Molecular upconversion

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Upconversion (UC) is the process by which the energy of two or more photons are stored in a compound and restored in the form of luminescence at a higher energy than the excitation beam. If the process is known for more than 60 years in solid compounds,[1] it is only some ten years ago that the first examples were described in discrete molecules at very low temperature (30K) in organic solvents.[2]

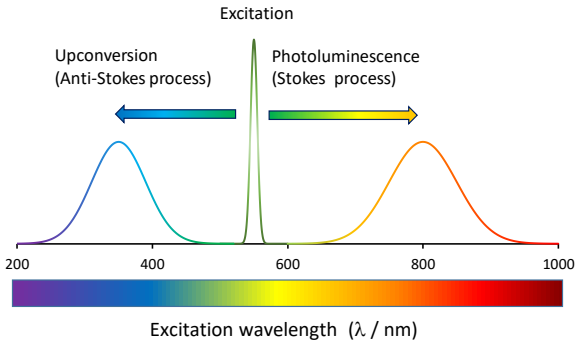

Figure 1: representation of conventional and non-conventional (Anti-Stokes) luminescence process

Through the rational design of heteropolynuclear lanthanide complexes, we succeeded to demonstrate that molecular UC can not only be observed at room temperature,[3] but also in aqueous solvents,[4] and even in pure water,[5] opening the space to a brand new family of luminescent labels.

Additionally, supramolecular architectures enlarged the perspectives of yet unexplored UC mechanism at the molecular level, such as the observation of cooperative sensitization in Yb/Tb nonanuclear clusters,[6] cooperative sensitization of Yb dimers,[7] or Yb to Ru UC energy transfer in hetero-polynuclear d-f complexes.[8]

Since my very first contact with UC at the university of Geneva with Pr Jørgensen's book,[9] up to the latest advances of our group, I will present a little journey into molecular UC.

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[1] Auzel, F. *Chem. Rev.* **2004**, *104*, 139.
[2] Piguet, C. et al *Angew. Chem. Int. Ed.* **2011**, *50*, 4108.
[3] Nonat et al. *Nature Comm.* **2016**, *7*, 11978.
[4] Souri et al. *J. Am. Chem. Soc.* **2017**, *139*, 1456.
[5] Nonat et al. *J. Am. Chem. Soc.* **2019**, *141*, 1568.
[6] Knighton, R. *Angew. Chem. Int Ed.* **2022**, *61*, 202113114.
[7] Knighton, R. et al. *Adv. Opt. Mater.* **2023**, doi: 10.1002/adom202202307.
[8] Knighton, R.*J. Am. Chem. Soc.* **2022**, *144*, 13356.
[9] Reisfeld, R., Jørgensen, C. K, in "lasers and excited states of rare earths", Springer, 1977.