Project Problem 7

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Weekly Progress Update

This week, the two objectives were to finish the *pyro* module and finalize the poster. Included in the poster are images showing the expected plasma behavior when our module is implemented. Figuring out how to get the information we want out of the *pyro* data files has been hard since the file types are unfamiliar to extract the information out of them. Because we did not want to cut it close on the poster deadline, we included an image from our code showing the relationship between kinetic and magnetic energy as well as the evolution of the fields to demonstrate how MHD should work. The images of the plasma from *pyro* are also included. We can, however, infer from the MHD equations and the plots of the gradient of the velocity field, that we should expect a changing magnetic field, since $\nabla \times (\boldsymbol{B} \times \boldsymbol{v}) = (\boldsymbol{B} \cdot \nabla)\boldsymbol{v} - (\boldsymbol{v} \cdot \nabla)\boldsymbol{B}$ (accounting for the incompressible fluid and no magnetic monopole conditions already). In the poster we also included a brief bullet point about what a dynamo is, and plan to elaborate on it when we present the poster and why it is relevant to the case of decaying TG vortices. To get the dynamos to decay, we included a small perturbation in the plasma to break the symmetry. We also updated our captions to try explain what is important more than what we did. Again, the plan is to elaborate more on what the images mean. As far as the outlook on this project, I think we learned a lot about how to code one of these modules and about the challenges of making numerical integration schemes. There still remains the problem of extracting the data from these data files if we would want to work with this suite of codes moving forward. From a personal reflection standpoint, this project pointed out the need for more work with our computational skills moving on in our careers. From our own work and from our references, we learned a lot about MHD, why it is useful, and how it is done. Moving forward, we would want to make our project more realistic. The perturbation that we included was simple enough to get the plasma decaying, but we would like to know what causes these perturbations in nature and figure out how our simulation could model those effects. Another extension of the project would be to go beyond the plane, since in reality this is a three dimensional problem. Finally, the overall goal would be to realistically model the B field of an object, since the goal of theory is to have something that can explain the reality of the situation. If this was something we were considering studying down the road, it might also be nice to investigate how good of an approximation this actually is. If there are more exact methods out there, once a working MHD code is established and fully functioning, it could be bench marked against more elaborate methods to find out where it holds up and where it breaks down. Overall, the final takeaway is that in these past few weeks, we've come a long way, but there is still a lot more work out there beyond simply getting the solver to run if we want to probe the physics of MHD.