

## Theory of Polymorphism in Bacterial Flagella

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Escherichia coli and Salmonella swim using several flagella, each of which consists of a rotary motor, a universal joint known as the hook, and a helical filament which acts a propeller. The filament is normally left-handed in the absence of external stress, but undergoes mechanical phase transitions to other helical states (polymorphs) in response to external torque. The filament is made of identical flagellin protein subunits which are organized into eleven protofilaments which wind around the filament. We develop an effective theory in which the flagellin subunits and their connections along the protofilaments are modeled with a double-well potential. A helical spring represents the other connections of the subunits, and introduces a twist-stretch coupling and an element of frustration in our model. We solve for the ground states and the phase diagram for filament shapes.

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