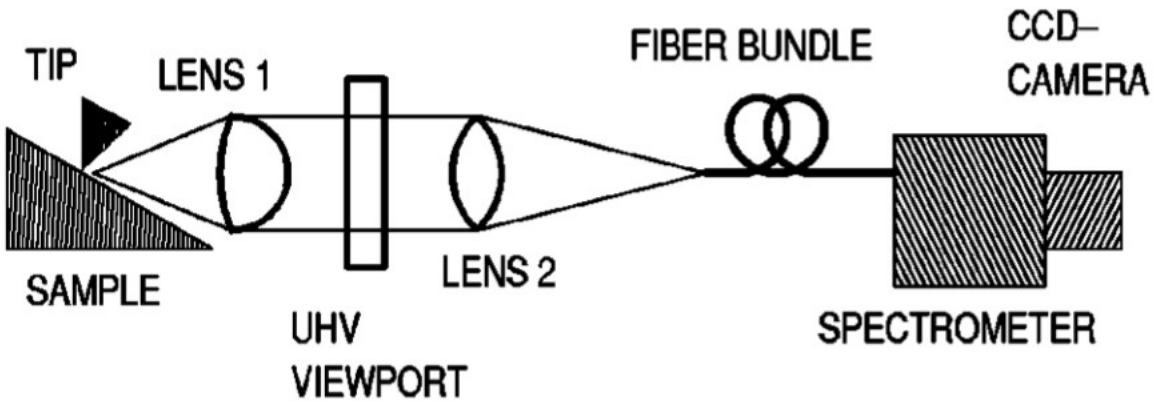
Übersicht über Kapitel 7

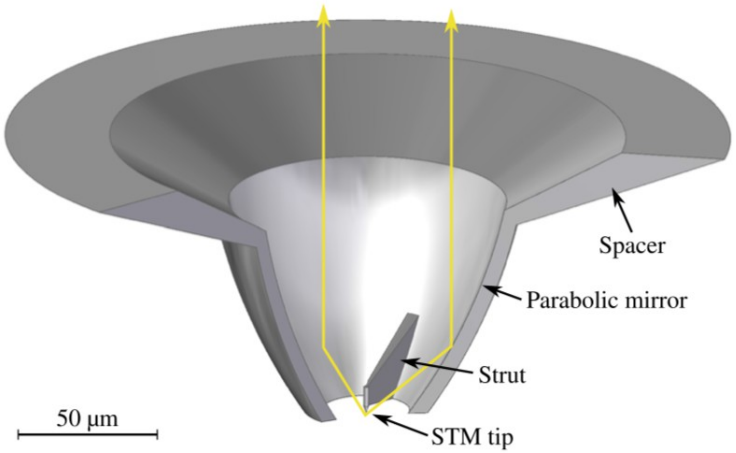
Lichtemission aus Tunnelkontakt

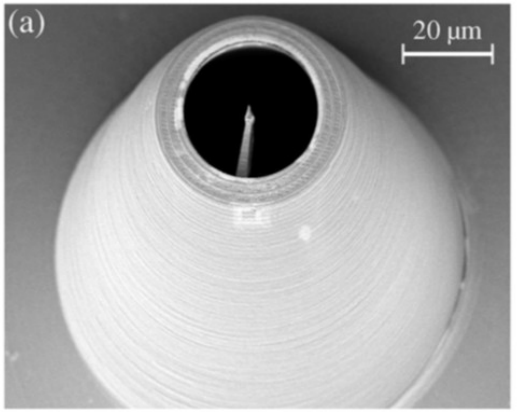


- Raumwinkelabdeckung ≈ 10 %
- Fokussierung (UHV, Kryostat)

Hoffmann et al., Rev. Sci. Instr. 73, 305 (2002)

Lichtemission aus Tunnelkontakt





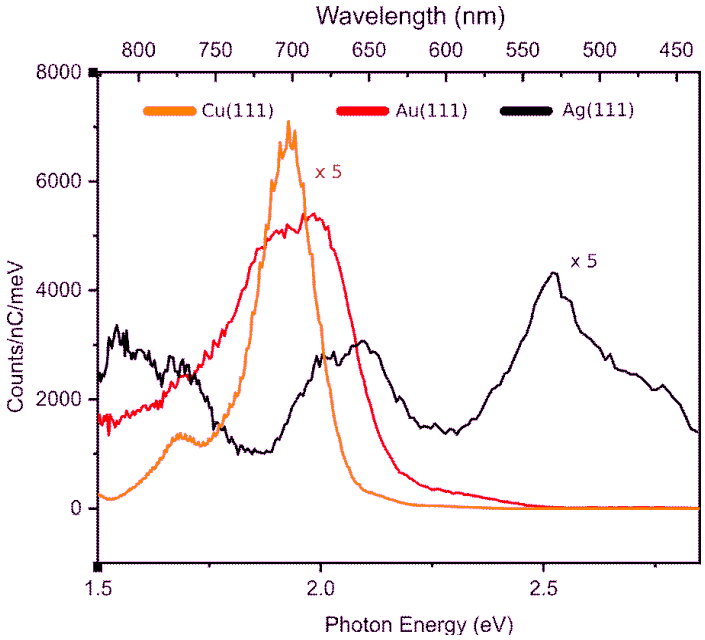
+ Raumwinkelabdeckung ≈ 80 %

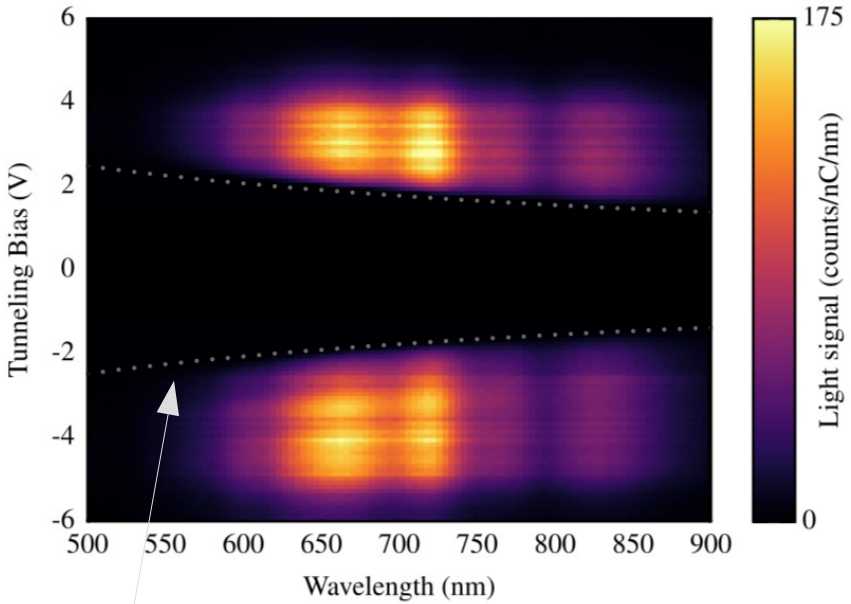
+ keine Fokussierung nötig

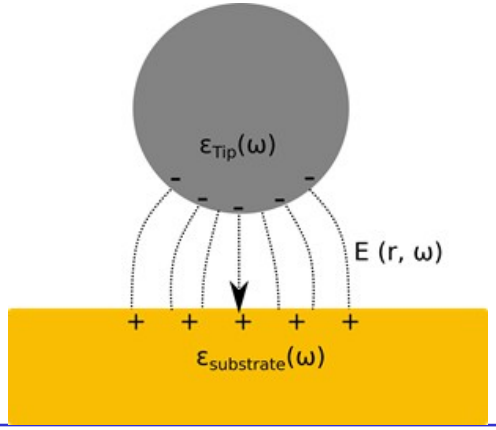
- Spitzen mit 3D-Druck (DLW)

AG Wulfhekel/AG Wegener 2018
Edelmann et al. Rev. Sci. Instr. 89, 123107 (2018)

Lichtemission aus Tunnelkontakt

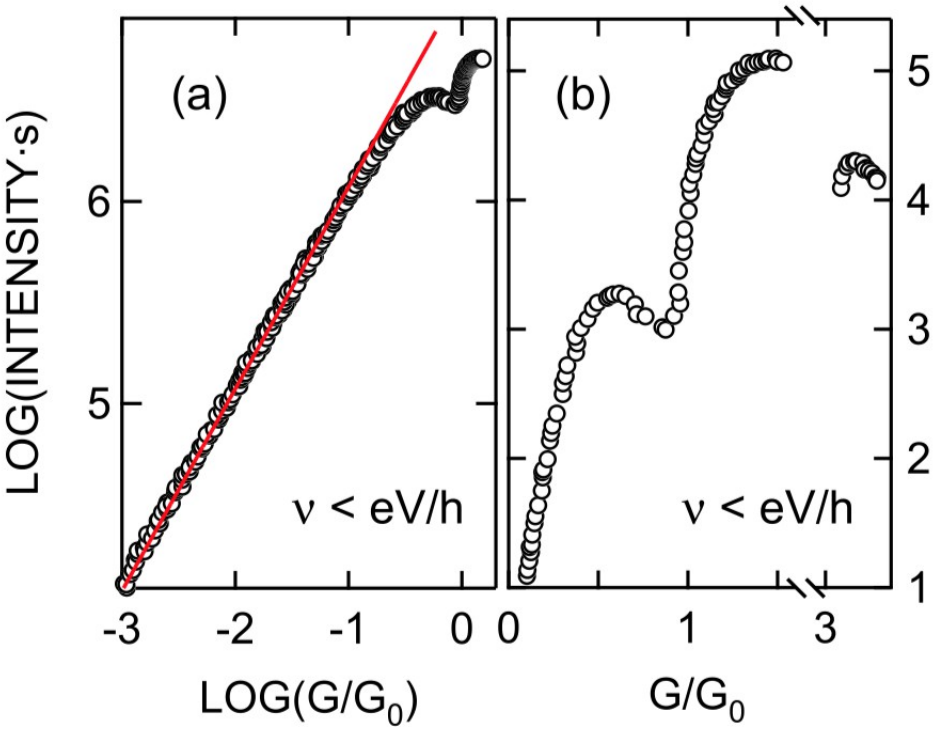


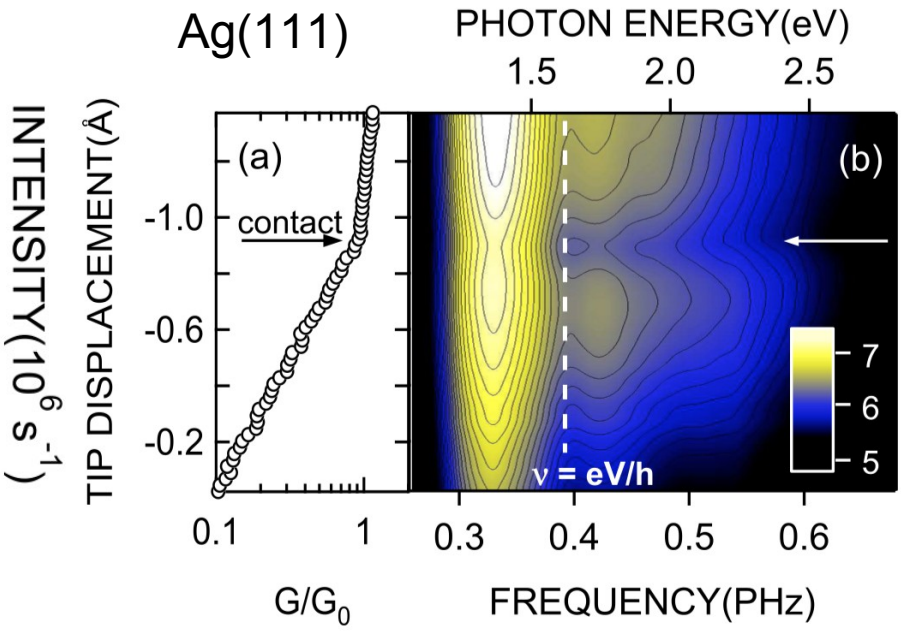




Cutoff der Photonenenergie bei hv=eV

Lichtemission versus Strom





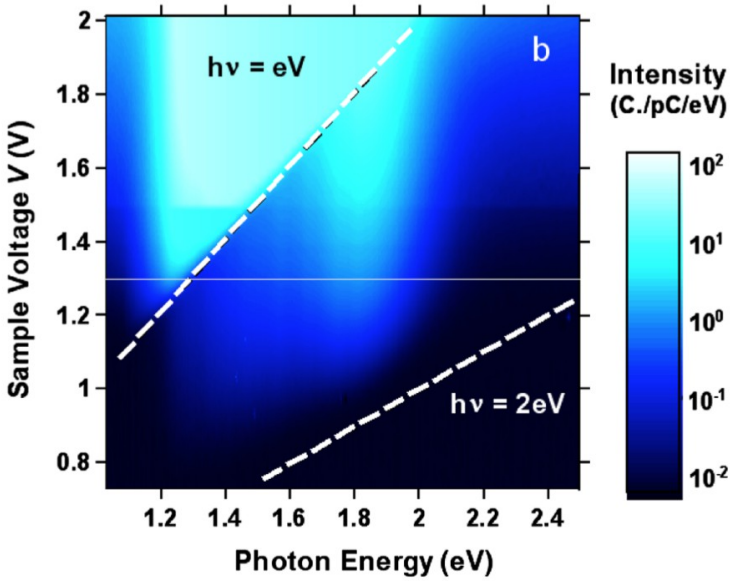
Intensität steigt zuerst linear mit dem Strom

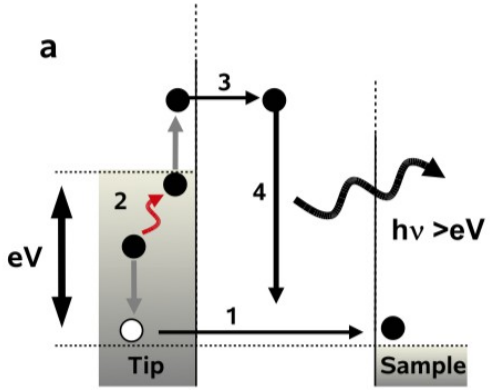
Lokales Minimum bei $G=G_0$

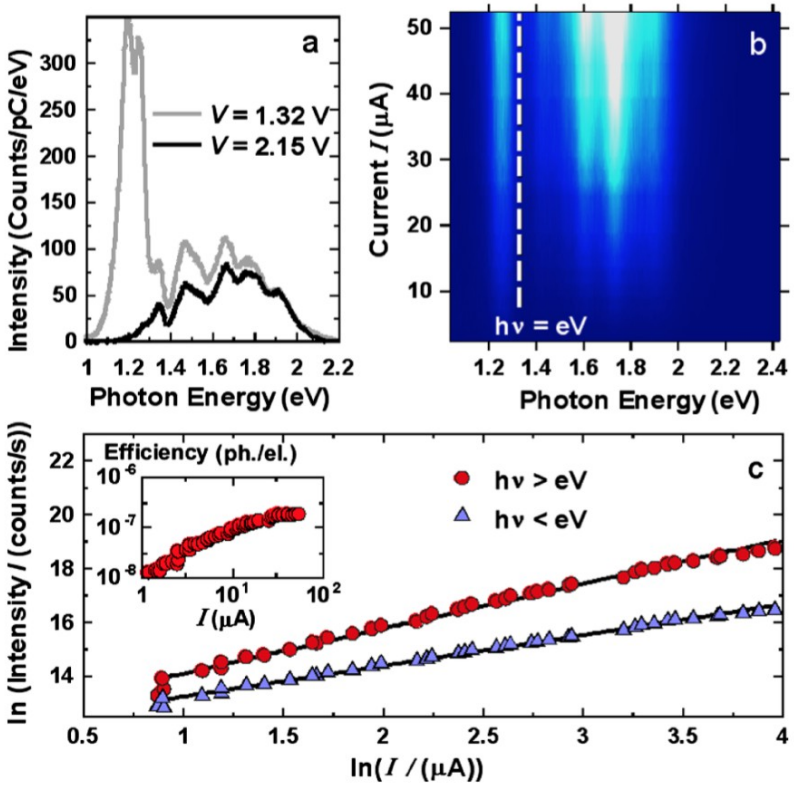
Stromrauschen

Schneider et al., Phys. Rev. Lett. 105, 026601 (2010)

Lichtemission höherer Ordnung



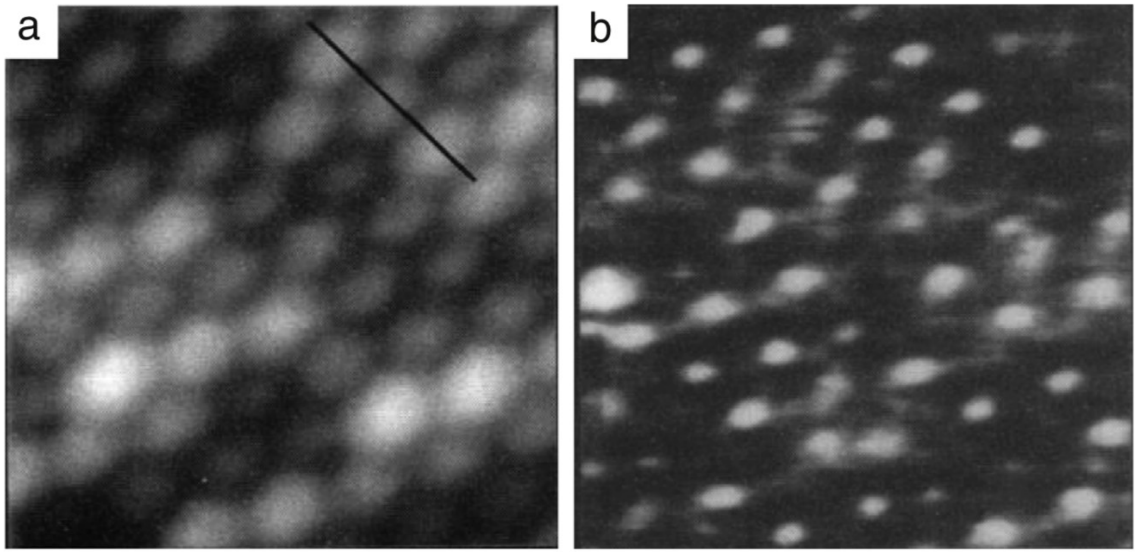


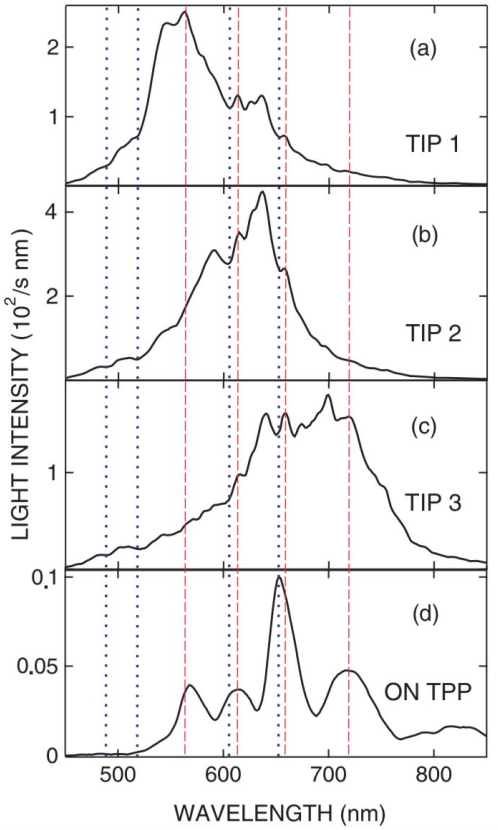


Energieerhaltung wird scheinbar verletzt
2 Elektronen Prozess
Sehr kleine Effizienz

Schull et al., Phys. Rev. Lett. 102, 057401 (2009)

Lichtemission aus C60/Au(111)

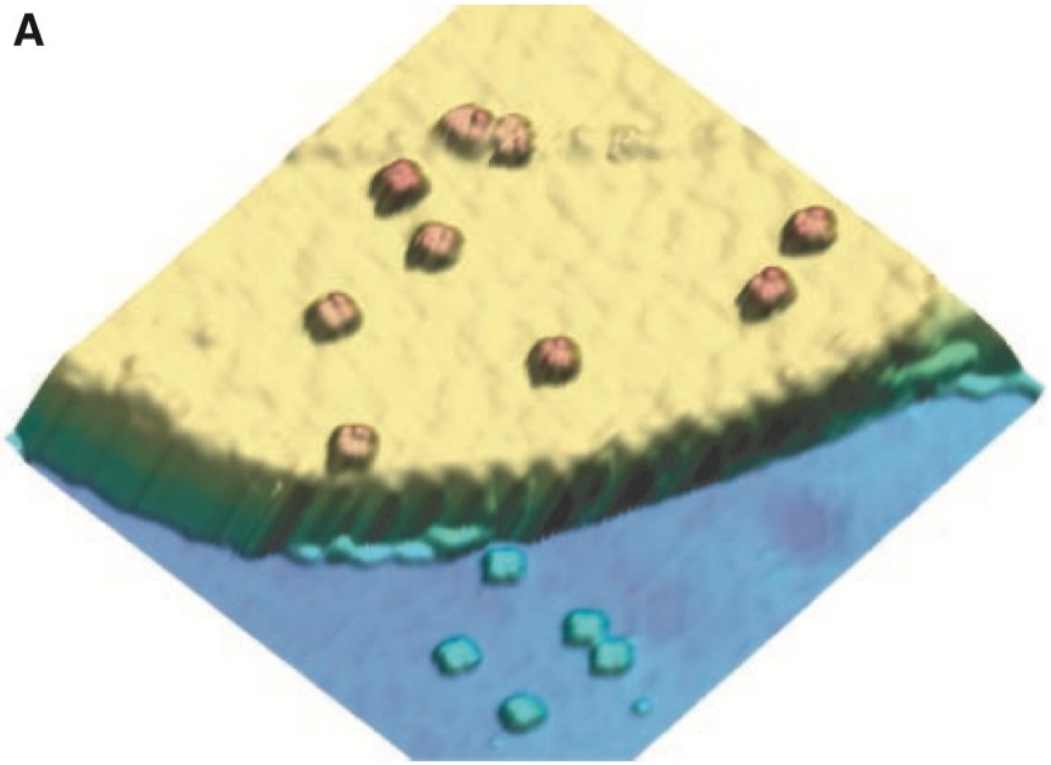


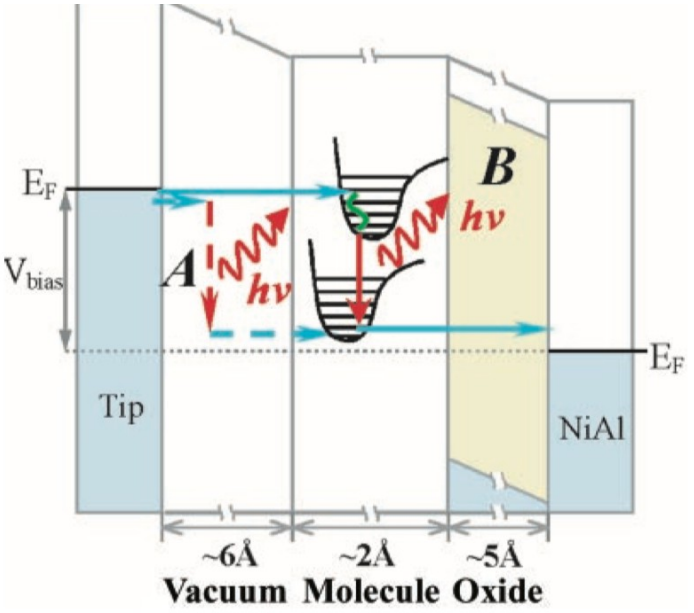


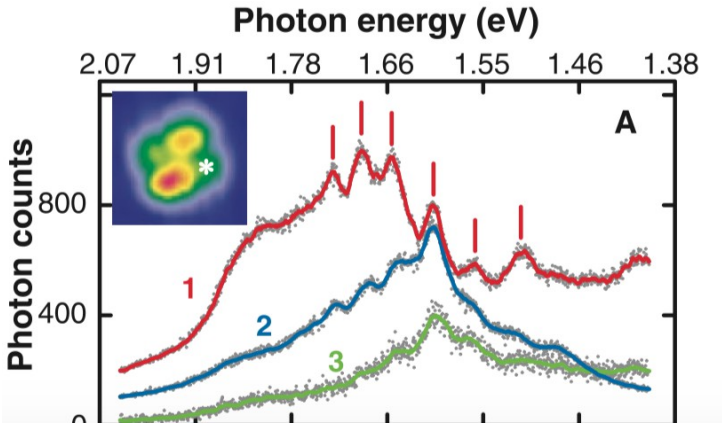
Hohe Photonenausbeute fällt auf Position von Molekülen
Spektren ähneln eher Plasmonen
Anregung auch, wenn Strom nicht durch Molekül fließt

Berndt et al., Science 262, 1425 (1993)
Schneider et al., Phys. Rev. B 86 035445 (2012)

Entkopplung durch Isolatoren

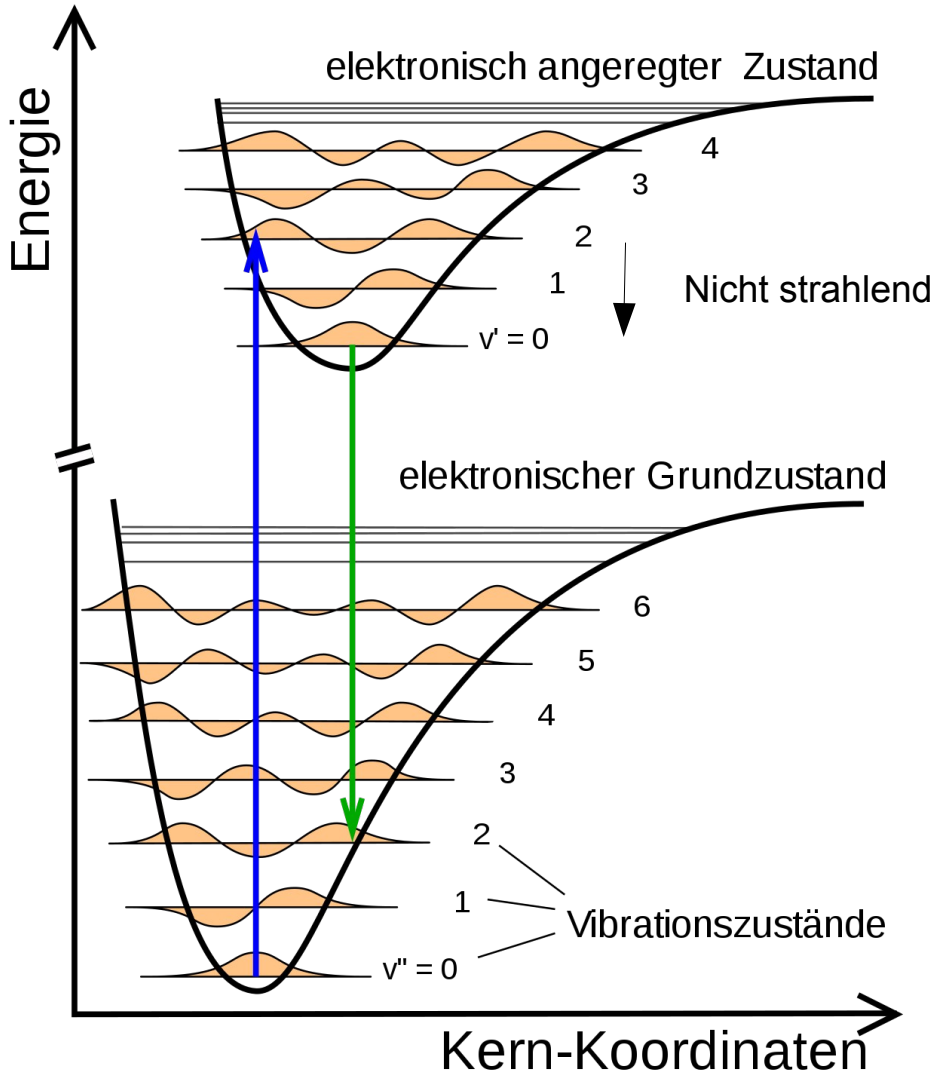






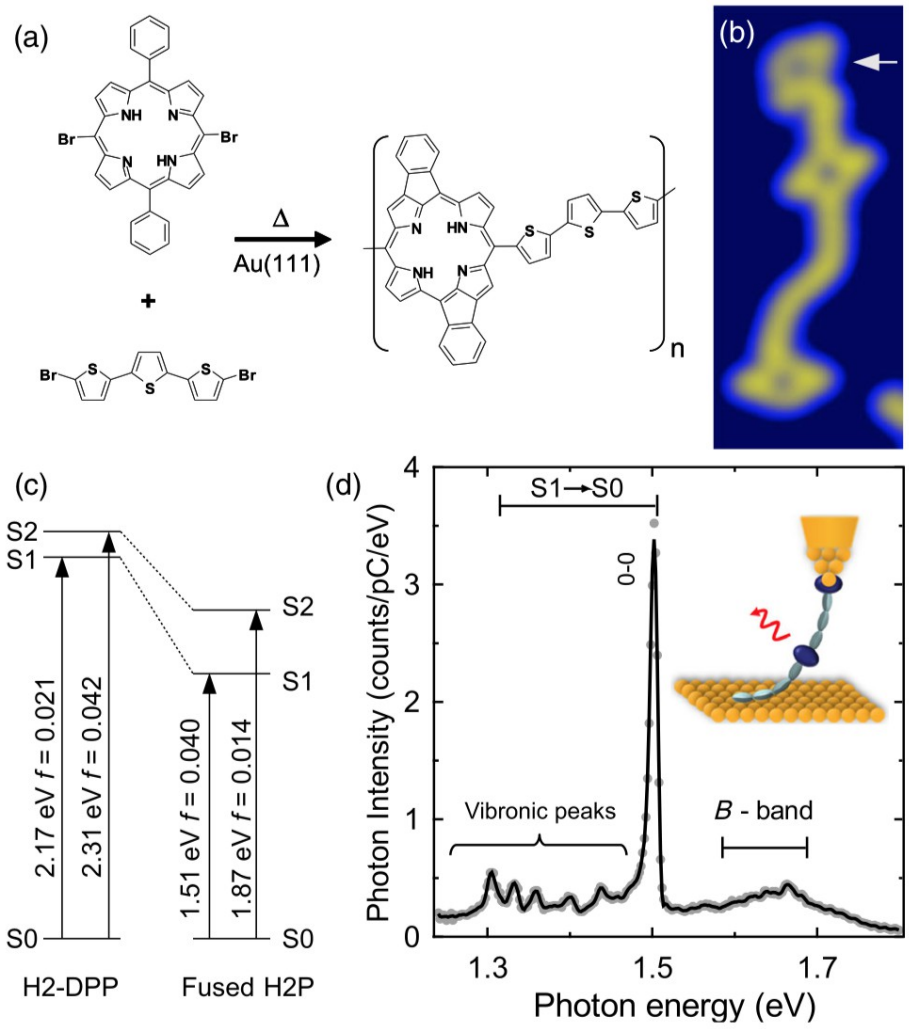
Qiu et al., Science 299, 542 (2003)

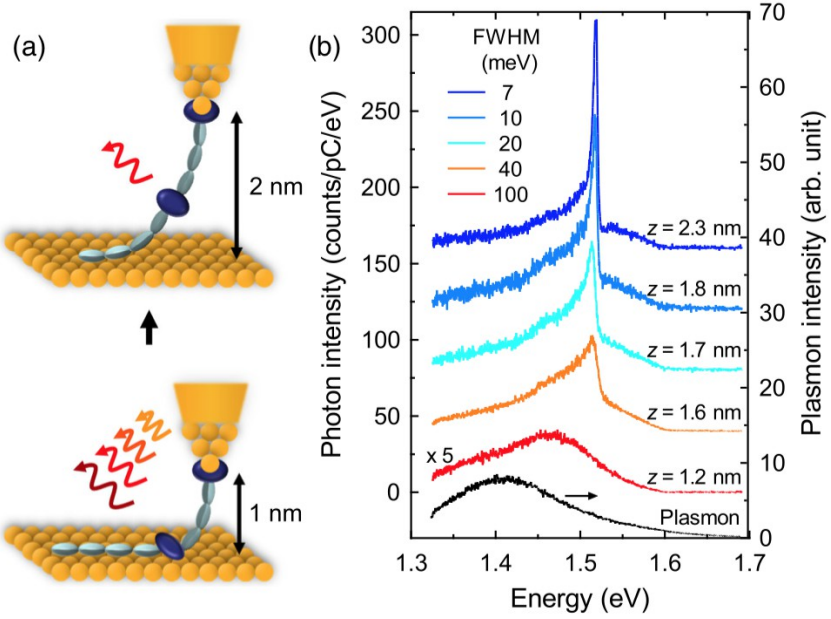
Frank-Condon Prinzip



Wikipedia

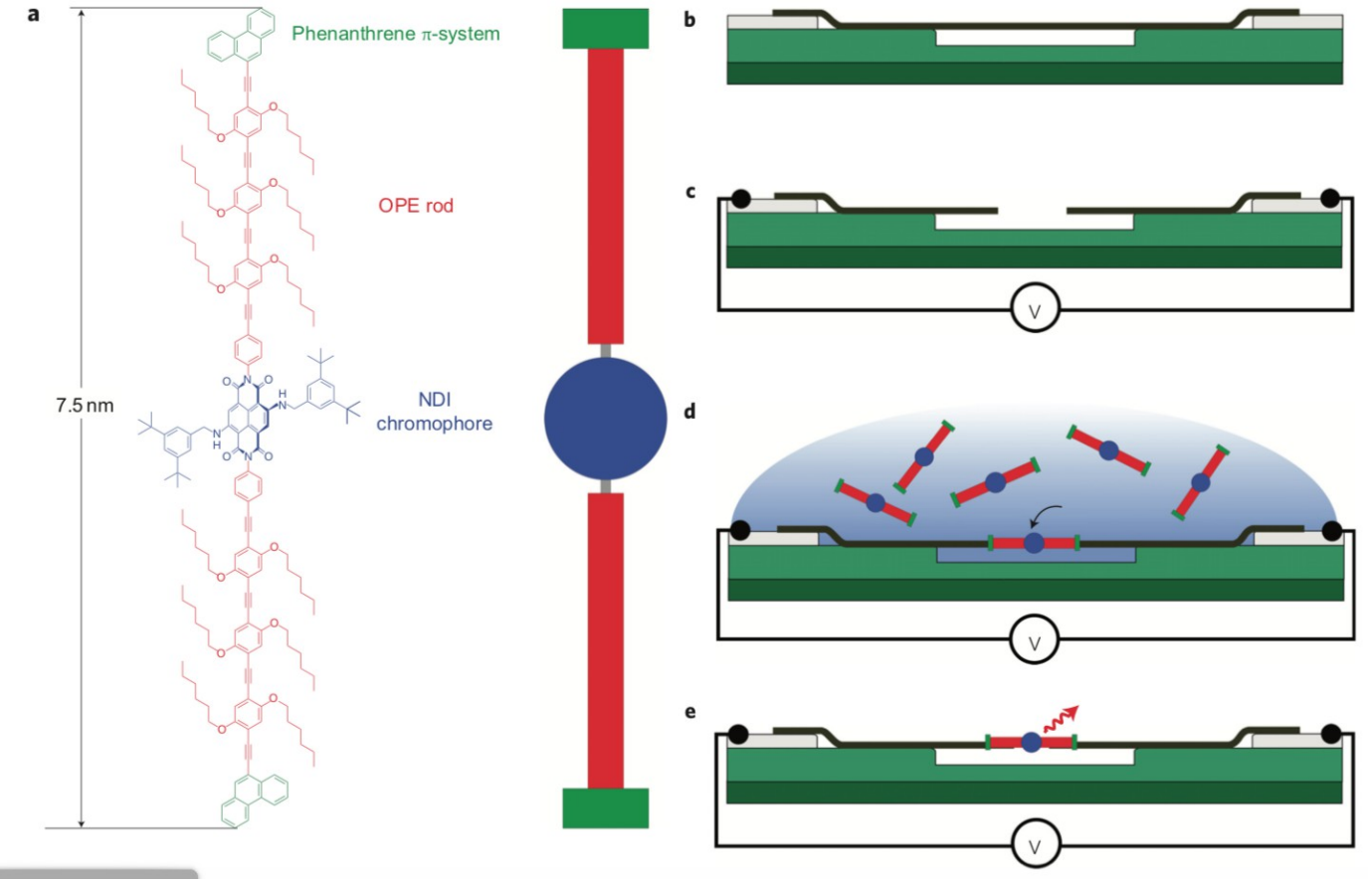
Anheben eines Moleküls

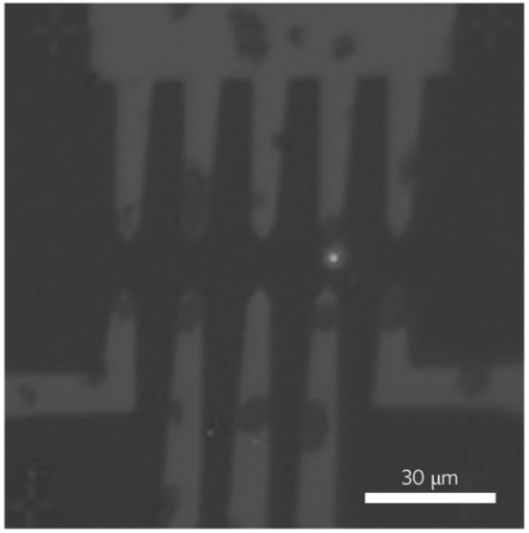




Chong et al., Phys. Rev. Lett. 116, 036802 (2016)

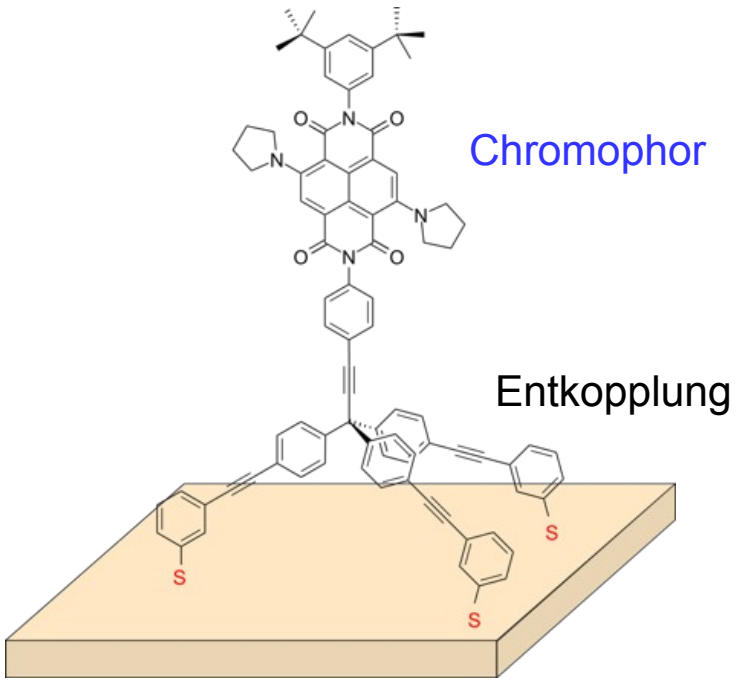
Freies Molekül zwischen CNTs

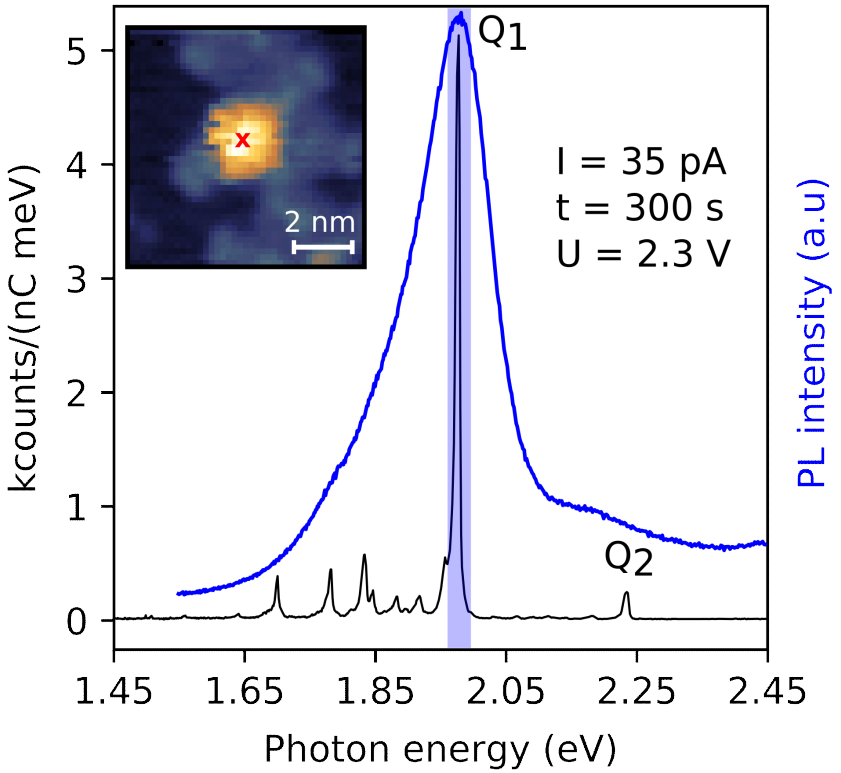




Marquardt et al., Nature Nano 5, 863 (2010)

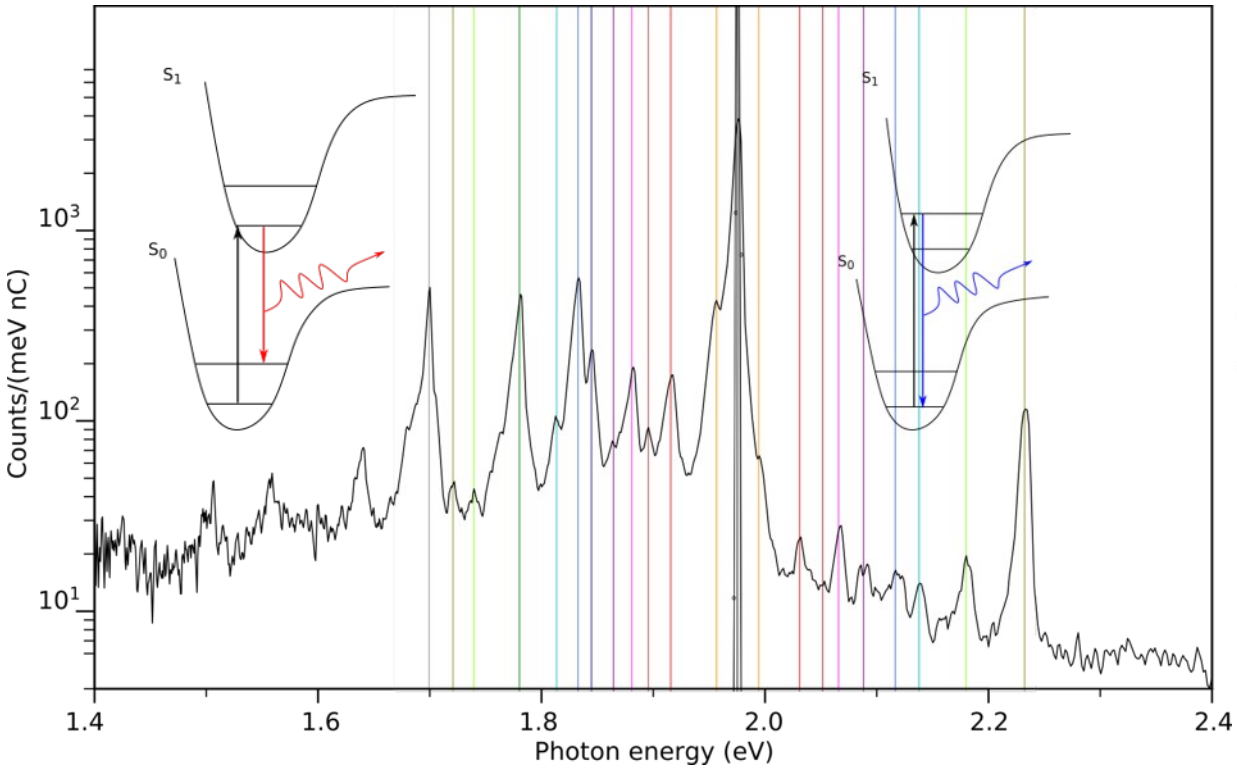
Selbstenkoppelte Molekülkomplexe

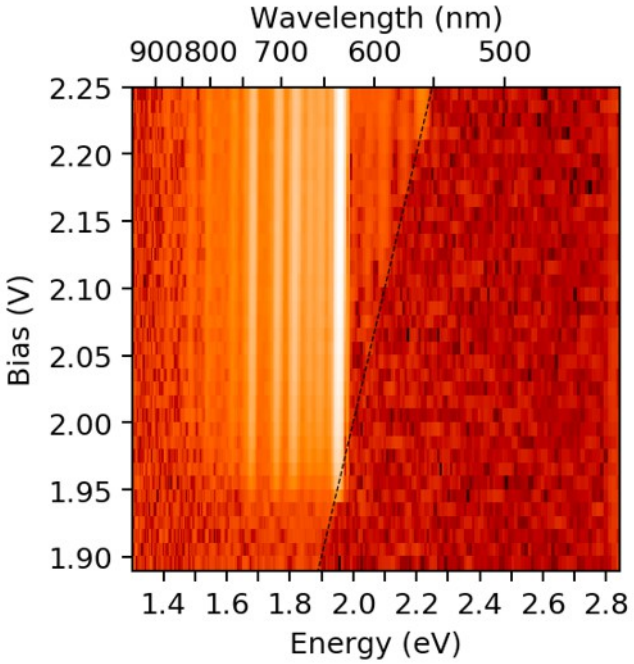




Scharfe Emissionslinien mit relativ hoher Effizienz, etwa 2 x 10^{-3} Photonen/Elektron

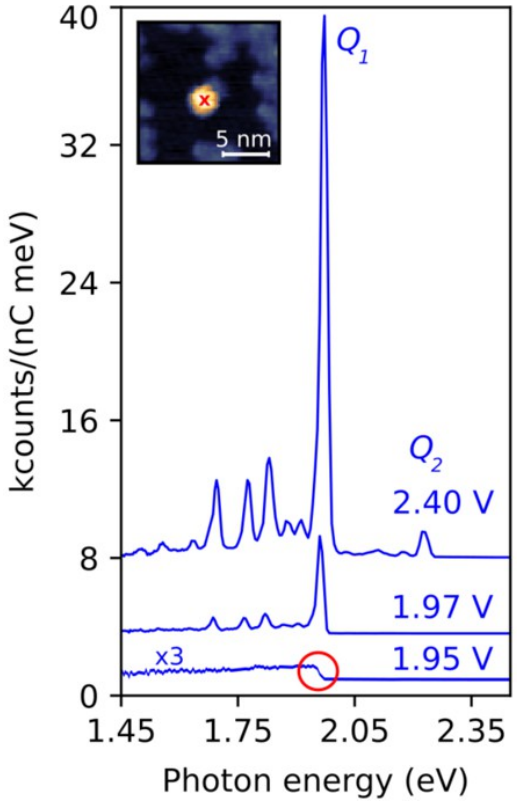
Selbstenkoppelte Molekülkomplexe

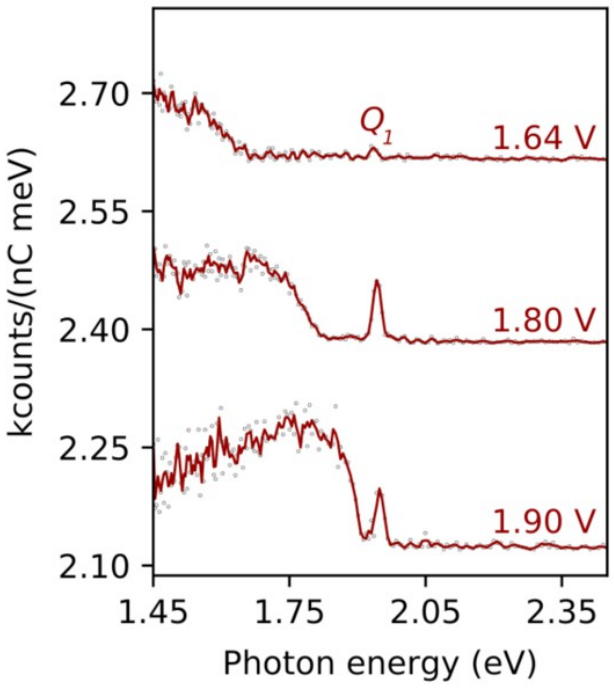


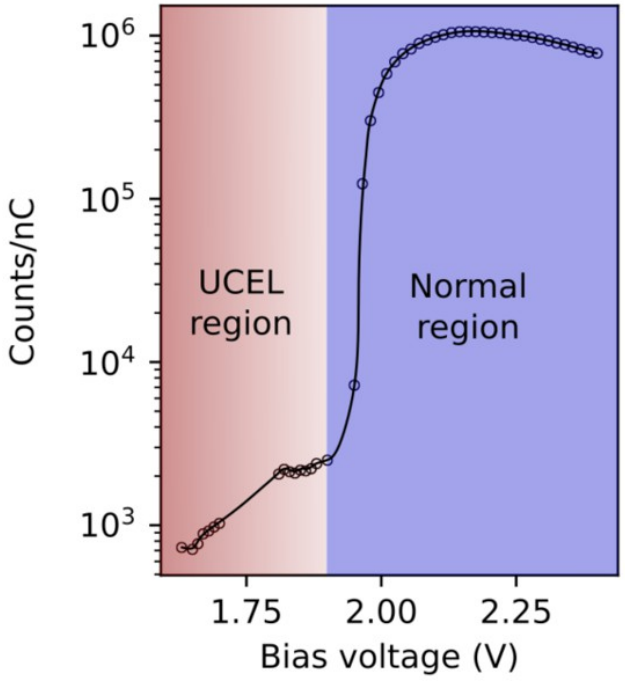


Nebenlinien durch strahlende Übergänge in und aus vibronisch angeregten Zuständen

Selbstenkoppelte Molekülkomplexe

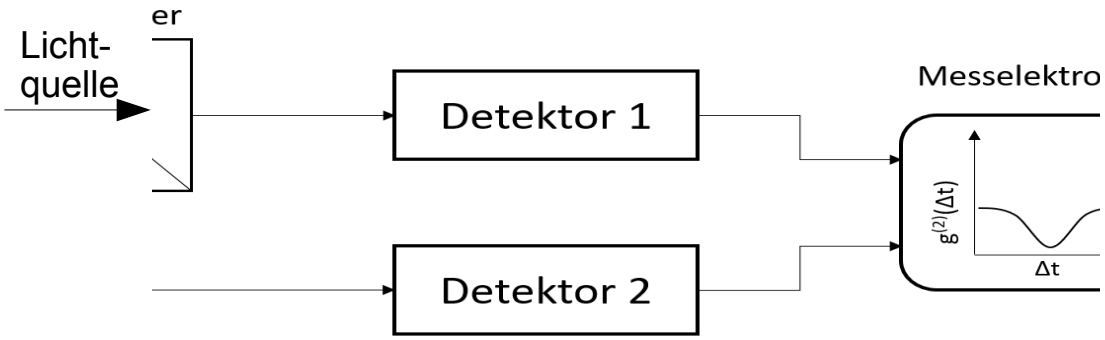


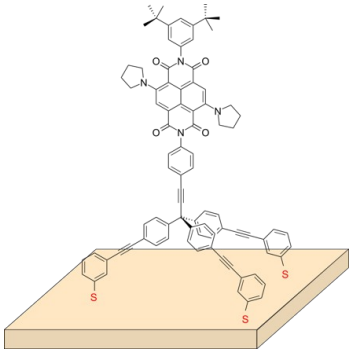




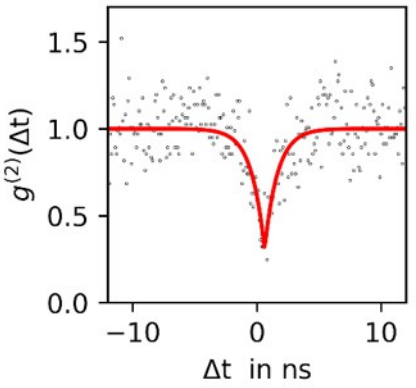
Zwei-Elektronen-Anregung bei deutlich kleineren Strömen (10^{-11} A vs 10^{-6} A)
als in rein metallischen Kontakten

Moleküle als Einzelphotonenquelle





$$g^{(2)}(\Delta t) = \frac{\langle n_1(t) n_2(t+\Delta t)\rangle}{\langle n_1(t)\rangle \langle n_2(t+\Delta t)\rangle}$$



Einzelphotonen zur Quantenkommunikation?

$g^{(2)}(0) = 0.31$

$T_0 = 1.05$ ns