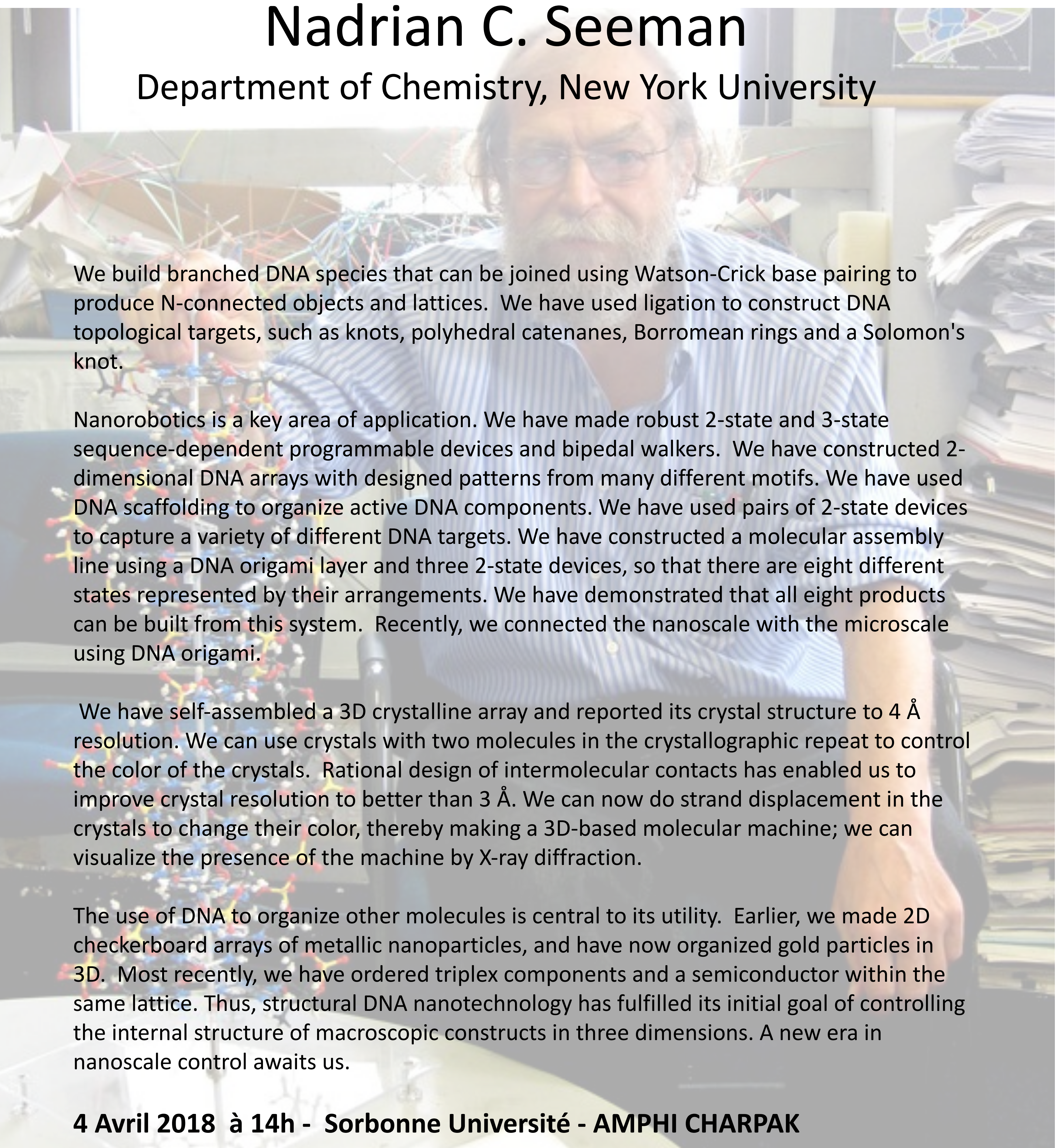
DNA: Not Merely the Secret of Life



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We build branched DNA species that can be joined using Watson-Crick base pairing to produce N-connected objects and lattices. We have used ligation to construct DNA topological targets, such as knots, polyhedral catenanes, Borromean rings and a Solomon's knot.

Nanorobotics is a key area of application. We have made robust 2-state and 3-state sequence-dependent programmable devices and bipedal walkers. We have constructed 2-dimensional DNA arrays with designed patterns from many different motifs. We have used DNA scaffolding to organize active DNA components. We have used pairs of 2-state devices to capture a variety of different DNA targets. We have constructed a molecular assembly line using a DNA origami layer and three 2-state devices, so that there are eight different states represented by their arrangements. We have demonstrated that all eight products can be built from this system. Recently, we connected the nanoscale with the microscale using DNA origami.

We have self-assembled a 3D crystalline array and reported its crystal structure to 4 Å resolution. We can use crystals with two molecules in the crystallographic repeat to control the color of the crystals. Rational design of intermolecular contacts has enabled us to improve crystal resolution to better than 3 Å. We can now do strand displacement in the crystals to change their color, thereby making a 3D-based molecular machine; we can visualize the presence of the machine by X-ray diffraction.

The use of DNA to organize other molecules is central to its utility. Earlier, we made 2D checkerboard arrays of metallic nanoparticles, and have now organized gold particles in 3D. Most recently, we have ordered triplex components and a semiconductor within the same lattice. Thus, structural DNA nanotechnology has fulfilled its initial goal of controlling the internal structure of macroscopic constructs in three dimensions. A new era in nanoscale control awaits us.

4 Avril 2018 à 14h - Sorbonne Université - AMPHI CHARPAK