Homework 00: LaTeX & GitHub Demonstration
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1 Definition

Heat diffusion is a partial differential equation governing a heat flow in a medium. In the general form of Cartesian coordinates, it can be written as

$$\frac{\partial T}{\partial t} = k\left(\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} + \frac{\partial^2 T}{\partial z^2}\right) \tag{1}$$

$$\frac{\partial T}{\partial t} = k\nabla^2 T \tag{2}$$

Where T is temperature that depends on time t and space x, y, z in 3-dimensional space, and k is the thermal conductivity. For one one-dimensional problem

$$\frac{\partial T}{\partial t} = k\frac{\partial^2 T}{\partial x^2} \tag{3}$$

2 Numerical Methods

We can solve the heat diffusion equation using the finite difference method. Let i be the position index and j be the time index. For a one-dimensional problem, it becomes

$$\frac{T_i^{j+1} - T_i^j}{\Delta t} = k\frac{\frac{T_{i+1}^j - T_i^j}{\Delta x} - \frac{T_i^j - T_{i-1}^j}{\Delta x}}{\Delta x}$$

$$\frac{T_i^{j+1} - T_i^j}{\Delta t} = k\frac{T_{i+1}^j - 2T_i^j + T_{i-1}^j}{(\Delta x)^2}$$

$$T_i^{j+1} = \frac{k\Delta t}{(\Delta x)^2}\left(T_{i+1}^j - 2T_i^j + T_{i-1}^j\right) + T_i^j$$

$$T_i^{j+1} = b\left(T_{i+1}^j - 2T_i^j + T_{i-1}^j\right) + T_i^j$$

Where b is a stability criterion which must have a value less than $1/2$.

3 Dummy Picture

Fig. 1 shows the variation of solar wind velocity by solving the fluid equation in one dimension.

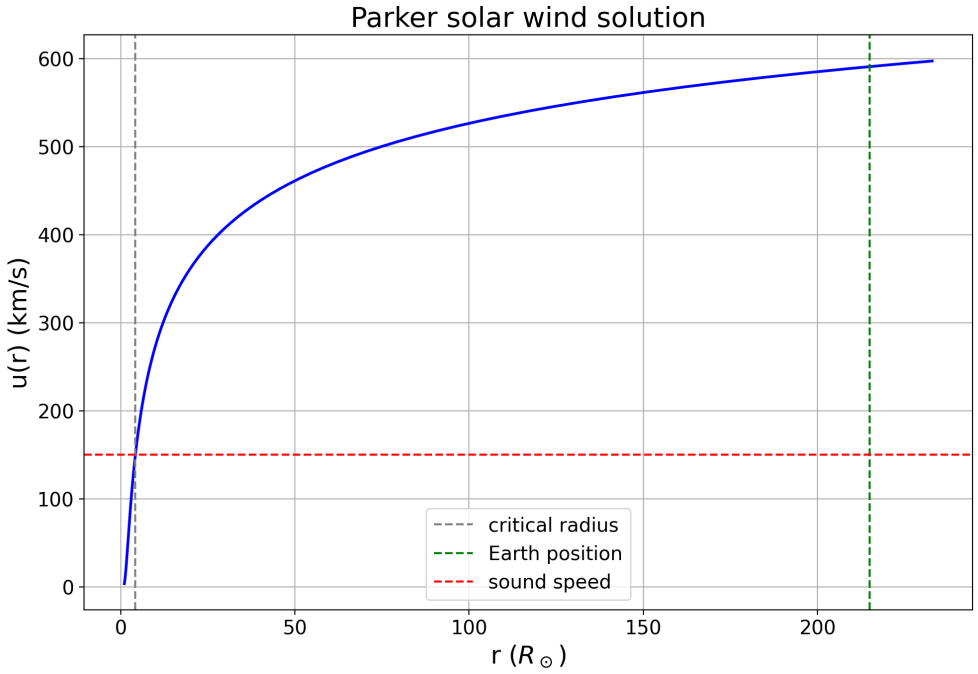

Figure 1: Parker solar wind solution using numerical integration.