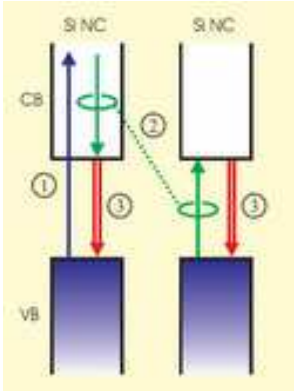
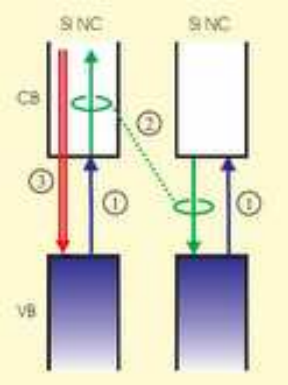
Pasting photons with silicon nanocrystals

Recently we have observed an effect of "quantum cutting" using Si nanocrystals (SiNCs). The idea behind this phenomenon is very simple, but could have great beneficial consequences for efficiency of solar cells and in that way contribute towards sustainable energy development. The process works as follows (figure to the right): when a NC is excited with a photon (1) it will eventually emit a photon with a typical wavelength corresponding to the NC bandgap (3). If the energy of this excitation photon is made large enough, part of its energy can be used to excite another neighboring NC (2). This means that with one "large" photon we can now excite two NCs! We have termed this process "space-separated quantum cutting" (SSQC) and described it in Nature Photonics **2**, 105 (2008) – see also *"Solar cells: Slicing and dicing photons"* – in the same issue of this journal, for the application potential of this finding for solar cells.



Space-separated quantum cutting



Quantum pasting

In quantum mechanics, however, absorption and emission are mirror-like processes and therefore if *down-conversion* of photons, as in the SSQC, is allowed, then so should also be the opposite effect of *up-conversion*. This means that besides "quantum cutting" we should also be able to observe "quantum pasting"; two neighboring NCs should be allowed to combine their "small" excitation energies into one "large" excitation - see figure left. This is the main task of the proposed research: it will be really interesting and also relevant, to observe this up-conversion process taking place in NCs (which has to our knowledge never been reported), from the quantum mechanical point of view, but also in view of the application perspective.