



JAPAN SOCIETY FOR THE PROMOTION OF SCIENCE (JSPS)
UK-JSPS Symposium Scheme

Report of Symposium

1. a.) Name (in full including title): Dr Christopher James Keylock b.) Position: Prize Senior Lecturer c.) Affiliated Institution: University of Sheffield
2. a.) Name of Japanese Scientific Lead (in full including title): Professor Kouichi Nishimura b.) Position: Professor of Environmental Science c.) Affiliated Institution: University of Nagoya
3. Title of Symposium: Interscale transfers and flow topology in equilibrium and non-equilibrium turbulence
4. Period of Symposium and Location: 15 th -16 th September, 2014 at the University of Sheffield
5. Names of Invited Speakers (please put a circle next to those supported by JSPS): <ul style="list-style-type: none">○ Kouichi Nishimura○ Susumu Goto○ Kiyosi Horiuti○ Yasuhiko Sakai○ Kouji NagataShigeo KidaTakashi IshiharaChristos VassilicosKoji OhkitaniChris KeylockFranck NicolleauRobert KerrBharath GanapathisubramaniNorbert PetersClaude CambonLuminata DanailaPierre Sagaut
6. Number of participants: UK: Six invited speakers (including one Japanese based in the U.K.) plus another 15 academics and PhD students = 21 Japan: Seven invited speakers and one JSPS Fellow currently at Aston University (Takeshi Akinaga) = 8 Other: Two Germans and three French participants, four of whom were invited = 5

7. Objective of Symposium and Outline:

Significant progress was made in the middle of the twentieth century in understanding turbulence, but fundamental issues still remain because these classical ideas hold under quite restrictive assumptions. Hence, there has been an explosion of work in the last decade examining what turbulence looks like when these classical assumptions are interrogated. The objective of this symposium was to consolidate our knowledge of this rapidly growing field from various theoretical standpoints, to explore applications of these notions and to determine the consequences of imposing classical assumptions upon the problem when a flow is not in equilibrium. The symposium was divided into four sessions that considered various aspects of this problem:

The topology and scaling of interscale transfers;

The effect of the nature of flow forcing on interscale transfers;

Interscale transfers: Analysis methods and boundary-layer flows; and,

Instability and interscale transfer in varying types of flow.

8. Please provide a report of the symposium including details about impact as well as the UK-Japan collaborations resulting from this event (do not exceed space provided):

The symposium unofficially commenced on the evening of Sunday 14th September when Chris Keylock (CK), Wernher Brevis and Koji Ohkitani (Sheffield) went for a meal with the invited Japanese participants and Christos Vassilicos (Imperial College).

The meeting proper began the next day and, following a welcome from CK, and an address from the Director of JSPS London (Prof. Takeyasu), the primary business of the meeting commenced. Each session consisted of four or five 30 minute presentations with 15 minutes for questions after each talk. In each case, the context for each session was established by the first speaker, who was one of the invited Japanese colleagues. The primary themes that emerged during the meeting were the nature of energy dissipation in complex flow forcings (Nicolleau, Vassilicos, Sagaut), the flow structures associated with this, both for idealized turbulence (Goto, Kerr) and cases more relevant to real flows such as jets (Sakai), grids (Nagata) and boundary-layers (Ganapathisubramani). In addition, and illustrating the links that exist between Japanese and European research in this field, Norbert Peters presented work on ways to analyse such flow fields and Takashi Ishihara provided a case-study where Norbert's techniques were used to study the flow structures in a combustion problem. Additional talks focused on either mathematical aspects of these issues (Ohkitani), or particular flows that raise intriguing questions as to the nature of the dynamics (Kida, Nishimura, Cambon). An important aspect of two of the talks, particularly from the perspective of the environmental scientists and engineers present, was a consideration of more applied numerical modelling techniques (Horiuti, Nagata), and how they might be adapted to model complex flows in a more appropriate fashion.

The immediate impact of a meeting directed towards fundamental considerations is difficult to gauge. However, *Fluid Dynamics Research* has agreed to publish a special issue devoted to our meeting in January/February 2016 and one could envisage a significant impact arising as a consequence. This issue will be edited by CK, Kida and Peters – a clear collaboration between UK, Japanese and European speakers. In addition, CK has been invited to provide a paper on related work to the 50th anniversary edition of *Water Resources Research*, perhaps the leading water science and engineering journal for publication in 2015, and Christos Vassilicos has a paper appearing in *Annual Review of Fluid Mechanics* on concepts intimately related to the topic of the symposium. That Susumu Goto and Kouichi Nishimura stayed in the UK after the meeting highlights that collaborations are underway. Indeed, CK and Nishimura have submitted a paper to *Geophysical Research Letters* in December based on notions discussed in the symposium and the paper CK will submit to the special issue is a new collaboration with Ganapathisubramani that arose directly as a consequence of the meeting. Similarly, Brevis in Sheffield has just initiated work with Sagaut in France. That the meeting was received so positively by all involved indicates that much more is to come in the near future. It only remains to thank JSPS London and Polly Watson in particular for all their support before, during and after the meeting.