ASTRONOMY 9602

Computer Project #2

Due: April 7, 2017

Carry out a numerical integration of the coupled set of ordinary differential equations for the time evolution of a wind-driven shock front in an exponential atmosphere, using the Kompaneets approximation. Follow the steps outlined in the Appendix of the following paper: Basu, Johnstone, and Martin (1999 ApJ, 516, 843). You must integrate the coupled set of equations (A6) and (A7) in the paper, using also the equations (A2), (A3), and (A8). I suggest you read the entire paper once before starting the project. This will give you the context of why this problem is interesting. In the BJM99 paper we were able to fit the age of the superbubble and the ambient gas scale height H by using the Kompaneets model (see § 2.2 and § 4 in the paper).

Work in a system with length unit $[L] = H$, mass unit $[M] = \rho_0 H^3$, and time unit $[t] = (\rho_0 H^5/L_0)^{1/3}$. Pick any integration scheme you wish; even first order differencing is adequate. Start your integration at an early time, when the normalized variable $\tilde{y} = y/H$ is well approximated by the radius R of a spherical bubble; see discussion in § A2 of the above paper. Integrate up to $\tilde{y} = 1.98$.

Please hand in your computer program that calculates the quantities $\tilde{y}(\tilde{t})$ and $\tilde{E_{\rm th}}(\tilde{t})$. Please reproduce the Figure 1 of BJM99 barring the dashed lines. You do not need the results of your numerical integration to produce this. Next, please use your numerical results to also reproduce all parts of Figure 10, barring the dotted lines in Figs. 10e and 10f. Please also provide a copy of the commands or code you used to display the results. Any computing language is acceptable. Finally, write a paragraph summarizing what you learned about the expansion of superbubbles in the Galaxy from doing this project.