Pre-class assignment #13

PHY-905-005
Computational Astrophysics and Astrostatistics
Spring 2023

This assignment is due the evening of Wednesday March 15, 2023. Turn in all materials via GitHub.

Reading:

1. Chapter 7.7-7.8 of *An Introduction to Computational Physics*, by T. Pang (PDF; provided)
2. Chapter 10.1-10.5 of Zingale's Computational Hydrodynamics Tutorial (PDF; provided in a previous pre-class assignment). Note: carefully read sections 10.1-10.3, and skim 10.4-10.5.

Your assignment:

1. Exercise 10.2 in Zingale (p. 187): Implement a 1-D *explicit* diffusion solver for the domain [0,1] with Neumann boundary conditions at each end and k = 1, using the discretization of Eq. 10.6. Begin with a Gaussian pulse as shown in Zingale's exercise 10.2, and compare to the analytic solution for solutions with $C = 0.8$ and $C = 2.0$ at the end point of the simulation. What difference do you see in the behavior of the solver in those two cases? When do you see numerical instabilities develop in either of the cases, if it happens at all? (Note: you may need to examine times between $t = 0$ and $t = t_{end}$ to see this.)
2. After doing the assigned reading, list at least two questions that you have about solving diffusion-like equations (i.e., parabolic PDEs) in the file `ANSWERS.md`.

Handing it in: Include your code, your plots, and your answers to the questions about (in the file `ANSWERS.md`) in your assignment.