CHEMISTRY AND THE EARLY UNIVERSE

Research Challenge
This project focuses on constructing and executing models of the formation of the stellar nurseries of the first stars in the universe, simulating their hydrodynamic and chemical properties to high resolution. Understanding the initial mass function of the first stars will guide the understanding of the sources of chemical elements in the modern universe, as well as help to refine the understanding of the progenitors of gravitational wave events.

Methods & Codes
The project has constructed a cross-domain software package for the efficient solution of chemical species abundances in hydrodynamic simulations, and also implemented a solver for the gravitational potential as defined in spherical coordinates in three dimensions. Codes used include the GAMER-2 simulation code, the Dengo rate construction package, and the Grackle software package.

Results & Impact
These developments will help to contextualize observations from the James Webb Space Telescope. Making these software packages available and accessible will enable scientific inquiry in a number of related domains.

Why Blue Waters
Blue Waters provided the necessary environment to ensure that the project’s solver would scale to the size and capacity required for high-resolution studies.