Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

Optimal transport of a drop I – internally actuated case[1] SURAJ SHANKAR, VIDYA RAJU, LAKSHMINARAYANAN MAHADEVAN, Harvard University — The Monge-Kantorovich problem of optimal mass transport is an old one, with deep connections to optimization theory and inviscid hydrodynamics and a range of applications to image analysis, machine learning etc. But can one use it or its variants to also construct policies to optimally transport real matter that obey complex physical dynamics? As a first example, we consider the motion of a drop of an active suspension by dynamically controlling the spatial profile of its internal active stress. Within the lubrication approximation, we use optimal control theory to pose and solve the problem of transporting such a drop with minimal expenditure of mechanical work. By parametrizing the position, size and shape of the drop, we uncover a general trade-off that bounds the maximum achievable displacement of the drop by its size, along with bistability in the optimal policies, determined using Pontryagin's Maximum Principle. Our analysis marries hydrodynamics and optimal control in a tractable and interpretable framework, paving the way forward for the spatio-temporal manipulation of active media.

[1]SS acknowledges support from the Harvard Society of Fellows.

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Date submitted: 10 Aug 2020 Electronic form version 1.4