Dr. J. Pratt
FOM Institute DIFFER
Edisonbaan 14
3439MN Nieuwegein
Netherlands

Professor Isabelle Baraffe
Physics & Astronomy, University of Exeter
Stocker Road
Exeter EX4 4QL, United Kingdom

5th January 2013

Dear Professor Baraffe,

I am writing to you regarding the advertised post-doc position in Computational Stellar Astrophysics at Exeter (reference P44453/P44454). I attach a summary of research accomplishments and a CV that contains a detailed publication list and a list of references.

As a postdoctoral researcher at FOM-DIFFER (Dutch Institute for Fundamental Energy Research) I am extending the nonlinear 3D reduced-MHD simulation-code JOREK to study the detailed evolution of unstable tearing modes and their suppression in fusion plasmas. Tearing modes are also a central topic for the study of space plasmas; tearing modes are intimately related to magnetic reconnection, a driving force in solar flares, coronal mass ejections, and the solar wind. The development of the JOREK simulation-code is part of the ITER fusion project in Cadarache, and has been carried out by an international group of scientists over the last decade. JOREK uses a finite-element method and employs several different fully-implicit time-integration schemes (Crank-Nicholson, BDF1 Implicit Euler, or BDF2 Gears method). The goal of my project is to design a more detailed and nuanced theory of neoclassical tearing-mode stabilization, including the limits of its effectiveness, based on the understanding we gain from these simulations.

As a postdoctoral researcher at the Max-Planck-Institut für Plasmaphysik in Garching I studied mechanisms of turbulent dynamo action in the solar convection zone in collaboration with a group at the Max-Planck-Institut für Sonnensystemforschung. I was responsible for the development of a suite of pseudo-spectral simulation-codes that perform a direct numerical simulation of Boussinesq convecting plasma. Some of my contributions to the development of this simulation were the implementation of an adaptive low-storage 3rd order Runge-Kutta time integrator, and the addition of a package that tracks Lagrangian fluid particles and calculates the resulting Lagrangian statistics. My simulation work has so far resulted in the discovery of a shearing behavior that produces magnetic energy intermittently at elevated levels.

My PhD dissertation, titled “Drift Wave Stability and Transport in Tandem Mirrors" was awarded by the University of Texas at Austin for research performed at the Institute for Fusion Studies.

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This work established the limits of MHD stability in a mirror magnetic field using a newly-proposed design. My thesis included data from the GAMMA-10 machine, and was investigated in collaboration with scientists from the University of Tsukuba, Japan. Along with my JOREK work, these studies form a record of high-quality international research in the theory and simulation of MHD plasmas. My academic record is evidence that my interest in fluids and plasmas is broad and interdisciplinary.

Having worked with turbulent convection in an ideal setting, I am eager to work on similar problems in a more practical setting. The complexity of rotational instabilities in convecting plasmas also interests me.

I look forward to hearing from you.

Sincerely,

Jane Pratt

Jane L. Pratt

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Education

Ph.D. Physics, University of Texas at Austin, Institute for Fusion Studies, May 2009 (thesis advisor Wendell Horton)

M.A. Applied Mathematics, Princeton, 2004

B.S. Mathematics, Harvey Mudd College, 2001, *with distinction*

High School diploma, Los Alamos High School, 1997 *with honors*

Research Experience

Post-doctoral Researcher — Jan 2012–present
Egbert Westerhof — FOM Institute DIFFER
Developing the 3D nonlinear reduced-MHD code JOREK to study the growth and suppression of neoclassical tearing modes by electron cyclotron current drive in tokamaks, including ITER. Formulation of a theory of tearing mode growth that accounts for dynamics inside magnetic islands.

Post-doctoral Research Fellow — 2009–2011
Wolf-Christian Müller — Max-Planck-Institut für Plasmaphysik
(joint appointment with the Max-Planck-Institut für Sonnensystemforschung) Examining fundamental solar dynamo mechanisms with high-resolution massively-parallel pseudo-spectral simulations of Boussinesq MHD convection. Investigation of Lagrangian statistics in plasma magnetoconvection. Development of the convex hull as a turbulence diagnostic.

PhD Research Assistant — 2005–2009
Wendell Horton — University of Texas at Austin
Institute for Fusion Studies

Establishing stability of MHD and trapped particle modes in the Kinetically Stabilized Tandem Mirror.

M.A. Research Assistant — 2002–2004
John Krommes — Princeton University
Theoretical research adapting the Mapping Closure to the Hasegawa-Wakatani equations.

Graduate Student — 2001
Leaf Turner, T-15 (Plasma Physics Group) — Los Alamos National Laboratory
Development of a pseudo-spectral calculation of the MHD equations closed using an EDQNM closure.

Undergraduate Student 1997–2000
Leaf Turner, T-3 (Fluid Dynamics Group) Los Alamos National Laboratory
Theoretical research adapting the EDQNM closure to the MHD equations.

Teaching Experience

Supervision of master students, FOM Institute DIFFER, August 2012 - July 2013

Substitute Lecturer for one lecture of Computational Physics, Universität Bayreuth, July 2010

Teaching Assistant and grader, Plasma Physics I, University of Texas at Austin, Fall 2006

Teaching Assistant (lecturing, designing assignments, and grading), Freshman Mechanics Lab for Engineers, University of Texas at Austin, fall 2004, spring 2005, spring 2006, supervisor: Professor John Keto

Noetherian Ring Secretary/Webmaster, Princeton University, 2002-2003

Teaching Assistant, Princeton Applied and Computational Mathematics (PACM) Certificate Program, fall 2002

Grader in the math and physics departments, Harvey Mudd College, fall 1998-2000 (courses graded: Electricity and Magnetism, Special Relativity, Discrete Math, Statistical Mechanics, Applied Analysis)

Computer and Programming Proficiency

Operating Systems and Platforms:
- Unix (Linux clusters, AIX) on IMB Power 6 (VIP at RZG), Dell (Lonestar at TACC), Sun (Ranger at TACC), Intel Xeon (HPC-FF at Jülich), Bullx B510 Xeon (Helios at the IFERC-CSC), IBM iDataPlex (Hydra at RZG)
- Mac, OpenSuse (personal desktop computers)

Programming Languages:
- Fortran 77/90/95, MPI
- C++, Java, Cuda, OpenMP

Scripting Languages:
- R
- Asymptote
- Julia, IDL, Python, Mathematica, and Matlab, gnuplot

Visualization Software:
- VisIt
- Vapor, ParaView

Participation in Training Sessions and Workshops

XSEDE training: Introduction to using Hadoop on Gordon Jan 31, 2013.

XSEDE/PRACE European-US Summer School on HPC Challenges in Computational Sciences, 24-28 June, 2012, Dublin, Ireland.

CECAM Summer School on Long-Range Interactions, Sept 2011, Jülich, Germany.

Les Houches School “Dynamics and turbulent transport in plasmas and conducting fluids", Les Houches, France, March 2011.

Seventh GOTiT (European Fusion Development Agreement (EFDA) Goal Oriented Training in Theory) High Level Course, Garching, Germany 2010.

Festival de Theorie, Aix-en-Provence, France July 2009, July 2011

UCLA Center for Multi-scale Plasma Dynamics and Center for Magnetic Self-Organization Winter School, Los Angeles California 2008, 2009, 2010

CISM (Center for Integrated Space-Weather Modeling) Summer School, Boston, Massachusetts, August 2005.

Publications

J. Pratt, A. Busse, W.-C. Müller. “Fluctuation dynamo driven by shear-bursts.” (draft to be submitted spring 2013)

J. Pratt, A. Busse, W.-C. Müller, S.C. Chapman, N.W. Watkins. “The convex hull as a diagnostic of local diffusion in turbulent Lagrangian particle simulations.” (draft to be submitted spring 2013)

J.W. Haverkort, J. Pratt et al “Implementation and verification of the nonlinear viscoresistive full magnetohydrodynamic equations in the JOREK code.” (to be submitted to Journal of Computational Physics, Jan 2013)

J. Pratt, E. Westerhof. “Toward 3D MHD modeling of neoclassical tearing mode suppression by ECCD.” Proceedings of the 17th Joint Workshop on Electron Cyclotron Emission and Electron Cyclotron Resonance Heating. European Physical Journal Web of Conferences. 2012.

H. L. Berk and J. Pratt. “Trapped Particle Stability for the Kinetic Stabilizer.” Nuclear Fusion, 51 (2011) 083025.

R. Moll, J. Pietarila-Graham, J. Pratt, R.H. Cameron, W.-C. Müller, and M. Schüssler. “Universality of the Small-Scale Dynamo Mechanism.” The Astrophysical Journal, Volume 736 Number 1 p36. July 2011.

J. Pratt. “Drift Wave Stability and Transport in Tandem Mirrors.” PhD dissertation. University of Texas at Austin, May 2009. http://repositories.lib.utexas.edu/handle/2152/18380/

J. Pratt, H. L. Berk, W. Horton. “Drift-Wave Eigenmodes and Spectral Gaps in Tandem Mirrors." Fusion Science and Technology, v55, 2T, p25, 2009.

W. Horton, P. J. Morrison, X. R. Fu, J. Pratt. “Transport with Reversed Er in the GAMMA-10 Tandem Mirror." Fusion Science and Technology, v55, 2T, p15, 2009.

T. Cho, V.P. Pastukhov, W. Horton, T. Numakura, M. Hirata, J. Kohagura, N. V. Chudin, and J. Pratt. “Active control of internal transport barrier formation due to off-axis electron-cyclotron heating in GAMMA 10 experiments." Phys. Plasmas 15 (1), 2008.

W. Horton, J. Pratt, H.L. Berk. “Energy Confinement Predictions for the Stabilized Tandem Mirror and GAMMA-10." (invited talk and proceedings paper) Innovative Confinement Concepts Workshop, University of Maryland. February 12-14, 2007.

W. Horton, J. Pratt, H.L. Berk, M. Hirata. “Energy Confinement Scaling Predictions for the Kinetically Stabilized Tandem Mirror." (invited talk and proceedings paper) Open Magnetic Systems For Plasma Confinement Conference Tsukuba, Japan. July 17-21, 2006.

J. Pratt, W. Horton. “Global Energy Confinement scaling predictions for the kinetically stabilized tandem mirror." Physics of Plasmas. 13 (4), 2006.

W. Horton, H.V. Wong, P.J. Morrison, A. Wurm, J.H. Kim, J.C. Perez, J. Pratt, G.T. Hoang, B.P. LeBlanc and R. Ball. “Temperature gradient driven electron transport in NSTX and Tore Supra." Nucl. Fusion 45 No 8, 976-985, June 2005.

H. Vernon Wong, B.-Y. Xu, W. Horton, J. Pratt, and J. W. Van Dam. “Nonlinear evolution of the firehose instability in a magnetic dipole geotail geometry." Phys. Plasmas 12, 056502, May 2005.

L. Turner and J. Pratt. “Eddy-Damped Quasinormal Markovian Closure: A Closure for Magnetohydrodynamic Turbulence?” LA-UR 01-3507. J. Phys.A:Math.Gen. 35, 781, 2002.

J. Pratt. “Adapting a closure scheme typically used in Turbulence Theory for use with the Magnetohydrodynamic Equations.” Undergraduate thesis, Harvey Mudd College, May 2001.

L. Turner and J. Pratt. “Does a Falling Pencil Levitate? When the Normal Becomes Abnormal" Quantum, New York: Springer-Verlag, March/April, 1998.

Presentations

J. Pratt, E. Westerhof. “Simulation of suppression of neoclassical tearing modes with ECCD." JOREK meeting FOM-IRFM-IO-JET, November 22, 2012, Nieuwegein, Netherlands and Cadarache, France.

J. Pratt, E. Westerhof. “Simulation of suppression of neoclassical tearing modes with ECCD." 17TH Workshop on MHD Stability Control, November 5 - 7, 2012, Columbia University, NYC.

J. Pratt, E. Westerhof. “Simulation of suppression of neoclassical tearing modes with ECCD." 54th APS Division of Plasma Physics, November 1, 2012, Providence, Rhode Island.

J. Pratt, E. Westerhof. “Investigation of neoclassical tearing modes with the nonlinear reduced-MHD simulation JOREK." (poster) 2012 XSEDE/PRACE European-US Summer School on HPC Challenges in Computational Sciences, 25 June, 2012, Dublin, Ireland.

J. Pratt, E. Westerhof. “Modeling the effect of ECCD on neoclassical tearing modes." (poster) 17th Joint Workshop on Electron Cyclotron Emission and Electron Cyclotron Resonance Heating, 9 May 2012, Deurne, Netherlands.

J. Pratt, W. -C. Müller. “Fluctuation dynamo driven by shear-bursts." (poster) 24th NNV Symposium Plasma Physics & Radiation Technology, 6-7 March 2012, De Werelt, Lunteren, Netherlands.

J. Pratt, E. Westerhof. “Investigation of neoclassical tearing modes with the nonlinear reduced-MHD simulation JOREK." (talk) FOM Programme 120 Progress Meeting, 5 March 2012, Rijnhuizen, Nieuwegein, Netherlands.

J. Pratt, W. -C. Müller. “Fluctuation dynamo driven by spontaneously-arising intermittent shear- flows." (talk) IPP Theory Meeting, Dec 5-9 2011, Liebenberg, Germany.

J. Pratt, W. -C. Müller. “The Role of Magnetic Structures in Dynamo Action." (talk) 53rd APS Division of Plasma Physics, 17 Nov 2011, Salt Lake City, Utah.

J. Pratt, W. -C. Müller. “Magnetic Structures in Convecting Plasmas." (poster) CECAM Summer School on Long-Range Interactions, 13 Sept 2011, Jülich, Germany.

S. C. Chapman, W. -C. Müller, J. Pratt, N. W. Watkins, A. Busse,Y.-X. Chau. “Anomalous diffusion and characterizing the fluctuating fields of finite sized turbulence in astrophysical plasmas." (talk) Sigma Phi International Conference on Statistical Physics, Larnaca Cyprus, July 12, 2011.

J. Pratt, W.-C. Müller. “Magnetic Helicity and Magnetic Structures in MHD Convection." (talk) Round-Table Contribution, 6th Festival de Theorie. Aix-en-Provence, July 5th, 2011.

J. Pratt, W.-C. Müller. “Magnetic Structures in Convecting Plasmas." (talk) 478th WE-Heraeus Seminar on Fusion and Astrophysical Plasmas. Bad Honnef, April 17-20 2011.

Rainer Moll and Jane Pratt, J. Pietarila Graham, R. Cameron, W.-C. Müller and Manfred Schüssler. “Universality of the Small-Scale Dynamo Mechanism." (talk) 478th WE-Heraeus Seminar on Fusion and Astrophysical Plasmas. Bad Honnef, April 17-20 2011.

J. Pratt, W.-C. Müller. “Lagrangian Statistics of Plasma Convection." (talk) DPG Fruehjahrstagung der Fachverbaende Plasmaphysik und Kurzzeitphysik, Kiel, March 28th to 31st 2011.

J. Pratt, W.-C. Müller. “Lagrangian Statistics of 3D MHD Convection.” (talk) School on Dynamics and turbulent transport in plasmas and conducting fluids. Les Houches, France March 2011.

J. Pratt, W.-C. Müller. “Fundamental Characteristics of Turbulent Dynamo Action." (poster) IPP Fachbeirat. Garching, Jan. 2011.

J. Pratt, W.-C. Müller. “Lagrangian Statistics of 3D MHD Convection." (poster) AGU Meeting 2010. San Francisco, Dec. 2010.

J. Pratt, W.-C. Müller. “Solar Dynamo Action: Lagrangian statistics and other characteristics of 3D MHD convection." (talk) Institute for Fusion Studies VIP Seminar. University of Texas at Austin, Dec. 2010.

J. Pratt, W.-C. Müller. “Lagrangian Statistics of 3D MHD and MHD Convection." (talk) 13th annual MHD Days. Dresden, Nov. 2010.

J. Pratt, W.-C. Müller. “Lagrangian Statistics of MHD Convection." (talk) IPP Theory Meeting. Ringberg, Nov. 2010.

J. Pratt, W.-C. Müller. “Investigation of Convective Dynamo Motion." (talk) CMPD/CMSO Winter School. UCLA, Jan. 2010.

J. Pratt, W.-C. Müller. “Investigation of Convective Dynamo Motion." (talk) IPP Theory Meeting, Sellin Nov. 2009.

J. Pratt, W. Horton, H.L. Berk “GAMMA-10 Simulation Results and Implications for a Tandem Mirror Effort." (invited talk) Fusion Power Associates Symposium, Lawrence Livermore National Laboratory. December 3-4, 2008.

J. Pratt, H.L. Berk, W. Horton “Drift-Wave Eigenmodes and Spectral Gaps in Tandem-Mirrors." (poster) 50th Annual Meeting of the Division of Plasma Physics, Dallas, TX. November 17-21, 2008.

J. Pratt, W. Horton, H.L. Berk. “Drift-Wave Eigenmodes and Spectral Gaps in Tandem Mirrors.” (talk) 7th International Conference on Open Magnetic Systems for Plasma Confinement, Daejeon Metropolitan City, Korea. July 15-18 2008.

W. Horton, X. Fu, J. Pratt, P.J. Morrison. “Modeling the reversal E_r Shear Transport in GAMMA-10 Experiments.” (talk) 7th International Conference on Open Magnetic Systems for Plasma Confinement, Daejeon Metropolitan City, Korea. July 15-18 2008.

J. Pratt, W. Horton, H.L. Berk “Drift-Wave Eigenmodes and Spectral Gaps in Tandem-Mirrors." (poster) Innovative Confinement Concepts Workshop, Reno NV, June 24-27, 2008.

J. Pratt, W. Horton. “Electromagnetic Eigenmodes and Spectral Gaps in Tandem-Mirrors." (poster) International Sherwood Fusion Theory Conference, March 30-April 2, 2008.

J. Pratt, W. Horton. “Electromagnetic Eigenmodes and Spectral Gaps in Tandem-Mirrors." (talk) 21st US Transport Taskforce Workshop, Energetic Particles Working Group, March 25-28, 2008.

J. Pratt, W. Horton. “Electromagnetic Eigenmodes and Spectral Gaps in Tandem-Mirrors." (talk) Institute for Fusion Studies VIP Seminar, Feb 21, 2008.

J. Pratt, W. Horton. “Electromagnetic Eigenmodes in the Tandem-Mirror-like Modulated LAPD." (talk) CMPD-CMSO Winter School, UCLA, Jan 2008.

J. Pratt, W. Horton. “Drift-Waves and Stability in the GAMMA-10." (poster) 49th APS-DPP Conference, Orlando FL, Nov 12-16, 2007.

J. Pratt, W. Horton, J-H Kim, and H. L. Berk. “Drift Wave Fluctuations in Tandem Mirrors with Anchor Cells and Sheared Flows." (poster) International Sherwood Fusion Theory Conference,

Annapolis, Maryland, April 23-25, 2007.

J. Pratt, W. Horton, J-H Kim, and H. L. Berk. “Control of Fluctuations in the GAMMA-10 by Sheared Flow." (poster) 12th US-EU Transport Task Force Workshop, San Diego, April 17-20, 2007.

W. Horton, J. Pratt, H.L. Berk. “Energy Confinement Predictions for the Stabilized Tandem Mirror and GAMMA-10." (talk) Innovative Confinement Concepts Workshop, University of Maryland, February 12-14, 2007.

W. Horton, J. Pratt, H.L. Berk, M. Hirata. “Energy Confinement Scaling Predictions for the Kinetically Stabilized Tandem Mirror." (talk) Open Magnetic Systems For Plasma Confinement Conference, Tsukuba, Japan, July 17-21, 2006.

J. Pratt, W. Horton , H.L. Berk. “Relation between Radial and Axial Losses in Tandem Mirrors." (poster) APS-DPP and Sherwood Conference, Dallas, Texas, 2006.

W. Horton, J. Pratt “Energy Confinement Scaling Predictions for the Kinetically Stabilized Tandem Mirror." (poster) Innovative Confinement Concepts Workshop, Austin, Texas. February 13-16, 2006.

J. Pratt, W. Horton. “Global Energy Confinement Scaling Predictions for the Kinetically Stabilized Tandem Mirror." (poster) APS-DPP Meeting, Denver, CO. October 24-28, 2005.

M. L. Mays, J. Pratt, E. Spencer, W. Horton, “Effect of Magnetic Clouds and IP Shocks on AL and Dst Indices.” (poster) AGU Fall Meeting, Dec 5-9 2005.

M. L. Mays, J. Pratt, E Spencer, W. Horton, “Magnetic Clouds and Magnetic Energy Storage." (poster) GEM/CEDAR joint conference, Santa Fe, New Mexico, June 26-July 1, 2005.

J. Pratt, J.H. Kim, W. Horton, H. V. Wong, T. K. Fowler. “Transport Analysis of the Kinetically Stabilized Tandem Mirror." (poster) APS-DPP Meeting. Savannah, Georgia. November 15-19, 2004.

J.A. Krommes and J. Pratt. “Mapping Closure for Hasegawa-Wakatani Dynamics." (poster) APS-DPP Meeting, Orlando Florida, Nov 11-15 2002.

L. Turner and J. Pratt. “Schema of a Basic Theoretical Approach to the Turbulent MHD RFP Dynamo." (talk) University of Wisconsin, April 18th 2001.

L. Turner and J. Pratt. “Realizability in a Closure for MHD Turbulence" (talk) LA-UR 01-1195. Sherwood Theory Conference. Santa Fe, New Mexico, 2001.

J. Pratt and L. Turner. “Realizability in an EDQNM Closure for MHD Turbulence Possessing Cross-Helicity". (talk) APS-DPP Meeting, Quebec City, Quebec, Canada, October 23-27, 2000.

J. Pratt and L. Turner. “Realizability in an EDQNM Closure for MHD Turbulence Possessing Cross-Helicity" (talk) 52nd Annual Meeting of the APS Division of Fluid Dynamics. New Orleans, LA, November 21-23, 1999.

Language Skills

English, American (native speaker)

German (conversational level)

Dutch (beginning level)

Society Memberships

Deutsche Physikalische Gesellschaft (current)

American Physical Society (current)

American Geophysical Union (defunct)

Honors and Awards

Presidential Fellowship from Princeton Graduate School

Harvey Mudd College Deans List for 4 semesters

Seely G. Mudd Fellowship from Harvey Mudd College

J. Robert Oppenheimer Scholarship in Memory of Mary and Harold Argo from the city of Los Alamos. Only 4 of these memorial scholarships are give each year. This particular scholarship is awarded to "a young woman for outstanding promise in the arts or sciences".

Los Alamos High School Book award 1997. (Two graduating students are selected by the honors teachers and awarded with a book each year.)

Robert C. Byrd Honors Scholarship for Undergraduate Study from the State of New Mexico (4 years)

References

Dr. Egbert Westerhof
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3439NM Nieuwegein, Netherlands
E.Westerhof@differ.nl

Prof. Dr. Wolf-Christian Müller
Max-Planck-Institut für Plasmaphysik
Boltzmannstr. 2
D-85748 Garching, Germany
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Professor Wendell Horton
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please contact through Cathy Rapinett (secretary) at rapinett@mail.utexas.edu

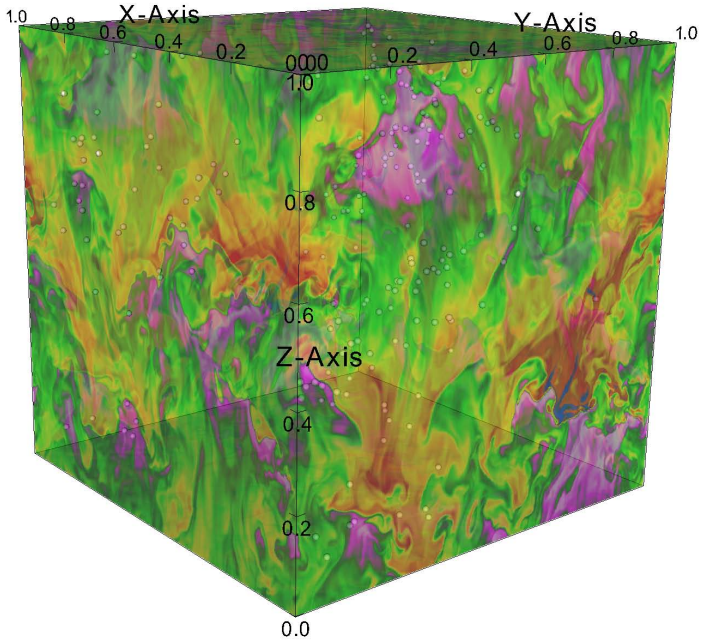
Statement of Research Accomplishments

J. Pratt

In my research, I aim to understand properties of MHD turbulence and MHD instabilities. I am interested in the ways that turbulence and plasma instabilities interact with each other and with physical phenomena like large-scale structures and energetic particles. Plasma turbulence and MHD instabilities are basic universal processes, key to the entire earth-sun system, contributing to the dynamics of convection, dynamo efficiency, solar storms, and the solar wind. Turbulence and instabilities are among the few remaining impediments to fusion energy. Understanding turbulent processes sometimes impacts national security by affecting satellites, and sometimes is a matter of convenience, as when airplanes cannot fly over the poles because of radiation concerns. The best way to gain fresh insight into these kinds of non-linear processes is through high performance simulations.

RESEARCH BACKGROUND

As a postdoctoral researcher at the Max-Planck-Institut für Plasmaphysik in Garching, I studied mechanisms of dynamo action in the solar convection zone. I was responsible for the further development of a suite of simulation-codes that perform a direct numerical simulation of plasma magnetoconvection. This simulation solves the Boussinesq MHD equations using a pseudo-spectral calculation at high resolutions, and simulations were performed over extremely long times. The simulation is written in a combination of C++, Fortran, and MPI, and makes use of pre-processing commands. One of my contributions to the development of this simulation was the implementation of a low-storage 3rd order Runge-Kutta time stepper with an adaptive time step. I combined this (Eulerian) simulation with a package that tracks Lagrangian fluid particles written by a PhD student in our group, Angela Busse. This Lagrangian package works by interpolating particle-velocity and magnetic field from the grid. The figure below shows a typical state of the thermal fluctuations (and a selection of Lagrangian particles) in a convecting plasma.



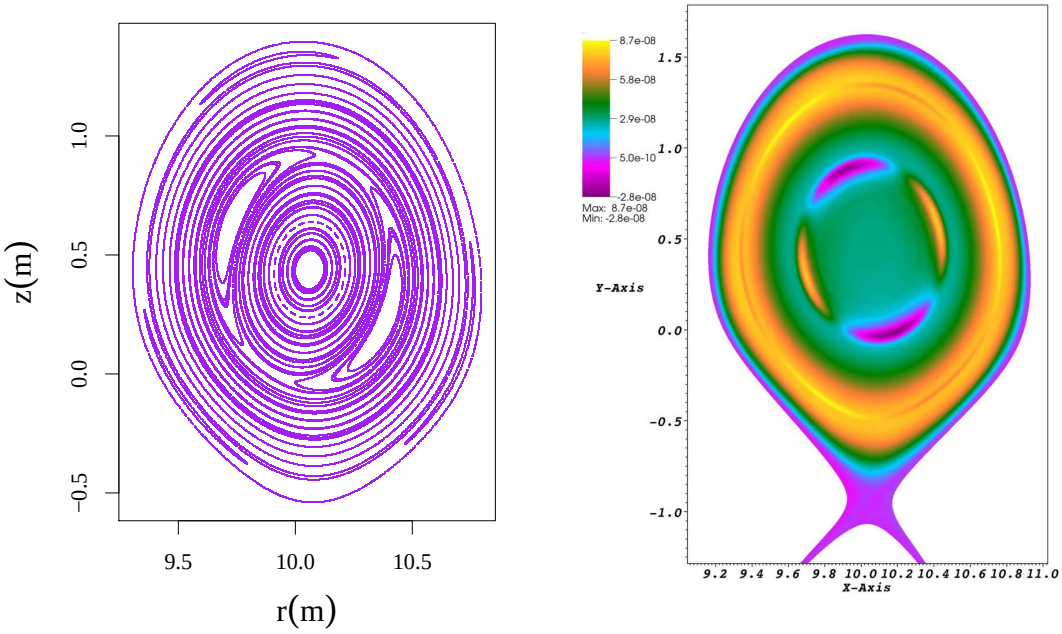
To understand the results of these Lagrangian simulations, I wrote a series of post-processing routines in Fortran, IDL, and R that calculate Lagrangian statistics from the movements of several million particles. These Lagrangian statistics are compared with Eulerian statistics that are also calculated. My statistics routines calculate cumulative distribution functions and probability distribution functions (both single and joint), structure functions, time correlation functions, spatial correlation functions, the diffusion of particles, and the dispersion of particle-pairs. I have also used parallel visualization software packages Vapor and VisIt (run with Python scripts) to visualize energy fields, coherent flows, magnetic-field vectors and field-lines, and the movements of groups of particles.

For a short time at IPP, I also worked with a compressible MHD turbulence code (KT-MHD), written by a PhD student in our group, Christian Vogel[1]. This code uses a Kurganov-Tadmor scheme (a higher-order extension of the Lax-Friedrich method) to solve the 3D compressible MHD equations. The KT-MHD code has been benchmarked against other state-of-the-art compressible MHD codes[2], and shown to successfully capture shock behavior.

As a PhD student at the University of Texas at Austin in the Institute for Fusion studies, I studied instabilities that are important to plasmas confined in mirror traps and tandem mirrors, including flute-modes, ballooning modes, MHD instabilities, and trapped particle instabilities. In my thesis work, I theoretically evaluated a method of stabilizing a symmetric tandem mirror to MHD instabilities and the trapped particle instability.

CURRENT RESEARCH

At FOM-DIFFER I have extended the nonlinear 3D reduced-MHD simulation-code JOREK to study the detailed evolution of tearing modes. How magnetic islands develop while current is added inside the islands using electron cyclotron current drive is interesting to fusion because it has been shown – experimentally, and with crude theory – to limit the island size. The current theory is not sufficiently detailed to explain the stabilization process because it is based on an average over the area of the entire magnetic island; however the current applied to stabilize the island growth is applied only to a very small and finely targeted area within the magnetic island. Experimentally, the inside of an island is difficult to examine, so simulation results should potentially shed new light on processes developing inside the island, and result in better theoretical understanding. JOREK has been developed over the last decade by a large and on-going international collaboration centered around Project ASTER at Association Euratom-CEA, Centre de Cadarache to study edge-localized modes in the ITER experiment. My contribution to this development is the addition of a targeted current to the JOREK simulation. Below you can see a Poincaré plot of the magnetic field-lines around magnetic islands produced by a JOREK simulation of a general tokamak, and (to the right) the corresponding signature in the velocity stream function.



The JOREK simulation uses a combination of MPI and OpenMP, a Bezier finite element method in the poloidal plane, a Fourier decomposition in the toroidal plane, and fully-implicit time integration.

DIRECTIONS FOR FUTURE RESEARCH

In my future work, I would like to build on my interdisciplinary past, and continue to study plasma turbulence, MHD instabilities, and dynamo action. I want to work on problems of practical importance that are also intellectually challenging. Working with plasma instabilities in different physical settings lends a deeper understanding of how physical constraints drive or limit growth. It is critical to the understanding of turbulence and MHD stabilities to employ the most advanced numerical tools available. I would enjoy being part of a team that seeks to develop new and innovative computational methods and apply those methods to support a deep theoretical understanding of turbulent magnetic processes.

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[1] C. Vogel, *Statistical properties of compressible hydrodynamic and magnetohydrodynamic turbulence*. PhD Thesis, Ludwig-Maximilians-Universität München, München, Germany, 2010.

[2] A. G. Kritsuk, Å. Nordlund, D. Collins, P. Padoan, M. L. Norman, T. Abel, R. Banerjee, C. Federrath, M. Flock, D. Lee, P. S. Li, W.-C. Müller, R. Teyssier, S. D. Ustyugov, C. Vogel, and H. Xu, "Comparing numerical methods for isothermal magnetized supersonic turbulence," *The Astrophysical Journal*, vol. 737, no. 1, p. 13, 2011.