X-ray Characteristics of Thermally Launched Winds
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Introduction
Determining the structure of galactic outflows is an important step toward a better understanding of galaxy evolution, but an even more important task is determining what components of an outflow would be observable with today's telescopes. To this end, we have generated a number of outflow simulations using FLASH and then generated projections of X-ray luminosity using yt-Project software. In this poster, we show one such outflow for a mock disk galaxy with size and shape appropriate for the Large Magellanic Cloud (LMC). In light of growing observational evidence for small, local outflows from the LMC [1, 2], it is instructive to provide simulated X-ray diagnostics that may be compared to observations.

Simulation Set-up
For this simulation, we use the FLASH 4.2 hydrodynamics code run on the UW-Madison HPC cluster. The isolated, rotating galaxy is initialized in equilibrium with a fixed Plummer-Kuzmin disk potential. The disk scale height is equal to one-fifth the scale length. The wind is launched through the addition of mass and thermal energy in a rotating region of radius 100 pc. We assume 1000 supernovae occur over a period of 30 Myrs, where each supernova injects $10^{51}$ ergs of thermal energy and 10 solar masses into the region. Radiative cooling is included assuming 0.3 solar metallicity and collisional ionization equilibrium. Adaptive mesh refinement (AMR) is used to resolve the launch region with a maximum resolution of ~17 pc. See [3] for more details.

Discussion & Conclusion
This work was built on our previous efforts to model the X-ray emission of 1D thermal wind models. Stepping up our simulations to 3D FLASH models gave us a much wider range of tools to work with including the yt-Project software. We modelled a galaxy similar to the LMC, injected energy and mass, and then watched a wind develop. From the model we found that the best time to observe the wind’s X-rays is during energy injection when the gas is both dense and hot. After energy injection stops, the wind begins to cool and spread out which results in a drop in X-ray luminosity.

Figure 1: This sequence of images contains projections of the density (Top), temperature (Middle), and X-ray luminosity (Bottom) of our simulation at 30, 60, and 151 Myr. At 30 Myr there is a high concentration of hot gas and high X-ray luminosity within the galaxy which is ejected over time, cools off, and dims in the X-ray band 0.5–8keV.

Figure 2: The high temperature gas (Red) tracks the X-ray luminosity, 0.5-8keV, (Blue) quite well. Nearly all of the hot gas (and luminosity) is initially concentrated in a small region which is blown out of the galaxy and results in a drop in luminosity (see Figure 1).

Figure 3: Face-on projections of the density and X-ray luminosity at 30 Myr show the outflow forming in a region shining bright in X-rays. The square discontinuities present in the density projection are an effect of the higher resolution cells lying adjacent to lower resolution cells.

References:
3) Bustard et al. 2018 (in prep)
5) Tomesh et al. 2017, AAS 230, 316.01