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Taylor-Aris dispersion in time-dependent laminar channel flows
SØREN VEDEL, HENRIK BRUUS, Department of Micro- and Nanotechnology, Technical University of Denmark — The effective axial diffusion of solute concentrations advected in channel flows is known as Taylor-Aris dispersion [1,2]. Due to the no-slip condition, particles near the walls are displaced less than those close to the channel center axis, leading to concentration gradient perpendicular to the axis and an enhanced axial diffusivity. In many applications the velocity field is unsteady, but concentration dispersion in such time-dependent flows is largely unexplored, except for transient dispersion of an initial concentration profile in a steady flow [3], and dispersion in a velocity field with one harmonically oscillating component superimposed on a steady component [4]. We present a mathematical theory for Taylor-Aris dispersion in a straight channel with an arbitrary time- dependent flow, based on Fourier expansion of the velocity field, valid for all times and all values of the Péclet number. The theory is applied to different time-dependent flows in channels of different cross sections, and we discuss the new phenomena arising by adding an increasing number of higher harmonics.
[1] Taylor, *Proc. Roy. Soc. Lond. A* **219**, 186 (1953)
[2] Aris, *Proc. Roy. Soc. Lond. A* **235**, 67 (1956)
[3] Barton, *J. Fluid Mech.* **126**, 205 (1983)
[4] Mukherjee and Mazumder, *Acta Mech.* **74**, 107 (1988)

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