

# Adrian E. Fraser

Hale Postdoctoral Fellow at 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. I often work to capture these details in reduced models that I check against direct numerical simulations or measurements and observations. This involves code development, running massively parallelized simulations and analyzing the results, and applying a variety of mathematical methods to model complex physical systems.

## Affiliations and Education

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

## Honors, Awards, and Scholarships

- 2024 **NSF Astronomy and Astrophysics Postdoctoral Fellowship**, CU Boulder, Applied Math department  
- Proposal title: *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](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](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

## Invited Talks

- 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 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 ( <a href="#">link</a> )
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 – poster presentation ( <i>meeting canceled</i> )
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

2014-2017	Teaching Assistant, Introductory Physics I & II for Life Sciences, UW <i>Taught four semesters total; granted ratings of “Excellent” three times and “Very Good” once by TA coordinator; granted campus-wide TA award in 2018</i>
2010-2014	Co-instructor, instructional lab manager, Undergraduate Teaching Assistant, tutor, mentor, and peer advisor at UO and a local high school <i>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</i>

## Mentoring

- 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-mentoring UCSC PhD student **Arstanbek Tulekeyev** on project on diffusive DDC/semiconvection in bounded domains in astrophysical 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 eventually 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 collaborators*
  - *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 collaboratively 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* (<https://www.physics.wisc.edu/resources/committee>)

**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 meeting

**Open-source software contributions:** contributed to Dedalus, Eigentools, and MESA multiple PRs and issues, see [my GitHub](#) for details

## Other Experience

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 <i>Worked on analytical and numerical models of accretion disks, including global fluid simulations, linear stability analyses, and radiation transport models</i>
2011–2013	Torrence Group, University of Oregon <i>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</i>

## Refereed Publications

Red text highlights undergraduate and/or graduate students I mentored on these projects.

- (In Press) *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.*, [arXiv](#)
- Mar 2024 *Magnetized fingering convection in stars*,  
**A.E. Fraser**, S.A. Reifstein, 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**