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A Lagrangian approach for the incompressible Navier-Stokes equations with variable density

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Here we investigate the Cauchy problem for the inhomogeneous Navier-Stokes equations in the whole n-dimensional space. Under some smallness assumption on the data, we show the existence of global-in-time unique solutions in a critical functional framework. The initial density is required to belong to the multiplier space of $\dot B^{n/p-1}_{p,1}(\R^n)$. In particular, piecewise constant initial densities are admissible data \emph {provided the jump at the interface is small enough}, and generate global unique solutions with piecewise constant densities. Using Lagrangian coordinates is the key to our results as it enables us to solve the system by means of the basic contraction mapping theorem. As a consequence, conditions for uniqueness are the same as for existence.

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