Resonance optical trapping of single dye-doped polystyrene nanoparticles with blue- and red-tuned lasers

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Tightly focused laser beam can optically trap micro- and nano-sized objects in solution by using a radiation force [1]. From the viewpoint of light and matter interaction, resonance optical trapping using the electronically resonant laser, is conceptually interesting and the movement of the objects can be directly controlled by quantum mechanical properties of the objects.

Previously, we theoretically found that nonlinear optical effects play an essential role in the resonance optical trapping [2]. In particular, we proposed that the resonance optical trapping with blue-tuned laser gives a larger optical potential than that with red-tuned laser. On the other hand, there are several experimental reports of the resonance optical trapping by using blue-tuned [3] or red-tuned laser [4]. Unfortunately most of the reports show the results without operating both lasers and also without comparing with a non-resonant laser.

In order to understand the mechanism more deeply including a verification of the theoretical proposal, we have demonstrated the resonance optical trapping of single polystyrene nanoparticles with and without the dye-doping using blue- and red-tuned lasers. In particular, we have measured immobilization time of trapped single particles, which is straightforward to compare with our theoretical calculation. As a result, we have found that the immobilization time of the dye-doped polystyrene nanoparticle becomes longer than that of bare one, for both blue-tuned and red-tuned lasers. Through the experimental and theoretical studies, we expect that resonance optical trapping will provide a new perspective to the field of light and matter interaction.

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