Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

Rotational and translational drag on a sphere in an active fluid[1]

WAN LUO, Center for Fluid Mechanics, School of Engineering, Brown University, Providence, Rhode Island 02912, ROBERT PELCOVITS, Department of Physics, Brown University, Providence, Rhode Island 02912, THOMAS POWERS, Center for Fluid Mechanics, School of Engineering, Brown University, Providence, Rhode Island 02912 — We theoretically and computationally study the rotational and translational drag on a sphere in an active fluid. The active fluid is described by a hydrodynamic theory of active nematics in the isotropic phase. We solve the linearized steady state equations in three dimensions for the velocity and order parameter fields and find the torque on a rotating sphere and drag on a translating sphere. Working in the regime where the active fluid is stable, we find that for prolate active particles, activity helps the sphere to rotate or translate in extensile fluids but resists its rotation and translation in contractile fluids. For oblate active particles, activity leads to a resistive drag on a rotating or translating sphere in extensile fluids but helps the rotation and translation of a sphere in contractile fluids. When the size of the sphere is comparable to the correlation length, there is a non-Newtonian dependence of the effective shear viscosity on the radius of the sphere for both rotation and translation. Additionally, we see this effect for both the contractile and extensile cases.

[1]National Science Foundation Grant No. CBET-1437195 and Grant No. MRSEC-1420382

Wan Luo
Center for Fluid Mechanics, School of Engineering, Brown University, Providence, Rhode Island 02912

Date submitted: 31 Jul 2020 Electronic form version 1.4