INSTABILITIES OF COUETTE FLOWS

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Couette flows are flows driven by moving boundaries. The two classical examples are planar Couette flow, in which fluid is confined between two planes moving with respect to one another, and cylindrical Couette flow (also known as Taylor-Couette flow), in which fluid is confined between two concentric, differentially rotating cylinders. In both cases exact, analytic solutions exist for the resulting flow; in the planar case it is simply $U_x = A + Bz$, in the cylindrical case it is $U_\phi = Ar + B/r$.

It might seem then that there is nothing more to say about these flows, certainly not enough to fill out an entire project. On the contrary! What makes the study of Couette flows so interesting is that, for sufficiently large driving, these solutions may become *unstable*, giving way instead to other, considerably more complicated flows. The study of these instabilities is such a fundamental part of classical fluid dynamics that it has been said that what the hydrogen atom is to quantum mechanics, the Taylor-Couette problem is to fluid mechanics.

This project will involve studying some of the more basic instabilities, as well as possible extensions such as spherical Couette flow, or driving the flow by oscillating rather than steadily moving boundaries, or the inclusion of magnetic fields, or .... Depending on the student's interests, the emphasis could also be on either analytical or computational results. Some knowledge of fluid dynamics (e.g. MATH 2620) would be advantageous.