Chaotic Fluid Mixing

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Chaos is ubiquitous in nature, and an investigation of this amazing phenomena leads to many interesting turns and tumbles. My exploration of chaos took me to the realms of fluid mixing.

As a starting point, I constructed a model flow to mimic a simple fluid mixer. During the project, I wrote MATLAB codes to simulate and visualize the flow, in order to extract information about the mechanisms underlying the chaotic dynamics. For instance, taking Poincare sections of the flow generated by the mixer reduced the complexity of analysis, while still capturing important features of the system.

I used a novel algorithm devised by Pingel, Schmelcher and Diakonos to find the location of periodic orbits scattered throughout the domain. Having obtained the periodic orbits, I was then able to determine braids embedded in the flow, which may be used to characterise the flow topology. By appealing to the Thurston-Nielsen theory of surface diffeomorphisms, it was possible to prove rigorous lower bounds on a measure of mixing quality called the topological entropy.

The CSIRO Big Day In event presented a marvellous opportunity to interact and share ideas with other peers with common interests. It was exciting to meet accomplished scientists, view and discuss projects in a variety of areas, and it was a valuable experience presenting to a knowledgeable audience coming from diverse backgrounds.

I wish to thank AMSI/MASCOS, and CSIRO for their support of the entire project, and especially my supervisor Matt Finn, for his guidance and advice throughout the project. The project enabled me to explore mathematical research with a hands-on approach, and I would thoroughly recommend undertaking a summer research project to any other students considering research as a career path.

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