From Electrostatics to Piezoelectrics: A Decade-Long Journey in the Development of Microscale Centrifugation and Lab-on-a-Disc Platforms

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***Abstract*— This talk describes the discovery of the first microcentrifugation platforms which originated from a completely unrelated phenomenon—AC electrohydrodynamic atomization. Almost by serendipity, unsuccessful attempts at electrospraying high surface tension liquids led to the accidental observation that it is possible to drive vortical microflows on the free surface of a sessile drop, and, consequently, secondary bulk meridional liquid recirculation, through the application of an external high voltage gas phase electric field, which upon atmospheric dielectric breakdown, induced a bulk electrohydrodynamic air thrust that, in turn, generated the azimuthal liquid flow through shear. Both the surface and bulk recirculation can then be demonstrated for concentrating particles suspended in the liquid, the former due to shear-induced particle diffusion, and the latter, due to an effect analogous to Einstein's tea leaf paradox associated with Batchelor flows occurring in a cylindrical liquid column between a stationary and rotating disc. These early forays in symmetry-breaking subsequently inspired work on the development of microcentrifugation and Lab-on-a-Disc platforms using piezoelectric materials that can be exploited for driving rapid chaotic micromixing and bioparticle separation/concentration for a host of microfluidic chemical and biological sensing applications.**