Active bio-photonic films in natural and biomimetic systems

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Summary: The project aims to exploit soft active matter to produce bio-photonic films that can find application as living optical sensor that change their response if expose to specific environmental conditions.

Project Description
Different bacteria colonies can develop in thin photonic films due to self-assembly processes that are still poorly understood [1]. Their complex motion is one of the numerous examples of “active matter” that includes self-propelled colloidal particles that are either inorganic (such as H₂O₂ hydrolysing colloids) or bio-sourced (as ATP-consuming actin and microtubule filaments) [2]. These energy dissipative systems lead to a variety of complex hierarchical patterning at different length scale, from few nanometres to the millimetre scale.

This length scale is comparable with visible light wavelength making these bacterial, in the case of Flavobacterium johnsoniae, acting as Bragg mirror for specific colours [3]. We aim to understand this self-organising system and eventually exploit it to design totally biological, sustainably coloured films, avoiding often-toxic dyes. These structures have the potential to be used as fully biocompatible living optical sensors that indicate trough colour variation changes in the environment.

Project Description
Within this project the student will study the effect of depositon of bacteria in Agar on their self-assembly behaviour and eventual optical response. As the living bacteria move and spontaneously evolve slowly (few minutes), I will characterise the optical response of the hierarchical structure in which they organise during the growth depending on different growth conditions (temperature, substrates, external stimuli such as light, external fields).

The optical characterisation includes microscopy and angular resolved light spectroscopy.

References: