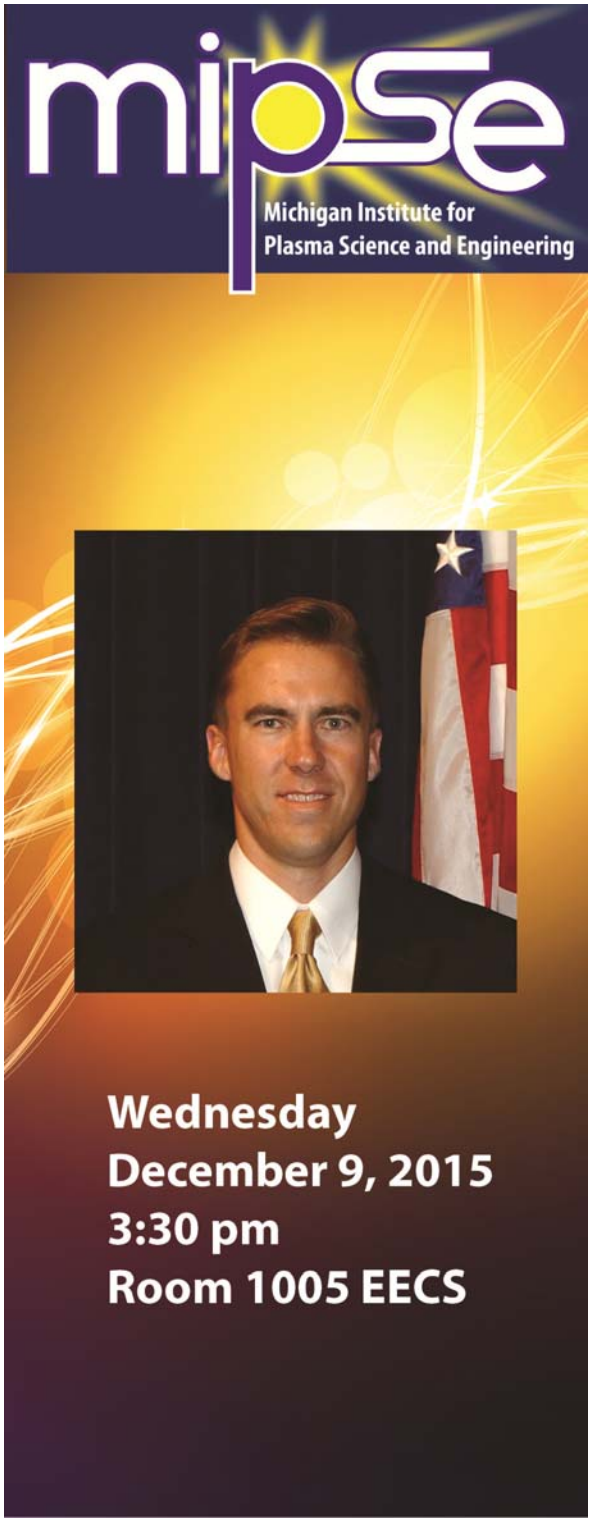

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Plasma in a Bottle: The Strange Dynamics of Superparamagnetic Ionic Liquids

Anyone with a refrigerator and a prized piece of child's art has witnessed the impressive external torques and forces that can be transmitted between two magnetized solids. Less obvious to the kitchen observer are the internal forces and torques within a single magnet, since these reactions are strongly opposed by the elastic rigidity of the magnetic material and hence the outward shape of each magnet changes imperceptibly. If instead the magnetic material is a fluid then the internal magnetic stresses cause large-amplitude and often surprising rearrangement of the medium. While strongly magnetic fluids do not exist in nature they can be created in the laboratory by dispersing magnetic nanoparticles into a carrier liquid; the resulting colloids are known as 'ferrofluids.' In work reported here, novel ferrofluids are synthesized where the carrier liquid is a room-temperature molten salt composed of molecular ions. The resulting 'ionic liquid ferrofluids' are both superparamagnetic and electrically conductive. Owing to the conductivity, ionic liquid ferrofluids can be stimulated with electric fields to induce Lorentz forces and electrohydrodynamic effects in addition to the magnetic response. The dynamics of these exotic fluids will be examined by comparing magneto-electrostatic surface instabilities, jets, and sprays with their traditional neutral fluid counterparts. A unique application will be introduced wherein an ionic liquid ferrofluid is persuaded to self-assemble into an array of parallel independent electrospray beams useful for spacecraft propulsion.

About the Speaker: Dr. Lyon (Brad) King earned his PhD in Aerospace Engineering from the University of Michigan in 1998. Dr. King was then awarded a National Research Council Postdoctoral Fellowship, where he conducted research in the area of laser cooling and quantum manipulation of trapped ions at the National Institute of Standards and Technology (NIST) under advisor David Wineland. In 2000 Dr. King was appointed an Assistant Professor of Mechanical Engineering at Michigan Technological University in his hometown of Houghton, Michigan. In this position Dr. King earned the National Science Foundation Faculty Early Career Award for his research into the plasma physics of Hall-effect space thrusters in 2004. Also in 2004, Dr. King received the Presidential Early Career Award for Scientists and Engineers (PECASE) through a DoD nomination. Dr. King is presently engaged in research and educational activities in the areas of spacecraft design, nanosatellite technology, defensive and offensive counter-space architectures, plasma physics, nanostructured magnetic fluids, and advanced spacecraft propulsion. Dr. King is an Associate Editor of the AIAA Journal of Propulsion and Power and has served as Technical Chair of the AIAA Electric Propulsion Technical Committee.