Physics of 
Solar Energy Conversion 
in Halobacteria by 
Photoinduced Proton Pumping

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Photoinduced translocation of \( H^+ \) from cytoplasmatic channel with pH > 10 to extracellular channel with pH < 3.5

**How can this happen?**

**Traditional model:**
- translocation of \( H^+ \) from cytoplasmatic channel to extracellular channel by conformational change of protein corresponding to step from 7 (stage L550) to 8 (stage M412)

**Present model:**
- initial steps from 1 to 3: **photoinduced \( \pi \)-electron shift away from N and thus deprotonation of Schiff base** leaving \( H^+ \) in extracellular channel
- translocation of \( H^+ \) from cytoplasmatic channel to extracellular channel by thermal cis-trans isomerisation (step from 9 to 10)
Coulomb field (4 · 10^9 V/m, from D212 and D85)
shifting π-electron cloud away from N:
bonding of NH\(^+\) weakened by 0.5 eV → ΔpK = -8.3 (exp: 3.5 - 10 = - 6.5)
Presented model: Synopsis

Present model supported by mutant in which trans-form of chromophore is blocked:

- photoinduced release of H⁺ into extracellular channel as in wild-type
- recombination slow (16ps)
Traditional model:
- U. Haupts, J. Tittor, D. Oesterhelt
  Biochemistry 36, 2 (1997)

Present model:
- H. Kuhn, C. Kuhn
- H. Kuhn, H.-D. Försterling, D. Waldeck
  Principles of Physical Chemistry
  2nd Ed., Wiley 2008

Femto-second spectroscopy:
- J. Dober, W. Zinth, W. Kaiser, D. Oesterhelt
- J. Herbst, K. Heyne, R. Diller
  Science 217, 822 (2002)

Mutant with chromophore blocked in trans-form:
- A. Aharoni, I. Weiner, M. Ottolenghi, M. Sheves
  J. Biol. Chem. 275, 21010 (2000)