Photon correlations permit to distinguish between classical and quantum states of light. Three types of light sources can be considered, coherent, bunched and antibunched.[1] Despite recent advances in photon statistics on nanoscale systems, obtaining correlations from individual quantum emitters (QEs) is difficult as non-classical phenomenology becomes obscured in ensemble measurements. Suppression of photons from adjacent QEs requires spatially or energetically separation between them. By contrast, it is possible to address individual QEs even at high densities if a selective excitation by charge injection is employed. This has the potential to access classes of light sources which could not be investigated otherwise. In this talk I will give a brief introduction on the experimental observation of photon (anti) bunching from individual molecular systems with atomic resolution. We have merged correlation spectroscopy with scanning tunneling microscopy luminescence (STML). By profiting from STML we can image and identify individual molecular emitters located in the nanocavity formed between a gold tip and surface. By using the tip to inject current with atomic precision we are able to excite plasmons and excitons on individual
molecules [2] and demonstrate antibunched single photon emission from C\textsubscript{60} films [3]. Additionally, we have measured bunched emission from H\textsubscript{2} molecules adsorbed on gold surfaces. [4]

By analyzing the photon statistics we can conclude that in the first case C\textsubscript{60} acts as a QE and we have a pure quantum-mechanical emission process whereas in the second case the emission stems from intensity blinking upon H\textsubscript{2} motion in the nanocavity and it is fully classical.

References

International Day of Women and Girls in Science – 11 February

In order to achieve full and equal access to and participation in science for women and girls, and further achieve gender equality and the empowerment of women and girls, the United Nations General Assembly adopted a resolution declaring 11 February as the International Day of Women and Girls in Science. February 11 is an initiative aiming at encouraging the organization of activities to commemorate the International Day of Women and Girls in Science in Spain. For more information click here.
Chirality (or handedness) is an important concept across modern science. The word “chiral” was originally used to describe objects which were not identical to their mirror images, but now the term now encompasses asymmetries in many forms, including in chemical reactions and in sub-nuclear processes. The emerging field of chiral quantum optics is concerned with systems where forward and backward moving photons interact differently with a quantum emitter (such as atoms, molecules or quantum dots) The most extreme case of chirality is the unidirectional (or one-way) coupling between two quantum systems. Scientists are increasingly interested in exploiting chiral light-matter interactions in order to realize novel applications in the areas of quantum communication, information and computing.

New insight into the area of chiral quantum optics has now been revealed in a work published in Physical Review Letters (PRL) by Elena del Valle, Antonio Fernández-Domínguez and co-workers. This work proposes a system consisting of two circularly-polarized quantum emitters held above a plasmonic surface as tunable setup in which one may explore chiral light-matter coupling at the nanoscale. Most excitingly, these researchers reveal a hitherto unknown regime, dubbed “quasichiral”, which is the stage for a number of remarkable quantum optical phenomena. In particular, the quasichiral regime gives rise to extremely sharp and intense spectral features (which may be
important for sensing) and strong photon correlations, including strong photon antibunching (which appears in a remarkable butterfly structure in the two-photon spectra). The full article can be read here. [Full article]

Impact of Detuning and Dephasing on a Laser-corrected Subnatural-linewidth Single-photon Source

![Graph showing impact of detuning and dephasing on a laser-corrected subnatural-linewidth single-photon source](image)


We discuss a scheme which makes interfere the emission from a qubit with a laser to produce single photons with subnatural linewidth (monochromatic), although having both properties seems to be in contradiction with the Heisenberg uncertainty principle. In this paper, we consider the effect of dephasing and of the detuning between the driving laser and/or the detector with the emitter. We find that our scheme brings such considerable improvement as compared to the standard schemes as to make it one of the best single-photon sources. While the scheme is particularly fragile to dephasing, its superiority holds even for subnatural-linewidth emission down to a third of the radiative lifetime. [Full article]
The genomic material needs to be precisely organized and access to its information carefully regulated in order to ensure proper functioning of a cell. These instructions are encoded in the DNA, although not in the form of the well-known three-letter words (or codons) that chemically code for proteins. In this work we found a striking connection between DNA sequence, structure and flexibility: the sequence can specifically modify the flexibility by means of concerted changes in the structure of the double-helix. Our state-of-the-art computer simulations showed that DNA molecules with different sequences substantially differed in their extension. This was a consequence of an internal curvature of the DNA that we denoted crookedness. As we increased the force, sequences that were initially more compressed – or more crooked – were able to elongate by a greater amount than those that were already elongated at low forces. Crookedness works as a reservoir of elastic energy that is directly encoded in the nucleotide sequence. Remarkably, sequences that lacked this reservoir had been previously described to destabilize nucleosomes, the first step of DNA compaction into chromosomes. As a consequence, these DNA regions are known to be highly accessible to the cellular machinery, triggering many key biological processes. [Full article]

Research Highlight in Nature Reviews Physics: DNA’s crooked path.