Elasto-hydrodynamics of the gliding motion of myxobacteria

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College Station, TX 77843, KRANTHI MANDADAPU, Department of Chemical
and Biomolecular Engineering, UC Berkeley, CA 94720 — The mysterious "A-
motility of myxobacteria has long been a mystery, since no appendage is involved in
its motion known as gliding. Several studies in molecular microbiology have identi-
fied a number of structural features of this motion: 1) A trail of a nanometer slime
film secreted underneath the bacteria 2) the shape of this rod-like bacteria, and 3)
the soft substrate over which the gliding motion occurs. Using the above mentioned
features, we present a mechanism for the gliding of myxobacteria. In our theory, we
consider a thin slime film bounded on the top by a bacterial membrane displaying
a traveling wave and on the bottom by a deformable substrate. Enforcing the lift
force on the bacteria to vanish, we obtain the velocity of bacteria to be dependent
on the so-called softness parameter. Using the celebrated lubrication approximation
for the slime coupled to linear elastic theory for the substrate, we show that the
velocity of bacteria is proportional to the shear modulus in the limit of very stiff
substrates. More surprisingly, we find that the velocity is independent of substrate
stiffness for softer substrates. Our results are validated with experimental measures
of the gliding speed of M. xanthus cells on agar pads at various concentrations.

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