Richard H D Townsend — Curriculum Vitae

Professional Preparation

- University of Oxford; B. A. Physics; 1st Class Honors, 1994
- University College London; Ph. D. Astronomy; 1994 – 1997
  - Thesis: 'Non-radial Pulsations in Early-Type Stars' (Advisor: Prof. Ian Howarth)
  - Awarded UCL Harrie Massie prize for best Astronomy/Astrophysics PhD thesis
  - Awarded Royal Astronomical Society Blackwell Prize for best Astronomy/Astrophysics PhD thesis

Appointments

- Chair, Department of Astronomy, University of Wisconsin-Madison; 2020 –
- Fluno Bascom Professor of Astrophysics, Department of Astronomy, University of Wisconsin-Madison; 2020 –
- Associate Professor, Department of Astronomy, University of Wisconsin-Madison; 2014 – 2020
- Assistant Professor, Department of Astronomy, University of Wisconsin-Madison; 2008 – 2014
- Associate Scientist, Bartol Research Institute, University of Delaware; 2006 – 2008
- Research Associate, Bartol Research Institute, University of Delaware; 2004 – 2006
- Limited Term Researcher, Bartol Research Institute, University of Delaware; 2003 – 2004
- Postdoctoral Research Fellow, University College London; 1998 – 2003
- Research Fellow, Reuters Limited, London; 1998
- Physics Teacher, Tuna Secondary Technical School, Ghana; 1997 – 1998

Recent Awards

- NASA Astrophysics Theory Program : *Cardiology for Heavyweights: Deciphering the Tidally Excited Oscillations of Intermediate & High-Mass Stars*; PI; 1/1/2020–12/31/2022
- NSF Astronomy and Astrophysics Grants Program : *Here be Dragons: Mapping the Instabilities of Massive Stars*; PI; 7/1/2017–6/30/2021
- NSF Sofrware Infrastructure for Sustained Innovation Program : *SI2-SSI: Modules for Experiments in Stellar Astrophysics*; PI; 5/1/2017–4/30/2021
- NSF Software Infrastructure for Sustained Innovation Program : *SI2-SSE: Modules for Experiments in Stellar Astrophysics*; PI; 1/1/2014–12/31/2017
- NASA/NSF Theory & Computational Astrophysics Networks (TCAN) Program : *The SPIDER Network: Supernova Progenitor, Internal Dynamics and Evolution Research*; 1/1/2014–12/31/2016; PI
- NASA Astrophysics Theory Program : *Massive-Star Magnetospheres: Now in 3D!*; PI; 1/1/2012–12/31/2015

Recent Publications

1. Townsend R. H. D., 2020: 'Improved asymptotic expressions for the eigenvalues of Laplace's tidal equations', *MNRAS*, **497**, 2670
2. Goldstein J., Townsend R. H. D., 2020: 'The Contour Method: a new approach to finding modes of non-adiabatic stellar pulsations', *ApJ*, **899**, 116

3. Christensen-Dalsgaard J., Townsend R. H. D. et al. 2020: 'The Aarhus red giants challenge. II. Stellar oscillations in the red giant branch phase', *A&A*, **635**, 165
4. Silva Aguirre V., Townsend R. H. D. et al. 2020: 'The Aarhus red giants challenge. I. Stellar structures in the red giant branch phase', *A&A*, **635**, 164
5. Keszthelyi Z., Meynet G., Shultz M. E., David-Uraz A., ud-Doula A., Townsend R. H. D., Wade G. A., Georgy C., Petit V., Owocki, S. P. 2020: 'The effects of surface fossil magnetic fields on massive star evolution – II. Implementation of magnetic braking in MESA and implications for the evolution of surface rotation in OB stars', *MNRAS*, **493**, 518
6. Goldstein J., Townsend R. H. D., Zweibel E. G., 2019: 'The Tayler Instability in the Anelastic Approximation', *ApJ*, **881**, 66
7. Paxton B., Smolec R., Schwab J., Gautschy A., Bildsten L., Cantiello M., Dotter A., Farmer R., Goldberg J. A., Jermyn A. S., Kanbur S. M., Marchant P., Thoul A., Townsend, R. H. D., Wolf W., Zhang M., Timmes, F. X., 2019: 'Modules for Experiments in Stellar Astrophysics (MESA): Pulsating Variable Stars, Rotation, Convective Boundaries, and Energy Conservation', *ApJS*, **243**, 10
8. Timmes F. X., Townsend R. H. D., Bauer E. B., Thoul Anne., Fields C. E., Wolf W. M., 2018, *ApJL*, **867**, 30
9. Van Reeth T.. Mombarg J. S. G., Mathis S., Tkachenko A., Fuller J., Bowman D. M., Buysschaert B., Johnston C., García Hernández A., Goldstein J.; Townsend R. H. D., Aerts C., 2018: 'Sensitivity of gravito-inertial modes to differential rotation in intermediate-mass main-sequence stars', *A&A*, **618**, 24
10. Townsend R. H. D., Goldstein J., Zweibel E., 2018: 'Angular momentum transport by heat-driven g-modes in slowly pulsating B stars', *MNRAS*, **475**, 879
11. Wolf W. M., Townsend R. H. D., Bildsten L., 2018: 'Nonradial Pulsations in Post-outburst Novae', *ApJ*, **855**, 127
12. Paxton B., Schwab J., Bauer E. B., Bildsten L., Blinnikov S., Duffell P., Farmer R., Goldberg J. A.; Marchant P., Sorokina E., Thoul A., Townsend R. H. D., Timmes F. X., 2018: 'Modules for Experiments in Stellar Astrophysics (MESA): Convective Boundaries, Element Diffusion, and Massive Star Explosions', *ApJS*, **234**, 34
13. Owocki S. P., Townsend R. H. D., Quataert E., 2017: 'Super-Eddington stellar winds: unifying radiative-enthalpy vs. flux-driven models', *MNRAS*, **472**, 3749
14. Petit V., Keszthelyi Z., MacInnis R., Cohen D. H., Townsend R. H. D., Wade G.A., Thomas S. L., Owocki S. P., Puls J., ud-Doula A., 2017: 'Magnetic massive stars as progenitors of 'heavy' stellar-mass black holes', *MNRAS*, **466**, 1052
15. Kurapati Sushma, Chandra Poonam, Wade Gregg, Cohen David H., David-Uraz Alexandre, Gagné Marc, Grunhut Jason, Oksala Mary E., Petit Veronique, Shultz Matt, Sundqvist Jon, Townsend Richard H. D., ud-Doula Asif, 2017: 'A JVLA survey of the high-frequency radio emission of the massive magnetic B- and O-type stars', *MNRAS*, **465**, 2160
16. Owocki S. P., ud-Doula A., Sundqvist J. O., Petit V., Cohen D. H., Townsend R. H. D., 2016: 'An analytic dynamical magnetosphere formalism for X-ray and optical emission from slowly rotating magnetic massive stars', *MNRAS*, **462**, 3830
17. Bard C., Townsend R. H. D., 2016: 'Effect of a magnetic field on massive-star winds - I. Mass-loss and velocity for a dipole field', *MNRAS*, **462**, 3672
18. Moravejji E., Townsend R. H. D., Aerts C., Mathis S., 2016: 'Sub-inertial Gravity Modes in the B8V Star KIC 7760680 Reveal Moderate Core Overshooting and Low Vertical Diffusive Mixing', *ApJ*, **823**, 130

19. Paxton B., Marchant P., Schwab J., Bauer E. B., Bildsten L., Cantiello M., Dessert L., Farmer R., Hu H., Langer N., Townsend R. H. D., Townsley D. M., Timmes F. X., 2015: 'Modules for Experiments in Stellar Astrophysics (MESA): Binaries, Pulsations and Explosions', *ApJS*, **220**, 1
20. Townsend R. H. D., Teitler S. A., 2013: 'GYRE: an open-source stellar oscillation code based on a new Magnus Multiple Shooting scheme', *MNRAS*, **435**, 3406
21. Paxton B., Cantiello M., Arras P., Bildsten L., Brown E. F., Dotter A., Mankovich C., Montgomery M. H., Stello D., Timmes F. X., Townsend R. H. D., 2013: 'Modules for Experiments in Stellar Astrophysics (MESA): Giant Planets, Oscillations, Rotation, and Massive Stars', *ApJS*, **208**, 4
22. Townsend R. H. D., Rivinius Th., Rowe J. F., Matthews J. M., Moffat A. F. J., Bohlender D., Neiner C., Telting J. H., Guenther D. B., Kallinger T., Kuschnig R., Rucinski S. M., Sasselov D., Weiss W. W., 2013: 'MOST Observations of σ Ori E: Challenging the Centrifugal Breakout Narrative', *ApJ*, 769, 33
23. Carciofi A. C., Faes D. M., Townsend R. H. D., Bjorkman J. E. , 2013: 'Polarimetric observations of sigma Orionis E', *ApJL*, **766**, 9
24. Petit V., Owocki S. P., Wade G. A., Cohen D. H., Sundqvist J. O., Gagné M., Maíz Apellániz J., Oksala M. E., Bohlender D. A., Rivinius Th., Henrichs H. F., Alecian E., Townsend R. H. D., ud-Doula A., the MiMeS Collaboration , 2013: 'A Magnetic Confinement vs. Rotation Classification of Massive-Star Magnetospheres', *MNRAS*, **429**, 398
25. ud-Doula A., Sundqvist J. O., Owocki S. P., Petit V., Townsend R. H. D., 2013: 'First 3D MHD simulation of a massive-star magnetosphere with application to Hα emission from θ^1 Ori C', *MNRAS*, **428**, 2723
26. Rivinius Th., Townsend R. H. D., Kochukhov O., Štefl S., Baade D., Barrera L., Szeifert Th., 2013: 'Basic parameters and properties of the rapidly rotating magnetic B2 Vpn star HR 7355', *MNRAS*, **429**, 177
27. Wade G. A., Grunhut J., Gr afener G., Howarth I. D., Martins F., Petit V., Vink J. S., Bagnulo S., Folsom C. P., Nazé Y., Walborn N. R., Townsend R. H. D., Evans C. J., 2012: 'The spectral variability and magnetic field characteristics of the Of?p star HD 148937', *MNRAS*, **419**, 2459
28. Sundqvist J. O., ud-Doula A., Owocki S. P., Townsend R. H. D., Howarth I. D., Wade G. A., 2012: 'A dynamical magnetosphere model for periodic Hα emission from the slowly rotating magnetic O star HD 191612' *MNRAS*, **423**, L23
29. Oksala M. E., Wade G. A., Townsend R. H. D., Owocki S. P., Kochukhov O., Neiner C., Alecian E., Grunhut J., 2012: 'Revisiting the Rigidly Rotating Magnetosphere model for σ Ori E – I. Observations and data analysis', *MNRAS*, **419**, 959
30. Grunhut, J. H., Rivinius Th., Wade G. A., Townsend R. H. D., Marcolino W. L. F., Bohlender D. A., Szeifert Th., Petit V., et al., 2012: 'HR 5907: Discovery of the most rapidly rotating magnetic B-type star by the MiMeS Collaboration', *MNRAS*, **419**, 1610
31. Wade G. A., Howarth I. D., Townsend R. H. D., Grunhut J. H., Shultz M., Bouret J.-C., Fullerton A., Marcolino W., et al., 2011: 'Confirmation of the magnetic oblique rotator model for the Of?p star HD 191612', *MNRAS*, **416**, 3160
32. Oksala M. E., Wade G. A., Marcolino W. L. F., Grunhut J., Bohlender D., Manset N., Townsend R. H. D., the MiMeS Collaboration, 2010: 'Discovery of a strong magnetic field in the rapidly rotating B2Vn star HR 7355', *MNRAS*, **405**, L51
33. Rivnius Th., Szeifert Th., Barrera L., Townsend R. H. D., Štefl S., Baade D., 2010: 'Magnetic

field detection in the B2Vn star HR 7355', *MNRAS*, **405**, L46

34. Townsend R. H. D., Oksala M. E., Cohen D. H., Owocki S. P., ud-Doula A., 2010: 'Discovery of Rotational Braking in the Magnetic Helium-Strong Star σ Orionis E', *ApJL*, **714**, 318
35. Townsend R. H. D., 2010: 'Fast Calculation of the Lomb-Scargle Periodogram Using Graphics Processing Units', *ApJS*, **191**, 247
36. Harvey-Smith L., Gaensler B. M., Kothes R., Townsend R. H. D., Heald G. H., Ng C.-Y., Green A. J., 2010: 'Faraday rotation of the supernova remnant G296.5+10.0: Evidence for a Magnetized Progenitor Wind', *ApJ*, **712**, 1157

Recent Presentations

1. 'Angular Momentum Transport by Heat-Driven Modes', invited review talk at *Europen Astronomical Society 2020 Special Session: New insights of angular momentum transport in stellar interiors*, Leiden (virtual), Netherlands, July 2020
2. 'Yin-Yang Seismology of Slowly-Pulsating B Stars with MESA and GYRE', invited colloquium at The Ohio State University, Columbus, OH, Feb 2020
3. 'Yin-Yang Seismology of Slowly-Pulsating B Stars with MESA and GYRE', invited colloquium at Villanova University, Philadelphia, PA, Feb 2020
4. 'GYRE in MESA', invited lecture/workshop at *MESA Summer School 2019*, Santa Barbara, CA, Aug 2019
5. 'A Crash Course in Stellar Astrophysics', invited lecture at *Multscale Modeling of Astrophysical Plasmas*, Flatiron Insitutte, New York, NY, June 2019
6. 'GYRE: A Software Instrument for Stellar Oscillations', invited talk at *Open Digital Infrastructure in Astrophysics* workshop, Kavli Institute for Theoretical Physics, Santa Barbara, CA, Jun 2019
7. 'Regularities in Frequency/Period Spacings: How Asteroseismology Works', invited lecture at *Better Stars, Better Planets* program, Kavli Institute for Theoretical Physics, Santa Barbara, CA, May 2019
8. 'GYRE: A Stellar Oscillation Toolkit for the TESS Era', contributed talk at *TASC4/KASC11: First Light in a New Era of Astrophysics*, Aarhus, Denmark, Jun 2018
9. 'Yin-Yang Seismology of Slowly-Pulsating B Stars with MESA and GYRE', invited colloquium at University of Illinois-Urbana Champaign, IL, Mar 2018
10. 'A Crash Course in Massive-Star Oscillations', seminar during *The Mysteries and Inner Workings of Massive Stars* program at Kavli Institute for Theoretical Physics, University of California, Santa Barbara, CA, May 2017
11. 'Yin-Yang Seismology of Slowly-Pulsating B Stars with MESA and GYRE', invited seminar at University of Chicago, IL, Jan 2017
12. 'The Yin and Yang of Slowly-Pulsating B Stars: Asteroseismology and Angular Momentum Redistribution', invited seminar at Georgia State University, Atlanta, GA, Oct 2016
13. 'Yin-Yang Seismology of Slowly-Pulsating B Stars with MESA and GYRE', invited seminar at Center for Computational Astrophysics, New York City, NY, Oct 2016
14. 'The Yin and Yang of Slowly-Pulsating B Stars: Asteroseismology and Angular Momentum Redistribution', invivted seminar at Royal Military College of Canada, Kingston, ON, Sep 2016
15. 'MESA & GYRE: Stellar Astrophysics for the People', invited Leverhulme lecture, University of Exeter, UK, Dec 2015
16. 'MESA & GYRE: Stellar Astrophysics for the People', invited seminar at Aarhus University,

Denmark, Nov 2015

17. 'MESA & GYRE: Stellar Astrophysics for the People', invited seminar at University of Leicester, UK, Nov 2015
18. 'MESA & GYRE: Stellar Astrophysics for the People', invited seminar at University of Central Lancashire, Preston, UK, Nov 2015
19. 'MESA & GYRE: Stellar Astrophysics for the People', invited seminar at Katholieke Universiteit Leuven, Belgium, Oct 2015
20. 'BRITE's Role in Stellar Physics', invited review talk at *Science with BRITE-Constellation: Initial Results*, Gdansk, Poland, Sep 2015
21. 'Hunting Distant Ghosts: The Glowing Magnetospheres of Massive, Luminous Stars', invited seminar at Canadian Institute for Theoretical Astrophysics, Toronto, ON, Apr 2015
22. 'Ghost Hunting at Five Hundred Parsecs: The Magnetospheres of Massive Luminous Stars', invited colloquium at Space Telescope Science Institute, Baltimore, MD, Nov 2014
23. 'The MESA and GYRE Codes: Stellar Astrophysics for the People', invited seminar at University of Wisconsin-Milwaukee, MilwauWI, Nov 2014
24. 'Extrapolating the Magnetospheres of OB Stars', contributed talk at *Magnetism and Variability in O stars*, Amsterdam, Netherlands, Sep 2014
25. 'Ghostly Impostors: The Glowing Magnetospheres of Massive Stars', invited seminar at Iowa State University, Ames, IA, Nov 2013
26. 'The Pulsation-Rotation Interaction: Greatest Hits and the B-side', invited review talk at *IAU Symposium 301: Precision Asteroseismology*, Wroclaw, Poland, Aug 2013
27. 'GYRE: Yet another oscillation code, why we need it and how it works', invited talk at *ERC/PROSPERITY/BAG Meeting 2012: Asteroseismology in Action: From Young to Old Stars*, Leuven, Belgium, Dec 2012
28. 'Asteroseismology', invited seminars (2) at *The MESA Summer School*, University of California, Santa Barbara, CA, Aug 2012
29. 'Massive-Star Magnetospheres: The Interplay between Outflows, Rotation and Magnetic Fields ', invited review talk at *Circumstellar Dynamics at High Resolution*, Foz do Iguaçu, Brazil, Feb/Mar 2012
30. 'Magnetic Braking of Massive Stars: Theory and Observations', invited talk at *52nd American Physical Society-Division of Plasma Physics Annual Meeting*, Chicago, IL, Nov 2011
31. 'A Cartoon Overview of the Fundamentals of Stellar Seismology', invited blackboard talk at *Asteroseismology in the Space Age*, Kavli Institute for Theoretical Physics, University of California, Santa Barbara, CA, Oct 2011
32. 'Rigid-Field Models for Massive-Star Magnetospheres', invited talk at *Midwest Magnetic Fields Workshop*, Madison, WI, May 2011
33. 'Ghostly Impostors: The Magnetospheres of Massive Stars', invited colloquium at St Mary's University, Nova Scotia, Canada, Mar 2011
34. 'Modeling the Winds and Magnetospheres of Massive Stars', invited review talk at *IAU Symposium 272: Active OB Stars: Structure, Evolution, Mass Loss and Critical Limits*, Paris, France, Jul 2010
35. 'Modeling Ejecta of Massive Stars', invited review talk at *Asymmetric Planetary Nebulae 5: The Shaping of Stellar Ejecta*, Bowness-on-Windermere, England, Jun 2010
36. 'Progress in Observations and Modeling of Magnetic Massive Stars', invited talk at *Midwest Magnetic Fields Workshop*, Madison, WI, Apr 2010

Advising

2008	present	Supervised 2 postdoctoral researchers: Seth Teitler, Meng Sun
2008	present	Supervised 5 graduate students: Nicholas Hill (PhD 2015), Brittin Borland (MSc 2013), Chris Bard (PhD 2016), Jaqueline Goldstein, Aaron Lopez
2008	present	Supervised 4 undergraduate students: Nicholas Mast, Zachary Way, Kyle Fruhling, Aaron Bailey

Courses Taught

Spring 2020	Astronomy 910 (*Seminar in Astrophysics*)
Fall 2019	Astronomy 310 (*Stellar Astrophysics*)
Spring 2019	Astronomy 715 (*Stellar Interiors & Evolution*)
Fall 2018	Astronomy 310 (Stellar Astrophysics)
Summer 2018	Astronomy 103 (*The Evolving Universe*), online
Fall 2017	Astronomy 310 (*Stellar Astrophysics*)
Fall 2016	Astronomy 103 (*The Evolving Universe*)
Spring 2015	Astronomy 702 (*Basic Astrophysics II*)
Fall 2014	Astronomy 700 (*Basic Astrophysics I*)
Spring 2014	Astronomy 702 (*Basic Astrophysics II*)
Fall 2013	Astronomy 310 (*Stellar Astrophysics*)
Spring 2013	Astronomy 702 (*Basic Astrophysics II*)
Fall 2012	Astronomy 103 (*The Evolving Universe*)
Spring 2012	Astronomy 702 (*Basic Astrophysics II*)
Fall 2011	Astronomy 310 (*Stellar Astrophysics*)
Spring 2011	Astronomy 715 (*Stellar Interiors & Evolution*)
Fall 2010	Astronomy 113 (*Hands on the Universe*)
Spring 2010	Astronomy 910 (*Seminar in Astrophyscs*)
Fall 2009	Astronomy 310 (*Stellar Astrophysics*)
Fall 2008	Astronomy 310 (*Stellar Astrophysics*)

Software & Infrastructure Development

- Leading UW-Madison's participation in the *Modules for Experiments in Stellar Astrophysics* (MESA) project, a multi-institutional open source software project. MESA is used a worldwide community of scientists (around 900, as of 2019) to simulate the internal structure and evolution of astrophysical objects from gas-giant planets to white dwarfs to supermassive stars. I serve on the MESA Administrative Council, which establishes the science roadmap for the project and overseas all MESA-related education and community engagement activities, and on the MESA Technical Council, which guides the technical development of the software.
- Creating and further developing the open-source *GYRE* stellar oscillation code. Since its release in 2013, *GYRE* has quickly established itself as the state-of-the-art tool for asteroseismic analyses of oscillating stars, and has been adopted by other research groups to yield over 100 scientific publications.

Institutional Service

- Serving on the Organizing Committees of the IAU Working Groups on *Massive Stars* and *Active OB Stars* (vice chair).
- Serving on/chairing time allocation committees for the *Hubble Space Telescope* and *Chandra X-Ray Observatory*.
- Serving/chairing grant review panels for NASA.
- Serving as referee on numerous journal papers.
- Serving on the Scientific Organizing Committees for the *IAU Symposia* 272, 307 and 329 conferences.

Academic Service

- Creating the new Astronomy 103 Online class, built around bespoke multimedia products that include virtual observatory lectures, *2-Minute Universe* mini-lectures, and the *At Play in the Cosmos* computer game (developed by GEAR Learning with my consultative input).
- Chairing the UW Department of Astronomy, and serving on and/or chairing the computing, web, admissions, colloquium, undergraduate, awards and prelims committees.
- Serving as the faculty senator for the UW Department of Astronomy.
- Serving on the UW Advanced Computing Infrastructure committee.