Abstract Submitted
for the DFD16 Meeting of
The American Physical Society

Three-dimensional modelling of thin liquid films over spinning disks[1] KUN ZHAO, ALEX WRAY, JUNFENG YANG, OMAR MATAR, Imperial College London — In this research the dynamics of a thin film flowing over a rapidly spinning, horizontal disk is considered. A set of non-axisymmetric evolution equations for the film thickness, radial and azimuthal flow rates are derived using a boundary-layer approximation in conjunction with the Karman-Polhausen approximation for the velocity distribution in the film. These highly nonlinear partial differential equations are then solved numerically in order to reveal the formation of two and three-dimensional large-amplitude waves that travel from the disk inlet to its periphery. The spatio-temporal profile of film thickness provides us with visualization of flow structures over the entire disk and by varying system parameters(volumetric flow rate of fluid and rotational speed of disk) different wave patterns can be observed, including spiral, concentric, smooth waves and wave break-up in exceptional conditions. Similar types of waves can be found by experimentalists in literature and CFD simulation and our results show good agreement with both experimental and CFD results. Furthermore, the semi-parabolic velocity profile assumed in our model under the waves is directly compared with CFD data in various flow regimes in order to validate our model.

[1]EPSRC UK Programme Grant EP/K003976/1

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Date submitted: 28 Jul 2016 Electronic form version 1.4