Adrian E. Fraser

NSF Astronomy and Astrophysics Postdoctoral Fellow
University of Colorado, Boulder
(Publications listed at end of document)

Contact Information, Links

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Interests at a Glance

I study a variety of fluid and plasma instabilities, particularly how they saturate, drive turbulence, and affect mixing in astrophysical and geophysical contexts. My goal is to capture these details in reduced models that I check against direct numerical simulations or measurements and observations. This involves code development, running and analyzing massively parallelized simulations, and applying a variety of mathematical methods to model complex physical systems.

Affiliations and Education

Sep 1, 2024–	**NSF AAPF Fellow, University of Colorado, Boulder** Department of Applied Mathematics
2022–2024	**Hale Postdoctoral Fellow, University of Colorado, Boulder** Astrophysical and Planetary Sciences, Applied Mathematics, and LASP
2020–2022	**University of California, Santa Cruz** Postdoc, Applied Mathematics PI: Pascale Garaud
2014–2020	**University of Wisconsin–Madison** Ph.D., Physics Advisors: Paul W. Terry, Ellen G. Zweibel Graduation date: Aug 23, 2020 Thesis title: *Role of Stable Eigenmodes in Shear-flow Instability Saturation and Turbulence*
2010–2014	**University of Oregon** B.S., Physics (with honors), Mathematics

Awards, Honors, and Fellowships

$330k, 2024 **NSF Award: Astronomy and Astrophysics Postdoctoral Fellowship**
- Award No. AST-2402142: *Predicting the spins of stellar cores and remnants: 3D models of the Tayler-Spruit dynamo*
- *Nation-wide, competitive fellowship awarded by NSF to me as PI to conduct independent research and teaching/mentoring*
(https://new.nsf.gov/funding/opportunities/nsf-astronomy-astrophysics-postdoctoral)

2022 **George Ellery Hale Postdoctoral Fellowship in Solar, Stellar, and Space Physics**, CU–Boulder and the National Solar Observatory
Institutional fellowship to conduct independent research
(http://halefellows.org/postdoc_about.html)

2022 **Marie Skłodowska-Curie Postdoctoral Fellowship Seal of Excellence**
Submitted a proposal that "was recognised as a high-quality project proposal in a highly competitive evaluation process", and could not be funded due to budgetary constraints
(https://afraser3.github.io/files/Seal_of_Excellence.pdf) (link)

2021 **Outstanding Postdoc Spotlight**, UCSC press release
(https://engineering.ucsc.edu/news/outstanding-postdoc-adrian-fraser)

2019 **Callen Award for Excellence in Plasma Theory**, UW–Madison
Annual award given to plasma students by committee selection based on academic record and research contributions

2019 **Karl Guthe Jansky & Alice Knapp Jansky Fellowship for Physics & Astronomy**, University of Wisconsin–Madison, Department of Physics
Annual award given to outstanding graduate student in Physics or Astronomy
(http://www.physics.wisc.edu/awards)

2018 **Exceptional Service Award**, University of Wisconsin–Madison
***Campus-wide** TA award, nominated by the Physics department*
(https://grad.wisc.edu/teaching-assistant-awards/)

2017 **Student Poster Prize**, Sherwood Fusion Theory Conference
(http://www.sherwoodtheory.org/sw2018/poster_awards.php)

2015 **Piore Award**, University of Wisconsin–Madison, Department of Physics
Annual award given for academic achievement in early stage of the Ph.D. program
(http://www.physics.wisc.edu/awards)

2014 **Van Vleck Fellowship**, University of Wisconsin–Madison, Department of Physics
Awarded to incoming Ph.D. students with outstanding undergraduate records
(http://www.physics.wisc.edu/awards)

Successful Computing Allocation Requests (Co-) Authored

2023	**How does rotation modify double-diffusion erosion of Jupiter's core?**, Explore ACCESS computing allocation, NSF Resources awarded: 200k ACCESS credits (approx. 200,000 CPU-hours) PI: E.A. Anders, Co-PI: **A.E. Fraser**, R. Fuentes
2023	**Momentum transport in stars: saturation of the Tayler instability, 1) Initial benchmarking**, Explore ACCESS computing allocation, NSF Resources awarded: 200k ACCESS credits (approx. 200,000 CPU-hours) PI: **A.E. Fraser**, Co-PI: E.A. Anders
2021	**Momentum transport by shear-flow-driven turbulence in stars**, XSEDE computing resources, NSF (education allocation) Resources awarded: approx. 200,000 CPU-hours PI: **A.E. Fraser**
2018-2019	**Role of Stable Eigenmodes in Shear-flow MHD Turbulence**, XSEDE computing resources, NSF (start-up allocation) **Lead author on proposal**, but not listed as PI due to XSEDE policy Resources awarded: approx. 200,000 CPU-hours PI: P.W. Terry, Co-PIs: **A.E. Fraser**, M.J. Pueschel, E.G. Zweibel
2017-2018 & 2018-2019	**Gyrokinetic Plasma Microturbulence Simulation in Fusion and Basic Plasmas**, XSEDE computing resources, NSF (research allocation) Contributed to proposal, but the lead author was the PI Resources awarded: approx. 6,750,000 (2018-2019) & 11,300,000 (2017-2018) CPU-hours PI: M.J. Pueschel, Co-PIs: **A.E. Fraser**, P.W. Terry, Z.R. Williams, S-.W. Tsao

Colloquia and Invited Talks

Sep 2024	"Chemical mixing and angular momentum transport in stars" - Astronomy colloquium, University of Wyoming
Jul 2024	"Nonmodal growth in MHD shear flows" - Invited talk at WHOI GFD, international meeting
Jul 2022	"Non-ideal instabilities in sinusoidal shear flows with a streamwise magnetic field" - Invited talk at WHOI GFD, international meeting
Mar 2021	"Capturing negative turbulent viscosity in reduced models of unstable shear flows" - 'Staircase21' KITP meeting
Oct 2019	"Saturation of Shear-flow Turbulence in Magnetized Plasmas" - American Physical Society Division of Plasma Physics Meeting, Fort Lauderdale, Florida
Apr 2019	"Role of Stable Modes in the Saturation and Transport Properties of Shear Flow Turbulence" - Sherwood Fusion Theory Conference, Princeton, New Jersey

Seminars

Oct 2023	"Perturbation growth in MHD shear flows despite strongly stabilizing magnetic fields" - KITP, UCSB, Bildsten group meeting
Apr 2023	"Destabilization of Alfvén waves by periodic shear flows" - Northwestern University, Lecoanet group meeting
Apr 2023	"Missing mixing problems in RGB stars and the role of MHD thermohaline mixing" - CIERA theory seminar
Apr 2023	"Destabilization of Alfvén waves by periodic shear flows" - University of Wisconsin-Madison plasma group talk
Mar 2023	"Magnetized fingering convection in stars: problems with parasitic models" - IRAP (Toulouse, France) Astroplasma seminar
Mar 2023	"Destabilization of transverse waves by periodic shear flows" - University of Exeter GAFD seminar
Mar 2023	"Broad astro-fluid studies enabled by Dedalus" - Whole Sun 2023 meeting (Paris, France)
Feb 2023	"Unexpected instabilities in sinusoidal shear flows with a streamwise magnetic field" - Leeds ECR Spotlight
Apr 2022	"Fingering convection in MHD: problems with parasites, and speculative solutions" - CU-Boulder GAFD Seminar
Nov 2021	"Fingering convection in MHD: problems with parasites, and speculative solutions" - University of Leeds, Fluids and MHD Seminar (Youtube link)
Jun 2021	"MHD effects on thermohaline mixing in stars: the problem with parasites" - UW-Madison Astronomy, Monday Science Seminar series
Jun 2021	"MHD effects on thermohaline mixing in stars: the problem with parasites" - Kavli Summer Program in Astrophysics
Apr 2021	"MHD effects on thermohaline mixing in stars: the problem with parasites" - Flatiron Institute CCA, Stars & Compact Objects group meeting
Oct 2020	"Momentum transport, dissipation, and models built from linear modes in MHD shear flows" - Astronomy Seminar, Stony Brook University
Mar 2019	"Role of Stable Modes in Shear-Flow Turbulence" - Plasma Physics Seminar, University of Maryland
Oct 2018	"Role of Stable Eigenmodes in Kelvin-Helmholtz Turbulence" - Plasma Seminar, IFS, University of Texas at Austin

Contributed Presentations

Nov 2024	American Physical Society Division of Fluid Dynamics Meeting, Salt Lake City, UT – contributed oral
Nov 2023	American Physical Society Division of Fluid Dynamics Meeting, Washington, DC – contributed oral
Oct 2023	American Physical Society Division of Plasma Physics Meeting, Denver, CO – contributed oral
Nov 2022	American Physical Society Division of Fluid Dynamics Meeting, Indianapolis, IN – contributed oral
Oct 2022	American Physical Society Division of Plasma Physics Meeting, Spokane, WA – poster presentation
Nov 2021	KITP Conference: Transport in Stellar Interiors, Santa Barbara, CA – contributed oral (link)
Nov 2021	American Physical Society Division of Fluid Dynamics Meeting, Phoenix, AZ – contributed oral
Nov 2021	American Physical Society Division of Plasma Physics Meeting, Pittsburg, PA – poster presentation
Nov 2020	American Physical Society Division of Plasma Physics Meeting, remote – poster presentation
Apr 2020	Sherwood Fusion Theory Conference, Santa Rosa, CA *(meeting canceled)*
Nov 2018	American Physical Society Division of Plasma Physics Meeting, Portland, Oregon – poster presentation
Apr 2018	Sherwood Fusion Theory Conference, Auburn, Alabama – poster presentation
Oct 2017	American Physical Society Division of Plasma Physics Meeting, Milwaukee, Wisconsin – poster presentation
May 2017	Sherwood Fusion Theory Conference, Annapolis, Maryland – poster presentation
Oct 2016	American Physical Society Division of Plasma Physics Meeting, San Jose, California – poster presentation
Apr 2016	Sherwood Fusion Theory Conference, Madison, Wisconsin – poster presentation

Teaching Experience

2023	Guest Lecturer, Astrophysical Fluid Dynamics, CU–Boulder Subject: *Thermohaline mixing as an example where long-standing observational conundrums are explained by careful and rigorous fluid dynamics*
2019	Guest Lecturer, Graduate Astrophysics II, UW–Madison Subject: *The Kelvin-Helmholtz instability: derivation and relevant features for astrophysics*
2014-2017	Teaching Assistant, Introductory Physics I & II for Life Sciences, UW–Madison *Taught four semesters total; granted ratings of "Excellent" three times and "Very Good" once by TA coordinator; granted* ***campus-wide TA award*** *in 2018*
2010-2014	Co-instructor, instructional lab manager, Undergraduate Teaching Assistant, tutor, mentor, and peer advisor at UO and a local high school *The teaching activities I was involved in at UO were broad and occurred over the span of my time there; I am happy to discuss them in greater detail if asked*

Mentoring

2024	Co-mentored WHOI GFD fellow **Paul Curtis** on a project involving asymptotic limits of rotating, moist convection
2022-	Mentoring UW-Madison PhD students **Joey Duff** and **Alex Sainterme** on a project involving novel shear-flow instabilities in reduced drift-wave models
2022-	Co-mentoring CU-Boulder PhD student **Whitney Powers** on project on rotating, moist convection
2022	Co-mentored UCSC PhD student **Arstanbek Tulekeyev** on project on diffusive DDC/semiconvection in bounded domains in planetary regimes
2022	Co-mentored UCSC undergraduate student **Henry Olling**, alongside Prof. Patrick Chuang, on research project on water droplet accumulation in turbulent clouds
2021-	As a senior participant at the Kavli Summer Program in Astrophysics 2021 (link), directly supervised Kavli student fellow **Imogen Cresswell**'s research project on shear-flow turbulence in MHD, motivated by small-scale dynamics in stellar interiors - *Imogen's KSPA project was published to the KSPA project report repository here, and was incorporated into my 2023 JFM publication* - *I continue to mentor Imogen at CU-Boulder on a project involving fingering convection in stellar interiors*
2021-2022	Co-mentored UCSC undergraduate student **Amishi Sanghi** on research project, led to 2022 publication listed below and her presentation at APS-DFD 2021
2019-	Peer mentor to **Bindesh Tripathi**, UW-Madison *(I continue to mentor Bindesh on research)*
2019-2020	Supervised an undergraduate research project: **Jack Schroeder**, studying how magnetic fields affect coupling to large-scale stable modes in shear-flow instabilities

Professional Service

2022-2023	Organized and led Brown group weekly group meeting, CU-Boulder - *Group included 2 postdocs, 2 graduate students* - *Duties included scheduling/organizing, leading discussion, deciding weekly agenda*
2023	Organized and led bi-weekly astrophysical fluid dynamics journal club, CU-Boulder - *Participants included Brown group and colleagues* - *Duties included scheduling/organizing, selecting speakers, helping students select appropriate papers, and inviting local experts where appropriate*
2018-2019	Co-founder and President, Physics Graduate Student Council (PGSC) - *Led department-wide town halls to democratically form PGSC, served as president for its first year* - *Worked with department administrators and peers on two $1,000 professional development **grants** awarded by the university with which we hosted seminar speakers; secured additional $4,000 in support from the department for our first year* - *Worked with department and peers to: restructure graduate student recruitment and orientation; address major concerns regarding the graduate program; secure graduate student representatives on relevant faculty committees; implement peer mentoring* (https://pgsc.physics.wisc.edu/)
2018-2019	Graduate Program Committee Member, UW-Madison Department of Physics *Served as student representative on faculty committee*

Thesis committee member: Hongke Lu, Bates College honors thesis, *The Impact of Stable Modes*

on Saturation in Magnetorotational Turbulence (2024)
Peer reviews: J. Plasma Phys. (2020-present), Phys. Rev. Fluids (2022-present), Phys. Plasmas (2022-present), GAFD (2023-present); 1 NASA grant review panel; 1 NSF ad-hoc proposal review
Session chair: KITP "transtar21" conference (link), APS-DFD 2022 and 2024 meetings
Open-source software contributions: contributed to Dedalus, Eigentools, and MESA multiple PRs and issues, see my GitHub for details

Other Experience

Summer 2024	Participant in WHOI GFD program—extended stay, mentored a student
Spring 2023	Participant in Whole Sun 2023 ERC meeting (Paris/Saclay)
Summer 2022	Participant in WHOI GFD program
Fall 2021	Participant in KITP Program: Probes of Transport in Stars
Summer 2021	Participant in Kavli Summer Program in Astrophysics (KSPA): Fluid Dynamics of the Sun and Stars
Spring 2021	Participant in KITP Program: Layering in Atmospheres, Oceans and Plasmas
Summer 2017	Student in Summer School on Astrophysical Plasmas - Niels Bohr International Academy, Copenhagen, Denmark
2013–2014	Imamura Group, University of Oregon *Worked on analytical and numerical models of accretion disks, including global fluid simulations, linear stability analyses, and radiation transport models*
2011–2013	Torrence Group, University of Oregon *Using Geant4, a Monte Carlo-based particle physics software package, developed and ran a model to test the performance of an electron energy spectrometer originally proposed for use in the International Linear Collider*

Refereed Publications

* denotes publications that are particularly representative of my research interests.
Red text highlights undergraduate and/or graduate students I mentored on these projects.

*(Submitted)	*Nonmodal growth and optimal perturbations in magnetohydrodynamic shear flows*, **A.E. Fraser**, A.K. Kaminski, and J.S. Oishi, Phys. Rev. Lett.
(Submitted)	*Evolution of Semi-convective Staircases in Rotating Flows: Consequences for Fuzzy Cores in Giant Planets*, J.R. Fuentes, B.W. Hindman, **A.E. Fraser**, and E.H. Anders, Astrophys. J. Lett., ADS, arXiv
(Accepted)	*An examination of nonlinear collisionless magnetic reconnection through eigenmode decomposition*, N.T. Stolnicki, Z.R. Williams, and **A.E. Fraser**, Phys. Plasmas, letter
May 2024	*Predicting the Slowing of Stellar Differential Rotation by Instability-Driven Turbulence*, B. Tripathi, A.J. Barker, **A.E. Fraser**, P.W. Terry, and E.G. Zweibel, Astrophys. J., DOI, ADS, arXiv
*Mar 2024	*Magnetized fingering convection in stars*, **A.E. Fraser**, S.A. Reifenstein, and P. Garaud, Astrophys. J., DOI, ADS, arXiv
Oct 2023	*Three-dimensional shear-flow instability saturation via stable modes*, B. Tripathi, P.W. Terry, **A.E. Fraser**, E.G. Zweibel, M.J. Pueschel, Phys. Fluids and Phys. Plasmas joint issue, DOI, arXiv
Jul 2023	*Nonlinear mode coupling and energetics of driven magnetized shear-flow turbulence*, B. Tripathi, **A.E. Fraser**, P.W. Terry, E.G. Zweibel, M.J. Pueschel, and E.A. Anders, Phys. Plasmas, DOI, ADS, arXiv → Designated as a Phys. Plasmas **Featured Article**
Dec 2022	*Characterizing Observed Extra Mixing Trends in Red Giants using the Reduced Density Ratio from Thermohaline Models*, **A.E. Fraser**, M. Joyce, E.H. Anders, J. Tayar, and M. Cantiello, Astrophys. J., DOI, arXiv
*Oct 2022	*Non-ideal instabilities in sinusoidal shear flows with a streamwise magnetic field*, **A.E. Fraser**, I.G. Cresswell, and P. Garaud, J. Fluid Mech., DOI, arXiv
Sep 2022	*Near-cancellation of up-and down-gradient momentum transport in forced magnetized shear-flow turbulence*, B. Tripathi, **A.E. Fraser**, P.W. Terry, E.G. Zweibel, and M.J. Pueschel, Phys. Plasmas, DOI, arXiv

July 2022 | *Mechanism for Sequestering Magnetic Energy at Large Scales in Shear-Flow Turbulence*,
B. Tripathi, **A.E. Fraser**, P.W. Terry, E.G. Zweibel, and M.J. Pueschel, Phys. Plasmas, DOI, arXiv

Aug 2022 | *Magnetized Oscillatory Double-diffusive Convection*,
A. Sanghi, **A.E. Fraser**, E.R. Tian, and P. Garaud, Astrophys. J., DOI, arXiv

Mar 2022 | *Schwarzschild and Ledoux are equivalent on evolutionary timescales*,
E.H. Anders, A.S. Jermyn, D. Lecoanet, **A.E. Fraser**, I.G. Cresswell, M. Joyce, and J.R. Fuentes, Astrophys. J. Lett., DOI, ADS, arXiv

Feb 2021 | *The impact of magnetic fields on momentum transport and saturation of shear-flow instability by stable modes*,
A.E. Fraser, P.W. Terry, E.G. Zweibel, M.J. Pueschel, and J.M. Schroeder, Physics of Plasmas 28, 022309 DOI, ADS
→ Designated as a Phys. Plasmas **Editor's Pick**

Dec 2018 | *Role of stable modes in driven shear-flow turbulence*,
A.E. Fraser, M.J. Pueschel, P.W. Terry, and E.G. Zweibel, Physics of Plasmas 25, 122303 DOI, ADS
→ Designated as a Phys. Plasmas **Featured Article**
→ Selected for an **AIP Scilight** article (https://aip.scitation.org/doi/10.1063/1.5083843)
→ UW press release
(https://news.wisc.edu/taming-turbulence-seeking-to-make-complex-simulations-a-breeze/)

Jun 2017 | *Coupling of damped and growing modes in unstable shear flow*,
A.E. Fraser, P.W. Terry, E.G. Zweibel, and M.J. Pueschel, Physics of Plasmas 24, 062304 DOI, ADS
→ Designated as a Phys. Plasmas **Editor's Pick**