Nicholas H. Brummell

Curriculum Vitæ

Birth Data:

31 October 1961; Northampton, England
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Education:

Ph.D.	Imperial College, University of London, 1988
DIC ($\sim$ M.Sc.)	Imperial College, University of London, 1986
B.Sc.	Imperial College, University of London, 1984 (First Class)

Appointments:

1988–1991	Research Associate, Joint Institute for Laboratory Astrophysics, University of Colorado at Boulder
1991–1995	Senior Research Associate, Joint Institute for Laboratory Astrophysics, University of Colorado at Boulder
1996	Research Assistant Professor, JILA & Astrophysical, Planetary and Atmospheric Sciences Department, University of Colorado at Boulder

Biographical Sketch:

Brummell did his undergraduate studies at Imperial College at the University of London (UK) in Mathematics and received his B.Sc. there with first class honours. He was accepted to do a Ph.D. in the Department of Applied Mathematics at the same university, under the supervision of Dr. D.R. Moore. In 1988, Brummell received his Ph.D. and soon after moved to JILA, University of Colorado, where he has been working on problems of astrophysical and geophysical fluid mechanics.

Brief summary of current and future research:

Brummell's interests are in research and teaching related to astrophysical and geophysical fluid dynamics, in particular the study of the magnetohydrodynamics (MHD) of the outer envelopes of stars and in other astrophysical bodies. Since turbulence is a ubiquitous feature of the motivating situations, an underlying goal of Brummell's work has been to understand the intricacies of highly nonlinear dynamics. Major themes include the development of coherent and large-scale structure (including mean flows or differential rotation) from small-scale turbulent driving, turbulent as opposed to laminar transport of energy, momentum and magnetic fields, mixing at high Reynolds numbers, and nonlinear dynamos. Active areas of research then encompass high resolution 3-D simulations of turbulent compressible convection with and without rotation, with relevence to the solar convection zone and its differential rotation; 3-D turbulent compressible convection with penetration and magnetic fields, and 3-D simulations of magnetic structure creation by shear-induced magnetic buoyancy, all pertaining to generation, storage, redistribution and emergence of magnetic fields at the base of the solar convection zone; fully nonlinear 3D MHD dynamo simulations which question our understanding of the definition of nonlinear dynamo action; 2-D turbulent β-convection pertaining to the zonal winds of Jupiter; and, simulations coupled with low-order dynamical systems and plume models of Rayleigh-Benard convection, double-diffusive convection and baroclinic chaos that provide insight into the basic nature of turbulence, chaos and mean flow production.

Brummell's research approach revolves around the design, implementation, use and analysis of high resolution multi-dimensional numerical experiments, coupled with dynamical modelling, analytical work and graceful visualisation. Brummell is adept in the use of modern numerical techniques on forefront technology having made extensive use of supercomputers such as the Cray Y-MP, C-90 and T3D/E machines, the IBM SP series of computers and most recently the SGI Origin 2000. Smaller simulations have employed Sun, Silicon Graphics and DEC workstations, and particular emphasis has been placed on the lucid visualisation and analysis of results using such powerful workstations based locally for all simulations.

Current technical commitments:

Co-Investigator for NSF HPCC Grand Challenge Application Groups, grant ESC-9217394: 'High Performance Computational Methods for Coupled Fields and GAFD Turbulence', involved in the GAFD Turbulence 'Grand Challenge' component which demands $500K/year (with matching funds from CU) from an overall grant of $900K/year. The grant collaborates with the University of Colorado, the National Center for Atmospheric Research and the University of Minnesota, and is funded for a 5-year interval (Sept. 1992 - Sept. 1998).

Co-Investigator for NSF Solar Terrestrial Research Program grant: 'Collaborative Study of Solar Turbulent Convection and Differential Rotation', funded for 3 years (1 June 1998 - 31 May 01) at $436K for the duration with $60K matching from CU.

Co-Investigator for NASA Cooperative Agreement, grant NCCS 5-157: 'Turbulent Convection and Dynamos in Stars'. This multi-institute 'Grand Challenge' grant of 3-year duration involves the University of Chicago, the University of Colorado, Argonne National Laboratory and the University of Minnesota, and averages about $600K/year with the CU portion being approximately $200K/year (Aug. 1996 - Aug. 1999).

Co-Investigator for NASA Space Physics Theory Program, grant NAG 5-2256: 'Global-scale turbulent solar convection coupled to rotation and magnetic fields'. This 3-year grant started with an initial rampup of $135K with subsequent two years funded at about $270K (Mar. 1996 - Mar. 1999).

Co-Investigator for NASA Sun-Earth Connection Theory Program, grant NRA-98-03-SECT-020: 'Global models of solar convection, rotation and magnetic activity'. This 3-year grant (1999-2001) is for approximately $300K per year. .

Co-Investigator for NASA Space Physics Theory Program Supporting Research and Technology, grant NAG 5-4953, University of Chicago: 'Small-scale photospheric flows and local dynamo action'. This is a 3-year grant with $90K per year (Jun. 1998 - Jun. 2001).

Teaching experience:

At the University of Colorado:

Invited lectures. ATOC 5400, Fall, 1998.

Seminar in Astrophysics. APS 6000, Fall, 1997.

Mathematical Methods: Numerical solutions of ODEs and PDEs. APAS 5400, Fall 1992 and Spring 1997.

Fluid turbulence and non-linear processes: numerical simulations. APAS 7430, Fall 1994.

Parallel computation: co-instructor. CS 7111, Spring 1994.

Fluid instabilities and waves: invited lectures. APAS 5410, Spring 1993.
Fluid dynamics: invited lectures. APAS 5400, Fall 1993.

Other:

Assisted various fluid dynamical and numerical methods courses during Ph.D.
Ten years experience teaching martial arts.

Publications:

"Non-linear, low Prandtl number penetrative convection in two dimensions", in *Proc. of Euromech Colloqium 207 on Natural Convection,* Delft, Holland, 7–9 April, pp. 21–25, (1986).

"Hexagons, harmonics and Helmholtz", in *Procs. GFD program*, Woods Hole Oceanographic Institution, *WHOI-86-45*, pp. 251–265, (1986).

"Numerical experiments on thermohaline convective motions across interfaces of intrusions" (with S.A. Piacsek and B.E. M^{c}Donald), in *Procs. of the Euromech Meeting on Ocean Hydrodynamics—Fine Scale Structure and Turbulence*, ed. J. Nihoul, Liege, Belgium, pp. 257–265, (1987).

"Modal models of convection" Ph.D. thesis, University of London (1988).

"Three-dimensional compressible convection" (with F. Cattaneo, N.E. Hurlburt and J. Toomre), in *Science at the John von Neumann National Supercomputing Center*, (CSC, National Science Foundation), pp. 59–64, (1990).

"Three-dimensional compressible convection at low Prandtl number" (with F. Cattaneo, N.E. Hurlburt and J. Toomre), *Comp. Phys. Comm.*, **59**, pp. 105–117 (1990).

"Turbulent supersonic convection in three dimensions", (with A. Malagoli and F. Cattaneo), *Astrophys. J.* , **361**, pp. L33–L36, Sept. 20 (1990).

"Turbulent compressible convection" (with F. Cattaneo, N.E. Hurlburt, A. Malagoli and J. Toomre), *Astrophys. J.* , **370**, pp. 282–294, (1991).

"The organization of turbulent convection" (with F. Cattaneo, A. Malagoli, J. Toomre and N.E. Hurlburt), in "Challenges to theories of the structure of moderate-mass stars", (ed. D.O. Gough and J. Toomre; Springer), *Lecture Notes in Physics*, **388**, pp. 189–194, (1991).

"The effect of the Prandtl number on penetrative convection", *Geophys. and Astrophys. Fluid Dynamics*, **68**, pp. 115–132, (1993)

"High Rayleigh number β-convection", (with J. E. Hart), *Geophys. and Astrophys. Fluid Dynamics*, **68**, pp. 85–114, (1993).

"Turbulent compressible convection with rotation", (with N.E. Hurlburt and J. Toomre), in *Seismic Investigation of the Sun and Stars: GONG 1992*, ed. T. Brown, Astron. Soc. Pacific Conf. Ser., **42**, pp. 61–64 (1993).

"Three-dimensional turbulent compressible convection coupled with rotation" (with N.E. Hurlburt and J. Toomre), in *NCCS Science Highlights: Supercomputing and Mass Storage Applications Supporting NASA Research for Earth and Space Sciences, FY93*, pp. 77–78 (1993).

"Turbulent compressible convection with rotation" (with N.E. Hurlburt and J. Toomre), in *Procs. of Int. Workshop on Large Eddy Simulations of Turbulent Flows in Engineering and the Environment*, CERCA, Université de Montréal, pp. 145–146 (1993).

"Inner turbulence of the Sun" (with S. Eisenberg, J. Toomre), in *Pittsburgh Supercomputing Center: Projects in Scientific Computing*, pp. 28–29, (Pittsburgh), (1994).

"Linear and non-linear baroclinic instability with rigid sidewalls" (with M. Mundt and J.E. Hart) *J. Fluid Mech.*, **291**, pp. 109–138 (1995).

"Maintenance of differential rotation in turbulent compressible convection with rotation", (with X. Xie, J. Toomre and C. Baillie), in Astron. Soc. Pacific Conf. Ser. **76**, *GONG '94: Helio- and Astero-Seismology from the Earth and Space*, ed. R. K. Ulrich, E.J. Rhodes, Jr. and W. Däppen, pp. 192–195, (1995).

"Modelling Astrophysical Turbulent Convection", (with J. Toomre), in *Proc. Astronomical Data Analysis Software and Systems IV*, ed. R.A.Shaw, H.E.Payner and J.J.E. Hayes, Astron. Soc. Pacific Conf. Ser. **77**, pp. 15–24, (1995).

"Turbulent compressible convection with rotation" (with N.E. Hurlburt and J. Toomre) in *Proc. 9^{th} Int. Couette-Taylor Workshop*, eds. P.D. Weidman, R.P. Tagg, pp. 1–4 (1995)

"Turbulent dynamics in the solar convection zone", (with F. Cattaneo and J. Toomre), invited article for *Science* (and colour cover), Computational Fluid Dynamics special issue, **269**, 1370–1379, (1995).

"Solar convection zone dynamics and rotation" (with J. Toomre) in *Proc. 4th SOHO Workshop: Helioseismology*, eds. V. Domingo et al., ESA SP-376, (ESA: Noordwijk), vol.1, pp. 47–62 (1995).

"Local area simulations of rotating compressible convection and associated mean flows" (with N.E. Hurlburt, J. Toomre) in *Proc. 4th SOHO Workshop: Helioseismology*, eds. V. Domingo et al., ESA SP-376, (ESA: Noordwijk), vol.2, pp. 245–248 (1995).

"Turbulent compressible convection with rotation. I: Flow structure and evolution" (with N.E. Hurlburt, J. Toomre) *Astrophys. Jou.*, **473**, 494–513 (1996)

"Differential rotation in turbulent compressible convection" (with N.E. Hurlburt, J. Toomre) in *Solar convection, oscillations and their relationship*, eds. F. Pijpers, J. Christensen-Dalsgaard, Kluwer, pp. 223–226 (1997)

"Turbulent compressible convection with rotation. II: Mean flows and differential rotation" (with N.E. Hurlburt, J. Toomre) *Astrophys. Jou.*, **493**, 955–969 (1998).

"Pumping of magnetic fields in turbulent penetrative convection", (with S.M. Tobias, T.Clune, J. Toomre) *Astrophys. Jou. Lett.*, **502**, L177-L180 (1998).

"Transport and storage of magnetic fields in turbulent penetrative convection", (with S.M. Tobias, T.Clune, J. Toomre) *Astrophys. Jou. Lett.*, submitted (1998).

"Linear and nonlinear dynamo action", (with F.Cattaneo, S.M.Tobias), *Phys. Lett. A*, in press (1998).

"Turbulent transport in rotating compressible convection" in *Geophysical and Astrophysical Convection*, eds. R. Kerr, P.Fox, Gordon & Breach, in press (1998).

"Nonlinear dynamo properties of ABC flows", (with F.Cattaneo, S.M.Tobias), *J. Fluid. Mech.*, submitted (1998).

"Nonlinear flows induced by centrifugal bouyancy acting between infinite rotating discs" (with J. E. Hart), *J. Fluid Mech.*, submitted (1998)

"Nonlinear flows induced by centrifugal bouyancy acting between infinite differentially rotating discs" (with J. E. Hart), *J. Fluid Mech.*, submitted (1998)

References:

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