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Behavior of the Flagellar Rotary Motor Near Zero Load

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Many bacteria are propelled by the rotation of helical flagellar filaments that extend out into the external medium. Each filament is driven at its base by a reversible rotary motor embedded in the cell wall. The motor runs far from thermal equilibrium near zero load, so studies of the motor in this regime allow one to gain more insights into the kinetics of motor function. Previously, the load regime was limited to high to medium loads. Here, we describe an assay that allows systematic study of the motor near zero load [1]. Sixty-nanometer-diameter gold spheres were attached to hooks of cells lacking flagellar filaments, and light scattered from a sphere was monitored at the image plane of a microscope through a small pinhole. Resurrection experiments were carried out near zero load [2]. Paralyzed motors of cells carrying a motA point mutation were resurrected at 23 $^\circ$C by expression of wild-type MotA, and speeds jumped from zero to a maximum value of about 300 Hz in one step. The temperature and solvent-isotope dependence of the speed near zero load were also studied and showed a high activation enthalpy comparable to that observed previously in electrorotation experiments. The assay has been modified so that both the speed and the direction of rotation can be monitored near zero load. Switching properties of the flagellar motor near zero load were investigated and showed a near linear dependence of the switching rate on motor torque [3].

[1]. J. Yuan and H.C. Berg (2009) Following the behavior of the flagellar rotary motor near zero load. *Exp. Mech.* DOI: 10.1007/s11340-009-9290-1.

[2]. J. Yuan and H.C. Berg (2008) Resurrection of the flagellar rotary motor near zero load. *Proc. Natl. Acad. Sci. USA* **105**:1182-1185.

[3]. J. Yuan, K.A. Fahrner and H.C. Berg (2009) Switching of the bacterial flagellar motor near zero load. *J. Mol. Biol.* **390**:394-400.