PoreLab
NTNU-UiO Porous Media Laboratory

MSc project: Renormalization Group Technique for Local Load Sharing Fiber Bundle Model

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Ken Wilson won the 1982 Nobel Prize in physics for devising the renormalization group technique. Here is the essence of the idea behind it: We have a system that consists of many interacting parts. We wish to find a description of the macroscopic variables that reflects the underlying behavior of the interacting parts. The renormalization group technique consists of finding a way to replace the original system by another coarse-grained one – one that consists of fewer interacting parts, but which leads to the same behavior of the macroscopic variables. By making the coarse-graining incremental, we keep track of how the relation between the coarse-grained interacting parts and the macroscopic variables changes. We repeat the coarse graining over and over and a pattern of change emerges. This patterns tells us how the macroscopic variables behave.

The fiber bundle model consists of elastic fibers placed between two clamps. Each fiber has a maximum load it can take before it fails. The question is what the force on the clamps versus elongation of the distance between the clamps looks like. In 2018, we constructed a renormalization group procedure for this problem [1], which combining fibers pairwise into "super"-fibers.

There is a version of the fiber bundle model which is much more complex than the one I just described: The local load sharing fiber bundle. When a fiber fails in this model, the force it was carrying is given to the nearest surviving fibers. This makes the model much more complex. The aim of this project is to construct a renormalization group for this problem. This is a hard but not impossible problem.

[1] S. Pradhan, A. Hansen and P. Roy, Front. Phys. https://doi.org/10.3389/fphy.2018.00065.