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The lawnmower: an artificial protein-based burnt-bridge molecular motor

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Molecular motors are essential for powering directional motion at the cellular level, including transport and sorting of cargo, cell locomotion and division, and remodelling of the extracellular environment. Such molecular motors are made out of proteins whose directed motion is coupled to the consumption of chemical free energy. Inspired by such biological machines, significant strides have been made to design and implement synthetic devices capable of directed motion on the nanoscale and the microscale. While these have been impressive achievements, thus far, directed motility of a synthetic protein-based motor has not been demonstrated. In this talk I will present our synthesis and characterization of a novel protein-based microscale motor we dub the lawnmower. It is comprised of a spherical hub decorated with trypsin enzymes; its “burnt-bridge” motion is directed by cleavage of a peptide lawn, which promotes motion towards fresh substrate. We characterize the dynamics of the lawnmower on a 2D surface and in a 1D confined geometry; we characterize its dynamics via its mean-squared displacement and speeds. The lawnmower is the first example of an autonomous protein-based synthetic motor purpose-built using nonmotor protein components. (Current paper draft: arXiv:2109.10293v2)

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