Ratchet transition is required for nanostructured intermediate band solar cell.

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The Intermediate Band Solar Cell (IBSC) is an elegant concept proposed by Luque and Marti in 1997 as a way to overcome the Shockley Queisser limit by introducing an energy level within the bandgap [1]. Electrons can be promoted to the conduction band through a double photon absorption, corresponding to an effective built-in up-conversion system and leading to a theoretical efficiency increase up to 46.8%. Yet, no experimental system managed to exceed the SQ limit so far, and the proof of concept of an IBSC is still to be made.

One well accepted approach for the realization of such device is to consider nanostructured systems, where the intermediate state would be confined within a quantum dot or a quantum well [2]. However, in such a configuration, the intermediate-band-to-conduction-band transition is intraband, and therefore necessarily narrow [3]. Moreover, such nanostructures are likely to suffer from important non-radiative recombination processes.

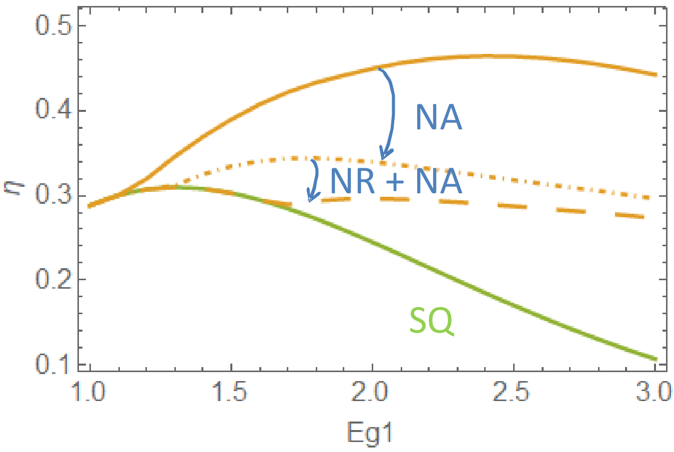

Fig1 : Maximal conversion efficiency for a single junction (green) and a IBSC as described in [1] (yellow plain line). The influence of a narrow absorption (NA, dotted line) and NA + non-radiative losses (NR+NA, dashed line) reduces the efficiency, below SQ limit for the latter.

In this presentation, we will show that the combination of these two detrimental effects (narrow absorption and non-radiative losses) has a very strong detrimental effect on the IBSC (see Fig 1), and prevents it from exceeding the Shockley Queisser limit in most practical case [4]. By contrast, if a non-emissive state is introduced slightly below the intermediate band (the so-called *ratchet band* [5]), the system becomes extremely robust against the combined effects of those non-idealities. Based on these observations, we conclude on effective guidelines for the realization of efficient IBSC.

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