University of Birmingham

Dr David Smith PhD, MIMA

Lecturer in Applied Mathematics & Birmingham Science City Fellow

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About

David J. Smith is Lecturer in Applied Mathematics.

Dave's main research area is sperm motility biofluiddynamics, working alongside Centre for Human Reproductive Science, Birmingham Women's Hospital (Science Lead Dr Jackson Kirkman-Brown). This collaboration involves a network of colleagues in Birmingham (Dr Daniel Loghin, Dr David Foo), Warwick (Dr Petr Denissenko), Oxford (Dr Eamonn Gaffney) and Cambridge (Dr Vasily Kantsler, Hermes Gadelha). Dave supervises a PhD student working on computational modelling of sperm motility, in addition to a number of masters project students.

Dave is author or co-author of 20 research papers in scientific journals, including in the Internationally-leading publications Annual Review of Fluid Mechanics, Proceedings of the National Academy of Sciences, Journal of Fluid Mechanics, and Proceedings of the Royal Society of London A. He is currently funded by an independently competitive Birmingham Science City Fellowship (IT and Translational Medicine Themes), and was previously awarded an MRC Training Fellowship in Computational Biology, spending a period working in the School of Medicine. He has received other funding from STFC and Wellcome Trust.

Another central area of interest is the related problem of how cilia shape the development of the growing embryo. Dave has recently begun working with international collaborators in Portugal (Dr Susana Lopes) and Spain (Professors Julyan Cartwright & Oreste Piro, Dr Idan Tuval) on combined experimental and computational approaches to this problem. Dave also supervises a PhD student working in this area (jointly with Professor John Blake).

Dave is an enthusiastic communicator of applied mathematics and biological modelling, and provides talks to young people on this subject, including a recent presentation as part of the British Science Festival Schools programme.

As a keen multidisciplinary collaborator, Dave is a member of the University's Systems Science for Health Initiative and affiliate to Centre for Systems Biology, and works with scientists and medics ranging from cancer diagnosis to plastic surgery and trauma medicine. He also works with a group studying digestive mechanics, linking mathematics (Professor Steve Decent) and Chemical Engineering (Dr Mark Simmons, Dr Rachel Bridson), and supervises a PhD student in this area. Dave also researches fluid mechanics in spectroscopy and synthetic biology (Professor Alison Rodger, Dr Matt Hicks, Dr Tim Dafforn).

He has lectured a range of undergraduate material, from 1st year Probability and Combinatorics to masters-level Numerical Methods in Linear Algebra, Viscous Flow and Computational Methods.

School web page: **web.mat.bham.ac.uk/D.Smith (http://web.mat.bham.ac.uk/D.Smith/)**

Qualifications

- PhD Applied Mathematics, University of Birmingham, June 2006
- BA (Hons I), Mathematical Sciences, University of Oxford, July 2000

Biography

Dave qualified with a BA (Hons) from the University of Oxford in 2000. In 2001 he began studying for a PhD at the University of Birmingham, inspired by emerging links between Applied Mathematics and the School of Medicine. Dave completed his PhD in 2005 (graduating the following year), leading to several publications on the mechanics of airway defence, and the role of fluid mechanics in early embryo development.

Following his PhD, Dave received funding from the Wellcome Trust Value in People Fellowship scheme, enabling him to begin working with colleagues at Birmingham Women's Hospital and Medical School on studying how human sperm swim, from a combined mathematical and experimental perspective. This led to an MRC Training Fellowship, and subsequently a Birmingham Science City Fellowship.

In December 2009, Dave was appointed lecturer in the School of Mathematics, and combines collaborative research both within the department, cross-college and with other universities, with teaching and management responsibilities, including Master's programme development.

Teaching

- Single Honours Mathematics (G100, G103, G141)
- Mathematics Majors: Mathematics with Business Management (G1N2); Mathematics with Engineering (J920); Mathematics with Philosphy (G1V5)
- Joint Honours Mathematics: Mathematics & Computer Science (GG14); Pure Mathematics & Computer Science (GGC4); Mathematics & Sport Science (GC17); Mathematics & Music (GW13); Mathematics & Philosophy (GV15)

- Theoretical Physics and Applied Mathematics (FG31)
- Mathematics Minors: French Studies and Mathematics (GR11); German Studies and Mathematics (GR12)
- Natural Sciences (CFG0, FCG0)

Postgraduate supervision

- Lead supervisor of one PhD student
- Co-supervisor of two PhD students

I am very happy to discuss PhD project supervision in Mathematical Biology and Viscous Fluid Dynamics with highly-qualified candidates.

Research

RESEARCH THEMES

- Cell motility, particularly sperm swimming
- Modelling embryonic development
- Biological viscous fluid mechanics
- Biomedical modelling

RESEARCH ACTIVITY

Mathematical and computational modelling of biological systems, with a focus on microscale mechanical processes.

Publications

P. Denissenko, V. Kantsler, D. J. Smith and J. Kirkman-Brown (2012) Human spermatozoa migration in micro-channels reveals boundary-following navigation. Proc. Natl. Acad. Sci. USA. To appear.

A. A. Smith, T. D. Johnson, D. J. Smith and J. R. Blake (2012) Symmetry-breaking cilia-driven flow in the zebrafish embryo. J. Fluid Mech. To appear.

W. Arlt, M. Biehl, A. E. Taylor, S. Hahner, R. Libé, B. A. Hughes, P. Schneider, D. J. Smith, H. Stiekema, N. Krone, E. Porfiri, G. Opocher, J. Bertherat, F. Mantero, B. Allioli, M. Terzolo, P. Nightingale, C. H. L. Shackleton, X. Bertagna, M. Fassnacht, P. M. Stewart (2011) Urine steroidobolomics – combining mass spectrometry-based steroid profiling and machine learning for detecting adrenal malignancy. J. Clin. Endocrinol. Metab. 96, 3775-3784. **dx.doi.org/10.1210/jc.2011-1565 (http://dx.doi.org/10.1210/jc.2011-1565)**

(The Endocrine Society's International Award for Publishing Excellence in The Journal of Clinical Endocrinology & Metabolism (JCEM) in 2011)

E. L. Gilroy, M. R. Hicks, D. J. Smith and A. Rodger (2011) Viscosity of aqueous DNA solutions determined using dynamic light scattering. Analyst. 136, 4159-4163 **dx.doi.org/10.1039/c1an15475c (http://dx.doi.org/10.1039/c1an15475c)**

J. Kirkman-Brown and D. J. Smith (2011) Sperm motility: is viscosity fundamental to progress? Mol. Hum. Reprod. 17, 539-544. **dx.doi.org/10.1093/molehr/gar043 (http://dx.doi.org/10.1093/molehr/gar043)**

D. J. Smith, E. A. Gaffney, H. Shum, H. Gadelha and J. Kirkman-Brown (2011) Comment on the article Hydrodynamics of sperm cells near surfaces. Biophys. J. 100, 2318-2320. **dx.doi.org/10.1016/j.bpj.2011.03.014 (http://dx.doi.org/10.1016/j.bpj.2011.03.014)**

E. A. Gaffney, H. Gadelha, D. J. Smith, J. R. Blake and J. C. Kirkman-Brown (2011) Mammalian sperm motility: observation and theory. Annu. Rev. Fluid Mech. 43, 501–528. **dx.doi.org/10.1146/annurev-fluid-121108-145442 (http://dx.doi.org/10.1146/annurev-fluid-121108-145442)**

D. J. Smith, A. A. Smith and J. R. Blake (2011) Mathematical embryology: the fluid mechanics of nodal cilia. J. Eng. Math 70, 255-279. **dx.doi.org/10.1007/s10665-010-9383-y (http://dx.doi.org/10.1007/s10665-010-9383-y)**

H. Gadelha, E. A. Gaffney, D. J. Smith and J. C. Kirkman-Brown (2010) Non-linear instability in flagellar dynamics: A novel modulation mechanism in sperm migration? J. R. Soc. Interface 7, 1689–1697. **dx.doi.org/10.1098/rsif.2010.0136 (http://dx.doi.org/10.1098/rsif.2010.0136)**

H. Shum, E. A. Gaffney and D. J. Smith (2010) Modelling bacterial behaviour close to a no-slip plane boundary: the influence of bacterial geometry. Proc. R. Soc. Lond. A, 466, 1725-1748. **dx.doi.org/10.1098/rspa.2009.0520 (http://dx.doi.org/10.1098/rspa.2009.0520)**

D. J. Smith (2009) A boundary element regularised Stokeslet method applied to cilia and flagella-driven flow. Proc. R. Soc. Lond. A, 465, 3605-3626 **dx.doi.org/10.1098/rspa.2009.0295 (http://dx.doi.org/10.1098/rspa.2009.0295)**

D. J. Smith, E. A. Gaffney and J. R. Blake (2009) Mathematical modeling of cilia-driven transport of biological fluids. Proc. R. Soc. Lond. A, 465, 2417-2429. **http://dx.doi.org/10.1098/rspa.2009.0018 (http://dx.doi.org/10.1098/rspa.2009.0018)**

D. J. Smith and J. R. Blake (2009) Surface accumulation of spermatozoa: a fluid dynamic phenomenon. Math. Sci. 34(2), 74-87.

D. J. Smith, E. A. Gaffney, H. Gadelha, N. Kapur and J. Kirkman-Brown (2009) Bend propagation in the flagella of migrating human sperm, and its modulation by viscosity. Cell Motil. Cytoskel. 66, 220-236. **dx.doi.org/10.1002/cm.20345 (http://dx.doi.org/10.1002/cm.20345)**

D. J. Smith, E. A. Gaffney, J. R. Blake and J. C. Kirkman-Brown (2009) Human sperm accumulation near to surfaces: a simulation study. J. Fluid Mech. 621, 289-320. **doi:10.1017/S0022112008004953 (http://doi:10.1017/S0022112008004953)**

D. J. Smith, E. A. Gaffney and J. R. Blake (2008) Modelling muco-ciliary clearance. Respir. Physiol. Neurobiol. 163, 178-188. **dx.doi.org/10.1016/j.resp.2008.03.006 (http://dx.doi.org/10.1016/j.resp.2008.03.006)**

D. J. Smith, J. R. Blake and E. A. Gaffney (2008) Fluid mechanics of symmetry-breaking flow due to embryonic nodal cilia. J. Roy. Soc. Interface 5, 567-573. **dx.doi.org/10.1098/rsif.2007.1306 (http://dx.doi.org/10.1098/rsif.2007.1306)**

D. J. Smith, E. A. Gaffney and J. R. Blake (2007) Discrete cilia modelling with singularity distributions – application to the embryonic node and the airway surface liquid. B. Math. Biol. 69, 1477-1510. **dx.doi.org/10.1007/s11538-006-9172-y (http://dx.doi.org/10.1007/s11538-006-9172-y)**

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