Adrian E. Fraser

Postdoctoral Scholar at University of California, Santa Cruz, Applied Math

Contact Information, Links

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Interests at a Glance

I am interested in fluid and plasma instabilities, particularly how they saturate, drive turbulence, and affect mixing. I pursue reduced models of turbulent mixing so we can better-understand systems where this mixing is important – for example, in stellar interiors, where improved descriptions of turbulent mixing might explain several so-called "missing mixing" problems. To do this, I derive reduced models and check them against advanced numerical simulations in parameter regimes accessible to modern supercomputers, then extrapolate these models to regimes that are physically relevant but inaccessible to simulations. This involves code development, running massively parallelizable simulations and analyzing the results, and applying a variety of mathematical methods to model complex physical systems. My work to date has generally been astrophysically-motivated, concerned shear-flow instabilities and double diffusive convection, and has explored neutral fluids as well as fluid and kinetic descriptions of plasmas. However, my interests extend to other instabilities, and include problems in geophysical fluid dynamics and fusion plasmas as well.

To learn more, visit this link, where my work was recently highlighted as part of the "Outstanding postdoc spotlight" series at UCSC.

Affiliations and Education

2020–Present	**University of California, Santa Cruz**
	Postdoc, Applied Mathematics
	PI: Pascale Garaud
2014–2020	**University of Wisconsin-Madison**
	Ph.D., Physics (Plasma)
	Advisors: Paul W. Terry, Ellen G. Zweibel
	Graduation date: Aug 23, 2020
2010–2014	**University of Oregon**
	B.S., Physics (with honors), Mathematics

Honors, Awards, and Scholarships

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)

2013 **Weiser Undergraduate Teaching Award**, University of Oregon, Department of Physics

2013 **Science Literacy Program Scholar**, University of Oregon
Co-instructed PHYS 155, a special topics elective for non-physics majors
(https://scilit.uoregon.edu/)

2011 **Dean's List**, University of Oregon
(https://advising.uoregon.edu/content/academic-honors)

2010-2013 **Scholarships for Oregon Scientists**, University of Oregon
(https://sciencescholars.uoregon.edu/)

Successful Computing Allocation Requests (Co-) Authored

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

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

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 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 – poster presentation *(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

2014-2017	Teaching Assistant, Introductory Physics I & II for Life Sciences, UW *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

2022-	Co-mentoring 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 - *Met daily for five weeks, and weekly thereafter, to discuss research progress and review concepts involving shear-flow instabilities and turbulence* - *Simulations performed using XSEDE resources I procured*
2021-	Mentoring UCSC undergraduate student Amishi Sanghi on research project, publication in prep.
2019-2020	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 - *Met weekly to discuss progress in his calculation and review underlying concepts*

Professional Service

2018-2019	Co-founder and President, Physics Graduate Student Council (PGSC) *Working with peers, led weekly department-wide town halls to decide mission and structure of PGSC before serving as president for its first year. Worked with department administrators and peers on two $1,000 professional development grants awarded by the graduate school with which we hosted seminar speakers, and secured $4,000 in support from the department for our first year. Worked with department and peers to restructure graduate student recruitment and orientation, address key concerns regarding the graduate program, secure graduate student representatives on relevant faculty committees, and 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); NSF ad-hoc proposal review (plasma physics, 2022)
Session chair: KITP "transtar21" conference (link)
Open-source software contributions: contributed to Dedalus (1 PR, 1 issue) and Eigentools (1 issue), see my GitHub

Ongoing External Collaborations

2021-	**A.E. Fraser**, M. Joyce, J. Tayar, and E.H. Anders, *Placing bounds on theoretical predictions of thermohaline mixing efficiency using stellar observations*
2021-	**A.E. Fraser**, J.S. Oishi, and A.K. Kaminski, *Nonmodal growth of MHD shear flows with stabilizing magnetic fields*, contributed poster to APS DPP 2021; progress shared openly on GitHub
2021-	I.G. Cresswell, **A.E. Fraser**, and P. Garaud, *Mixing in unstable shear flows with strong magnetic fields and high resistivity*, KSPA report available online, journal publication next step
2020-	B. Tripathi, **A.E. Fraser**, P.W. Terry, E.G. Zweibel, and M.J. Pueschel, *Stable-mode-mediated turbulence saturation and small-scale dissipation in MHD Kelvin-Helmholtz-unstable flows*, contributed abstracts to Sherwood Fusion Theory 2021 and APS DPP 2020 & 2021
2021-	Z.R. Williams, J.C. Timperman, M.S. Dickerson, and **A.E. Fraser**, *Investigating the role of stable eigenmodes in the nonlinear dynamics of resistive tearing instabilities*, contributed abstract to APS DPP 2021

Other Experience

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
August 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

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

(In prep)	**A.E. Fraser**, I.G. Cresswell, and P. Garaud, *Resistive Instabilities in magnetized sinusoidal shear flows with a streamwise magnetic field*, J. Fluid Mech.
(In prep)	**A.E. Fraser** and P. Garaud, *MHD effects on fingering convection in stars: the problem with parasites*, Astrophys. J.
(In prep)	A. Sanghi, **A.E. Fraser**, E.R. Tian, and P. Garaud, *Magnetized semiconvection and density layers in stars*, Astrophys. J.
(In prep)	B. Tripathi, **A.E. Fraser**, P.W. Terry, E.G. Zweibel, and M.J. Pueschel, *Stable modes in coherent vortices and scaling laws of MHD shear flow turbulence*, Phys. Plasmas
(Submitted)	E.H. Anders, A.S. Jermyn, D. Lecoanet, **A.E. Fraser**, I.G. Cresswell, M. Joyce, and J.R. Fuentes, *Schwarzschild and Ledoux are equivalent on evolutionary timescales*, Astrophys. J.
(Under review)	B. Tripathi, **A.E. Fraser**, P.W. Terry, E.G. Zweibel, and M.J. Pueschel, *A New Mechanism for Sequestering Magnetic Energy at Large Scales in Shear-Flow Turbulence*, Phys. Rev. Lett.
Feb 2021	**A.E. Fraser**, P.W. Terry, E.G. Zweibel, M.J. Pueschel, and J.M. Schroeder, *The impact of magnetic fields on momentum transport and saturation of shear-flow instability by stable modes*, Physics of Plasmas 28, 022309 DOI ADS → Designated as a Phys. Plasmas **Editor's Pick**
Dec 2018	**A.E. Fraser**, M.J. Pueschel, P.W. Terry, and E.G. Zweibel, *Role of stable modes in driven shear-flow turbulence*, 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	**A.E. Fraser**, P.W. Terry, E.G. Zweibel, and M.J. Pueschel, *Coupling of damped and growing modes in unstable shear flow*, Physics of Plasmas 24, 062304 DOI ADS → Designated as a Phys. Plasmas **Editor's Pick**