Running a Rings Experiment

4-4-2011

Opening Discussion

- There were quite a few different comments, but again there wasn't much overlap. After thinking them over I realized that for most of them my lecture wouldn't be much superior to you reading Wikipedia because of the lack of depth in my knowledge. (Especially for a single class lecture.)
- One suggestion was to talk about something related to my rings simulations.

Approach

- Scientific method vs. discovery based.
- A validated simulation code allows you to explore situations where you really don't know quite what will happen.
- Other times you have a hypothesis and you want to test it to see if your “model” of the system is correct.
- Challenges with level of detail of the simulation.

Parameter Space

- Numeric studies often involve varying certain parameters of the system. This gives you a parameter space that you have to explore.
- The dimensionality of the parameter space impacts how many simulations you have to run. High dimensional parameter spaces become intractable.

Latest Icarus Paper

- I want to use my latest journal paper as a case study for using simulations to do science.
- This paper is about a behavior I noticed in simulations back in grad school. I had to fully explore it though and it wasn't until 2008 that I had a good explanation for it.

The Code

- The code has been in place a long time.
- Modular form allows combining different particle population types with different forces.
- Does discrete event for collisions with a time step for force integration.
- Spatial data structures allow efficient handling of large numbers of particles.

The Phenomenon

- Back in grad school I noticed that particle orbits would migrate at a specific point downstream from a perturbation.
- The migration is toward regions of higher density. For this reason we call it negative diffusion.
- It is a fast process that occurs in wake peaks at the point where streamlines intersect.

Parameter Space

- To see when this process was significant I ran a bunch of simulations covering a 3-D parameter space.
  - Optical depth
  - Forced eccentricity
  - Particle size
- Particle size turns out to be only minimally significant, but I had to establish that.

Epiphany

- Simulation can point you in directions, but that doesn't mean it can find all the answers.
- It took me a long time to figure out what was really causing this behavior.
- The simulation was able to verify that my model of the cause was something that was occurring at the proper time.
- Simulations also allowed detailed analysis of exactly what was going on.

Minute Essay

- We are supposed to have a quiz next class.