Summary
The notion that smooth, non-turbulent flows can generate complex flow trajectories via chaotic advection has widespread implications for the natural, applied and engineering sciences, ranging from micro-fluidic devices to oceanic plankton dynamics. Almost everything is known about chaotic advection in 2D, however much less is known regarding chaotic flow and transport in 3D. This is chiefly due to: (i) local breakdown of the Hamiltonian analogy, and (ii) the explosion of topological complexity in 3D. Moreover, the presence of additional phenomena such as diffusion, inertia, chemical reaction or self-propulsion alters the transport characteristics from passive to active flow. Accordingly, the transport dynamics change from a conservative to a dissipative system.

In this project, we aim to use numerical methods and theoretical results to better understand the mechanisms which control transport in both passive and active chaotic 3D flows. The successful Ph.D. candidate will have the opportunity to travel to international conferences and meetings as well as develop research networks to further their career.

Project
This Ph.D. project will use numerical methods guided by theoretical results to study the routes to 3D chaos via perturbation away from 2D states. These results will assist in classifying coherent structures in the flow and provide a connection with and extension to existing theory. This connection between the flow field and the kinematic template can be extended to non-passive particles, non-passive dynamics, non-zero Reynolds number and larger perturbations.

One of these latter scenarios will be chosen in the third year of the Ph.D. in order to directly inform real world applications, such as microfluidics, biological or geophysical flows. These results shall provide key insights into the nature of transport in 3D passive and active flows, and generate new design principles for optimized mixing, heat transfer and chemical reaction. This project will be undertaken in collaboration with Dr Daniel Lester and Dr Guy Metcalfe from CSIRO.

Student
We are seeking a student with strong mathematical and analytic skills, with a good understanding of fluid mechanics, and some experience in Computational Fluid Dynamics at the undergraduate level. Desirable is some experience with coding in C or C++ and some Supercomputing experience. Although these are not essential, a preparedness to learn is.

Remuneration
Will be at the standard indexed APA scholarship level ($23,728 p.a. in 2012) plus a potential scholarship top up of $7,000 p.a. This project will offer the successful candidate a unique opportunity to undertake fundamental research at the cutting edge of fluid mechanics, and also deliver significant impact to real problems.

CONTACT:
Professor Murray RUDMAN Dept Mechanical and Aerospace Engineering Rm 119 Building 31 Murray.Rudman@monash.edu Phone: +61 (3) 9902 4627