THE ROLE OF COSMIC RAYS IN ISOLATED DISK GALAXIES

Research Challenge

- To simulate isolated disk galaxies for which cosmic rays are dynamically important in order to study how cosmic ray-driven outflows shape the structure and kinematics of the circumgalactic medium and to compare these with observations.
- To implement a new cosmic ray fluid that is compatible with the Riemann solvers in Enzo.

Methods & Codes

- Enzo code
- Finite volume method for hydrodynamics
- Adaptive mesh refinement
- Gravity
- Cosmic ray (particle) propagation including anisotropic diffusion, streaming, and gas heating

Results & Impact

- Results show evidence of strong, mass-loaded outflows that enrich the circumgalactic medium when cosmic rays are present.
- Directly comparing the simulations will place better constraints on theories pertaining to the circumgalactic medium and make predictions for the structure and metallicity distribution of the circumgalactic medium for future observations.

Why Blue Waters

- Galaxy simulations need to resolve a large dynamic range in physical and temporal scales from sub-parsec to kiloparsec (kpc) scale.
- Galaxy simulations require the use of massively parallel, high-performance supercomputers such as Blue Waters.
- This Graduate Fellow has benefited greatly from the support of Blue Waters staff, who are admirably dedicated to resolving issues in a timely manner.

An edge-on view of outflows from an isolated disk galaxy after 1.5 Gyr. The color depicts the metallicity (metal enrichment relative to solar abundances) of the gas, and the streamlines follow the topology of the magnetic field. The dimensions of the image are 90 kpc x 150 kpc.