Spatial extent of exciton states in DNA and RNA revealed by circular dichroism

L. Munksgaard Nielsen, S. Vrønning Hoffmann, S. Brøndsted Nielsen

Department of Physics and Astronomy, Aarhus University, DENMARK
lisbeth@phys.au.dk

In biology the interplay between multiple light-absorbers gives rise to complex quantum effects such as superposition states that are of extreme importance for life, both for harvesting solar energy and likely protecting nucleic acids from radiation damage. Still the characteristics of these states and their quantum dynamics are a much debated issue. While the electronic properties of single bases are fairly well understood, the situation for strands is complicated by the fact that stacked bases electronically couple when photoexcited. These newly arising states are denoted exciton states and are simply linear combinations of localised wavefunctions that involve $N - 1$ ground-state bases and one base in its excited state. There is disagreement over the number of bases, N, that coherently couple, *i.e.*, the spatial extent of the exciton, and how electronic deexcitation back to the ground state occurs. In this work, we focus on the bright states initially populated and discuss their spatial extent on information obtained from systematic absorption and synchrotron radiation circular dichroism experiments on single strands of different lengths in solution. The experiments were conducted at the CD1 beam line at the ASTRID storage ring facility in Aarhus, Denmark.

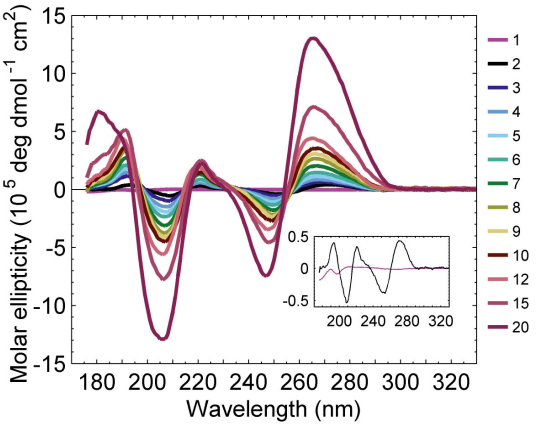

Fig. 1: Circular dichroism spectra of short RNA single strands of adenine. The strand lengths given by the number of bases, n, in a strand are indicated in the legend.

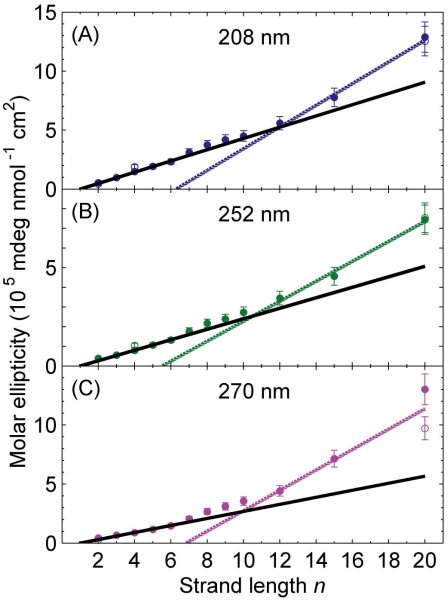

Fig. 2: The magnitude of the CD bands at the indicated wavelengths. The deviation from the solid black line reveals that the spatial extent of the excited excitons is up to about ten bases in RNA adenine single stranded.

References:
[1] L. Munksgaard Nielsen, S. Vrønning Hoffmann, S. Brøndsted Nielsen, Photochem. Photobiol. Sci., DOI: 10.1039/c3pp25438k (2013).
[2] L. Munksgaard Nielsen, S. Vrønning Hoffmann, S. Brøndsted Nielsen, Chem. Commun. **48**, 10425 (2012)