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Dr. Matthew John Davis

Career objective

To become a lecturer/researcher in theoretical physics at a leading research-based university, preferably in Australia or New Zealand.

Employment

6/2003–present University of Queensland Brisbane, Australia.
Lecturer in physics, fixed term.

5/2002–5/2003 University of Queensland Brisbane, Australia.
University of Queensland Postdoctoral Fellow

- Supervisor: Professor Peter Drummond. Research duties only.

3/2001–4/2002 University of Oxford Oxford, United Kingdom.
Engineering and Physical Sciences Research Council Postdoctoral Fellow in Theoretical Physics

- Supervisor: Professor Keith Burnett. Research duties only.

Education

10/1997–3/2001 University of Oxford Oxford, United Kingdom.
D.Phil., awarded October 2001.

- Thesis title: “Dynamics of Bose-Einstein condensation.”
- Supervisor: Professor Keith Burnett.
- Awarded Commonwealth Scholarship, North Senior Scholarship.

1993–1996 University of Otago Dunedin, New Zealand.
B. Sc. (Hons), first class in physics, awarded May 1997.

- Supervisor: Professor Rob Ballagh.
- Awarded 1996 Prince of Wales Prize, 1996 Royal Society Prize.

1988–1992 Marlborough Boys' College Blenheim, New Zealand.
'A' bursary

- Dux Litterarum, New Zealand Top Scholar Bursary Physics Exam 1992.

Referees

1. Professor Keith Burnett k.burnett1@physics.ox.ac.uk

Clarendon Laboratory, Department of Physics, University of Oxford, Parks Rd,
Oxford OX1 3PU, United Kingdom.

Phone: +44 1865 272 372 Fax: +44 1865 272 375

2. Professor Crispin Gardiner crispin.gardiner@vuw.ac.nz

School of Chemical and Physical Science, Victoria University of Wellington,
Wellington, New Zealand.

Phone: +64 4 495 5233 x8049 Fax: +64 4 463 5237

3. Professor Halina Rubinsztein-Dunlop halina@physics.uq.edu.au

Department of Physics, University of Queensland, St Lucia QLD 4072, Australia.

Phone: +61 7 3365 3139 Fax: +61 7 3365 1242

Teaching experience

- Supervision: Chris Foster (PhD, 2004–); Stuart Holt (PhD, 2004–); Martin Lenz (visiting student, 2004), Laura Noack (summer scholarship 2003–4); Mark Dowling (summer scholarship 2002–3 and honours project 2003); Ari Craven (summer scholar 2002–3); Sylvain Bernu (visiting scholar, 3 months 2002).
- Lecturing: 3rd year statistical mechanics (2004).
- Lab demonstrator for first year physics, University of Otago, 1997.
- Designed and ran tutorials in first year physics for Arana Hall, Studholme Hall, St Margaret's College, and Dalmore Hall, University of Otago, from 1994–6.
- Tutor for second year engineering mathematics, University of Otago, 1995.

Current research interests: atom optics and Bose-Einstein condensation

- Methods for dynamical calculations of thermal quantum fields;
 - ⇒ Wigner function (“classical field”) description of Bose gases at finite temperature.
 - ⇒ Application to representing thermal effects in experimental systems.
 - ⇒ Shift in critical temperature of degenerate Bose gases with interaction strength.
 - ⇒ Formation of topological defects in temperature quenches.
- Static field theory calculations for trapped Bose gases.
 - ⇒ Possibility of Evans-Rashid transition (analogous to BCS pairing).
- Kinetic theory for condensate growth and continuous wave (cw) atom lasers.
- Statistical mechanics of microcanonical systems.
- Quantum chaos using Bose-Einstein condensates.
- New phase space techniques for quantum dynamics.

Academic distinctions

- 1998** • North Senior Scholarship, St John's College, University of Oxford.
- 1997** • Commonwealth Scholarship to St John's College, University of Oxford.
- William Georgetti Scholarship.
 - TV2 New Zealand Young Achievers Award.
- 1996** • Prince of Wales Prize.
"Awarded annually by the University ... to the most outstanding student completing an undergraduate degree. Qualities in addition to academic performance may be taken into account in awarding the prize."
- Otago Branch of the Royal Society of New Zealand Prize.
"Awarded annually ... to the student adjudged to have demonstrated outstanding ability in the final year of the course of Bachelor of Science with Honours ... as measured by performance in the annual examinations and in particular the research component."
 - University of Otago Postgraduate Scholarship, Beverly Bursary in Physics.
- 1995** • Beverly Bursary in Physics, Beverly Scholarship in Physics, Staff Prize in Mathematics.
- Australian National University Vacation Scholarship in Theoretical Physics.
- 1994** • Beverly Bursary in Physics, Robert Jack/New Zealand Institute of Physics Prize.
- 1993** • New Zealand Institute of Chemistry Prize.

Professional affiliations

Associate Member of the Institute of Physics, joined in 1998.

Research funding

- Nonlinear dynamics and chaos in Bose-Einstein condensates on atom chips.
ARC Linkage International, grant LX0454394, from 2004–6, funding of AUD\$90k.
Chief Investigators: H. Rubinsztein-Dunlop, C. J. Vale, **M. J. Davis**. Overseas investigators: C. Zimmerman, J. Fortágh.
- ARC Centre of Excellence for Quantum Atom Optics, grant CE0348178 from 2003–7.
Funding from ARC AUD\$10.975m, University of Queensland AUD\$750k, Queensland State Government AUD\$750k, plus ANU/SUT contributions.
Chief Investigators: H. A. Bachor, K. G. H. Baldwin, J. D. Close, J. J. Hope, Y S Kivshar, P. K. Lam, E. A. Ostrovskaya, C. M. Savage, A. G. Truscott, J. F. Corney, **M. J. Davis**, P. D. Drummond, K. V. Kheruntsyan, M. D. Reid, B. J. Dalton, P. Hannaford, T. D. Kieu, R. McLean, W. J. Rowlands, A. Sidorov.
Partner Investigators: G. Leuchs, W. Ertmer, C. Fabre, W. Vassen, A. C. Wilson, H. J. Carmichael, R. J. Ballagh, E. Hinds, E. M. Giacobino.
- Quantum Atom Optics and Single Atom Detection with Micro-Bose-Einstein Condensates.
ARC Discovery grant DP0343094 from 2003–7, funding of AUD\$1.39m.
Chief Investigators: H. Rubinsztein-Dunlop, **M. J. Davis**, C. A. Holmes, N. R. Heckenberg, G. J. Milburn. Partner Investigator: K. C. Schwab.
- Application of novel computational techniques to Bose-Einstein condensates in optical lattices.
University of Queensland Early Career Researcher Grant 2003, funding of AUD\$29 993.
Chief Investigators: **M. J. Davis** and J. F. Corney.
- Dynamical simulations of Bose fields at finite temperature, 01/5/2002–30/04/2005.
University of Queensland Postdoctoral Fellowship, funding of salary plus AUD\$17000.
Chief Investigator: **M. J. Davis**.
- Multiphoton, Electron Collisions and BEC HPC Consortium from 01/04/2002–31/03/2005.
EPSRC (UK) GR/R83118/01, funding of £10 509.
Investigators: K. T. A. Taylor, K. A. Berrington, B. H. Bransden, P. G. Burke, K. Burnett, D. Glass, R. M. Potvliege, N. S. Scott, H. R. J. Walters, J. F. McCann, N. R. Badnell, M. P. Scott, H. W. van der Hart, C. J. Noble, N. J. Kylstra, J. Rasch, **M. J. Davis**, D. J. Dundas.
- Dynamical calculations of Bose fields at finite temperature, 12/03/2001 – 11/03/2004 (suspended).
EPSRC (UK) Postdoctoral Fellowship GR/N24490/01, funding of £99 833.
Principal Investigator: **M. J. Davis**.

Publications

- “Continuous evaporation as a method of producing a cw atom laser”, J. J. Hope and **M. J. Davis**, to be submitted to Phys. Rev. Lett. (2004).
- “Pairing phase for a trapped Bose gas with attractive interactions”, **M. J. Davis** and D. A. W. Hutchinson, to be submitted to J. Phys. B (2004).
- “Solving the Gross-Pitaevskii equation for finite temperature Bose gases: deterministic chaos and aliasing”, **M. J. Davis**, to be submitted to J. Phys. B (2004).
- “The stochastic Gross-Pitaevskii equation: II”
C. W. Gardiner and **M. J. Davis**, J. Phys. B **36**, 4731 (2003).
- “Microcanonical temperature for a classical field: application to Bose-Einstein condensation”, **M. J. Davis** and S. A. Morgan, Phys. Rev. A **68**, 053615 (2003).
- “Simulations of thermal Bose fields in the classical limit”, **M. J. Davis**, S. A. Morgan and K. Burnett, Phys. Rev. A, **66**, 053618 (2002).

- “Energy dependent scattering and the Gross-Pitaevskii equation in two dimensional Bose-Einstein condensates”, M. D. Lee, S. A. Morgan, **M. J. Davis** and K. Burnett, Phys. Rev. A **65**, 022706 (2002).
- “Growth of Bose-Einstein condensates from thermal vapor”, M. Köhl, **M. J. Davis**, C. W. Gardiner, T. W. Hänsch, and T. Esslinger, Phys. Rev. Lett. **88**, 080402 (2002).
- “Growth of a Bose-Einstein condensate: A detailed comparison of theory and experiment”, **M. J. Davis** and C. W. Gardiner, J. Phys. B **35**, 733 (2002).
- “Dynamics of thermal Bose fields in the classical limit”, **M. J. Davis**, R. J. Ballagh and K. Burnett, J. Phys. B **34**, 4487 (2001).
- “Simulations of Bose fields at finite temperature”, **M. J. Davis**, S. A. Morgan and K. Burnett, Phys. Rev. Lett. **87**, 160402 (2001).
- “Interactions and entanglements in BECs”, K. Burnett, S. Choi, **M. J. Davis**, J. A. Dunningham, S. A. Morgan and M. Rusch, C. R. Acad. Sci. Paris Sér. IV, **2**, 399-406 (2001).
- “Quantum Kinetic Theory VII: The effect of vapor dynamics on condensate growth”, **M. J. Davis**, C. W. Gardiner and R. J. Ballagh, Phys. Rev. A **62**, 063608 (2000).
- “Effects of temperature upon the collapse of a Bose-Einstein condensate in a gas with attractive interactions”, **M. J. Davis**, D. A. W. Hutchinson and E. Zaremba, J. Phys. B **32**, 3993-9 (1999)
- “Quantum Kinetic Theory of Condensate Growth: Comparison of Theory and Experiment”, C. W. Gardiner, M. D. Lee, R. J. Ballagh, **M. J. Davis**, and P. Zoller, Phys. Rev. Lett. **81**, 5266-9 (1998).
- “Kinetics of Bose-Einstein Condensation in a Trap”, C. W. Gardiner, P. Zoller, R. J. Ballagh, and **M. J. Davis**, Phys. Rev. Lett. **79**, 1793-7 (1997).
- “Temporal characteristics and dynamics of gain-switched Cr:YAG lasers”, I. T. McKinnie and **M. J. Davis**, Pure Appl. Opt. **6**, 759-772 (1997).

Conference Presentations (first author)

- “What can we learn about continuous phase transitions from Bose-Einstein condensates?” (invited talk), Quantum and Classical Field Day, University of Otago, New Zealand (Feb 2004).
- “Pairing transition of the attractive Bose gas” (talk). Australasian Conference on Optics, Lasers and Spectroscopy, Melbourne, Australia (Dec 2003).
- “Simulations of trapped Bose-Einstein condensates at finite temperature” (poster). Australasian Conference on Optics, Lasers and Spectroscopy, Melbourne, Australia (Dec 2003).
- “Temperature measurement and condensate formation in degenerate Bose gases” (talk). European Conference on Bose-Einstein Condensation, San Feliu de Guixols, Spain (Sept 2003).
- “Pairing transition of the trapped Bose gas with attractive interactions” (poster). Quantum Challenges, Warsaw, Poland (Sept 2003).
- “Temperature measurement and condensate formation in degenerate Bose gases” (talk). International Workshop on Laser Physics, Hamburg, Germany (Aug 2003).
- “Non-perturbative simulations of Bose-Einstein condensates at finite temperature” (poster). International Conference On Laser Spectroscopy, Palm Cove, Australia (July 2003).
- “Pairing transition of the trapped Bose gas with attractive interactions” (poster). International Conference On Laser Spectroscopy, Palm Cove, Australia (July 2003).
- “A thermometer for Bose-Einstein condensates” (talk). Bose-Einstein Condensation and Quantum Information Workshop, Caloundra, Australia (Feb 2003).
- “Investigation of the pairing transition in a trapped Bose gas” (poster). International Conference on Atomic Physics, Boston, USA (Jul 2002).
- “Thermal dynamics of Bose-Einstein condensation” (talk). Australasian Conference on Optics, Lasers and Spectroscopy, Brisbane, Australia (Dec 2001).
- “Thermal dynamics of Bose-Einstein condensation” (poster). Conference on Bose-Einstein Condensation, San Feliu de Guixols, Spain (Sep 2001).

- “Dynamics of Bose-Einstein condensation at finite temperature” (poster). Euroconference on Atom Lasers and Interferometry, Corsica, France (July 2000).
- “Mixing and the Gross-Pitaevskii Equation” (poster). European Conference on Bose-Einstein Condensation, San Feliu de Guixols, Spain (Sep 1999).
- “Bose-Einstein Condensates with Attractive Interactions” (talk). Euroconference on Slow Collisions between Laser manipulated systems, Crete, Greece (May 1999).
- “Growth of a Bose-Einstein Condensate from Evaporative Cooling” (poster). Australasian Conference on Optics, Lasers and Spectroscopy, Christchurch, New Zealand (Dec 1998).