Two-photon-pumped perovskite semiconductor nanocrystal lasers with remarkable low thresholds

With the supports of the National Natural Science Foundation of China and the Basic Research Program of China, the research team led by Prof. Xiao Min (肖敏)and Prof. Zhang Chunfeng at the National Laboratory of Solid State Microstructures and School of Physics, Nanjing University, demonstrated efficient-perovskite semiconductor nanocrystal lasers with two-photon pumping, which was published in *J Am Chem Soc* (2016, 138: 3791).

Two-photon-pumped lasers have been regarded as a promising strategy to achieve frequency up-conversion for situations where the condition of phase matching required by conventional approaches cannot be fulfilled. In particular, up-converted lasers with miniature sizesare of great promise for biomedical applications owing to the merits of spatially-confined excitation and deep tissue penetration of infrared pump light.

Many desired practical applications of two photon-pumped lasers have been hindered by the high pump threshold due to the lack of materials holding both efficient two-photon absorption and ease of achieving population inversion. This Nanjing University team has aimed to tackle this issue with different semiconductor nanostructures. Recently, they achieved a breakthrough with the emergent semiconductors of perovskite structured metal halides. In the $CsPbBr_3$ nanocrystals, the cross section of two-photon absorption was measured to be extremely high, over two orders of magnitude larger than the conventional CdSe nanocrystals. More excitingly, the efficient two-photon absorption can generate sufficient optical gain in $CsPbBr_3$ films with a modal gain coefficient over 500 cm^{-1}. The gain mechanism has been well studied by employing transient absorption spectroscopy. Based on those merits, two photon-pumped lasers have been demonstrated by coupling $CsPbBr_3$ nanocrystals with whispering gallery mode resonators. Remarkably, the achieved lasing threshold was recorded low for frequency up-converted nanocrystal lasers. In addition, the lasers show robust stability with no degradation over hours of pumping excitation under the ambient environment. These advances have shown a great promise to employ perovskite semiconductors for practical applications of two-photon-pumped lasers.

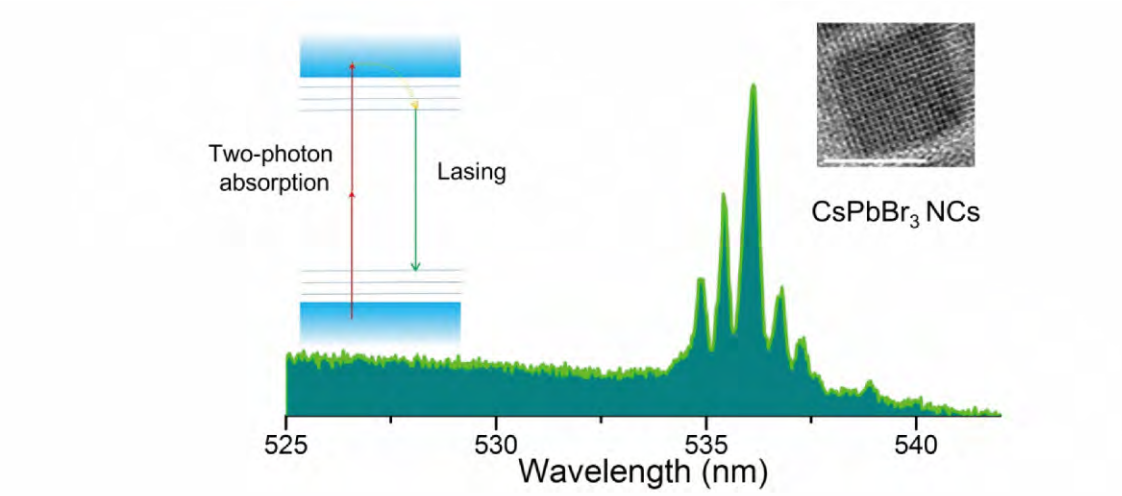

Figure Twophoton-pumped perovskite$CsPbBr_3$ nanocrystal lasers.