Electronic Supplementary Information: Effect of hydrodynamic inter-particle interaction on orbital motion of dielectric nanoparticles driven by an optical vortex

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Movie S1 (movieS1.avi)

Orbital motion of the particle with the diameter $d_\mathrm{p} = 1$ µm for the number of particles in the orbit $N = 8$, 10, and 12. The laser power $P_\mathrm{laser} = 541$ mW and the azimuthal mode $m = 1$ are used. As a consequence of hydrodynamic inter-particle interaction, the orbital speed is faster for larger N. The corresponding data are shown in Fig. 10(a). The radius of the orbital motion is about 2.1 µm.

Movie S2 (movieS2.avi)

The experiment without microscale confinement. The nanoparticle of the diameter $d_\mathrm{p} = 0.2$ µm with 5×10^{-4} vol% concentration is put in a cylindrical chamber with the diameter 5 mm and height 1 mm. The optical vortex beam irradiation at the center of the observation region starts at $t = 1.2$ s, where the laser focus is placed at the bottom of the chamber. The azimuthal mode is set to be $m = 1$ and P_laser is set to be 400 mW. After the onset of the laser irradiation, the particle starts to be de-focused, that is, the particle is pushed away in the z direction, which is the direction of the beam propagation. This movie demonstrates the importance of the microscale confinement for the stable orbital motion of dielectric nanoparticles. Note that the microscale confinement is also useful to avoid the onset of thermal convection, which may arise because of the temperature increase of the solution due to laser absorption, namely, a photothermal effect.

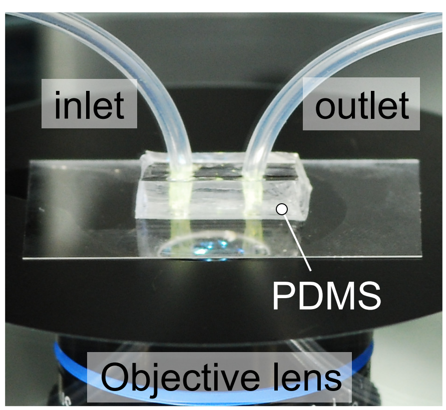

Fig. S1: Photograph of the microfluidic device on the microscope stage in Fig. 2.