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Implications of Cytoplasmic Streaming for Intracellular Transport and Micro-scale Mixing JAN-WILLEM VAN DE MEENT, IDAN TUVAL, DAMTP, University of Cambridge, WIM VAN SAARLOOS, Lorentz Institute, Leiden University, RAY GOLDSTEIN, DAMTP, University of Cambridge — Found in many large eukaryotic cells, particularly in plants, cytoplasmic streaming is the circulation of their contents driven by fluid entrainment from organelles carried by molecular motors at the cell periphery. Streaming has frequently been conjectured to aid in transport and mixing of molecular species in the cytoplasm, and, by implication, in cellular homeostasis, yet no mechanism quantifying this enhancement has been demonstrated. We solve the flow and its associated advection-diffusion equations for the archetypal 'rotational streaming' found in Characean algae, where the cytoplasm streams up and down along helical bands on the surface of cylindrical *internodal* cells. We find that the spiralling flow induces a secondary circulation, reminiscent of Dean vortices found at higher Reynolds numbers, which leads to the formation of a high-flux boundary layer allowing faster uptake and response to changes in external concentration. This effect constitutes a novel example of how high Peclét number flows can facilitate diffusive transport and mixing at the micro-scale.

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