# DPhil Project in Condensed Matter Physics

# Molecular Nanorings as Bio-Mimetic Light-Harvesters

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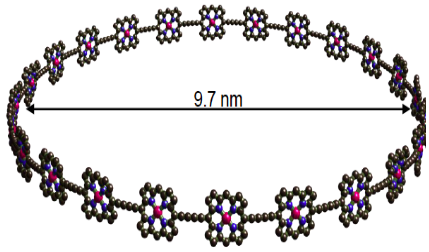


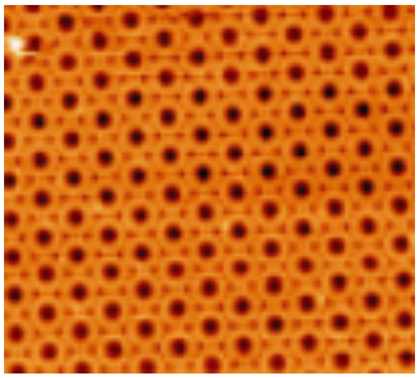

Efficient light harvesting lies at the core of our efforts to utilize sun light for environmentally sustainable power generation. Natural evolution very early on solved the problem of how to capture light and use it to initiate the primary electron transfer reactions of photosynthesis in a surprisingly efficient manner. Synthetic molecules that mimic such biological light-harvesting complexes should allow high-efficiency conversion of solar light into energy in the form of electrical current, rather than biological mass. For natural scientists striving to create new molecular light-harvesting materials for applications such as photovoltaics, the designs nature has invented for us are fantastic templates to learn from. This project will explore energy transfer within and between large porphyrin nanorings that directly mimic natural light-harvesting chlorophyl ring assemblies and which we have recently shown to support highly delocalized electronic states [1-3]. By creating interfaces with electron-accepting molecules we aim to create light-harvesting layers that rival their natural counterparts in photon conversion efficiency. For example, we will investigate two-dimensional assemblies porphyrin nanorings that are found to form with amazing regularity on certain surfaces (see Figure). These resemble the biological assemblies found on membranes of purple light-harvesting bacteria for which inter-ring energy transfer has been found to be highly efficient. To understand whether synthetic systems can also be similarly effective light-harvesters, experiments will determine the dynamics of excitation transfer between porphyrin nanorings and modelling will assess whether e.g. quantum mechanical effects such as electronic coherences or delocalization aids energy transfer. In addition charge transfer at interfaces between porphyrin nanoring layers and small-molecular layers with suitable energy level offsets will be explored with a view towards creating full charge-separating structures to be embedded in solar cell devices.

[1] *Parkinson et al.,* J. Am. Chem. Soc. **136**, 8217 (2014).
[2] *Parkinson et al.,* J. Phys. Chem. Lett. **5**, 4356 (2014).
[3] *Yong et al.,* Chemical Science **6**, 181. (2015).

**See also:** https://www-herz.physics.ox.ac.uk/research.html