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Control of Incompressible Flows ATUL SHARMA, BEVERLEY MCKEON, JONATHAN MORRISON, DAVID LIMEBEER, Imperial College, London — The prior art in flow control has not explicitly addressed the nonlinearity in the incompressible Navier-Stokes equations and has hitherto not produced a control strategy with a proof of closed loop stability for the nonlinear plant. We will show that because of the particular structure of the nonlinearities in the Navier-Stokes equations, relaminarisation is achievable in principle with a linear controller. The required controller synthesis problem has been solved in the control literature, subject to standard assumptions of detectability and stabilisability. We present a procedure to generate a controller that guarantees return to laminar flow in a closed or periodic domain, from any flow state and the region of guaranteed stability is not confined to a neghbourhood of small perturbations around laminar flow. The consequence of this is that fully turbulent flow or any mechanism of transition is controlled. The control of a simple 2x2 example that demonstrates the pertinent features is presented. The ongoing work of application to canonical turbulent flows and transition will be addressed with the aim of producing the associated benefits of greatly reduced skin friction.

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