1124-65-212 **Amanda E Diegel*** (adiegel@lsu.edu), 2009 Stanford Avenue, Baton Rouge, LA 70808, and **Steve Wise**, **Cheng Wang** and **Xiaoming Wang**. *A Second Order in Time Finite Element Scheme for the Cahn-Hilliard-Navier-Stokes Equation.*

We present a novel second order in time mixed finite element scheme for the Cahn-Hilliard-Navier-Stokes equations with matched densities. The scheme combines a standard second order Crank-Nicholson method for the Navier-Stokes equations and a modification to the Crank-Nicholson method for the Cahn-Hilliard equation. In particular, a second order Adams-Bashforth extrapolation and a trapezoidal rule are included to help preserve the energy stability natural to the Cahn-Hilliard equation. We show that our scheme is unconditionally energy stable with respect to a modification of the continuous free energy of the PDE system. Specifically, the discrete phase variable is shown to be bounded in $\ell^\infty(0,T;L^\infty)$ and the discrete chemical potential bounded in $\ell^\infty(0,T;L^2)$, for any time and space step sizes, in two and three dimensions, and for any finite final time T. We subsequently prove that these variables along with the fluid velocity converge with optimal rates in the appropriate energy norms in both two and three dimensions. (Received September 09, 2016)