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Buoyancy Effects on Intrathecal Drug Dispersion[1] JENNA J LAWRENCE, University of California San Diego, WILFRIED COENEN, Universidad Carlos III de Madrid, ANTONIO L SANCHEZ, JUAN C LASHERAS, University of California San Diego — This study investigates the transport of drugs delivered by direct injection into the cerebrospinal fluid (CSF) in the spinal subarachnoid space. CSF motion is caused by pressure oscillations induced by the cardiac and respiratory cycles. The resulting oscillatory velocity is known to have a time-averaged Lagrangian component, the sum of steady-streaming and Stokes drift velocities, which largely determines the drug dispersion rate along the canal. Although the relative density differences between the drug and the CSF are typically very small–on the order of 1/1000 for drugs diluted with water and 1/100 for drugs diluted with dextrose–the associated Richardson numbers are shown to be of order unity, so that the resulting buoyancy-induced velocities are comparable to those of steady streaming. As a consequence, the slow time-averaged Lagrangian motion of the CSF is strongly coupled with the transport of the drug, resulting in a slowly evolving steady-streaming problem which can be treated with two-time scale methods. The theoretical analysis produces a nonlinear transport equation that is solved numerically for several Richardson numbers, representing the dispersion of drugs that are slightly more dense or slightly less dense than the CSF.

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