HIGH-SPEED DYNAMICS OF HELICAL BACTERIA TRAPPED IN A LIGHT TUBE

Matthias Koch and Alexander Rohrbach
Lab for Bio- and Nano-Photonics, University of Freiburg,
Georges-Koehler-Allee 102, 79110 Freiburg, Germany

E-mail: matthias.koch@imtek.de, rohrbach@imtek.de

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Subsequent tracking of individual points from an ensemble allows imaging of the ensemble by circumventing the conventional resolution limit of optical microscopy. Scanning back focal plane interferometry enables us to image the high dynamics of ultra-small cells.

The helical bacterium spiroplasma melliferum is a wall-less bacterium, where genome reduction has left these bacteria with a minimal set of genes - sufficient for independent life and self-reproduction. As a consequence they have an extreme structural simplicity and are the smallest cells in size (~200nm thin, 3-5µm long). However, they infect various plants and insects and thereby do tremendous harm to agriculture industry. Their motility, defined by helicity changes, kinking and propelling is very complex, and enables propagation in complex environments.

However, it is unclear how this ~500 gene machine works. Which molecular motors and which filament proteins cooperate at which forces on which time scales ? What are the energetics of this apparatus and how do they change during external disturbances.

We try to answer these questions by optically trapping the whole bacterium in a light tube, which consists of a scanning line optical trap. Although propelling and kinking, the bacterium remains in the focal plane and can thereby be observed with video microscopy. In addition, trapping light scattered at the slopes of the helix gives precise information about its dynamics, which is analyzed and modeled with Fourier-techniques. Until recently scan rates and image acquisition has been possible with several 100 Hz, now AODs allow scan and acquisition rates at more than 10 kHz. This allows completely new insights into the inner life of these cells.

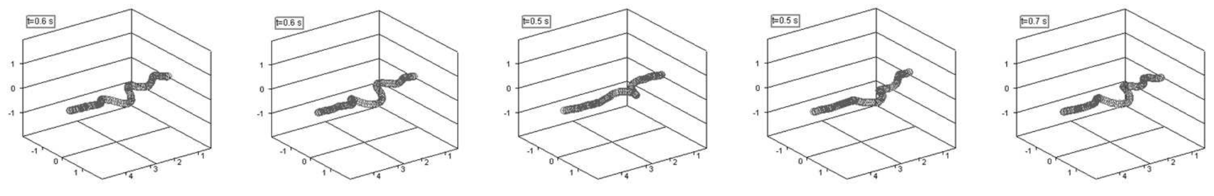

Figure: An image sequence of a 200nm thin helical bacterium obtained by scanning back focal plane interferometry recorded at 400 Hz.