Making it big : how characean algae use cytoplasmic streaming to enhance transport in giant cells

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PROPOSITIONS

1. In the giant cells of characean algae, helicity and mixing appear intertwined. The twist of the helical bands results in a circulation through the centre of the cell that is absent in a flow with non-helical topology.

This thesis, chapter 3

2. The benefits that can be derived from this circulation are maximised at the point in development where the helical twist of the cell is greatest, which coincides roughly with the point of maximal cell expansion.

This thesis, chapter 4

3. Because the magnitude of flux enhancements depend critically on the Péclet number, mixing improvements will only be significant for very slowly diffusing structures, such as larger proteins.

This thesis, chapter 4

4. Our measurements based on injection of fluorescent tracers provide an promising starting point for further investigations into cytoplasmic rheology and the collective action of myosin on the cytoplasm.

This thesis, chapter 5

5. The secondary circulation observed in Characean internodes is topologically similar to that observed in the microfluidic herringbone mixer. Therefore, the analysis presented in chapter 4 could also inform mixing properties of this microfluidic system.

Stroock et al. (2002)

6. The flow in characean internodes, and that around the colonial algae Volvox, are both examples of what could be called "Life at high Péclet numbers". The difference in scaling of boundary layers is rooted in the topological differences between the stagnation points.

Short et al. (2006)

7. Given the implication of pH bands in enhancing photosynthesis, a key function of cytoplasmic streaming could be to help maintain these bands and thereby aid carbon uptake from the environment.

Babourina et al. (2004), Mcconnaughey (1998)
Dorn and Weisenseel (1984)

8. The features of the simple fluid model known as *Dissipative Particle Dynamics* prove remarkably rich. Not only does it capture the transition to turbulence in compressible fluids, it can also be extended study drag reduction in viscoelastic fluids.

van de Meent et al. (2008), Sultan et al. (2010)