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**Swimming of Paramecium in confined channels**

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Many living organisms in nature have developed a few different swimming modes, presumably derived from hydrodynamic advantage. Paramecium is a ciliated protozoan covered by thousands of cilia with a few nanometers in diameter and tens of micro-meters in length and is able to exhibit both ballistic and meandering motions. First, we characterize ballistic swimming behaviors of ciliated microorganisms in glass capillaries of different diameters and explain the trajectories they trace out.We develop a theoretical model of an undulating sheet with a pressure gradient and discuss how it affects the swimming speed. Secondly, investigation into meandering swimmings within rectangular PDMS channels of dimension smaller than Paramecium length. We find that Paramecium executes a body-bend (an elastic buckling) using the cilia while it meanders. By considering an elastic beam model, we estimate and show the universal profile of forces it exerts on the walls. Finally, we discuss a few other locomotion of Paramecium in other extreme environments like gel.