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Description:

The setup of this problem was approaching the under dense Mach 10 jet by testing various parameters and running simulations using the software Visit. By changing density, pressure, velocity, jet velocity, and magnetic fields we were able to create various simulations for each trial. The common density for my simulations was 1.00, the ambient pressure was changed to varying values from its initial value of 6.0 e-3. The jet velocity stayed a constant value of 1 for most of the trials outside of my test trial. The remaining velocities would typically remain at a value of 0. The initial cycle time was 4997 cycles
<u>Parameters</u>

Problem / Background

This problem approaches collimated forms of high-speed matter in which we can simulate how changing the parameters of the problem will change the distances traveled of the matter, the density of the beam, and other parameters as the problem is dependent on the initial conditions that will change the outcome of how flow is produced. The reason this problem is done is to understand how initial conditions affect astrophysical jets.

Approach

Our group decided to first run our problem by using the program Visit to get visualization of the original problem. Afterwards we decided to break our problem up into separate sections by dividing our work for each individual to manage the various parameters. We felt that the most dynamic and straightforward parameters to adjust was the density, pressure, velocities, direction, and magnetic fields.

Computational Power Hypothesis

I think if I was able to have more computational power I would like to experiment with larger/smaller values over varying cycles to see how the simulation would vary. I'd likely try to incorporate more than 1 parameter change to see the results.

Roles

Nicholas: Pressure, Velocity, Time, CPU time, Cycles

Margaret: Magnetic Field, Time, CPU time, Cycles

Kevin: Density, Direction

We all worked out to develop our data onto a spread sheet. Collectively we visualized all of our data individually and had group meetings to discuss what our plans were for our approach and how we would handle the different parameters. All of us communicated by sharing our images of our visualizations with each other and discussed what might be useful data and or interesting things to go over. Margaret was very helpful in getting us started with using the Visit software. Overall, we all contributed to our PowerPoint and put it together with our respective parts. There wasn't anything overcomplicated as we all understood what to do and figured if we had any issues we would communicate. We had frequent meetings to go over anything we might need to talk. I suggested that we take into consideration the computational time / cycles of our programs as I felt that would be significant in our simulations to do analysis on.

Number of Trials: 7

Each trial tested changes in the parameters by seeing how they individually affected the problem

Ambient Pressure & Jet Pressure (Trial 1)

P = 1.20 e-1, P_jet = 1.20 e-1

ρ = 1.00 e+00

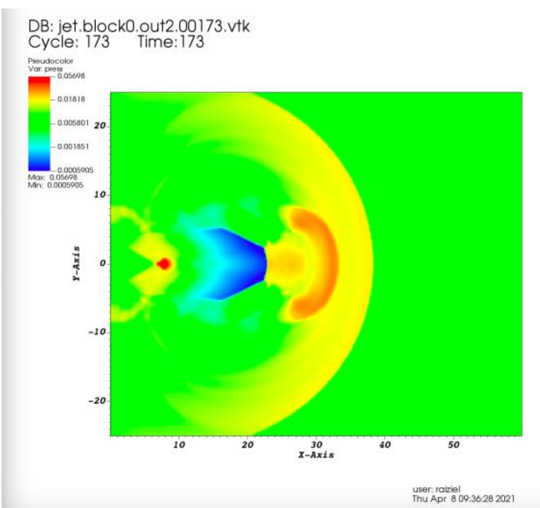
Vx = 0, Vy = 0, Vx_jet = 1, Vy_jet = 0

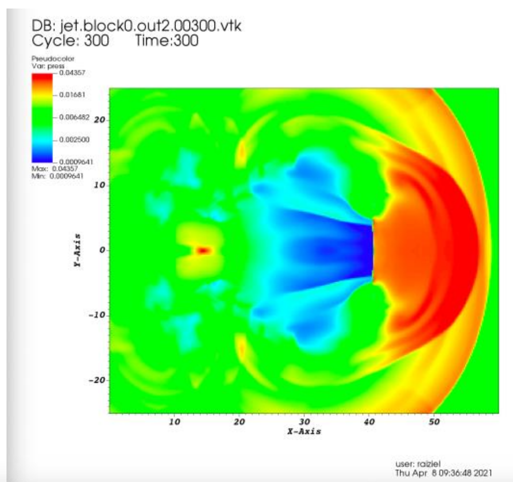
Bx, By, Bz = 0

Cycles = 10431

CPU Time = 2.36 e+2

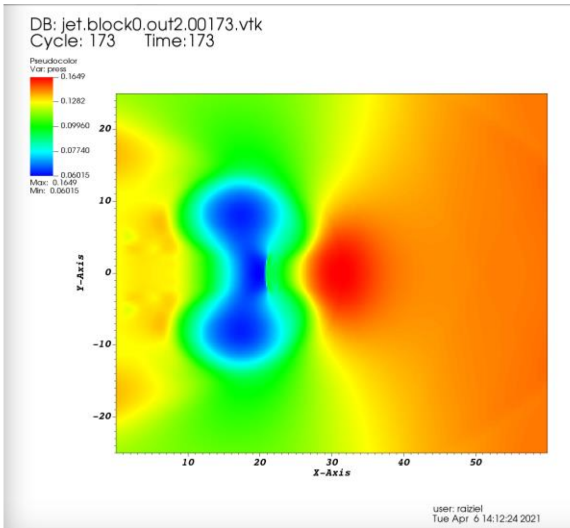
Time = 3.00 e+2

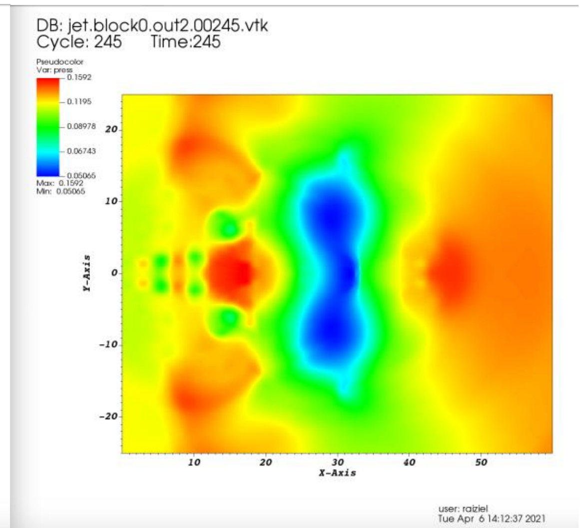




Results:

- **Decreasing both of these values in comparison to the original setup where P,Pjet = 6.0e-3 there is no shock wave**





Ambient Pressure (Trial 2)

P = 1.20 e-1, P_jet = 6.0 e-3

ρ = 1.00 e+00

Vx = 0, Vy = 0, Vx_jet = 1, Vy_jet = 0

Bx, By, Bz = 0

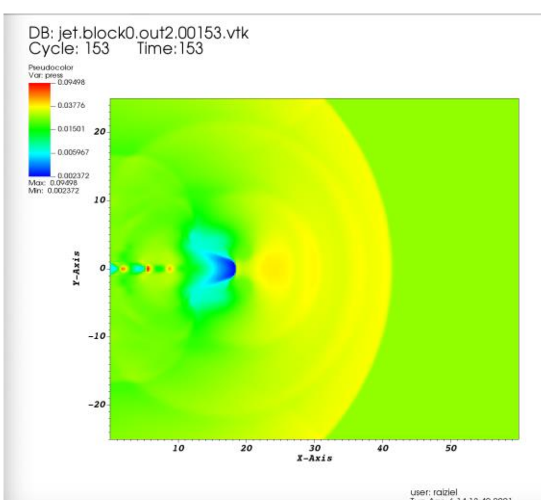
Cycles = 5039

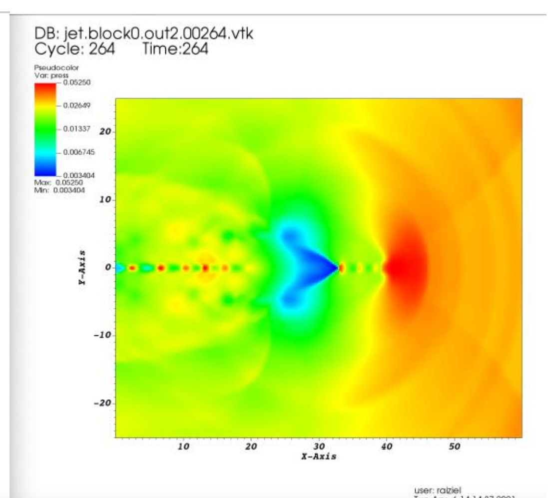
CPU Time = 1.12 e+2

Time = 3.00 e+2

Results:

- **Decreasing the ambient pressure increases the angle of outward flow**





Jet Pressure (Trial 3)

P = 6.0 e-3, P_jet = 7.4 e-4

ρ = 1.00 e+00

Vx = 0, Vy = 0, Vx_jet = 1, Vy_jet = 0

Bx, By, Bz = 0

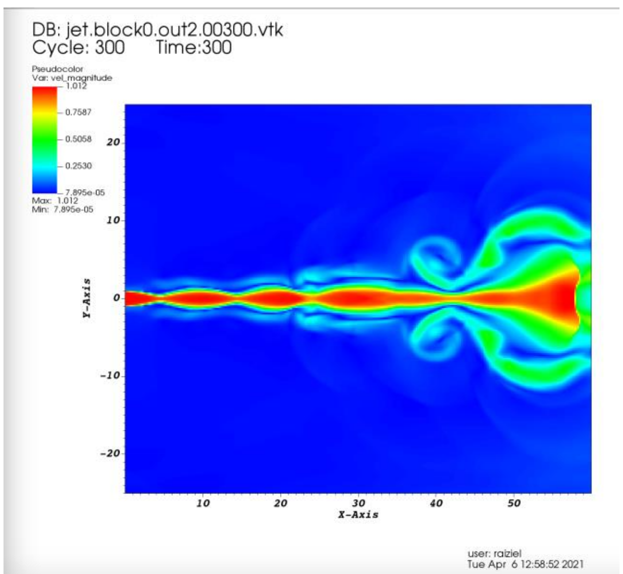
Cycles = 4500

CPU Time = 1.01 e+2

Time = 3.00 e+2

Results:

- Flow becomes condensed traveling at high speeds
- Travels further distances



Velocity in X (Trial 4)

P = 6.0 e-3, P_jet = 6.0 e-3

ρ = 1.00 e+00

Vx = 10, Vy = 0, Vx_jet = 1, Vy_jet = 0

Bx, By, Bz = 0

Cycles = 168

CPU Time = 3.67 e+0

Time = 3.00 e+2

Results:

- When Vx is significantly increased the cycles became proportionally shorter and took less computational time

Velocity in Y (Trial 5)

P = 6.0 e-3, P_jet = 6.0 e-3

ρ = 1.00 e+00

Vx = 0, Vy = 0, Vx_jet = 1, Vy_jet = 0.1

Bx, By, Bz = 0

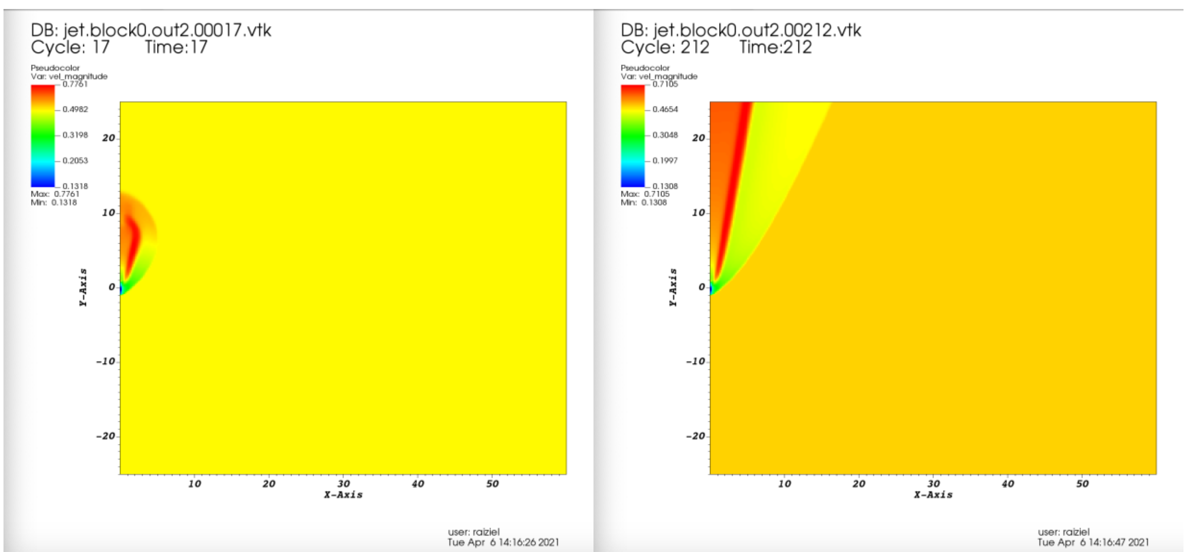
Cycles = 4599

CPU Time = 9.18 e+1

Time = 3.00 e+2

Results:

- **When Vy_jet is increased there is a condensed layer of high-speed flow while externally pushing outward mid-range gases.**



Jet Velocity in X (Trial 6)

P = 6.0 e-3, P_jet = 6.0 e-3

Vx = 0, Vy = 0, Vx_jet = 10, Vy_jet = 0

ρ = 1.00 e+00

Bx, By, Bz = 0

Cycles = 154

CPU Time = 3.36 e+0

Time = 3.00 e+2

Results:

- When Vx_jet is significantly increased the cycles became proportionally shorter and took less computational time

Jet Velocity in Y (Trial 7)

P = 6.0e-3, P_jet = 6.0e-3

ρ = 1.00 e+00

Vx = 0, Vy = 0, Vx_jet = 1, Vy_jet = 0.5

Bx, By, Bz = 0

Cycles = 5635

CPU Time = 1.24 e+2

Time = 3.00 e+2

Results:

- **The increase of y- jet velocity causes a region of high-speed gases to expand pushing the lower speed gases outward and causes more collisions resulting in a mixture of gases. If the simulation ran longer there would be an increase in high-speed gases**