloo, Canada, 5–8 June 2008.
- “Electromagnetic analogies in weak-field GR.” 9th Eastern Gravity Meeting, 24–25 March 2006.

## Posters

- R.E. Sanderson**, A. Helmi, and D. W. Hogg, “Action-space clustering to map the Galactic potential.” MPA/MPE/ESO/Excellence Cluster Universe Conference, The Physical Link between Galaxies and their Halos, 24–28 June 2013.
- J.J. Bochanski, **R.E. Sanderson**, A. A. West, A. J. Burgasser, “NEMESIS: Near Encounters with M-dwarfs from an Enormous Sample and Integrated Simulations”. AAS Meeting 217, January 2011.
- R.E. Sanderson** and E. Bertschinger, “Tidal debris in phase space”. AAS Meeting 215, January 3–7, 2010; APS April Meeting, February 13-16, 2010.
- A.J. Burgasser, **R.E. Sanderson**, J.J. Bochanski, A.A. West, M. Cushing, D. Looper, J. Faherty, “Wild Rides: The Galactic Orbits of Ultracool Subdwarfs”. AAS Meeting 214, June 7–11, 2009

**R.E. Sanderson** and E. Bertschinger, “Stellar and dark matter caustics: are both visible?” APS April Meeting, April 11–15, 2008.

**R.E. Sanderson** and E. Bertschinger, “Some analogies between electromagnetism and gravity”. APS April Meeting, April 14–17, 2007.

## Service & Outreach

**Referee** for *MNRAS*, *A&A*, and *PASA*.

Member of the **WEAVE spectroscopic survey definition team**. WEAVE (the WHT Extreme Area Velocity Explorer; <http://www.ing.iac.es/weave/Instrument/>) is a multi-object spectrograph planned for the William Herschel Telescope.

**Kapteyn Bayesian Reading Group**, February 2013-present (co-founder).

**Voiceovers for YouTube videos** about current astrophysics research:

- Six short films on planet formation and protoplanetary disks for the DIsc ANALysis project (PI: Peter Woitke; funded by the European Research Council through the 7th Framework Programme); in production & available soon on YouTube.
- “The Sticky Geometry of the Cosmic Web,” <http://www.youtube.com/watch?v=wI12X2zczqI>. Video presented at the [peer-reviewed] Symposium on Computational Geometry, 2012.

**Kapteyn Monday Lunch Talk committee**, 2012-2013.

**Substitute lecturer** for several courses at MIT. Gave a two-hour lecture in TEAL (interactive) format on central forces for 8.01 (Introduction to Mechanics), November 2009. Delivered two consecutive lectures (one week of classes) on cosmology for 8.282 (Introduction to Astronomy), May 2008. Gave the introductory lecture on astrophysical black holes for 8.224 (Exploring Black Holes), February 2007.

**MIT Kavli Institute Journal Club Committee**, 2007–2009 (founding member).

**Middle school outreach**: developed and presented an interactive, multimedia lesson on “The Birth, Life, and Death of Stars” for sixth-grade science students at Jonas Clarke Middle School, Lexington, MA, 2006–2007.

**MIT Physics Graduate Student Council**, 2005–2009. Representative, Astrophysics Division (2005–2008); Secretary (2008–2009). Helped design, administer, and analyze results from a survey of graduate students about the qualifying exam series (called the “general exams”) that had a  $\gtrsim 75\%$  response rate and resulted in several changes to general exam policy. Successfully advocated for representation of graduate students on the departmental academic council.

**Edgerton House Graduate Residence Association**, 2004–2009. Social Chairperson (2004–2005); President (2005–2006); Advisory Boardmember (2007–2009).