Final Technical Report for DOE Grant No. DE-SC0021290

Dynamical Inference and 3D Imaging of Magnetized Dusty Plasmas

DOE Program Manager: Nirmol Podder

Period of Performance: 9/1/2020 - 8/31/2022

Principal Investigator: Justin C. Burton, Professor of Physics at Emory University

Total Amount of Award: $97,795

The main purpose of this award was to perform 3D imaging of a dusty plasma at Auburn Universities MDPX experimental facility. The award supported the development of the 3D imaging and tracking system, which was successful, and our results were published in the Physics of Plasmas: https://doi.org/10.1063/5.0147458. In May 2022, a graduate student (Wentao Yu) and I traveled to Auburn University for 1 week and setup up our experimental apparatus on the MDPX device. The main goal was to collect (for the first time) data on the 3D trajectories of dust particles in a plasma at high magnetic fields where the forces on particles could be very different than in traditional, non-magnetized plasmas. We ran into many unforeseen problems. For example, the camera stopped working at B = 0.4 Tesla, which limited the range of our data. Nevertheless, we did successfully collect some data, and this helped us to implement a magnetic field in our laboratory plasma back at Emory University. Prof. Edward Thomas also got to know Wentao Yu well, and serves on his PhD committee now. Ultimately this grant was instrumental in developing machine learning techniques to extract forces on particles in dusty plasmas, and also led to another publication: https://doi.org/10.1103/PhysRevE.106.035303.

Finally, we have consulted with the company that manufactures our high-speed camera and we now have a work-around for the issues at high magnetic fields. We plan to implement these in future, possibly DOE-funded, campaigns to examine dust particles at fields up to 4 T. We thank the DOE for their support at Emory University.