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# REVISITING VISCOELASTIC FILM FLOWS ON SLIPPERY BOUNDARIES: LINEAR & NONLINEAR WAVES

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## 报告摘要


Slip phenomena are widely encountered in nature, e.g droplets sliding on solid surfaces. The Navier slip condition has been successful in modeling the slip phenomena. The original idea of Navier is that the wall frictional force is proportional to fluid velocity on the wall, i.e. $f = \lambda u_w$ , which should be balanced by the tangential shear stress $\tau_{xz}$ of the liquid. For Newtonian fluid flows, when there is no penetration, the slip condition is usually stated as

$$\lambda u_w = \mu_s \frac{\partial u_w}{\partial z} \quad (1)$$

Hence the slip length b is naturally defined as $b = \mu_s/\lambda$ ($\mu s$ is the fluid viscosity). Then, the slip condition Eq.(1) is restated as

$$\frac{u_w}{b} = \frac{\partial u_w}{\partial z} \quad (2)$$

The slip condition Eq. (2) has been experimental for Newtonian fluid flows. However, some recent studies applied it for non-Newtonian fluids, which, therefore, contradict Navier's idea because the non-Newtonian stress includes other effects other than the viscous term. Cross et al. examined the slip condition of a viscoelastic fluid flow and indicated that the concept of slip length breaks down. Instead, they invoked the stress balance idea, i.e. Eq. (1), which yielded analytical results that are in excellent agreement with experiments. It should be pointed out that $\mu s$ is complex in which models the time-delay effect caused by viscoelasticity. Therefore, a real valued slip length cannot be defined in, which implies that the rheological effect should play an important role in the slip condition. Recently, Grzelka et al. investigated a dilute viscoelastic fluid flow experimentally. However, unlike, the viscosity is real and constant (Boger fluid) and the slip length b can be defined as $b = \mu/\lambda$ ($\mu$ being the total viscosity). For steady flows, Grzelka et al. found that the elasticity does not affect the slip phenomenon, but it is important in an unsteady flow. By using the force balance idea on the wall, Grzelka et al. also obtained excellent agreement between experimental data and analytical results. These experimental findings indicated that previous studies using Eq. (2) as slip condition for viscoelastic fluid flows were incorrect, which should be revisited.


## 报告人简介

丁子敬，博士，主要从事界面非线性动力学现象、电磁流体力学、复杂流体和复杂流动转捩现象以及流体力学中的变分问题的研究。研究获得海外高层次人才引进计划、国家自然科学基金青年、面上项目、科技部重点研发计划等项目的支持。


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