A dark-field microscope for background-free detection of resonance fluorescence from single semiconductor quantum dots operating in a set-and-forget mode

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Optically active quantum dots, for instance self-assembled InGaAs quantum dots, are potentially excellent single photon sources. The fidelity of the single photons is much improved using resonant rather than non-resonant excitation. With resonant excitation, the challenge is to distinguish between resonance fluorescence and scattered laser light. We have met this challenge by creating a polarization-based dark-field microscope to measure the resonance fluorescence from a single quantum dot at low temperature. We achieve a suppression of the scattered laser exceeding a factor of 107 and background-free detection of resonance fluorescence. The same optical setup operates over the entire quantum dot emission range (920-980 nm) and also in high magnetic fields. The major development is the outstanding long-term stability: once the dark-field point has been established, the microscope operates for days without alignment. The mechanical and optical designs of the microscope are presented, as well as exemplary resonance fluorescence spectroscopy results on individual quantum dots to underline the microscope's excellent performance. (C) 2013 AIP Publishing LLC.

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