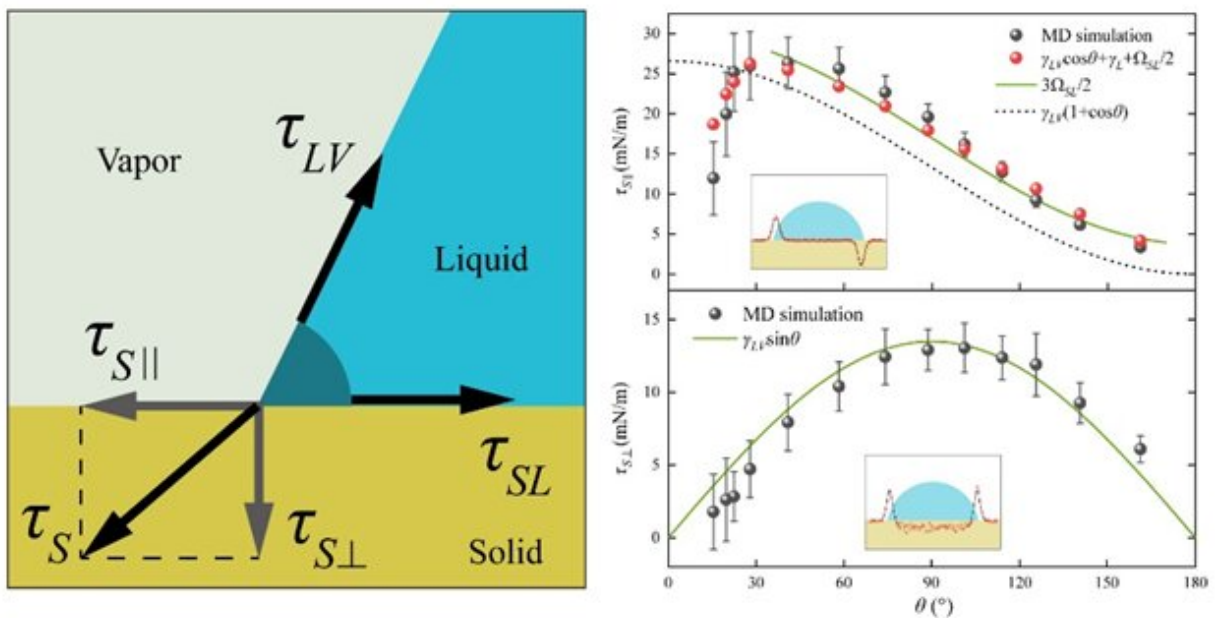


Researchers propose theoretical model to describe capillary force balance at contact line

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Theoretical model and verification of capillary force balance at the three-phase contact line. Credit: FAN Jingcun et al.

Recently, a group led by Prof. Wu Heng'an and Prof. Wang Fengchao from University of Science and Technology of China (USTC) of the Chinese Academy of Sciences (CAS) in collaboration with Prof. Joel De Coninck from University of Mons has provided a theoretical insight into

capillary forces at the contact line and validated Young's equation based on a mechanical interpretation. The research results were published online in *Physical Review Letters*.

In 1805, the British scientist Thomas Young described the quantitative relationship between [interfacial tension](#) and [contact angle](#) when studying wetting and [capillary](#) phenomena. For more than 200 years, Young's equation has become one of the most basic theories in the field of wetting. It describes the balance of three interface tensions parallel to the solid-liquid interface. However, researchers have disputed its interpretation as surface forces or surface energies and committed to prove its validity at the nanoscale.

Despite remarkable progress achieved in past years, puzzles and challenges still remain. First, the capillary [force](#) is not presented in the Young's equation. Additionally, the Young's equation cannot be verified directly in experiments. Compared with its thermodynamic derivation, there are more obstacles to put forward the mechanical interpretation of the equation.

To solve the problem, the group from USTC proposed a theoretical model to describe the capillary force at the contact line.

The researchers examined the capillary force balance on a liquid corner on the atomic scale and considered this problem with a liquid in coexistence with its vapor phase. The analysis was based on the decomposition of the solid-liquid and solid-vapor interface tensions into three terms, either of which has a clear physical meaning. The proposed model is verified by molecular dynamic simulations over a wide contact angle range. Differences in [capillary forces](#) are observed in evaporating droplets on homogeneous and decorated surfaces.

Following the same approach, they also verified Young's equation at the

nanoscale from a view point of mechanical interpretation. Microscopic details regarding the mechanism of wetting and capillarity. These results provide new physical insight into the capillary force balance at the contact line.

This study not only provides new insights for the profound understanding of many phenomena of interface wetting, but also has important scientific significance in the application fields of micro-nano fluidic chip design and the improvement of low-permeability reservoirs recovery.

More information: JingCun Fan et al, Microscopic Origin of Capillary Force Balance at Contact Line, *Physical Review Letters* (2020). [DOI: 10.1103/PhysRevLett.124.125502](https://doi.org/10.1103/PhysRevLett.124.125502)

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