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Run and Tumble Behavior of E. Coli

E. coli is a multi-flagellated bacterium with a prolate spheroidally-shaped body and several left-handed helical flagella (typically between 2 and 5). The helical flagella are rotated by a motor, enabling the bacterium to propel forward. *E. coli* generally has two modes of swimming: (i) 'run' with a straight swimming direction, and (ii) 'tumble' during which the bacterium can change its swimming direction [1-3]. During the run stage, all flagella rotate anticlockwise, such that they bundle into a single propeller. During the tumble stage, one or more flagella switch to the clockwise rotation, so that they leave the bundle and facilitate *E. coli* to change its swimming direction. In our work, we investigate how different *E. coli* properties, including body and flagella geometry, flagella stiffness and the strength of actuation, govern the run-and-tumble behavior of these bacteria. We establish a realistic *E. coli* model (see Fig. 1) and validate it using available experimental observations [1-3]. The model properly captures the running speed of *E. coli*, rotational frequency of the head and flagella, tumbling time and angle in comparison to experimental measurements [1-5]. Furthermore, our simulations show that the stiffness of a hook (the short part of a flagellum which connects it directly to the motor) plays an important role in the run-and-tumble behavior, which has also been suggested in experimental studies [6-7]. This detailed model of *E. coli* helps us better understand its swimming behavior, and allows the exploration of *E. coli* locomotion in more complex realistic environments such as with walls [8].

References

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