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Tentative topic of the invited talk

Tiny Differences, Big Impact: How Micro-Patterns Drive Capillary Action in Swelling Fibres

Abstract of the invited talk

Capillary action in porous materials plays a vital role in both natural systems and engineered applications, particularly when a wetting fluid (such as water) displaces a non-wetting fluid (such as air). Fibrous porous substrates, including filter paper, textiles, and wipes, are increasingly being used in the development of smart sensors for detecting chemical markers in body fluids. These substrates undergo fibre swelling upon absorption of water-based fluids, which locally alters the microscopic flow pathways. This, in turn, affects the macroscopic properties of the material, such as porosity and permeability, depending on the heterogeneity of the pore structure.

In this talk, we discuss how fibre swelling introduces spatio-temporal variations in permeability and porosity during capillary suction. These variations significantly influence the dynamics of fluid imbibition. By extending Darcy's law to account for these evolving properties and linking them to the changing microstructure, we identify distinct modes of capillary suction. Depending on the pore size distribution and the swelling characteristics of the fibres, these modes can lead to either a temporary interruption or complete arrest of fluid wicking. Our findings offer insights into controlling capillary-driven flow in fibrous porous media and provide a framework for optimizing such substrates in applications like diagnostics and fluid management.