MODELING PHYSICAL PROCESSES IN THE SOLAR WIND AND LOCAL INTERSTELLAR MEDIUM WITH A MULTISCALE FLUID-KINETIC SIMULATION SUITE: CONNECTING SOLAR, HELIOSPHERIC, AND ASTROPHYSICAL SCALES

Research Challenge
The grand challenge of this research is to create computer simulations of the interactions of solar wind within the solar system as well as with the Local Interstellar Medium (outside the solar system). This team’s simulations are data-driven and help interpret observations from such space missions as Interstellar Boundary Explorer (IBEX), New Horizons, Ulysses, Voyager, and a fleet of near-Earth spacecraft.

Methods & Codes
These simulations model the flow of atoms with a few systems of the Euler gas dynamic equations describing the different atom populations dependent on the domains of their origin. These are components of a Multi-Scale Fluid–Kinetic Simulation Suite (MS–FLUKSS)—an adaptive mesh refinement code we have built on the Chombo framework.

Results & Impact
• Performed a time-dependent simulation of the heliosphere that produces a comet-like heliotail and showed that the 11-year solar cycle leads to the formation of ENA lobes with properties remarkably similar to those observed by IBEX;
• Reproduced observations of pickup ions by New Horizons. These results have been published in six papers (one more paper is in press and three are in preparation) and reported at more than 10 scientific meetings;
• This research has been highlighted by the American Astronomical Society and other web news outlets.

Why Blue Waters
The Blue Waters system and project staff responded in a timely manner to our concerns and were very helpful in the development of job-scheduling strategies. The overall performance and reliability of Blue Waters has been outstanding.

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