MSc project: shape of Clusters in Immiscible Two-Phase Flow in Porous Media

Alex Hansen and Santanu Sinha (alex.hansen@ntnu.no)

When two immiscible fluids flow simultaneously through a porous medium, they will self-organize into complex pattern that are describable using the language of critical phenomena. This has profound consequences for the properties of the flow.

Underlying this self-organization is a competition between the viscous forces, i.e. the usual hydrodynamic forces and the capillary forces coming from the interfacial tension between the fluids and the wetting properties between the fluids and the pore walls.

The self-organization manifests itself through how the fluids distribute themselves into clusters, which – when they move – are called ganglia. Ganglia dynamics is very rich and still rather poorly understood despite a huge effort to study these experimentally.

It is the aim of this MSc project to use a dynamic network model (i.e. a numerical model) to characterize the shape of trapped clusters and ganglia geometrically. We know, e.g. that there are length scales associated with the two types of forces involved, viscous and capillary. How do these length scales influence the shapes? To answer these questions, we will use the machinery developed in connection with percolation theory – the quintessential example of a non-thermal critical system. We will then go on to correlate the shape of the ganglia with their speed. Is there a typical shape? How does speed correlate with their size?

The findings in this project will open for later experimental studies.