

# A new light on the interface condition between the flow in a porous medium and the free flow

**Eduard Marušić-Paloka**

Department of Mathematics, Faculty of Science, University of Zagreb,  
Bijenička cesta 30, 10000 Zagreb

e-mail address: emarusic@math.hr

**Abstract.** In this paper, we derive a new effective interface condition governing the transition between porous and free flow regions of a fluid domain via asymptotic analysis. The proposed non-standard condition represents a Darcy-type law acting across the imaginary interface, asserting that the trace of the free-flow velocity is proportional to the difference in stresses on both sides of the interface. Higher-order asymptotics reveals that the leading-order approximation corresponds to a no-slip condition, the first-order to a non-penetration condition with tangential slip, whereas the second-order approximation acknowledges the leaking across the interface. This hierarchical behavior is particularly relevant in modeling blood flow in the arteries, where the arterial wall behaves as a porous medium, allowing slow blood seepage relative to the main flow.

**Keywords.** porous medium, free flow, interface condition, macroscopic model.

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