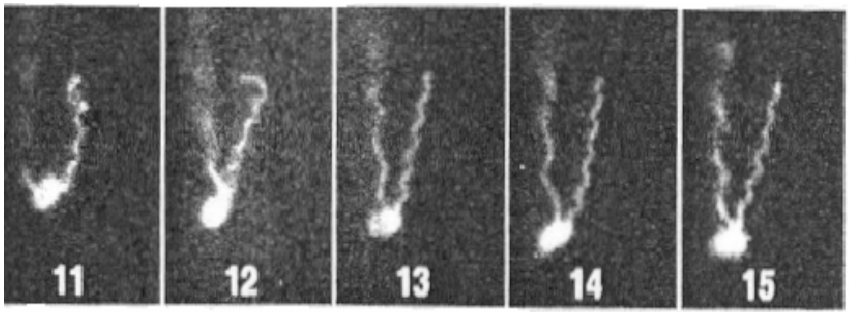
Theory for Polymorphism of Bacterial Flagella

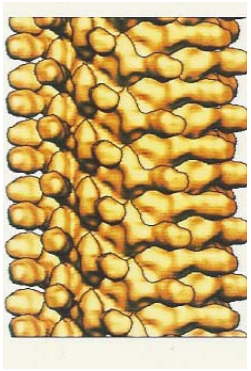
Srikanth V. Srigiriraju and Thomas R. Powers



10 μm

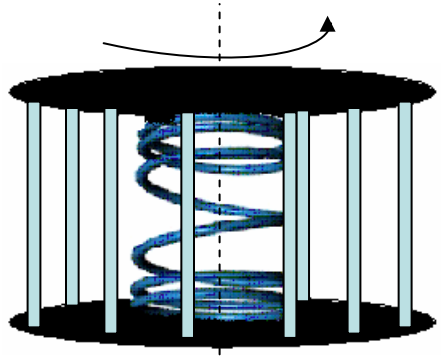
Snapshots of a swimming E. coli;
Turner, Ryu, Berg, 2000

E. Coli uses rotating helical flagella to swim. The bacteria change swimming direction by changing the rotation sense of their flagella, which in turn leads to hydrodynamic stresses which cause the flagella to change handedness (figure to left). Incorporating the mechanics of the microscopic protein subunits, we developed a new theory for these phase transitions. The model describes a short section of the flagella as a set of disks connected by springs (figure, lower left). The outer springs are bistable; the central spring is helical. By changing the central spring rest length and effective spring stiffness, we derive the phase diagram shown below. The phase diagram predicts when helices are stable as a function of the parameters, and also allows the calculation of a new curvature-twist relation which can be directly compared with experiments.



10 nm

Section of flagellum;
Namba & Vonderviszt 1997



10 nm

Model element for flagellum