Exploiting multi-drop interactions in microfluidic networks – Platforms for high throughput material and biological analysis

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Droplet-based microfluidics where reactants or biological species are encapsulated in thousands of tiny water droplets is witnessing a tremendous interest for applications in chemistry, biology, medicine and material science. Our laboratory is working on two engineering challenges in this field of drop-based microfluidics. The first is to store arrays of immobilized nanoliter-scale droplets in microfluidic substrates so that thousands of biochemical reactions can be monitored in individual drops over a desired duration. The second is to develop methods to change the composition of reactants in these static drop arrays so that high throughput screening can be pursued.

To address these challenges, our laboratory has been focusing on investigating the dynamics of trains of confined drops and/or long plugs in a special class of fluidic networks called microfluidic parking networks. These networks consist of a repeated sequence of loops, with each loop containing a fluidic trap to park (i.e. immobilize) drops. In this talk, I will discuss how we harness multi-drop interactions in these networks to achieve our engineering goals. I will also highlight the underlying physics regulating some of the droplet behaviors we observed in these networks. Finally, I will discuss our efforts to translate these inexpensive microfluidic platforms for specific applications in material science and biology.