Welcome to the first SPS Pizza Talk

I couldn't think up a better name

SPS Pizza Talks

- Once a month

- Different speaker (grad student or undergrad doing research). Be prepared!
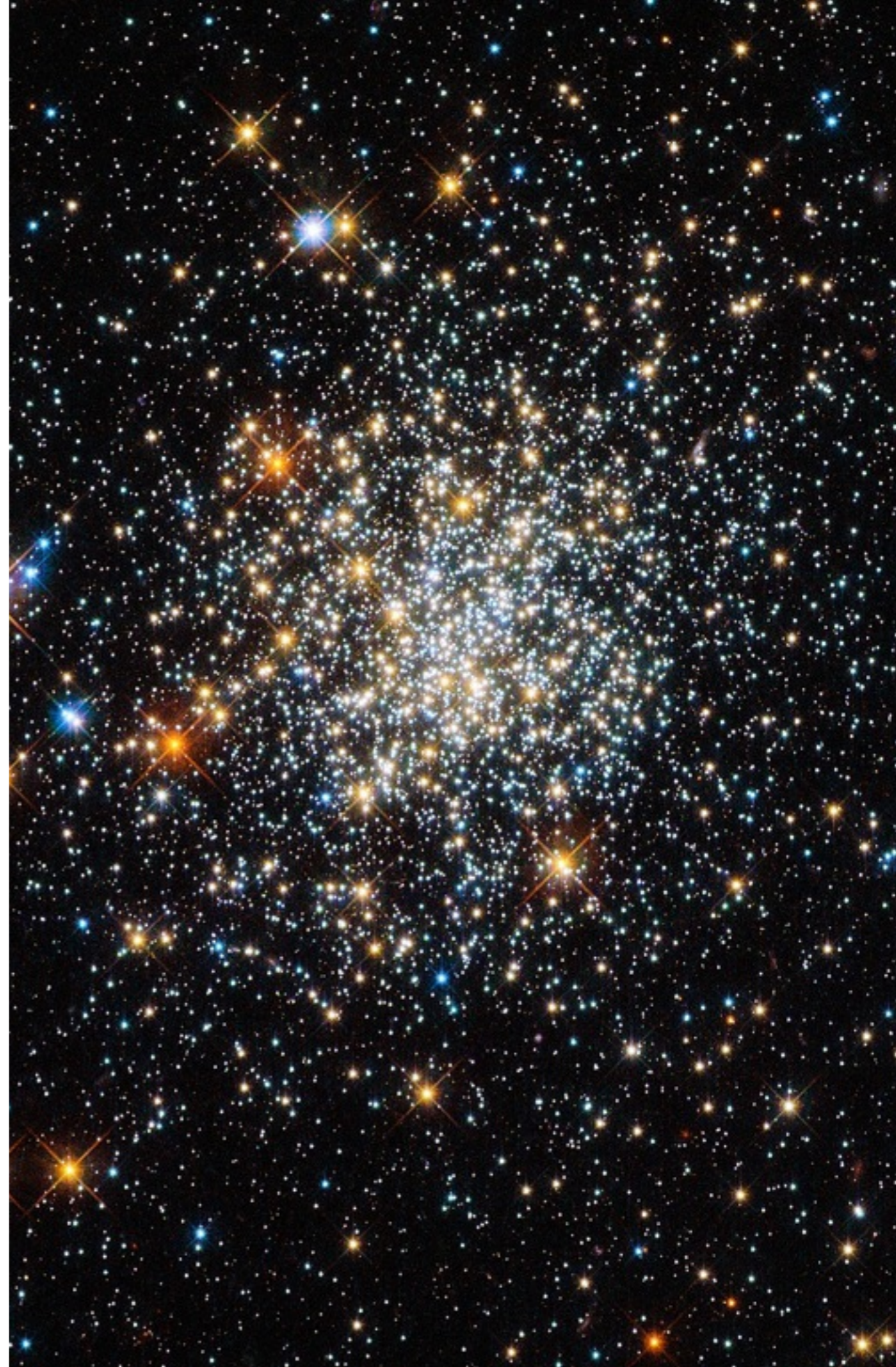
- Good prep for other talks / conferences.

The Byte-Sized Universe

My Research
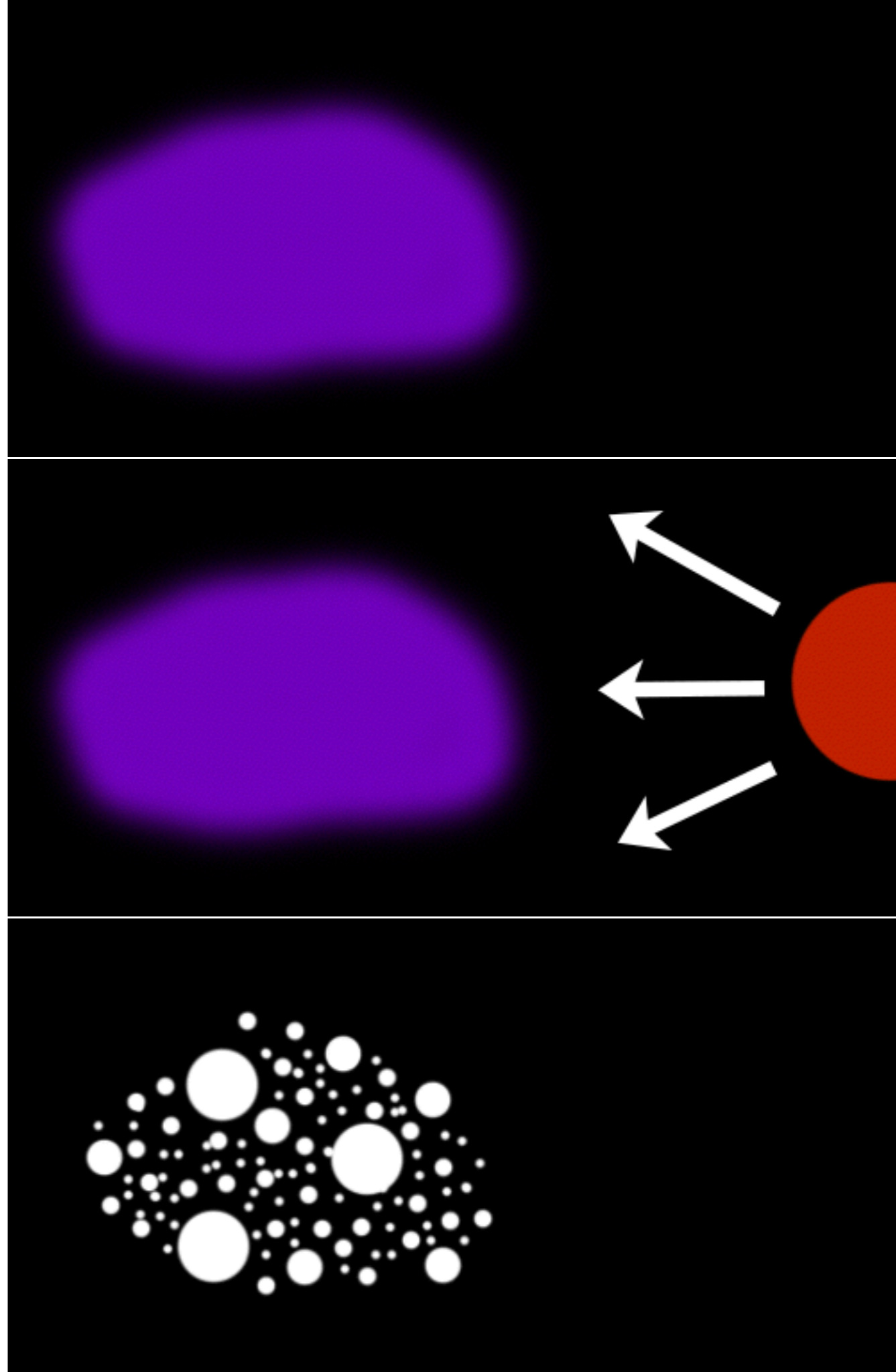
Binary Stars in Open Clusters

Many of you have heard this before!

Open Clusters: group of gravitationally bound stars
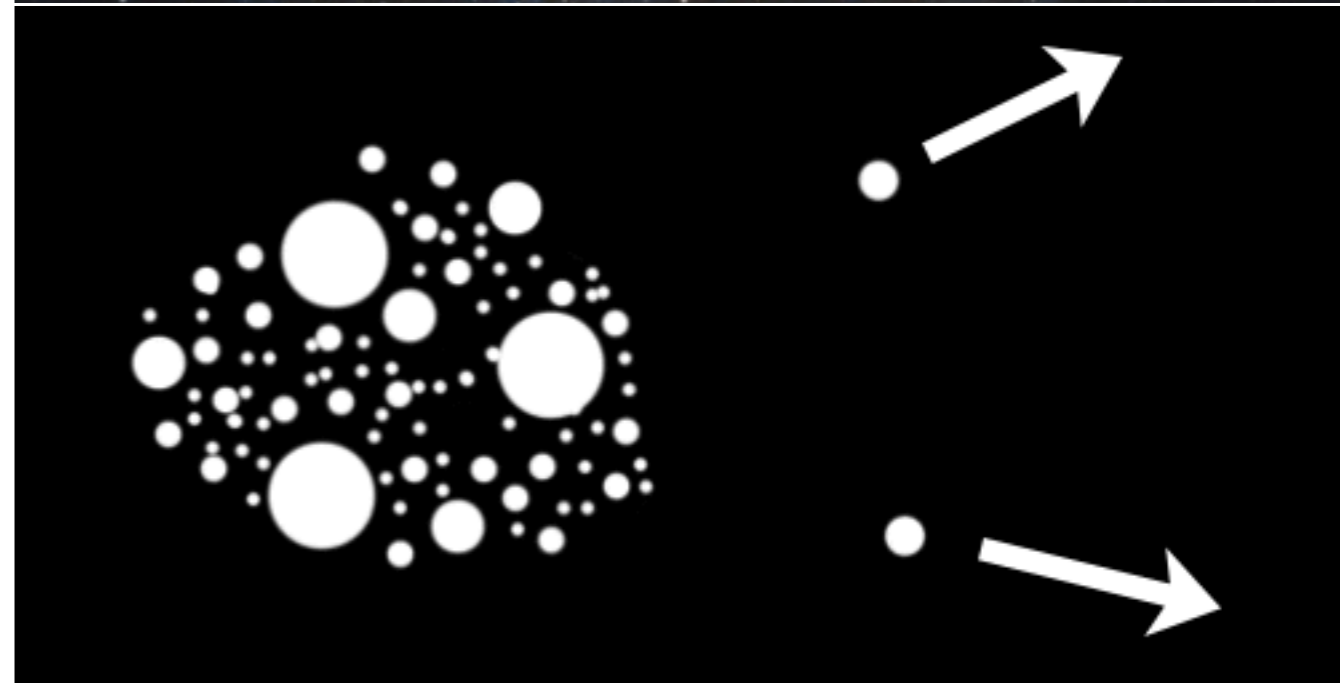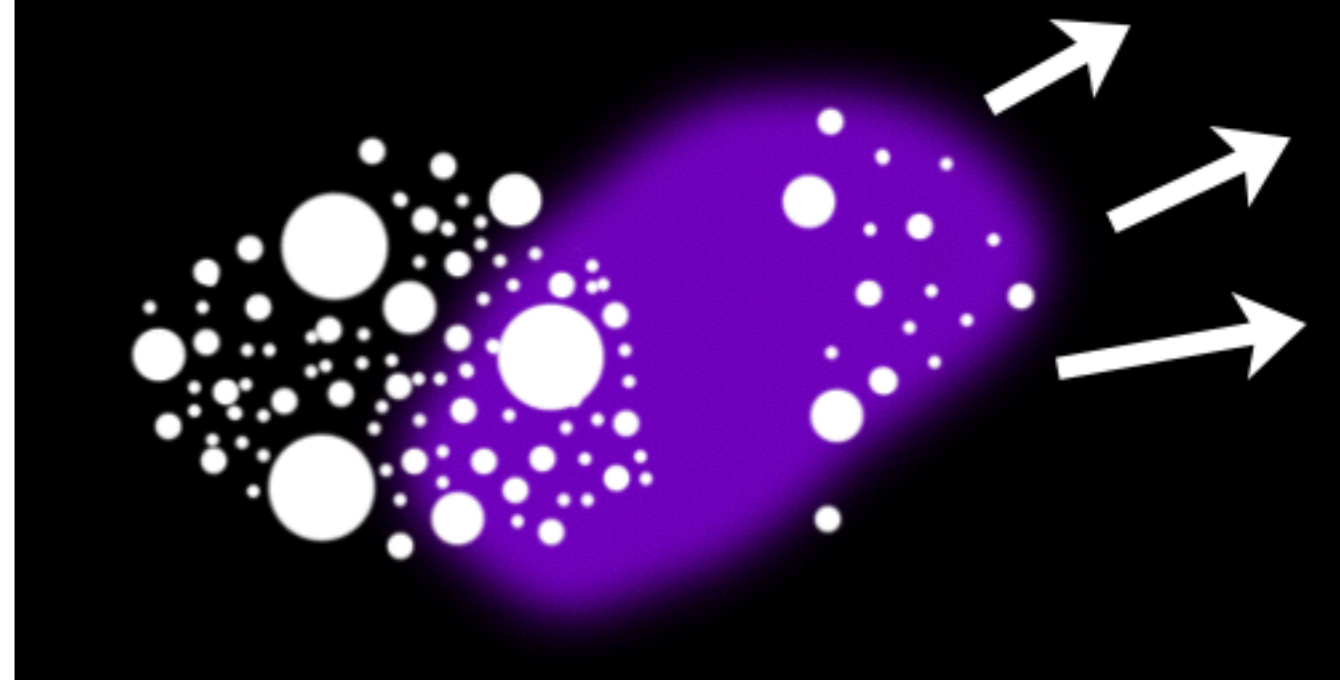
Open Cluster Lifetime

Formation
Gas Cloud ➤ Clump of Stars

Open Cluster Lifetime

Destruction
External Tidal Forces
Internal Cluster Heating

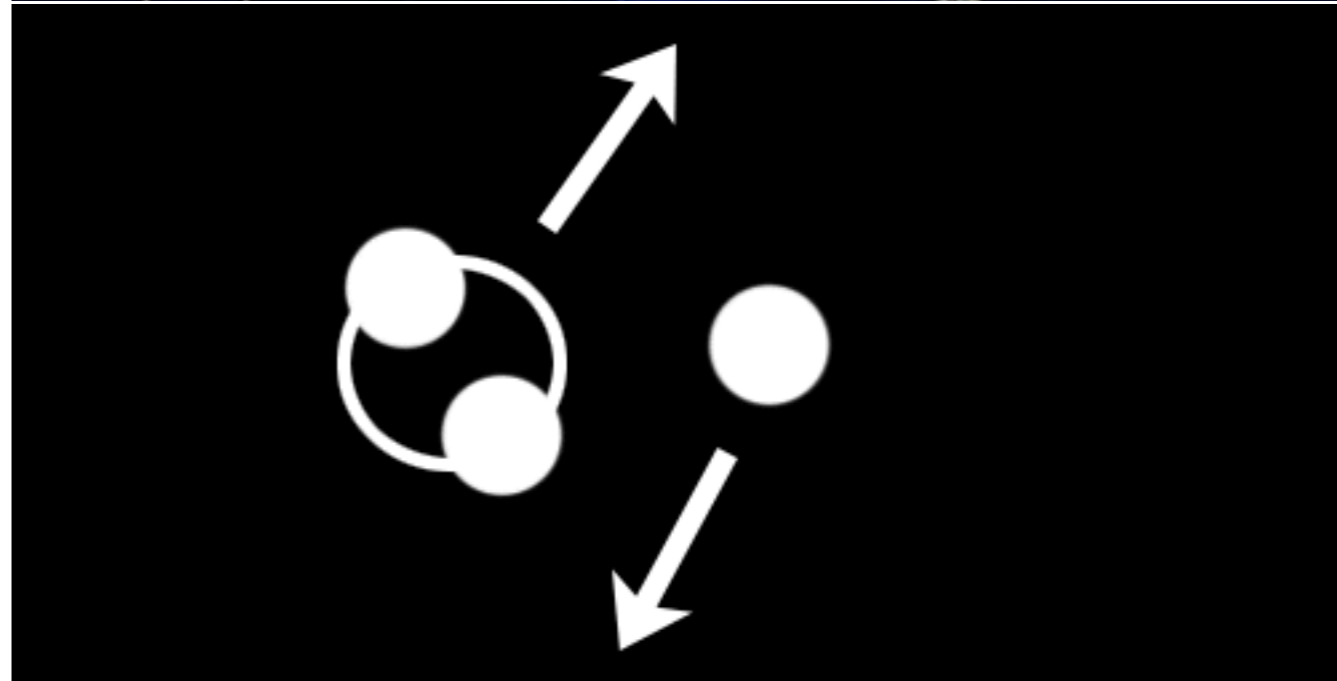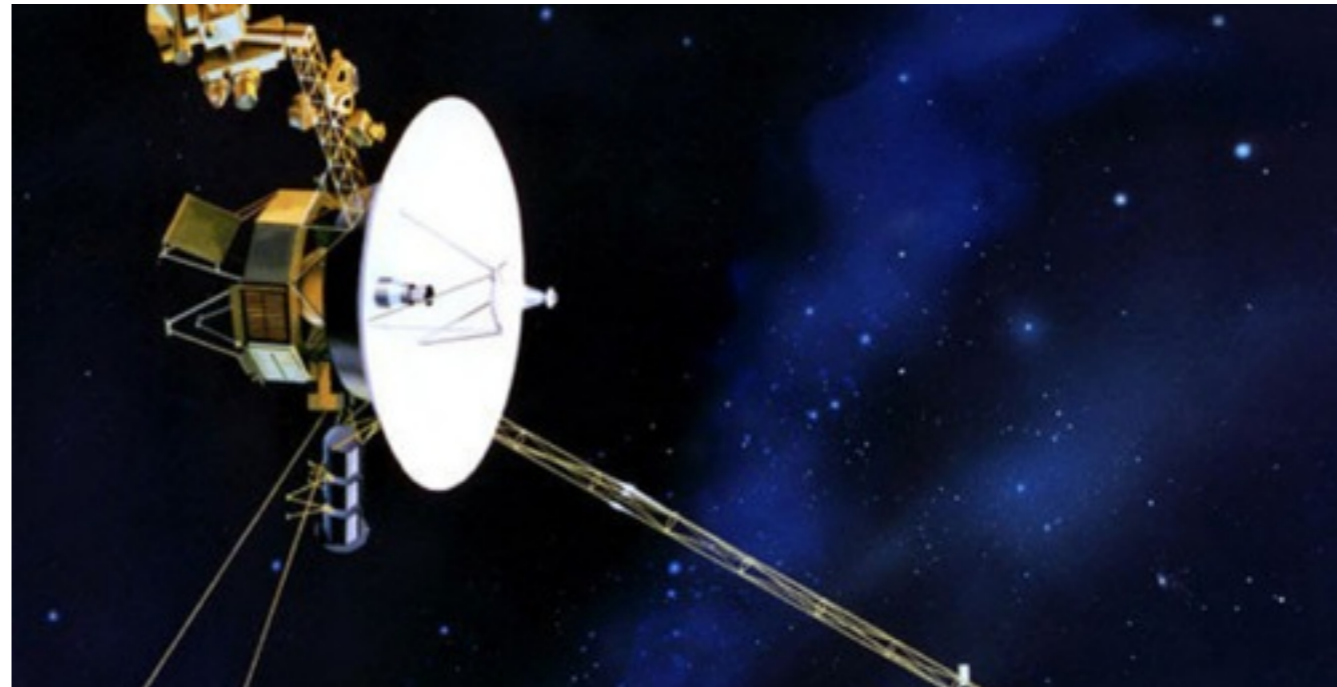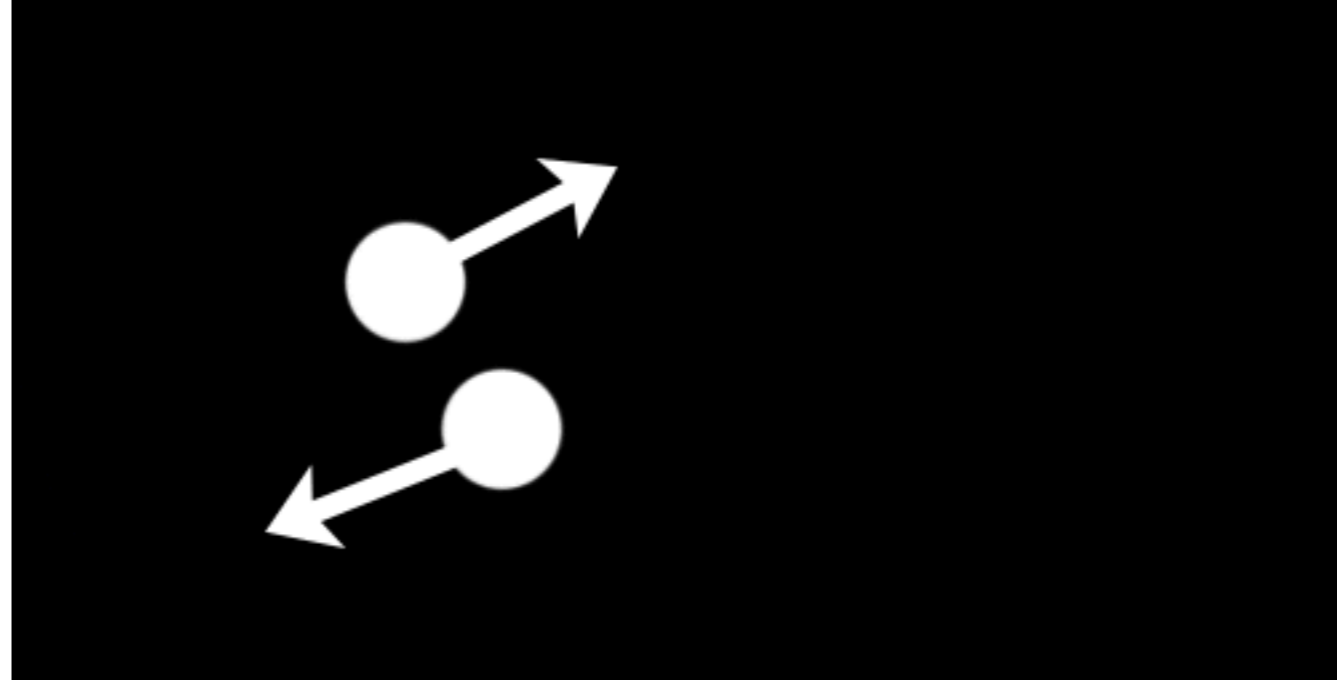70-80% of stars are born in star clusters

Binaries

Gravitational Interaction:

Single/Single

Binary/Single

$E_{BO} >> E_S$

How do we test this?

Things in space evolve **really** slowly (billions of years).
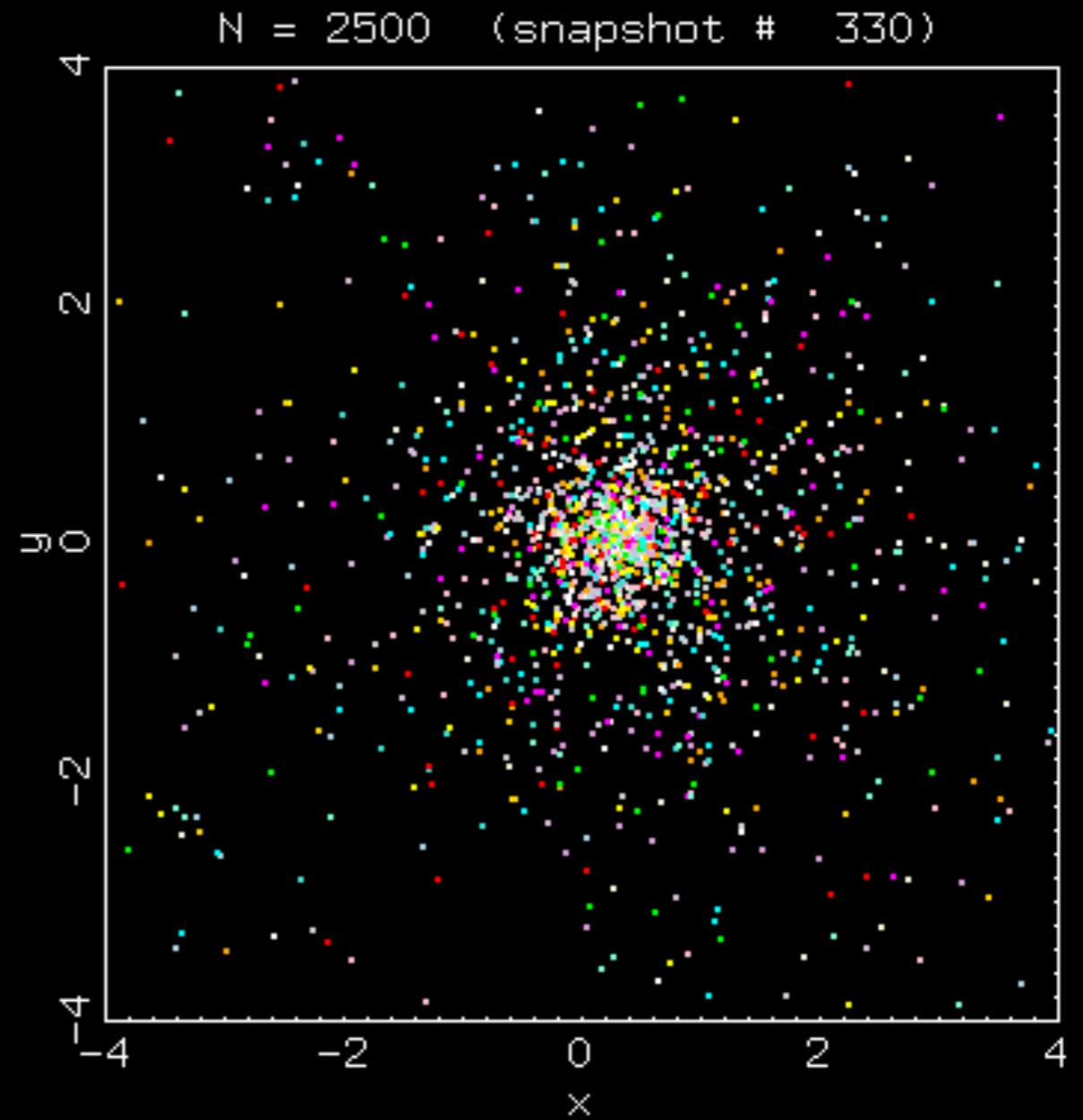
We instead run everything on a computer.

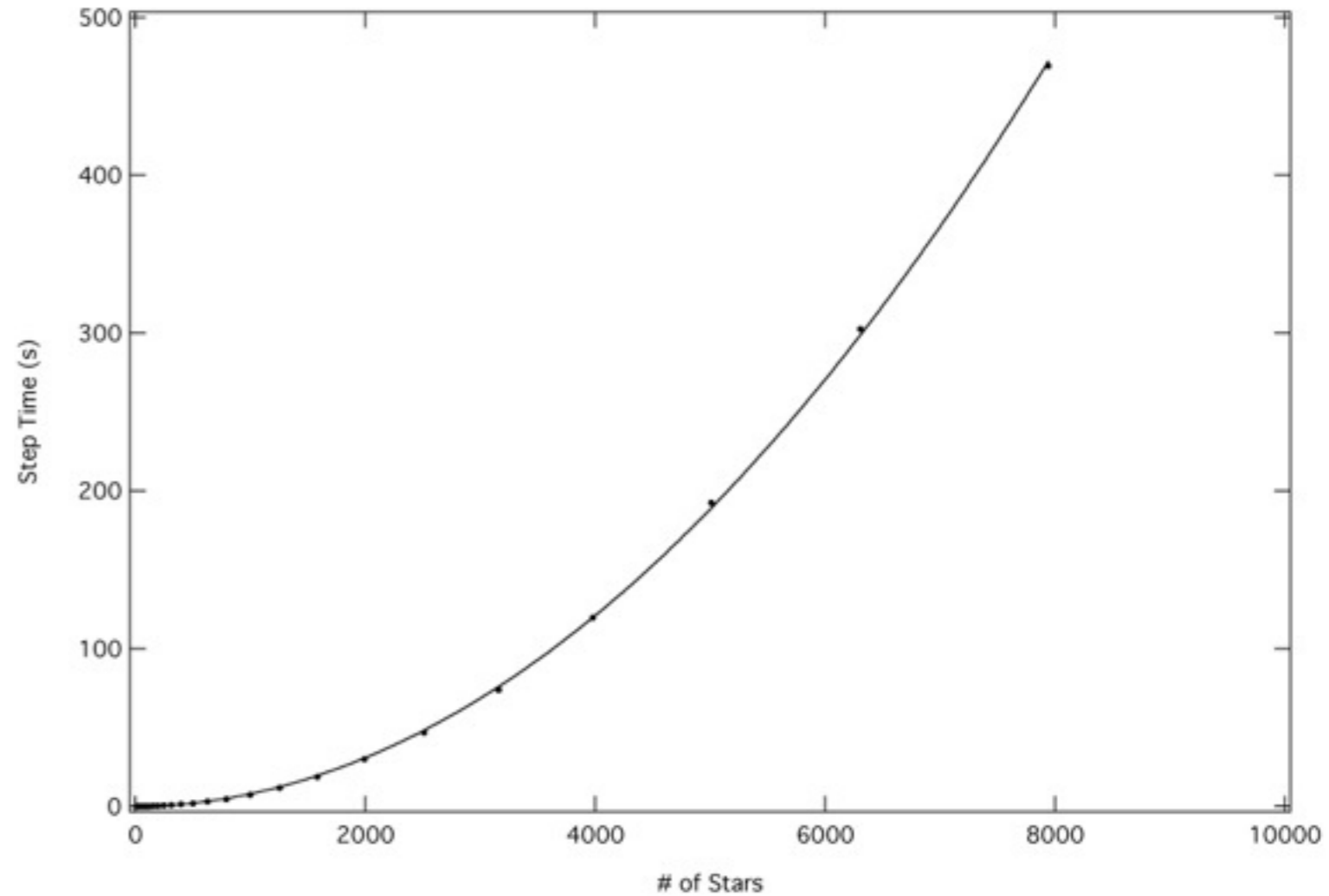# N-Body Models

We can easily simulate a simplified cluster:

$$a_i = \sum_{j, j \neq i} G \frac{m_j}{(\vec{r}_i - \vec{r}_j)^2}$$

N = 2500   (snapshot # 330)

N-Body Models

Wrote a simple Python program that simulates a single time-step of an N-Body simulation.
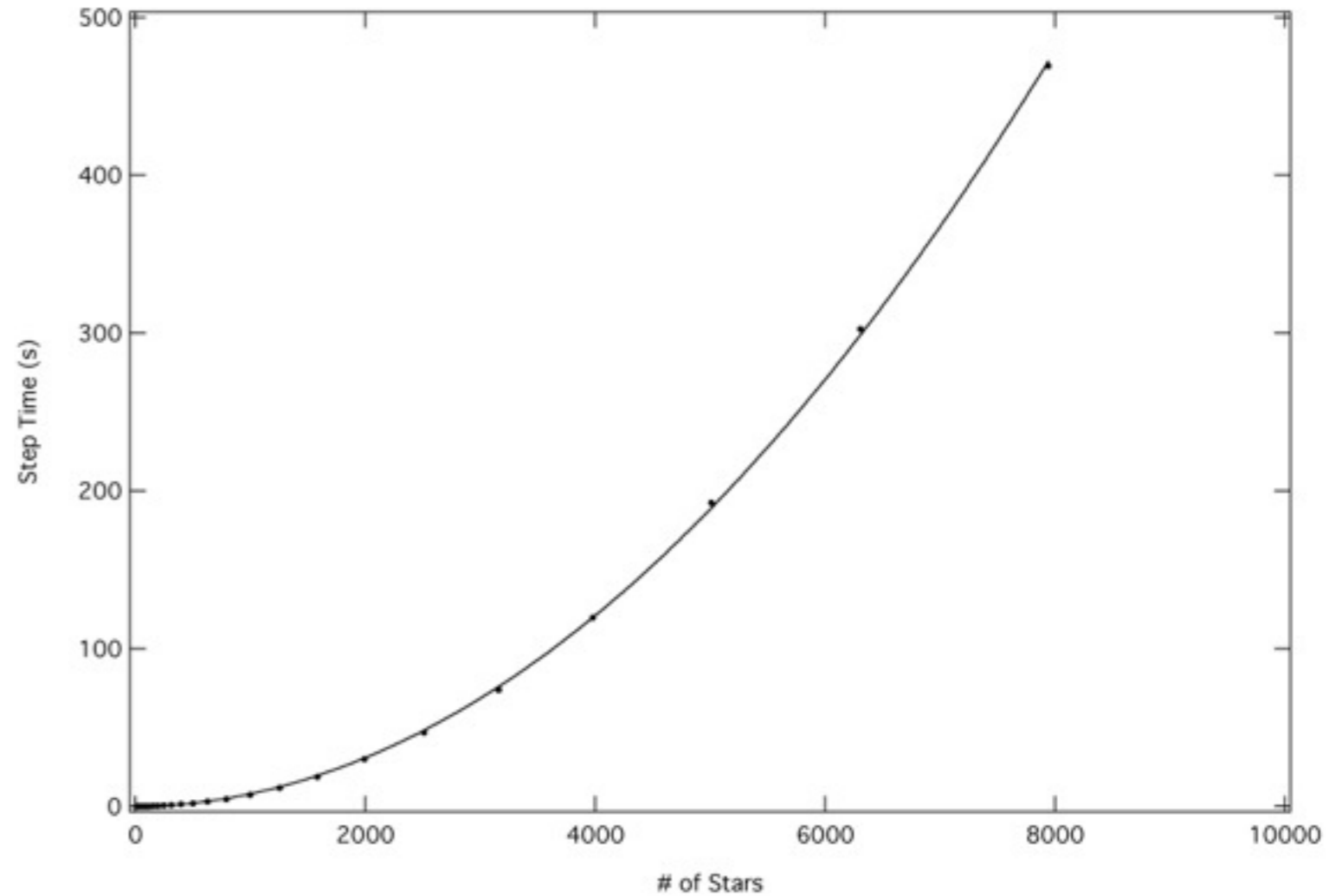
Ran script for various # of stars

N-Body Models

A normal-sized cluster N-Body simulation usually involves ~10k stars.

10k step = 15min

Cluster lifetime is a few billion years: lots of time-steps

N-Body Models

Basic code only runs one summation at a time.

My computer has an 8-thread processor: can we use all of them?

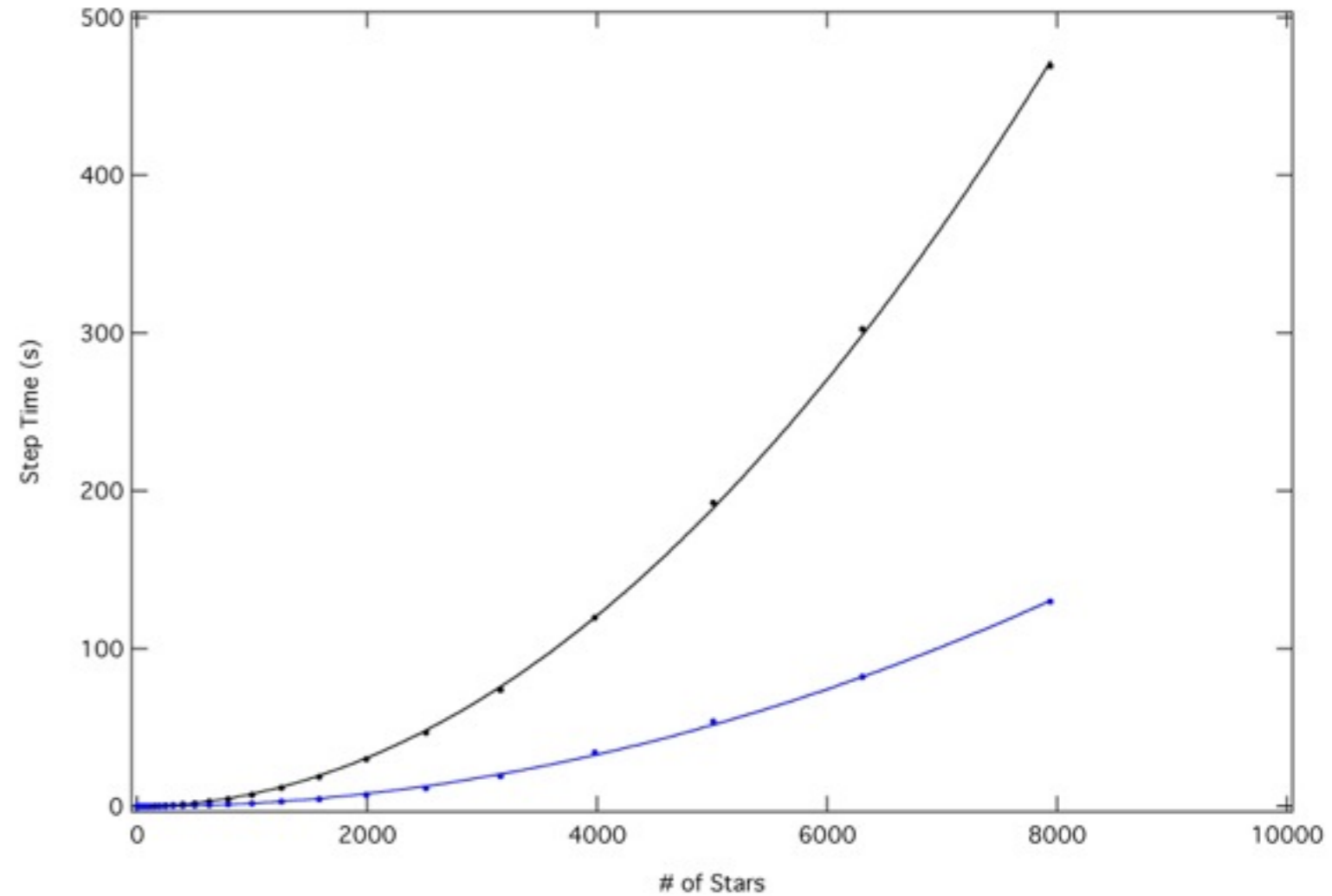Re-wrote program to break summations into 8 parts.

N-Body Models

Breaking the computation into parts vastly speeds up the calculation.

10k parallel step = 3min

Lots of steps for Gyrs, still will take quite a while!
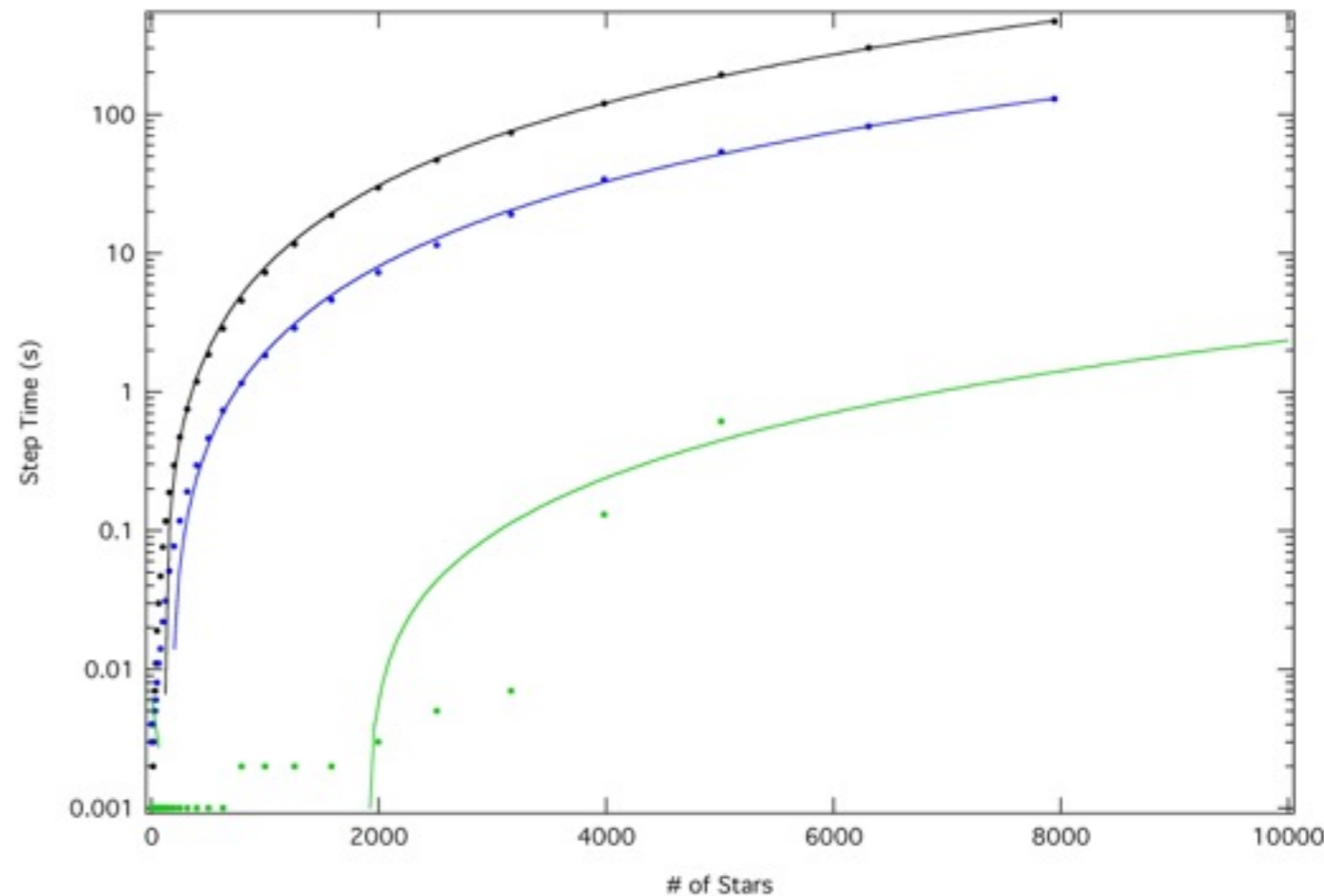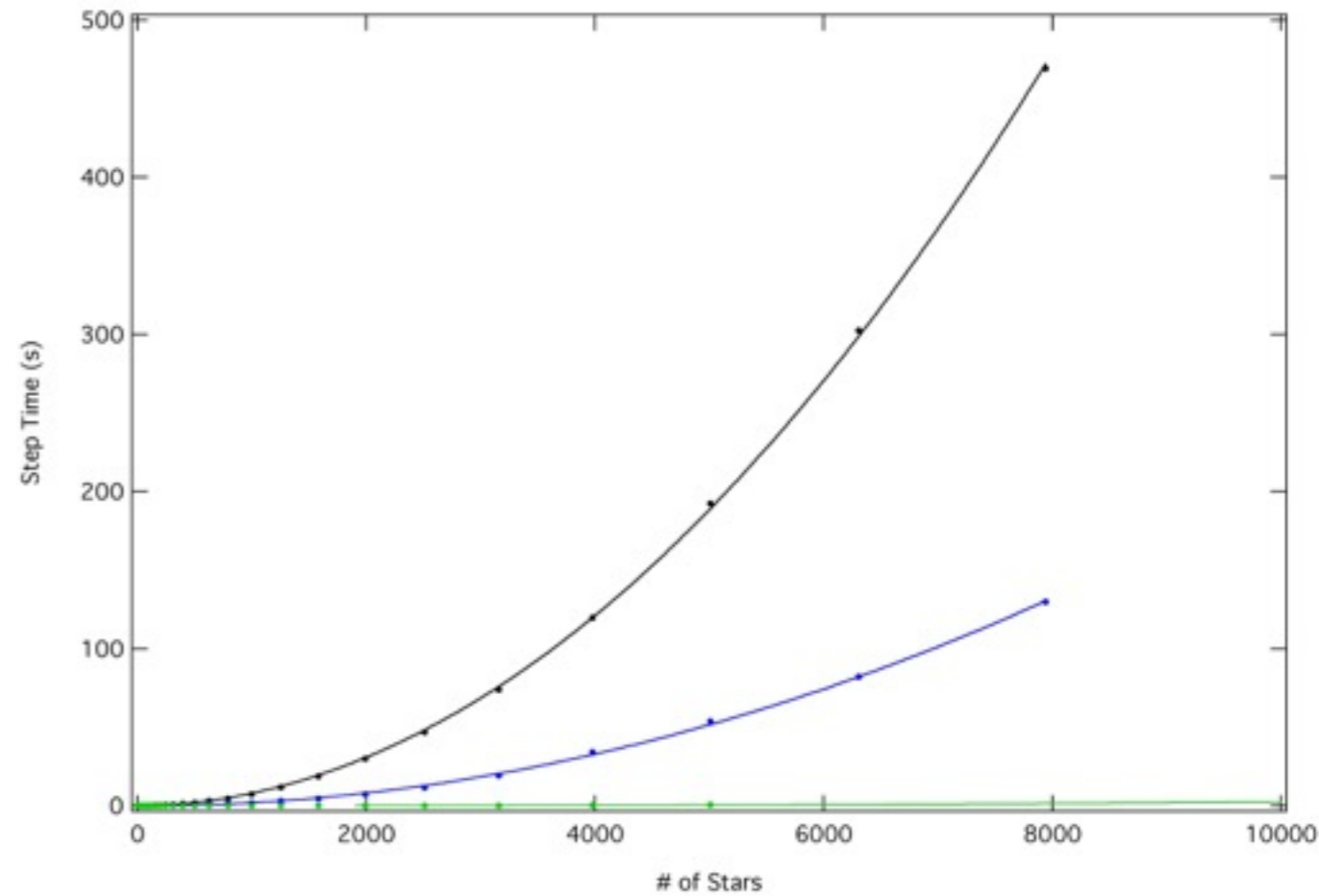
N-Body Models

Can we speed this up anymore?

Recent revolution: GPU computation

GPU cores have lower speeds, but many more

GPU Computing

Orders of magnitude improvements!

Simulating clusters for Gyr with 10k stars is possible on a desktop computer.
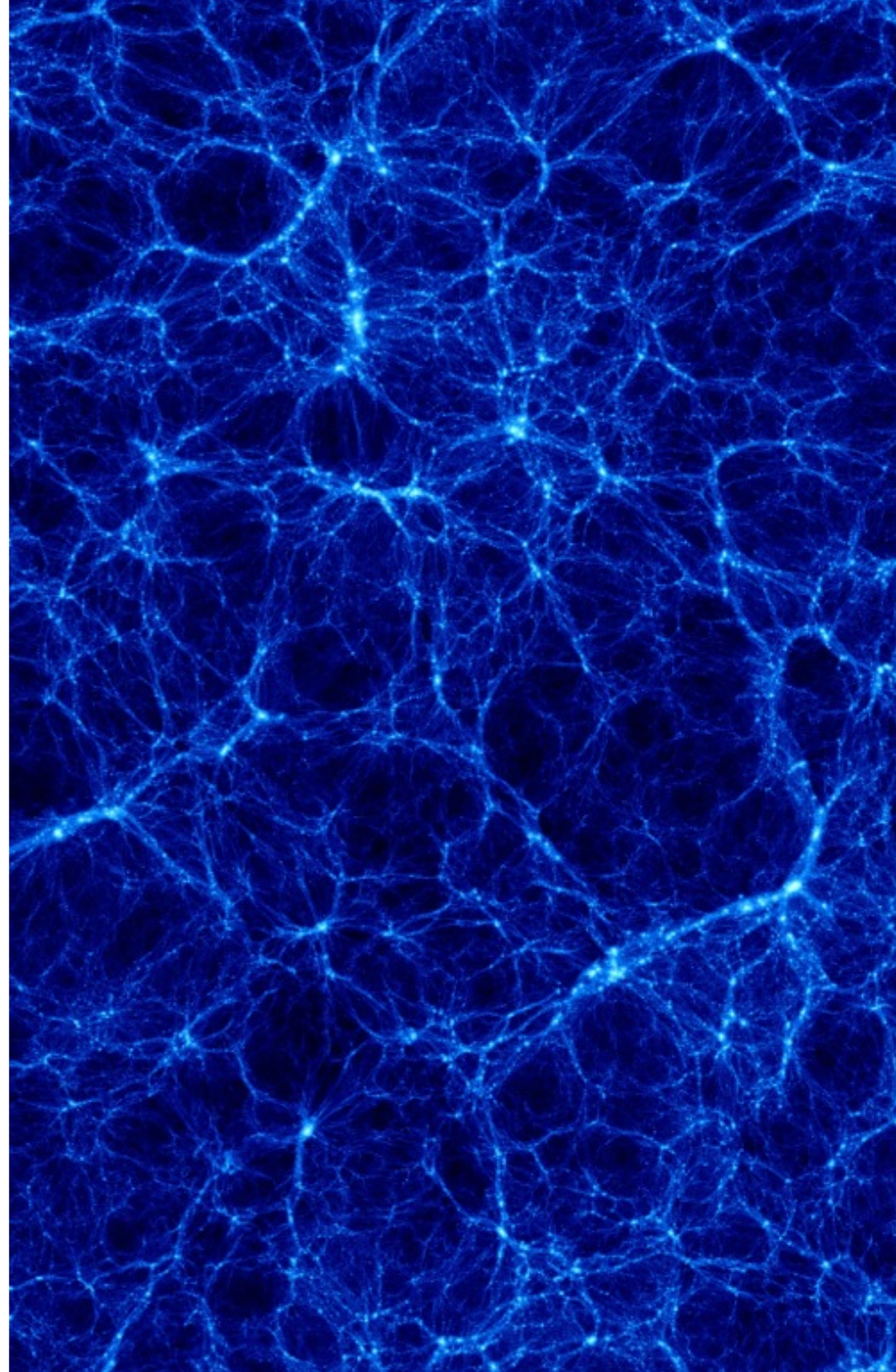
Hybrid Accelerated Cosmology Code

Team at Argonne National Lab simulated Universe:

- 500 Myr to 7.4 Gyr after Big Bang
- 1.1 trillion particles

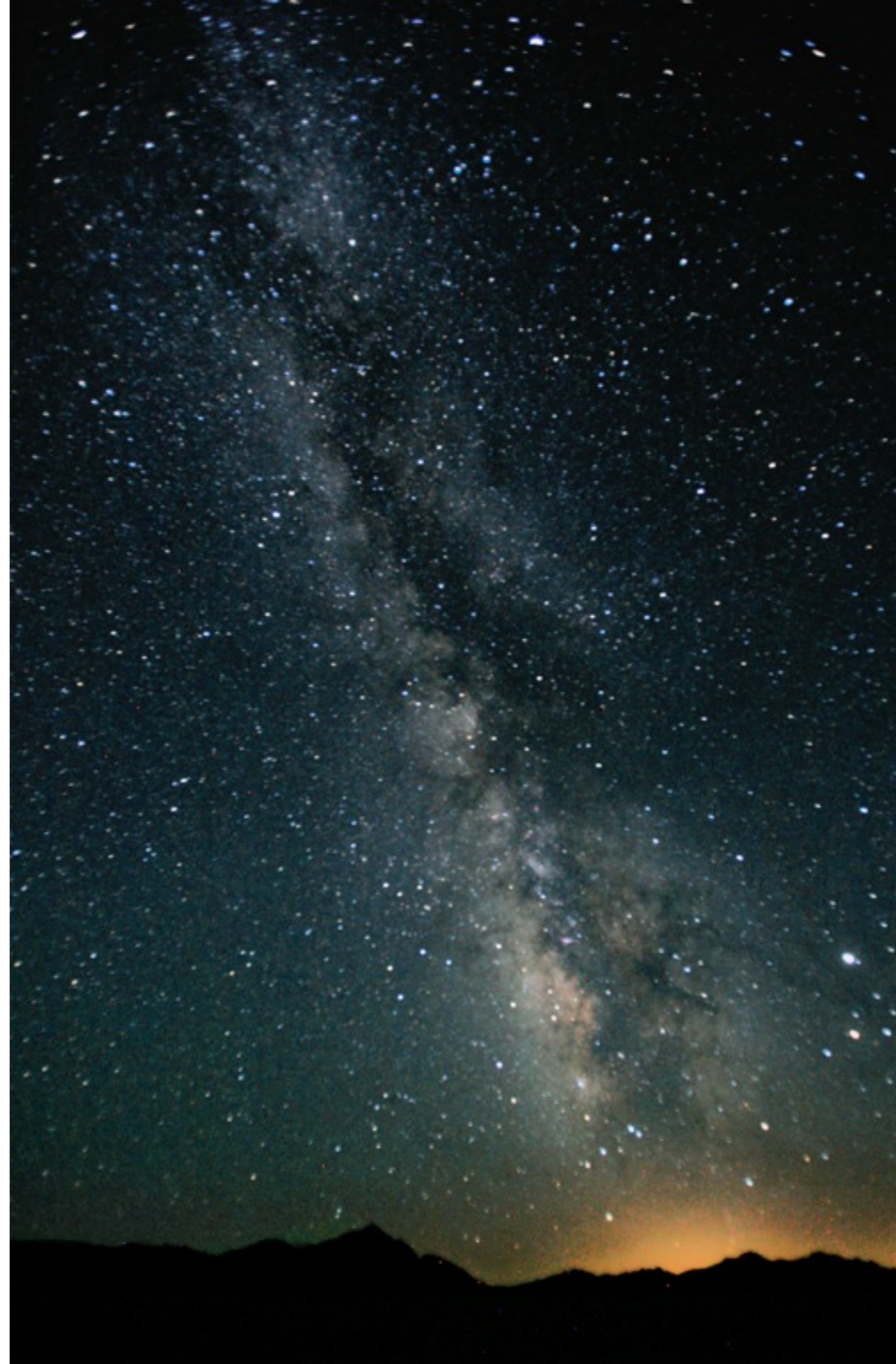Ran on Titan Supercomputer: 25 Petaflops of computing

HACC

Science is Getting Bigger

Trillion+ N-Body Cosmology

Detailed Climate Change Modeling

Combustion Gas Modeling for Alternative Fuels

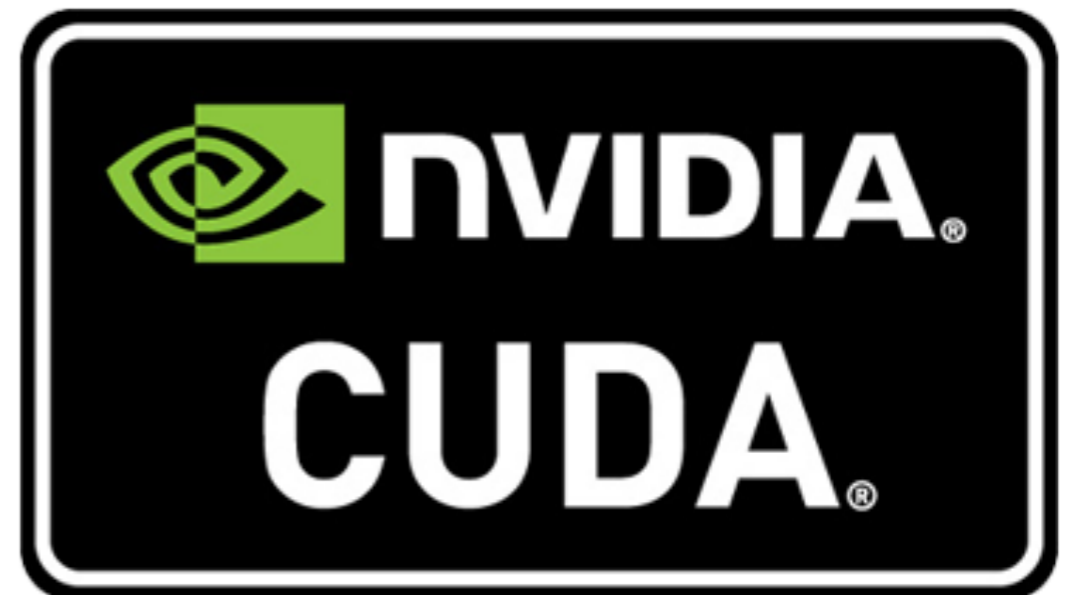***Running on massively-parallel supercomputers***

You can too!

Any programming language:
Python, C++, C, FORTRAN

Parallel CPU:
OpenMP, ParallelPython

GPU:
OpenCL, CUDA

Questions?