Pore scale modelling in porous media: diffusion-transport coupled to 3D Stokes equation at high resolution

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ABSTRACT

In this work, we present a particle based method for diffusion-transport coupled to Stokes equation at pore scale in porous media. This hybrid grid-particle method is used to manage transport phenomena, and ensures linear algorithmic complexity [3]. This complexity has been proved to be held when using adaptive multigrid in time and space [4]. Two challenging tasks are involved in this configuration. First, we need an efficient stokes solver for microfluidic computation over complex geometries in order to conserve linear complexity. In our case, this computation is made over a grid at high resolution. We use a vortex sheet method which inputs a rotational component at the fluid-solid interface. This method is close to the penalization technique [1,2], as it only requires to know the characteristic function defining the solid part: there is no need to mesh directly the fluid-solid boundary. This optimized method allows us to compute velocity and pressure fields on a 257^3 cartesian grid. On the second hand, the use of particles for diffusion and transport requires interpolation tools to make grid and particles communicate (as particles can move anywhere in the domain, and are not supposed to coincide with grid points). One of the challenges is to transmit informations without loosing positivity (for example, density, viscosity or chemicals concentration) and mass conservation [5]. Some results and perspectives in the frame of digital rock physics and geologic porous media will be presented.

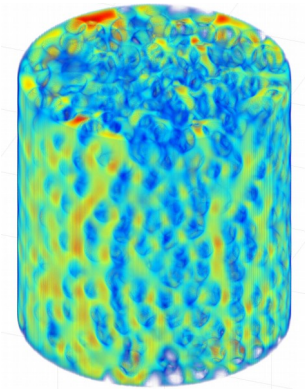

Figure 1 : Velocity field over beads network

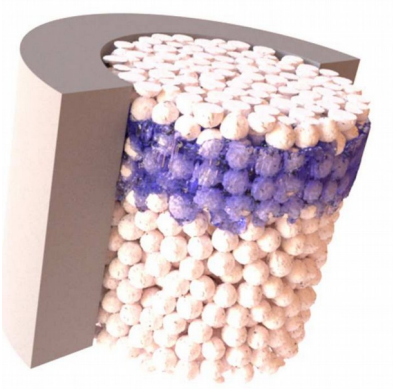

Figure 2 : Particles transport over beads network

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