Electronic Supplementary Material (ESI) for Soft Matter.

Application of Droplet Migration Scaling Behavior to Microchannel Flow Measurements

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Supplemental information

S1. Figure S1 a) and b) are scatter plots of droplet position vs. size, comparing data obtained at three different distances from the point where droplets enter the plastic tubing from a smaller diameter syringe. Flow is in the x-direction throughout the system. The data in red is collected at 15 cm from the syringe entrance, representing 5 cm into the glass tubing after 10 cm of plastic tubing of comparable inner diameter, the same as all data shown in the main manuscript. The data in blue is collected at 38 cm from the entrance, representing 8 cm into the glass tubing after 30 cm of plastic tubing. The average slope of the depletion layer is 0.43 for data collected at 38 cm from the entrance, as compared to a slope of 0.57 for data collected 15 cm after the entrance, which represents a ~24% difference. The data in black in Figure S1b is collected using 1 m of plastic tubing and at 8 cm into the glass tubing. The average slope of the depletion layer is 0.49 for 1 m from the entrance which is a 15% difference from the data collected at 15 cm from the entrance. Interestingly, the measurement of L/a does not strongly depend on the distance from the entrance, despite the order of magnitude difference in the tubing lengths used in the three measurements. The size difference in the three populations of droplets can be explained by sample-to-sample differences in preparing the emulsions. DLS measurements show that the droplets are stable against coalescence, with a polydispersity of ~20% for data collected over 5 minutes, longer than the time needed to obtain microscopy measurements.

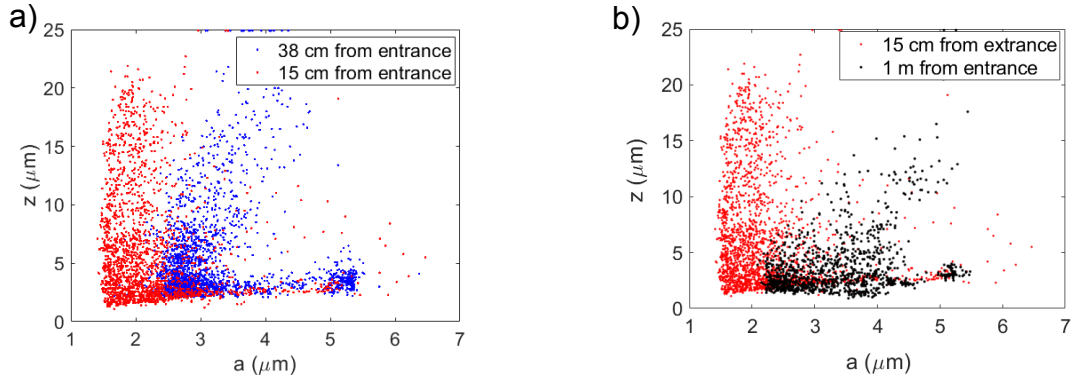

Figure S2. Scatter plots of droplet positions at $\phi_0 = 10^{-4}$ and $\dot{\gamma} = 13.3\ s^{-1}$ for droplets 15 cm from the entrance (red) with a) 38 cm from the entrance (blue) and b) 1 m from the entrance (black).

S2. In phase-contrast microscopy imaging, droplets appeared as both dark and bright objects. Both the bright and dark spots are analyzed as shown in Figure S2 which depicts the raw velocity data, the position distribution, and the size distribution for an emulsion flowing at 5 μL/min with a volume fraction of $1x10^{-3}$. The bright spots (red) are closer to the wall of the channel than the dark spots (blue). There are about twice as many dark spots as there are bright spots. The droplets appearing as bright spots are also smaller in diameter than the dark spots. As seen in figure S2b, there is a layer close to the wall where no droplets are present, characterized as a depletion layer. The dark spots do not affect the depletion layer which is formed by bright spots. Interestingly, there are two clear populations of droplet sizes and position probability distribution as seen in Figures S2c and S2d through the red and blue distributions. Although our system is polydisperse, similar position distributions across a channel are seen with binary systems of particles and blood.[1-3]

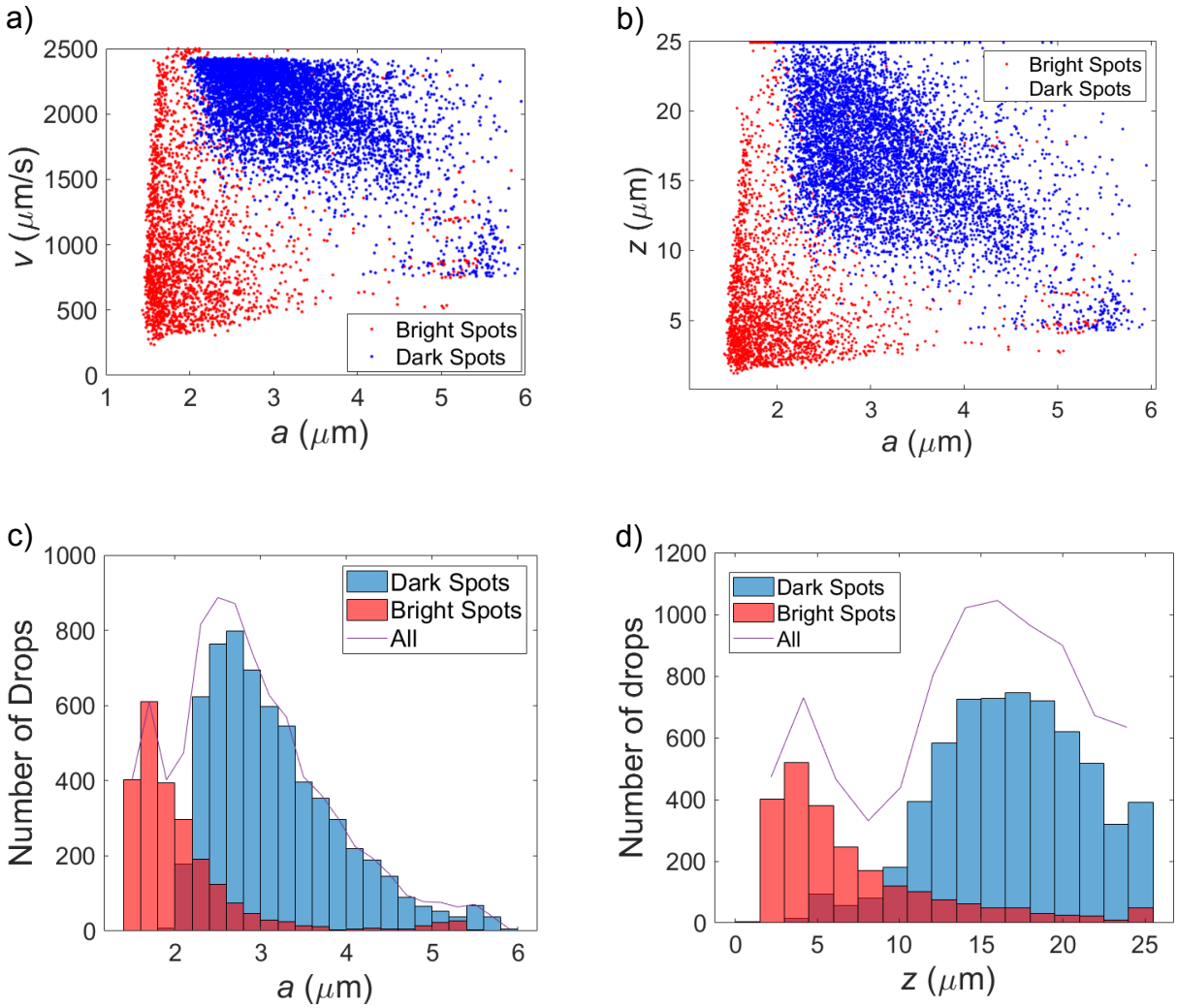

Figure S2. a) Raw velocity data for droplets that appear bright (red) and droplets that appear dark (blue) in phase contrast. b) Position of each droplet with respect to size for bright (red) and dark (blue) appearing droplets where 0 is the wall of the channel and 25 is the center of the

channel. c) Size distribution of bright (red), dark (blue), and all (purple) droplets. d) Position distribution of bright (red), dark (blue), and all (purple) droplets where 0 is the wall of the channel and 25 is the center of the channel.

[1] K. Sinha and M. D. Graham, "Shape-mediated margination and demargination in flowing multicomponent suspensions of deformable capsules," *Soft Matter,* vol. 12, no. 6, pp. 1683-1700, Feb 14 2016, doi: 10.1039/c5sm02196k.

[2] K. Vahidkhah and P. Bagchi, "Microparticle shape effects on margination, near-wall dynamics and adhesion in a three-dimensional simulation of red blood cell suspension," *Soft Matter,* vol. 11, no. 11, pp. 2097-2109, Mar 21 2015, doi: 10.1039/c4sm02686a.

[3] D. Semwogerere and E. R. Weeks, "Shear-induced particle migration in binary colloidal suspensions," *Phys Fluids,* vol. 20, no. 4, 2008, doi: 10.1063/1.2907378.