Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

Dynamics of Coating Flow on Rotating Circular and Elliptical Cylinders JAMES REILLY, STEPHEN WILSON, ALEXANDER WRAY, University of Strathclyde — Coating the exterior of an object in a layer of fluid is a fundamental problem in fluid mechanics, and perhaps the most well-known example of this problem is coating a uniformly rotating horizontal circular cylinder with a thin film of fluid, which was studied in the pioneering papers by Moffatt (1977) and Pukhnachev (1977). While this problem has been well studied in recent years (and has been extended to incorporate a variety of other physical effects), there has been almost no work on non-circular cylinders and, in many practical applications (such as the coating of chocolate bars and orthopaedic implants), the substrate may not be circular. Two-dimensional flow on the surface of a rotating elliptical cylinder was first studied by Hunt (2008) and more recently by Li et al. (2017), both of which used Direct Numerical Simulation (DNS). We use lubrication theory to derive and analyse a reduced model for thin-film flow on a uniformly rotating elliptical cylinder. This approach retains the essential physics inherent in the full two-dimensional Navier-Stokes problem, but is much less computationally expensive than DNS. Our calculations show that even a small eccentricity can cause a significant difference in the behaviour compared to the perfectly circular case.

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Date submitted: 29 Jul 2020 Electronic form version 1.4