**Title: Spectral, spatial and time resolved imaging of intact unicellular photosynthetic organisms**

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Cyanobacteria and purple bacteria are responsible for over half of photosynthetic output occurring on Earth and understanding the mechanisms of solar energy trapping, and the organisation of photosystem protein complexes in cellular membranes, has implications for both energy and food security.

Currently imaging of intracellular photosynthetic membranes is performed on purified material using atomic force microscopy (AFM) and electron microscopy (EM). The next step is to complement these studies with whole-cell fluorescence imaging, exploiting the native fluorescence of the photosystem complexes, as well as the acquired fluorescence of other cellular components labelled with GFP and other such proteins. Spectral and lifetime imaging, and three-dimensional structured illumination microscopy (3D-SIM) allow both spectral and spatial discrimination in living cells, providing the native information not achievable by AFM and EM, and at higher resolutions than standard confocal imaging.

Here we localise key fluorescently labelled photosynthetic complexes in the model cyanobacterium *Synechocystis* PCC 6803 and the purple phototrophic bacterium *Rhodobacter sphaeroides* with the super-resolving 3D-SIM technique that allows imaging at sub-diffraction resolutions. In addition, we apply spectral and lifetime imaging to gain an understanding of the distribution of complexes involved in photosynthesis under native conditions, allowing a greater appreciation of how these organisms use light as an energy source.