OPTICAL LEVITATION OF LIQUID DROPLETS

S. Radhakrishnan[1], K. Chang[1], J. Tello Marmolejo[1], A. Aleman[1], A. J. Bae[2], P. Bhaskar[1], J. Enger[1], O. Isaksson[1], A. Johansson[1], C-J. Karlsson[1], G. Magnusson[1], B. Mehlig[1], and D. Hanstorp[1]

[1]University of Gothenburg, Gothenburg, Sweden, [2]Max Planck Institute for Dynamics and Self-Organization, 37077 Göttingen, Germany.

dag.hanstorp@gu.se

Optical levitation was first demonstrated by Ashkin and Dziedzic [1]. We will here present a versatile experimental system for optical levitation of micron-sized liquid droplets that allows us to control many of the experimental parameters. Two piezo-driven dispensers are used to produce liquid droplets on demand. The charges of the droplets are controlled at the production by applying an electric field on the piezo-dispenser heads and during an experiment by exposing it to ionizing radiation or UV light. The dispensers release droplets into two independently controlled optical traps.

Three dimensional size and position data on droplets in the traps are measured using two orthogonally placed high speed cameras. The electrical charge of the droplets are measured by recording their motion when an electric field is applied. Spectroscopic information about the trapped droplets is obtained by imaging the droplets on the entrance slit of a spectrometer. Finally, the trapping cell can be evacuated, allowing us to investigate droplet dynamics in vacuum.

We present four different experiments. First, we investigate how the rate of droplet coalescence depends upon their charges. Fig. 1 shows the coalescence process between two droplets with a time resolution of 77 µs. Second, we measure the spectra of two colliding droplets which have been doped with different dyes. The mixing of the dyes is monitored by observing the FRET (Förster Resonance Energy Transfer) signal. Third, we describe the motion of two droplets trapped in the same optical trap. We observe how the droplets move in stable periodic orbits resembling the motion of balls being juggled by a carnival performer. Using a numerical model constructed with Newtonian mechanics and ray optics, we show that the juggling motion arises from particles taking turns eclipsing each other [2]. Finally, we measure the removal of electrons from a trapped droplet at a resolution that is better than a single electron charge, making it to a single-drop Millikan like experiment [3].

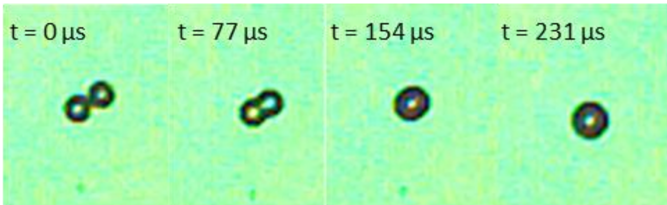

Fig. 1. *Coalescence process between two glycerol droplets held in two optical traps when close to each other.*

ACKNOWLEDGEMENTS: The authors thank Funding from the Swedish Research Council, Carl Tryggers foundation for Scientific Research and the Knut and Alice Wallenberg Foundation under Grant No. 2014.0048.

REFERENCES:

1. Ashkin A. and Dziedzic J.M., Applied Physics Letters **1971**, *19*, 283.

2. Bae A. J., D. Hanstorp and Chang K, Physical Review Letters, **2019**, *12*, 043902.

3. Millikan R. A., Physical Review 1913 *2*, 109.