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HYDRODYNAMIC MODELS OF THE ACCRETION STREAM IN MAGNETIC CATACLYSMIC VARIABLES

Kunegunda E. Belle[1]

Here I use the MHD code, FLASH, from the University of Chicago ASCI Center for Astrophysical Thermonuclear Flashes, to simulate initial two-dimensional simple models of accretion streams in magnetic CVs. These models explore the evolution of inflowing material for two white dwarf masses; $0.5M_{\odot}$ and $0.9M_{\odot}$. It is seen that a discontinuity forms at a height of 6.1×10^8 cm above the white dwarf 'surface' for $M_{\rm WD} = 0.5M_{\odot}$ and at 1.6×10^9 cm for $M_{\rm WD} = 0.9M_{\odot}$. These models will be developed further with the ultimate goal of completing a three-dimensional model of magnetic accretion onto a WD surface.

The Models: Models using different white dwarf masses were constructed. For each model, a 2D cartesian grid of width 4×10^7 cm and height 5×10^9 cm was used. An accretion stream of this width roughly corresponds to a fractional accretion area of $f = 0.001$ on the surface of a $0.9M_{\odot}$ white dwarf. The computational grid is set up so that one computational block is 2×10^7 cm on a side and three levels of adaptive mesh refinement (AMR) are allowed during the computation. Protons and electrons are used for the stream composition, the material is allowed to radiate, and a gamma-law EOS and plane parallel gravity are employed. The entire computational volume is given the initial stream parameters $T = 50,000$ K and $\rho = 1 \times 10^{-10}$ g cm^{-3}. A downward velocity of -3×10^5 cm s^{-1} is given to material above $y = 3 \times 10^9$ cm. Each model uses a 1 MG magnetic field.

Model 1. This simulation was performed for $M_{\rm WD} = 0.5M_{\odot}$ ($\log g = 7.86$). Figure 1 displays the temperature profile at times $t = 0$ and $t = 69$ s. This is the time at which a discontinuity forms at $y = 6.1 \times 10^8$ cm, as can be seen in the plot. After time $t = 69$ s, a numerically seeded instability develops.

Model 2. This simulation was performed for $M_{\rm WD} = 0.9M_{\odot}$ ($\log g = 8.49$). Figure 2 displays the temperature profile at times $t = 0$ and $t = 42.5$ s. This is the time at which a discontinuity forms at $y = 1.6 \times 10^9$ cm, as can be seen in the plot. After time $t = 42$ s, a numerically seeded instability develops.

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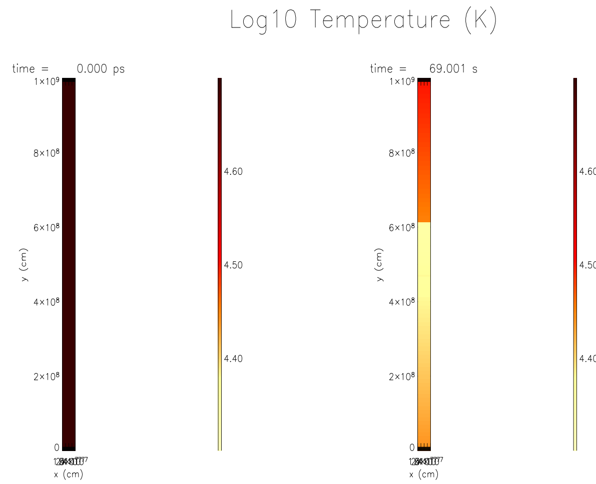

Fig. 1. Temperature profile for Model 1 ($M_{\rm WD} = 0.5M_{\odot}$).

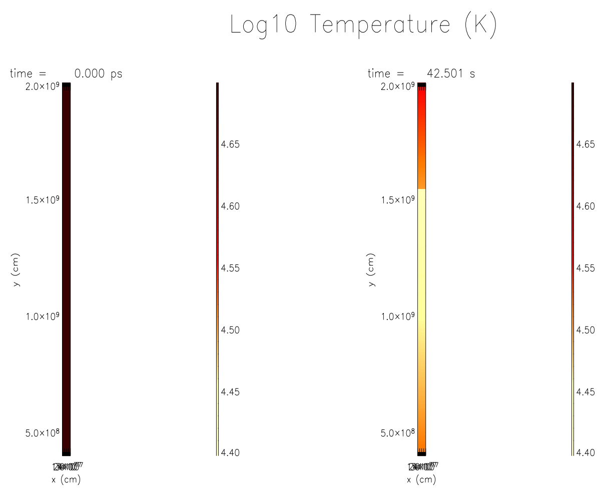

Fig. 2. Temperature profile for Model 2 ($M_{\rm WD} = 0.9M_{\odot}$).

The software used in this work was in part developed by the DOE-supported ASCI/Alliance Center for Astrophysical Thermonuclear Flashes at the University of Chicago.