DNA nanotechnologies to optically enhance or detect single molecules

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The ability to monitor single molecules or biomolecules with light is at the heart of numerous technologies ranging from diagnostic tools in biotechnology to single-photon sources in quantum technologies. However, single molecules interact extremely weakly with optical electromagnetic fields: a fluorescent molecule resonantly interacts with less than one in a million photons that are focused on it, while, for a typical biomolecule, this value drops by a further 6 orders of magnitude. Using natural and artificial DNA strands that are programmed to self-assemble into well-defined nanoscale architectures, and in conjunction with gold nanoparticles, we craft complex hybrid nanostructures that are capable of enhancing the fluorescence of single molecules by several orders of magnitude or of translating the detection of single DNA strands into macroscopic color changes. These architectures open exciting perspectives for the development of new biosensing strategies with single molecule sensitivity, as well as for the study of coherent interactions between light and single quantum emitters at room temperature.

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