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Multiscale modeling of brain blow flow

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Cardiovascular pathologies, such as brain aneurysms, are affected by the global blood circulation as well as by the local microrheology. Hence, developing computational models for such cases requires the coupling of disparate spatial and temporal scales often governed by diverse mathematical descriptions, e.g., by partial differential equations (continuum, 3D or 1D) and ordinary differential equations for discrete particles (atomistic). However, interfacing atomistic-based with continuum-based domain discretizations is a challenging problem that requires both mathematical and computational advances. We will present a physical model of the brain vasculature consisting at the macro level of all major arteries (about 200 down to 0.5 mm), at the mesoscale the fractal arteriolar tree (more than 10 millions down to 20 nm) and at the microscale the capillary bed. Correspondingly, we employ three different methods to model the total brain vasculature by developing proper interface conditions at each level. We will present examples from aneurysms and other hematological diseases, where red blood cell rheology is modeled explicitly.