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Dilute suspensions of chemically active particles in thin liquid films

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Thin liquid films are important for many microfluidic applications such as printing or coating of e.g. printable-electronics or photovoltaic cells where a evenly spread thin film of certain properties is of utmost importance as wellas so called lab-on-a-chip devices. In biophysics stable thin films play an important role in tear film on eyes or thelining of lungs. On a larger length scale stable thin films are also required in thin-film reactors or even appear ingeophysical contexts. It is well known that a thin film on a solid substrate can be unstable and droplet formationmay arise, especially for very thin films where gravity cannot dominate surface tension.The dynamics of thin liquid films and their instability has been the subject of intensive experimental, analytical,and numerical studies, the latter often based on the thin film equation. We propose a set of newly developed equationsfor the influence of chemical active colloids suspended in a thin liquid film based on the lubrication approximationas well as advection-diffusion and the Fick-Jackobs approximation. In order to do so we model the vertical andhorizontal distributions of particles within the thin liquid film. We can thereby simplify the problem to a set ofthree effective parameters. For this novel set of equations we perform a linear stability analysis (LSA) that revealssurprisingly interesting dynamics. We identify the subset of parameters for which the thin film becomes stable i.e.is not rupturing, as well as a variety of different dominating wave-modes. This allows us to control not only thestability but also the droplet form and size distribution after film rupture as well as the time the system takes froma homogeneous to a dewetted state.In order to assess the asymptotic state of the thin film, the LSA results are compared against numerical simulationsusing the Lattice Boltzmann method. This numerical tool allows us to study the dynamics of such a system moreintensely and to evaluate the equilibrium of the system.

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Sitzung Einordnung: Short Talks