From molecules . . . to atoms . . . to quantum entanglement

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Single molecules —the first single quantum emitter ever detected in the solid state— enable the generation of single photons across the entire visible spectrum from 400 to 850 nm. Unlike other emitters, their photon collection efficiency can approach unity [1]. Under cryogenic conditions, their spectral linewidth can be truly Fourier-limited. We observe more than 2 Mio raw single photon clicks per second on a silicon avalanche photo diode (APD). At the same time, the emitted photons have a spectral linewidth of less than 20 MHz.

In recent years, we have learned to exploit the spectral superposition of the molecular emission with alkali atoms. This has enabled us to observe slow light in a hot atomic vapor [2], to filter the emitted photons from background contributions, and to perform atomic spectroscopy with a stream of single photons [3]. The combination of an atomic filter with single molecule studies allows to achieve a unique, pure single photon stream aligned with the sodium D_2 line.

I will show our works between the microscopy of single molecules under cryogenic conditions and the spectroscopy of hot atomic vapors.

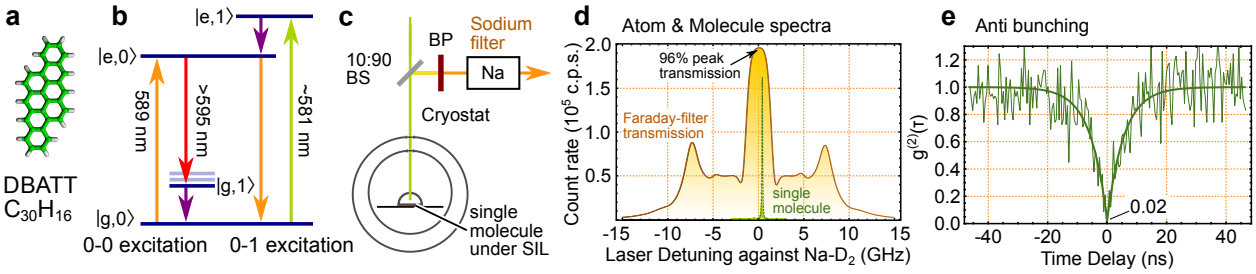

Figure 1: **a)** The utilized organic molecule dibenzanthanthrene (DBATT). **b)** simplified level scheme. **c)** experimental setup. **d)** spectrum from the atomic Faraday filter and the single molecule emission. **e)** single photon anti-bunching of a single molecule (raw data).

References

[1] – G. K. Lee *et al.*, A planar dielectric antenna for directional single-photon emission and near-unity collection efficiency, Nature Photonics, **5**, 166-169, (2011)
[2] – P. Siyushev *et al.*, Molecular photons interfaced with alkali atoms, Nature, **509**, 66-70, (2014)
[3] – W. Kiefer *et al.*, An atomic spectrum recorded with a single molecule light source, Applied Physics B, **122**, 1-12, (2016)