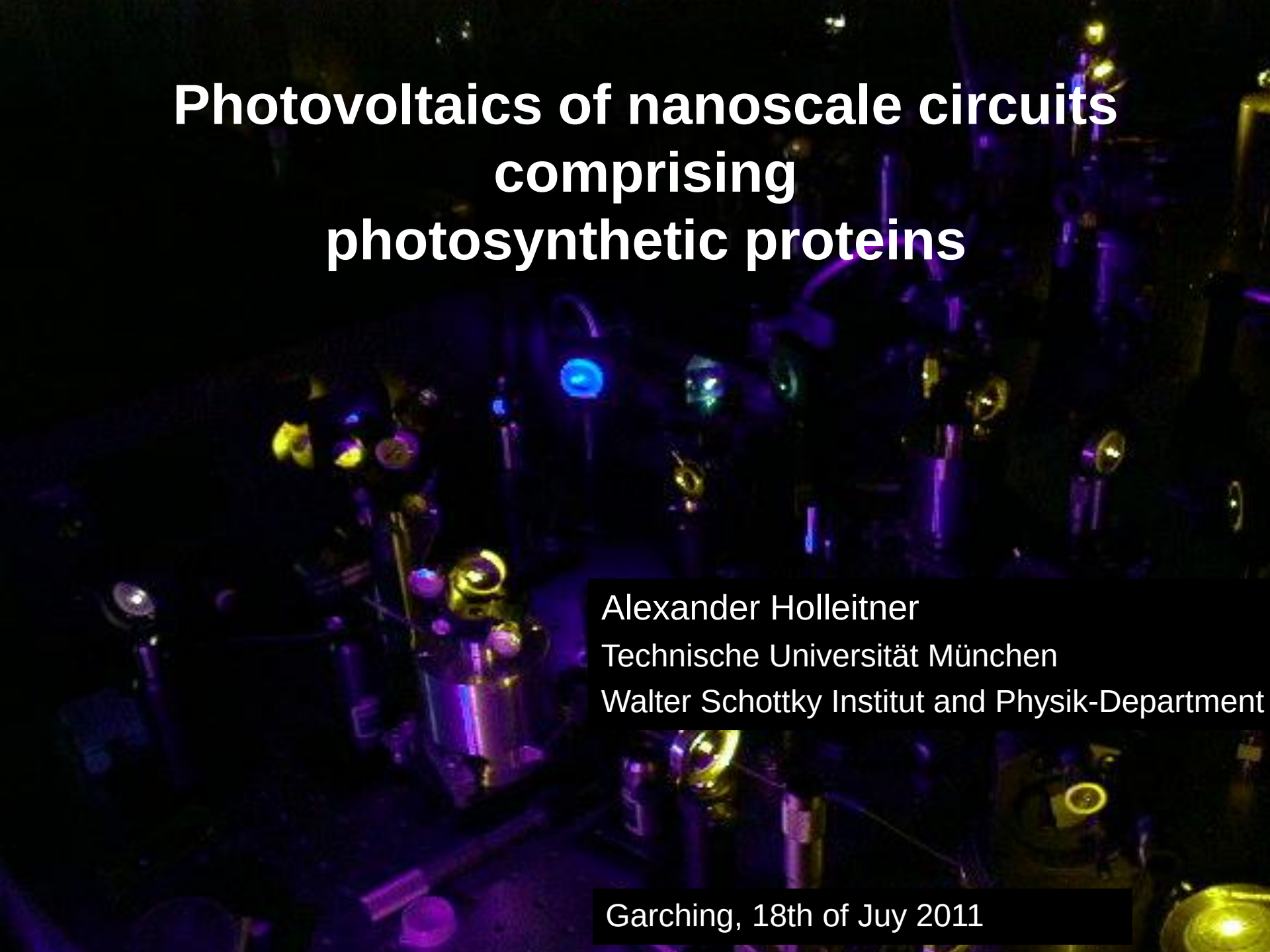

Photovoltaics of nanoscale circuits comprising photosynthetic proteins

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Garching, 18th of Juy 2011

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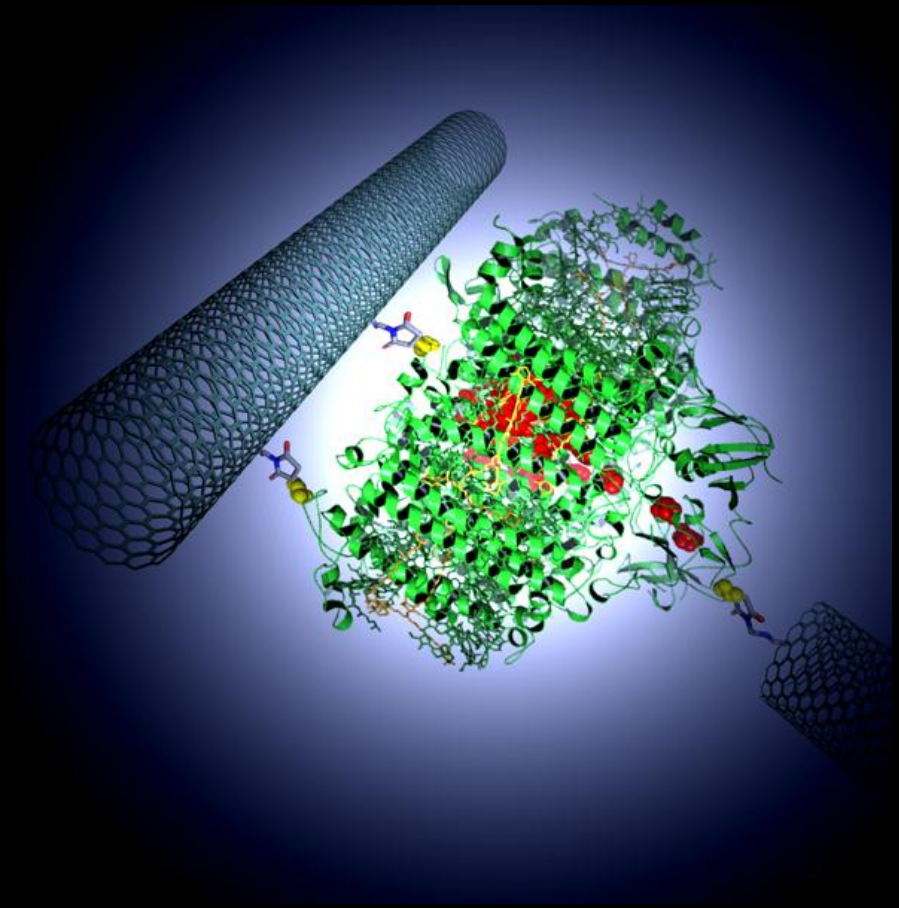
Itai Carmeli, Shachar Richter, Chanoch Carmeli
(Tel Aviv University, Israel)

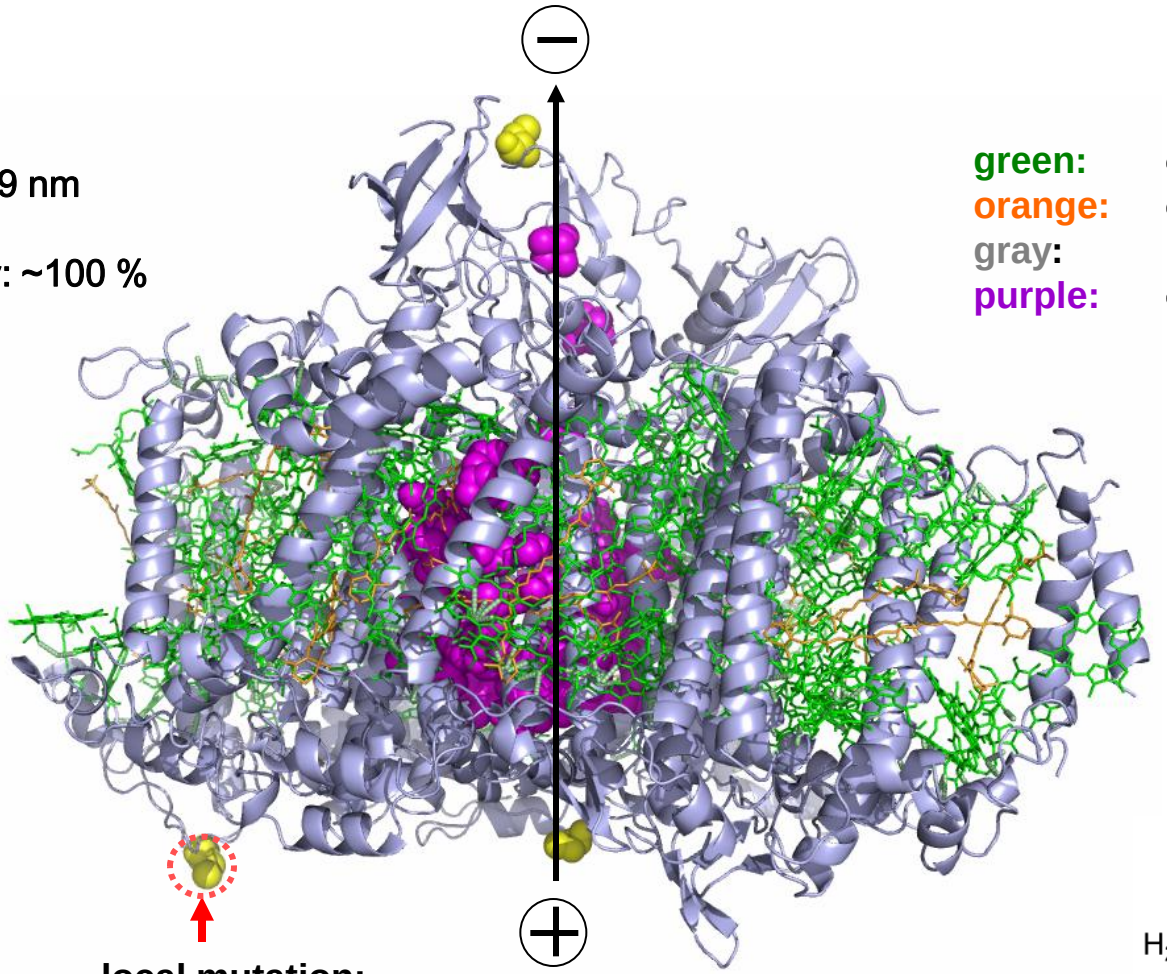
Iris Visoly-Fisher, Shlomi Sergani
(Ben Gurion University, Israel)



Photosynthetic proteins are the smallest organic solar cells.

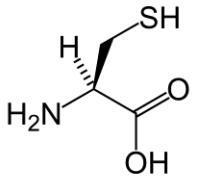
The Photosystem I (PS I)

dimension: 15 nm × 9 nm
photovoltage: ~1 V*
absorption efficiency: ~100 %



green: chlorophyll
orange: carotenoide
gray: protein
purple: electron transfer

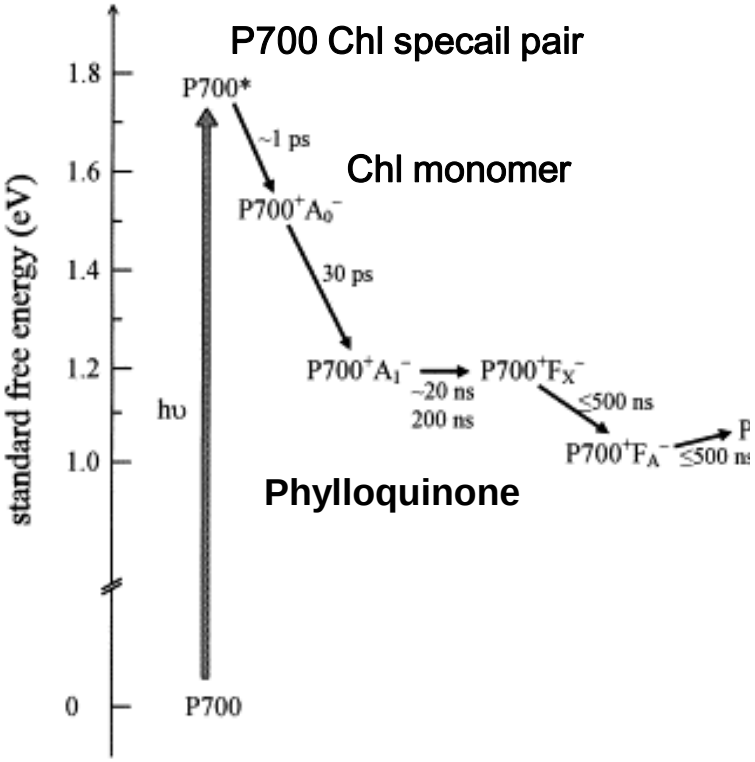
local mutation:
cysteine for carbodiimid chemistry
I. Carmeli, Tel Aviv, Israel



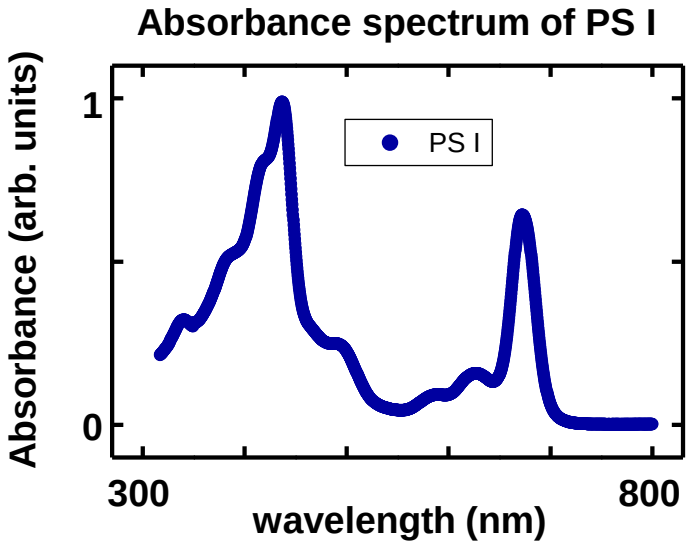
cysteine

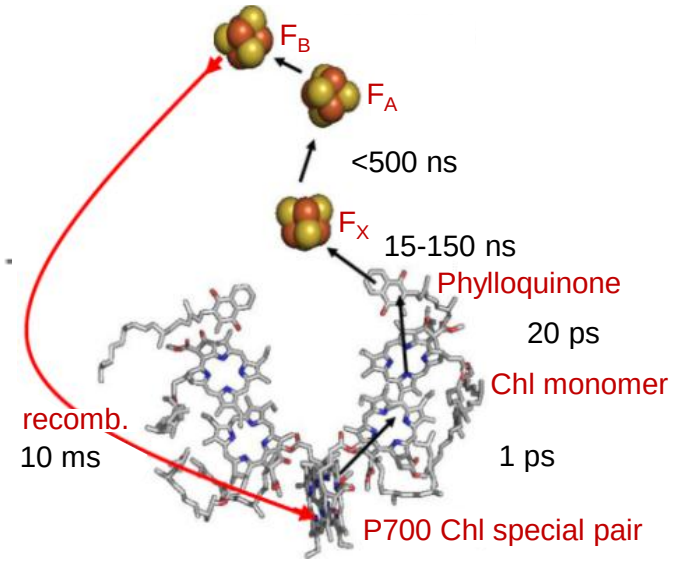
* L. Frolov et al., Adv. Mat. 17, 2434 (2005).
K. Brettel, Biochimica et Biophysica Acta 1318 , 322 (1997).

Electron transfer within the photosystem I



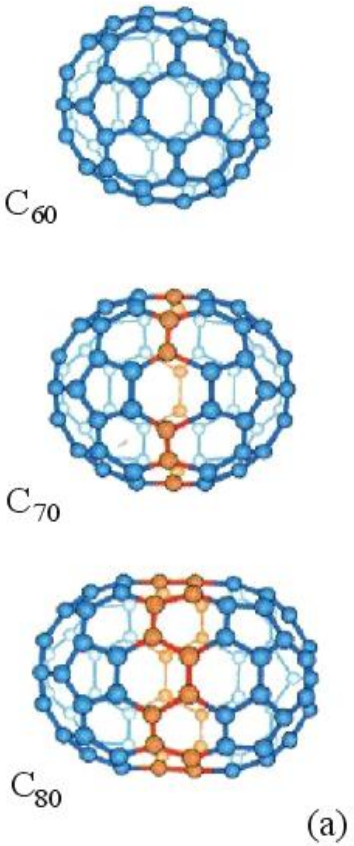
Energy efficiency: ~58 %

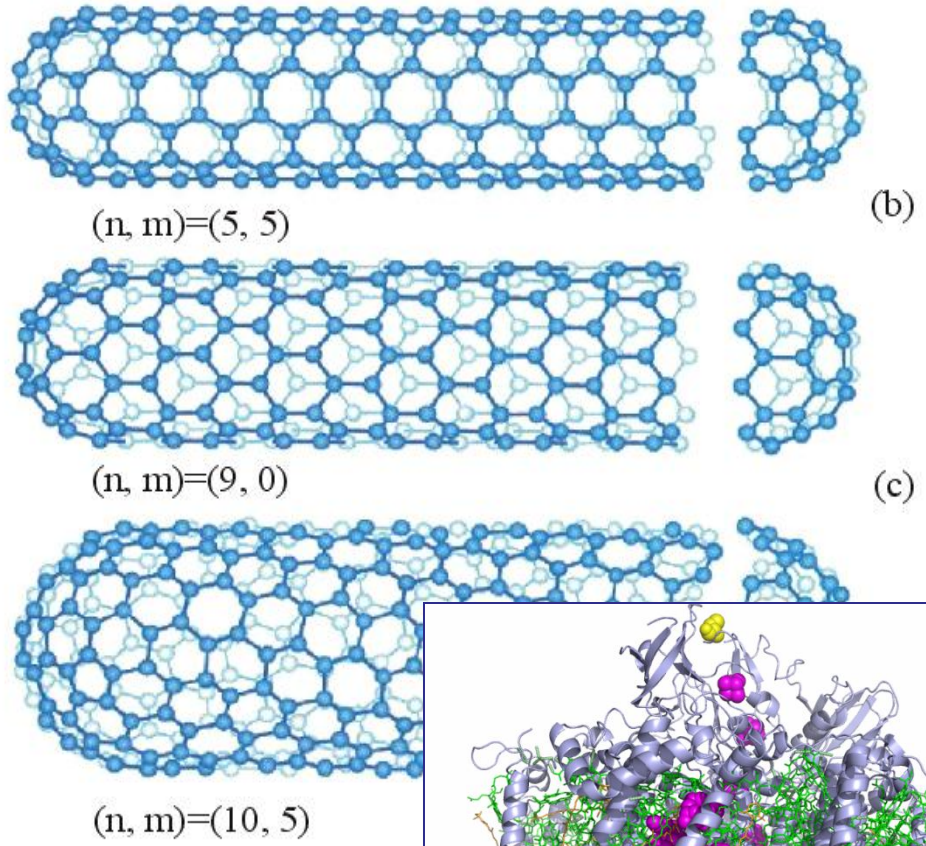




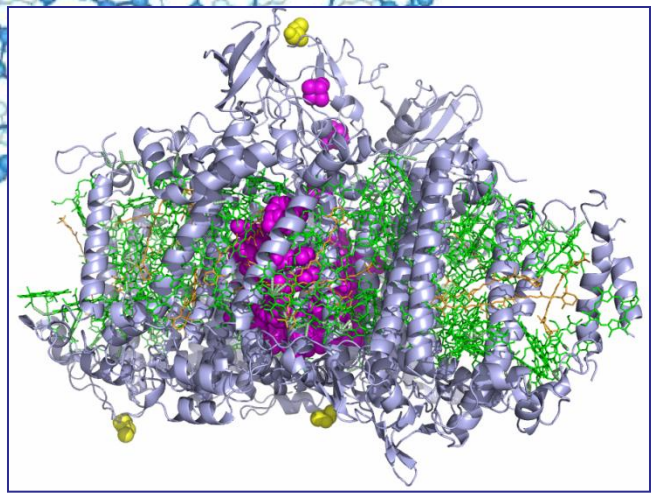
K. Brettel, Bioch. et Biophys. Act. 1318 , 322 (1997).

Protein wires



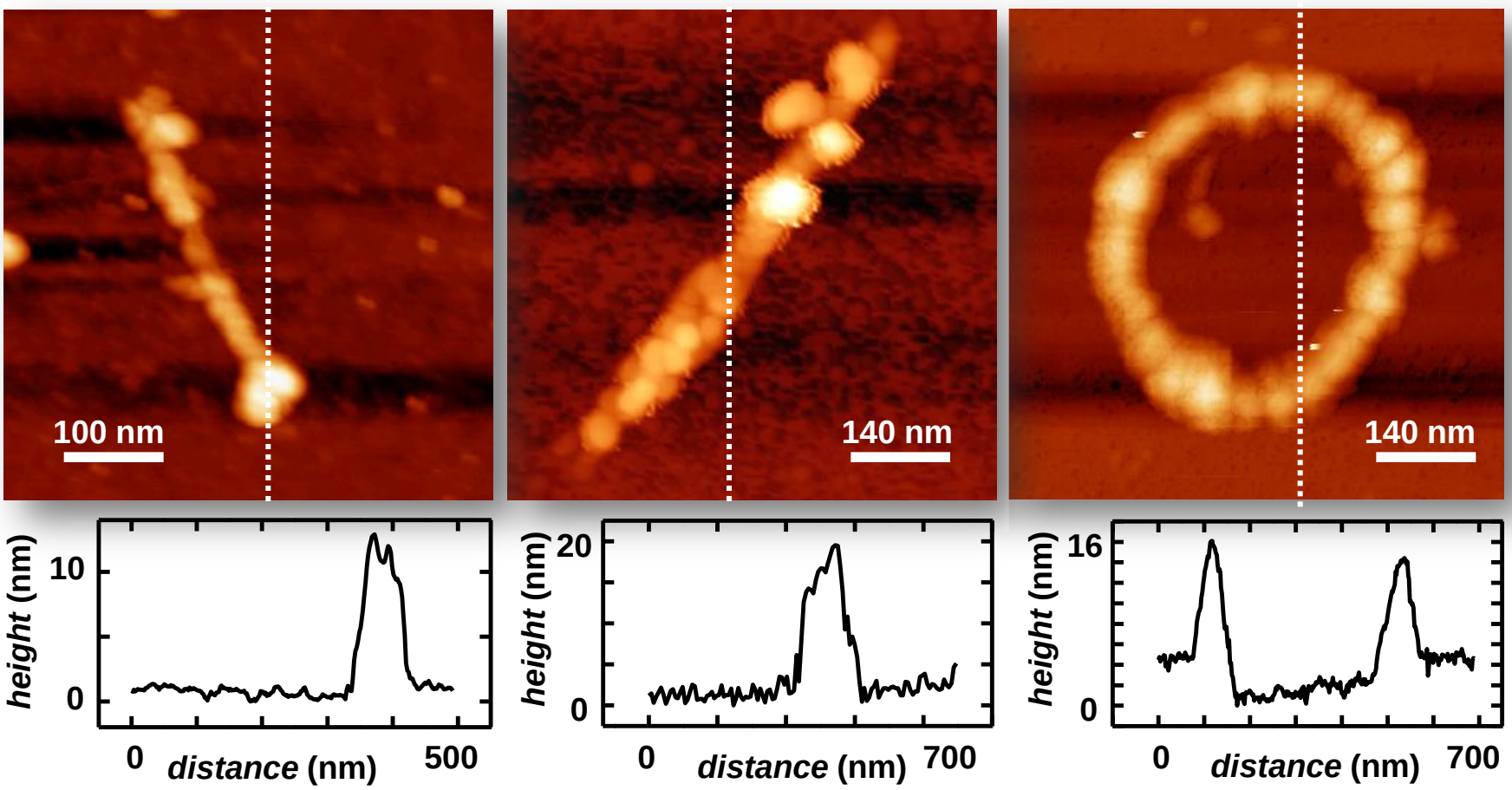


Assembly of photosystem I to carbon nanotubes by chemical recognition.



I. Carmeli, M. Mangold, L. Frolov, B. Zebli, C. Carmeli, S. Richter, and A.W. Holleitner, Adv. Materials 19, 3901 (2007).

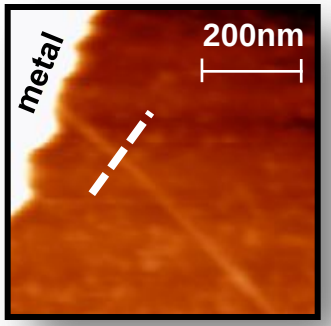
Protein wires

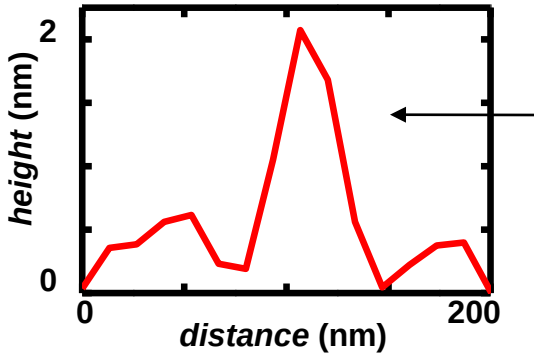


I. Carmeli, M. Mangold, L. Frolov, B. Zebli, C. Carmeli, S. Richter, and A.W. Holleitner, Adv. Materials 19, 3901 (2007).

„On Chip“ functionalization

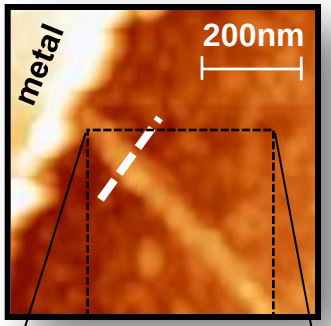
Contact carbon nanotubes by metal electrodes

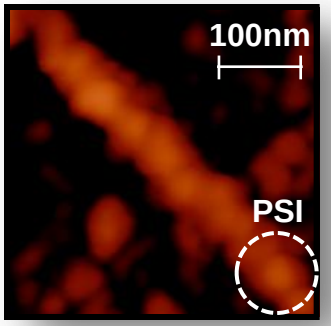


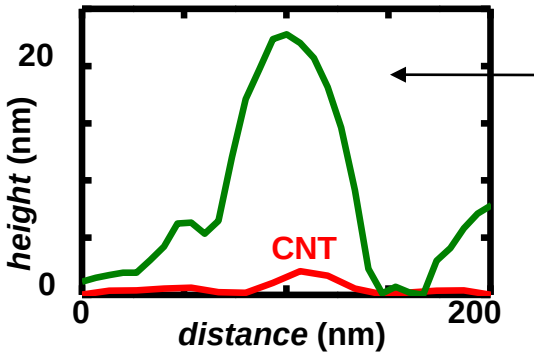


carbon nanotube

„on chip“ functionalization with photosystem I







carbon nanotube with photosystem I

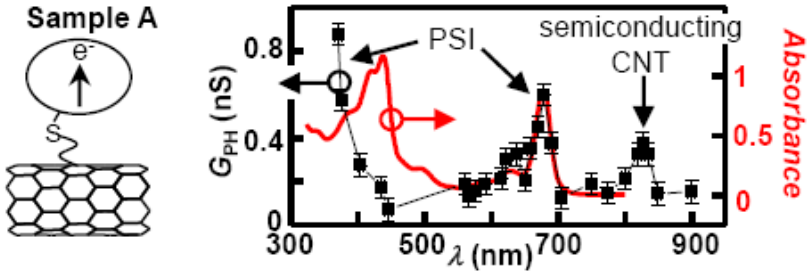
PSI-carbon nanotube hybrid wire

S. Kaniber, M. Brandtstetter, F.C. Simmel, I. Carmeli, A.W. Holleitner, J. Am. Chem. Soc. 132, 2872 (2010).

Optoelectronic functionalization

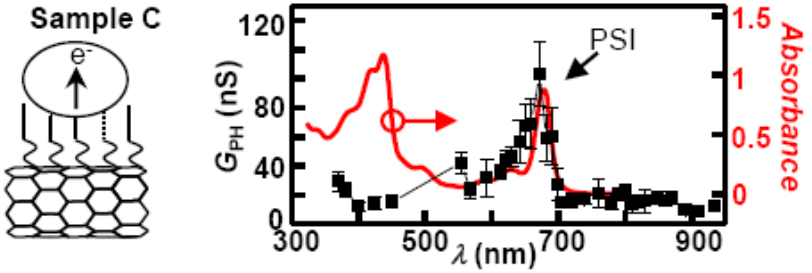
Covalently binding

perpendicular orientation



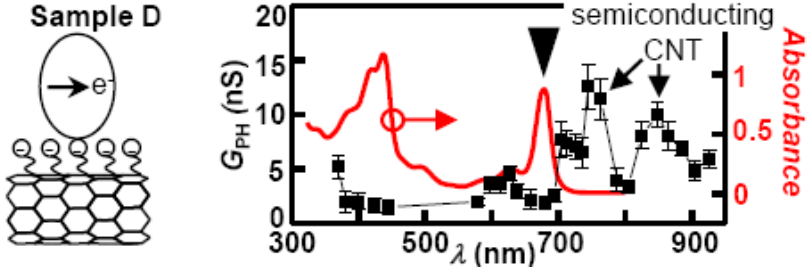
Hydrogene bonds
or electrostatic interactions

perpendicular orientation



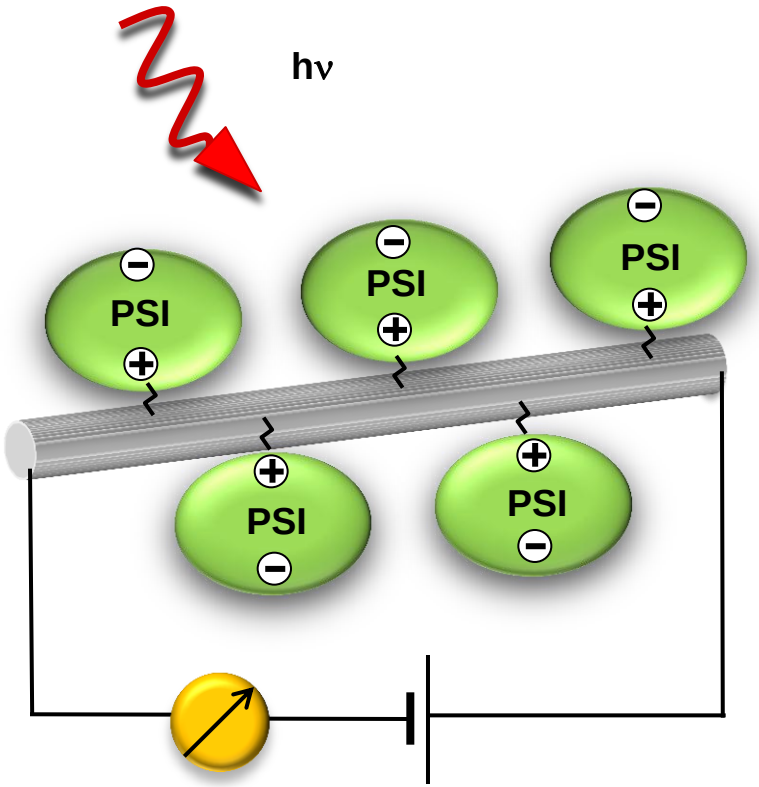
Coulomb interaction

parallel orientation



S. Kaniber, M. Brandtstetter, F.C. Simmel, I. Carmeli, A.W. Holleitner, J. Am. Chem. Soc. 132, 2872 (2010).

Charge carrier dynamics between the photosystem I and carbon nanotubes



light induced charge separation

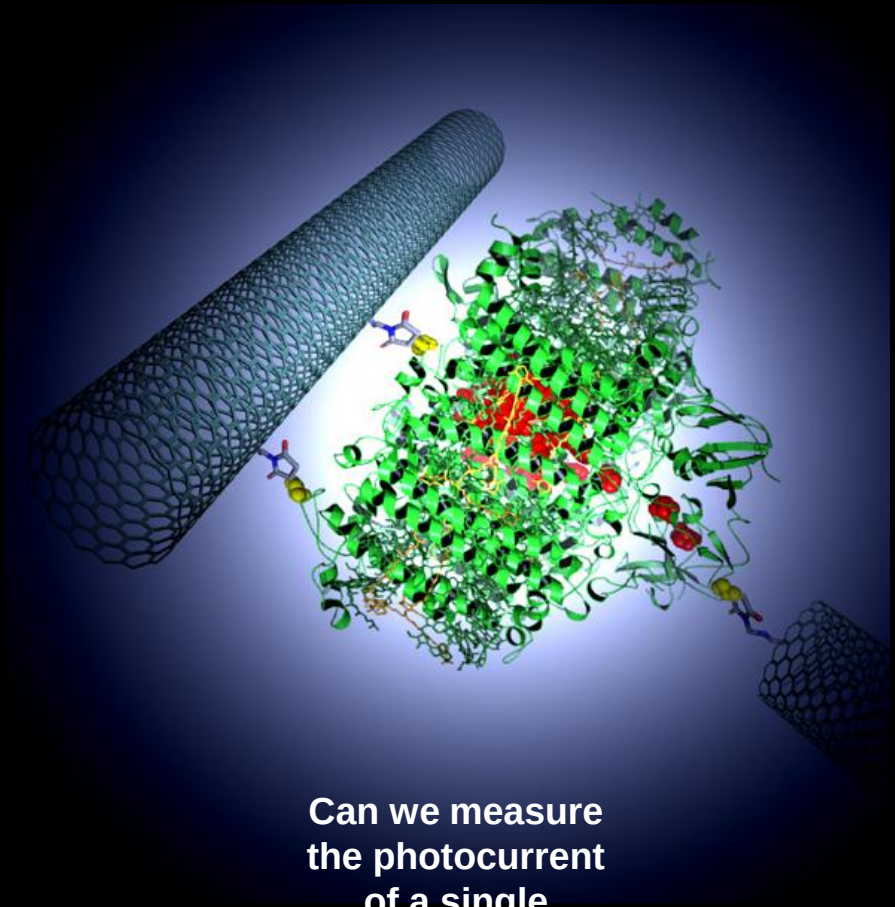
gating effect

energy transfer

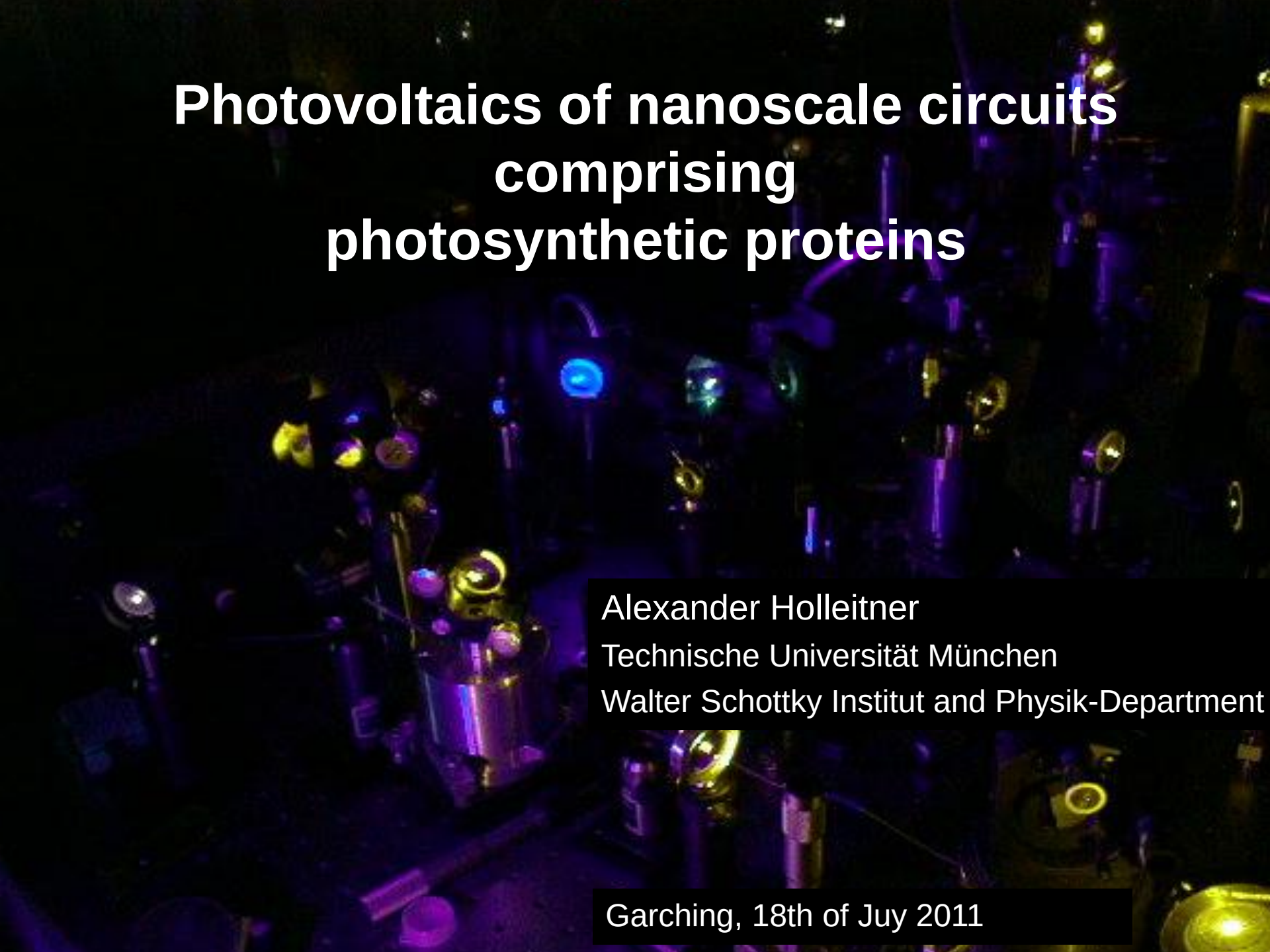
bolometric effects

charge transfer

S. Kaniber, F.C. Simmel, A.W. Holleitner, I. Carmeli, Nanotechn. 20, 345701 (2009).



Can we measure the photocurrent of a single photosynthetic protein?



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