Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

A non-Reynolds lubrication model and application to droplet levitation[1] SHINTARO TAKEUCHI, JINGCHEN GU, Osaka University, AMAURY BARRAL, Tokyo University of Agriculture and Technology, Ecole polytechnique, YOSHIYUKI TAGAWA, Tokyo University of Agriculture and Technology, NRL COLLABORATION, LEVITATION COLLABORATION — An attempt for extending the applicability of the Reynolds lubrication theory is presented. By considering a larger surface-to-surface distance than that for the Reynolds lubrication theory, the effect of the non-negligible pressure gradient in the surface-normal direction is incorporated into the lubrication model. The analysis shows that the local pressure is separated into (i) a base component satisfying the Reynolds lubrication theory and (ii) an adjusting component varying in the surface-normal direction, and the second component is found to be related with the velocity of the local Couette-Poiseuille flow. The lubrication model is verified in a non-Reynolds regime of a flow between a moving curved object and stationary object, and good agreement in the pressure distributions by analytical and numerical methods is observed in both wall-normal and longitudinal directions. The lubrication model is also applied to a droplet levitation problem over a moving wall (Sawaguchi 2019) involving a μm-thin air film, and the levitation lift reproduced from the full drop profile is found to provide a more accurate and complete view of the levitation problem.

[1]This work is partly supported by Grant-in-Aid (B) Nos.16H04271 and 17H03174 and Grant-in-Aid (A) No.17H01246 of the Japan Society for the Promotion of Science (JSPS). One of the authors, A.B., acknowledges the Innovative Process & Materials led by l'X - Ecole polytechnique and the Fondation de l'Ecole polytechnique and sponsored by SAINTGOBAIN.

Shintaro Takeuchi
Osaka University

Date submitted: 01 Aug 2019 Electronic form version 1.4