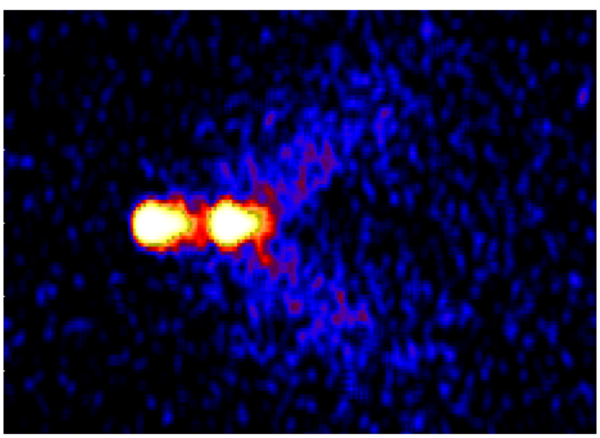
**Numerical Simulations of the Lunar Plasma environment with the VORPAL framework.** P. Messmer[1], M. Horanyi,[2,4] Z. Sternovsky,[2] J. Colwell,[3] and S. Robertson[4], [1]Tech-X Corporation, 5621 Arapahoe Avenue, Suite A, Boulder, CO 80303 , [2]Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder, CO 80309-0392, [3] Department of Physics, University of Central Florida, Orlando, FL 32816, [4]Physics Department, University of Colorado, Boulder, CO 80309-0390

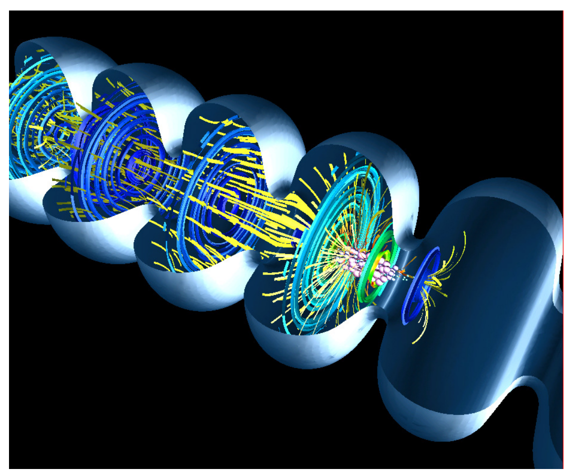
**Introduction**: As a function of time and location, the lunar surface is exposed to solar wind plasma, UV radiation, and/or the plasma environment of our magnetosphere. Dust grains on the lunar surface collect electrostatic charges and contribute to the large-scale surface charge density distribution. They emit and absorb plasma particles and solar UV photons, and provide an electromagnetic interface to the lunar interior[1]. There are several in situ and remote sensing observations that indicate that dusty plasma processes are responsible for the mobilization and transport of the lunar soil. These processes remain among the least understood effects on the lunar surface. Effects like the charging process of the lunar surface, as well as individual dust grains in the near-surface plasma, the formation of the photoelectron sheaths, and the possible mobilization and lift-off of dust particles might play a possibly prohibitive role in our ability to develop sensitive in situ instrumentation, and/or human habitats.



**VORPAL simulation of wake formation behind two dust grains in a plasma streaming from left to right. Bright colors indicate high net charge.**

To develop the appropriate in situ instrumentation for the observation of these processes, and to analyze and understand these measurements, there is an urgent need for theoretical models and computer simulations that account for the interactions between the surface and the plasma environment. Similarly, designing human habitats and protecting optical and mechanical devices on the moon poses various engineering challenges. In order to overcome these challenges, the properties of the lunar plasma environment have to be well understood. Here we report on the initial results on using a sophisticated plasma simulation package to investigate these dusty plasma processes on the lunar surface. The large-scale parallel plasma modeling framework VORPAL, developed at the University of Colorado, Boulder, and Tech-X Corporation, offers the physical models to investigate this environment in a self-consistent way in both 2 and 3 dimensions[2].

The code offers both an electromagnetic and electrostatic model, which allows investigating effects solving the full set of Maxwell's equations and problems where the magnetic induction can be neglected and computational time can be saved by solving Poisson's equation instead [3]. The plasma can be treated either kinetically, as a fluid or as a combination with e.g. fluid electrons and kinetic ions. In addition to models for collisionless plasmas, VORPAL also features collisional processes, including ionization and recombination. Finally, the capability to model complex geometries enables to investigate the effects of dust on man-made structures.



**Complex electromagnetic structure modeled with VORPAL.**

**References:**

[1] J. E. Colwell, S. Batiste, M. Horanyi, S. Robertson, S. Sture, The Lunar Surface: Dust Dynamics and Regolith Mechanics, *Reviews of Geophysics*, in print, 2007.

[2] Nieter, C and Cary, J.R. (2002) *J. Comp. Phys, 196, 448.*

[3] Messmer, P. and Bruhwiler, D, (2004) *Comp. Phys. Comm., (2004) 164, 118.*