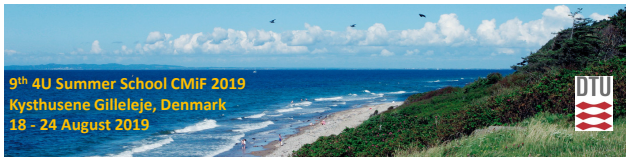

Active Matter

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Active materials such as bacteria, molecular motors and self-propelled colloids are Nature's engines. They extract energy from their surroundings at a single particle level and use this to do work. Active matter is becoming an increasingly popular area of research because it provides a testing ground for the ideas of non-equilibrium statistical physics, because of its relevance to the collective behaviour of living creatures, from cells to starlings, and because of its potential in designing nanomachines.

I will concentrate on describing dense active matter. This shows mesoscale, or active, turbulence, the emergence of chaotic flow structures characterised by high vorticity and motile topological defects. Active turbulence has now been observed in dense suspensions of microswimmers, in bacterial colonies, in eukaryotic cell layers and in mixtures of microtubules and molecular motors, and it is of interest to compare the different physical systems. I shall discuss what happens when active matter is confined in rings or channels, and whether this will help to harness its energy. Then I will talk about 'topology in biology': are concepts from active matter relevant to the behaviour of biological systems?

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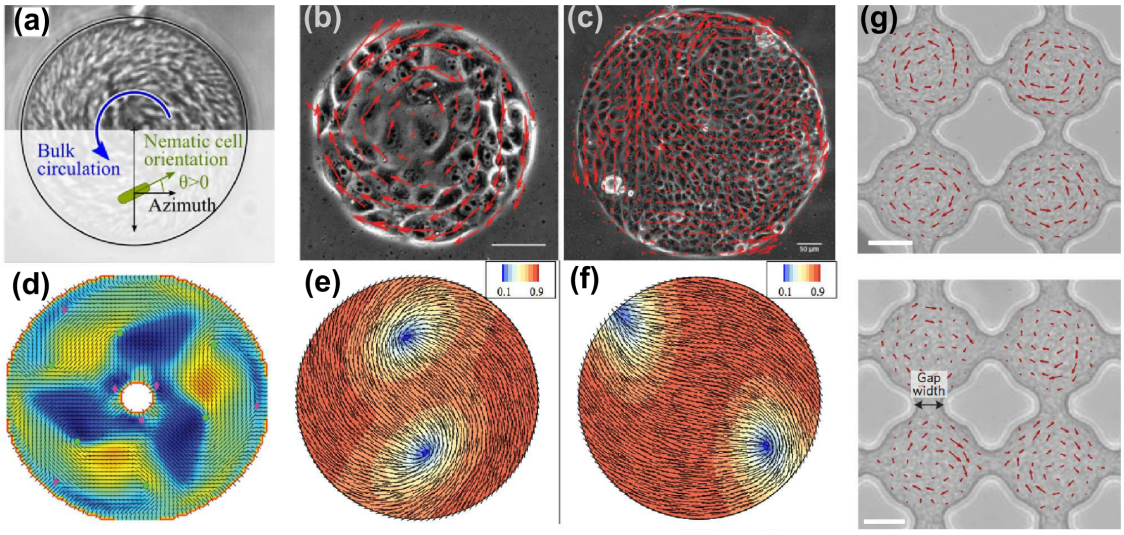

Figure 1: Flow and topological defect patterns in circular confinement. (a) Circulation of confined B. subtilis bacterial suspension (Phys. Rev. Lett., 110:268102, 2013). (b) Uniform circulation and (c) active turbulence of (Madin-Darby Canine Kidney) MDCK cells within different circle sizes (Integr. Biol., 5:1026, 2013). (d) Active nematic simulations of flow within an annulus. The colourmap represents the vorticity field. Circles (green) and diamonds (magenta) mark +1/2 and -1/2 topological defects, respectively (Soft Matter, 13:3853, 2017). (e),(f) Time evolution of director patterns and defect trajectories in simulations of active nematics confined in a circle (Phys. Rev. Fluids, 2:093302, 2017) (g) Counter-rotating and co-rotating circulations of B. subtilis bacteria within interconnected circular confinements (New J. Phys., 18:075002, 2016).