**High-speed holographic microscopy**

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**Abstract:**
Microscopic swimming organisms often move in three dimensions, but camera sensors are two-dimensional. We use ideas from classical optics and signal processing to design new image processing algorithms, to extract more information from digital images. I will present several examples from recent work in holographic imaging of microswimmers (including eukaryotic flagella, archaeal cells and bacteria cells) that use custom image-processing algorithms to obtain 3D data on microorganism swimming trajectory and shape. The ability to follow hundreds or thousands of individual swimming bacteria in volumes of up to $1\text{mm}^3$ allows us to address questions on the statistics and variability of cells’ swimming trajectories.

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*Above:* Swimming paths of *E. coli* bacteria, coloured to indicate different cells. Durations range from around 10-30 seconds, and the squares on the ground represent a distance of 50 μm.