Abstract Submitted
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Self-similarity in coupled Brinkman\Navier-Stokes flows[1] ILENIA BATTIATO, Clemson University — Coupled flows through and over porous layers occur in a variety of natural phenomena, biological systems and industrial processes. In this work we derive self-similar solutions of flows through both a porous medium and a pure fluid. Self-similar filtration velocity and hydrodynamic shear profiles are obtained by means of asymptotic analysis in the limit of infinitely small permeability, and for both laminar and turbulent regimes over the porous medium. We show that a spatial length scale, related to the porous layer thickness, naturally emerges from the limiting process and suggests a more formal definition of thin and thick porous media. The results of the analysis are applied to porous media constituted of patterned cylindrical obstacles, which can freely deflect under the shear exerted by the fluid flowing through and over the forest. A self-similar solution for the bending profile of the elastic cylindrical obstacles is obtained as intermediate asymptotic, and applied to carbon nanotube (CNT) forests' response to aerodynamic stresses. This self-similar solution is successfully used to estimate flexural rigidity of CNTs by linear fit of appropriately rescaled maximum deflection and average velocity measurements.

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