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A new stability criterion for density-driven flows in the framework of a two-scale expansion

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Density-driven flows occur in deep aquifers due to temperature differences, in coastal aquifers due to salt mass differences but also in contaminant migration at refuse dumps. Its relevance therefore cuts across many applications like exploitation of geothermal energy resources, oil recoverly from aquifers and remediation of contaminated sites. A typical feature of density dependent flow problems is that they can become unstable (physically or numerically). A big challenge todate is to derive a general criterion that states the following two properties of the flow problem: 1. Is the flow physically stable or unstable? and 2. What is the computational grid resolution one needs to solve the problem without creating numerical (artificial) instabilities?.

Here, we present a new explicit criterion based on techniques from homogenization and perturbation theories. The work continues the ideas developed in [1]. The criterion includes the effects of density and viscosity differences. The validity of the criterion is carefully tested in numerical simulations for a problem defined by Schincariol in [2] varying dispersivities, mesh diameter, time step, etc over a large parameter range. The numerical simulations are performed with the software toolbox UG.

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