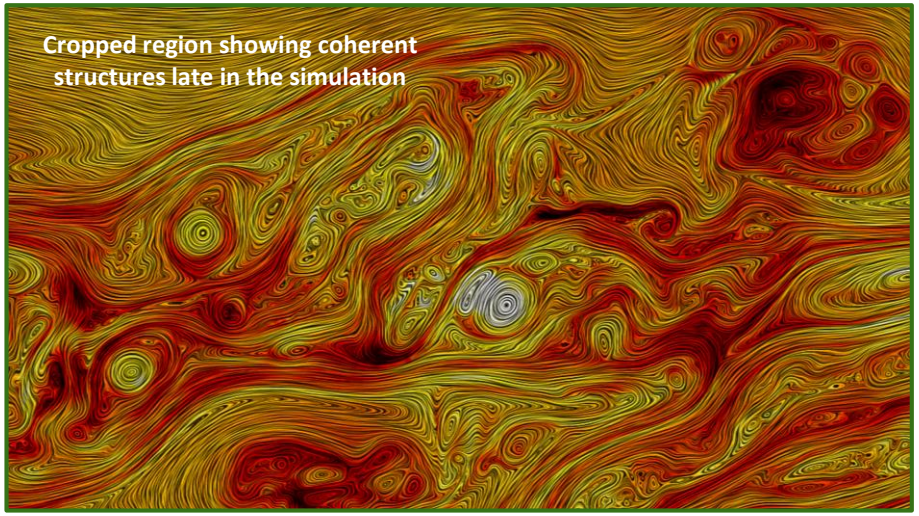
PIC simulations of heating in the solar wind resolve full spectrum of physics down to electron scales

Objectives

- Analyze the full spectrum of heating modalities from those measured in units of Earth radius down to those measured on the scales of electron interactions
- Interactive remote visualization and analysis of the entire dataset across the entire range of physical scales.

Approach

- Apply fully kinetic PIC explicit modeling of electrons and ions in hot magnetized plasma to study heating in the solar wind.
- VPIC ran for ≈72 hr w/ 50k cores on Jaguar to simulate $4x10^{10}$ particles on a 16384x8192 grid producing over 7 TB



- ***Coherent Structures, Intermittent Turbulence and Dissipation in High-Temperature Plasmas***, Physics of Plasmas, Jan 2013
- ***Intermittent Dissipation at Kinetic Scales in Collisionless Plasma Turbulence***, Physical Review Letters, Nov 2012
- ***Coherent Structures, Intermittent Turbulence and Dissipation in High-Temperature Plasmas***, SC13 Scientific Visualization Showcase, Nov 2013
- ***In-situ visualization for global hybrid simulations***, Proc. XSEDE '13, Aug 2013

Results

- Developed parallel surface LIC algorithm for data parallel "multi-block" composite datasets supporting VTK and ParaView. Fixed VTK so that it can run fully with or without GPUs. The work is released in VTK 6.1 and PV 4.1.
- Our analysis of the unprecedented PIC simulation revealed a previously unknown heating modality: waves driven by motion of coherent structures. We analyzed all of the heating modalities to put the discovery in its proper context
- "Partnering with the [visualization] group at Berkeley Lab has been critical in developing tools to analyze our data sets. There is an urgent need to develop accurate forecasting models; a severe space-weather event can have dire financial and national security consequences." lead scientist Dr. H. Karimabadi UCSD.

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