



A /ORNL PARTNERSHIP
NATIONAL INSTITUTE FOR COMPUTATIONAL SCIENCES

NICS

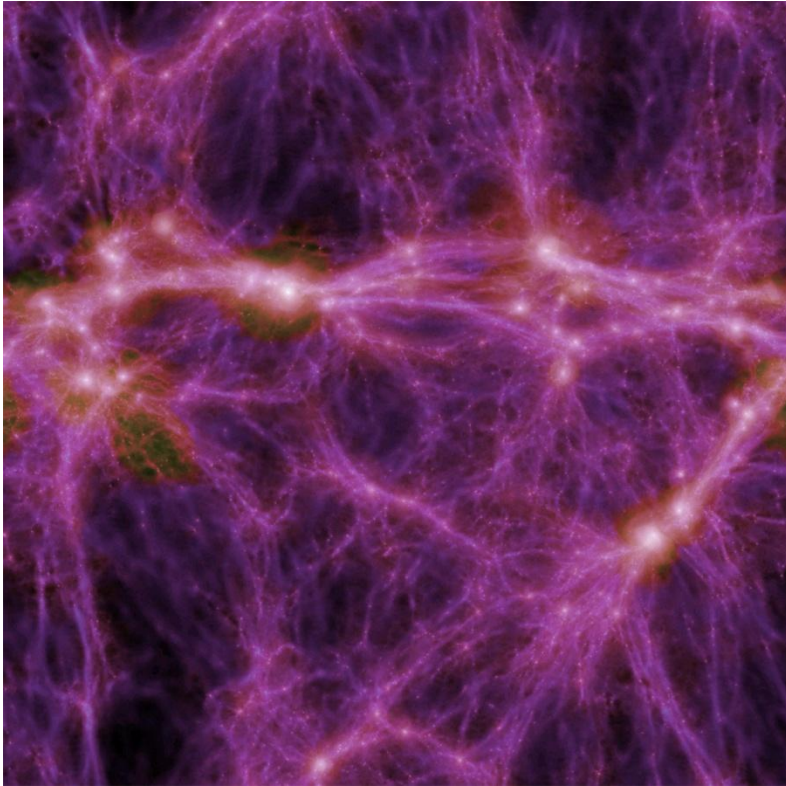
Simulating the Universe on a Supercomputer

Tiziana Di Matteo

McWilliams Center for Cosmology
Carnegie Mellon University



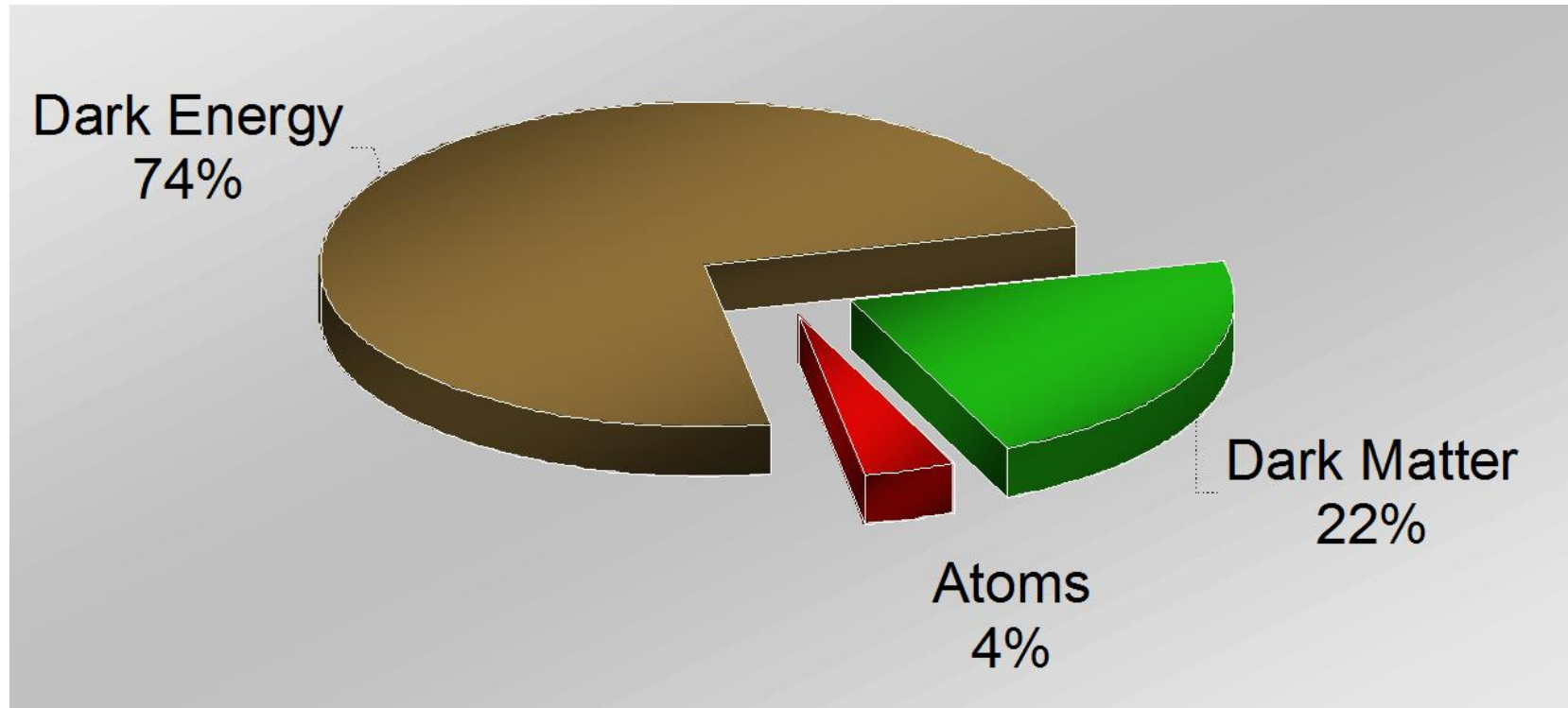
Questions in cosmology:



- What is the nature of the universe and what is it made of?
- What are matter, energy, space, and time?
- How did we get here and where are we going?

As we begin the 21st century

The matter–energy composition of our universe



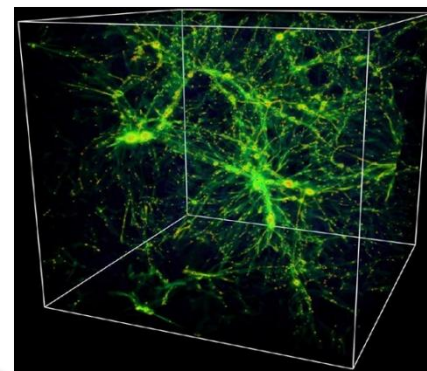
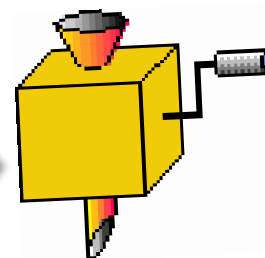
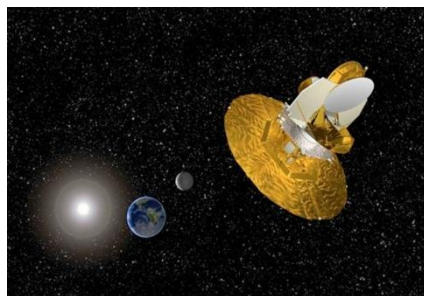
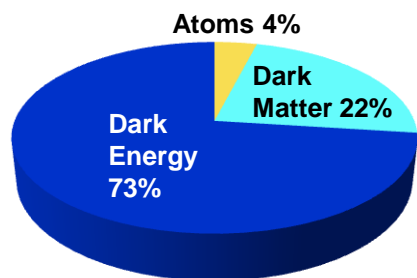
What happens to these fluctuations as the universe evolves?

- **Fluctuations amplifier: Gravity**
- **Fluctuations grow through gravitational instability**
 - **Regions with a higher density than the mean ($\rho > \langle \rho \rangle$) will exert a greater gravitational pull on the surrounding matter, and so attract it. They will then become even denser (ρ increases)**
 - **Regions with less density than the mean will lose matter to the denser regions, and so become even less dense (ρ decreases)**



Cosmological simulations

Well-specified initial conditions: inflation and components



Physics:

Gravity

Hydrodynamics

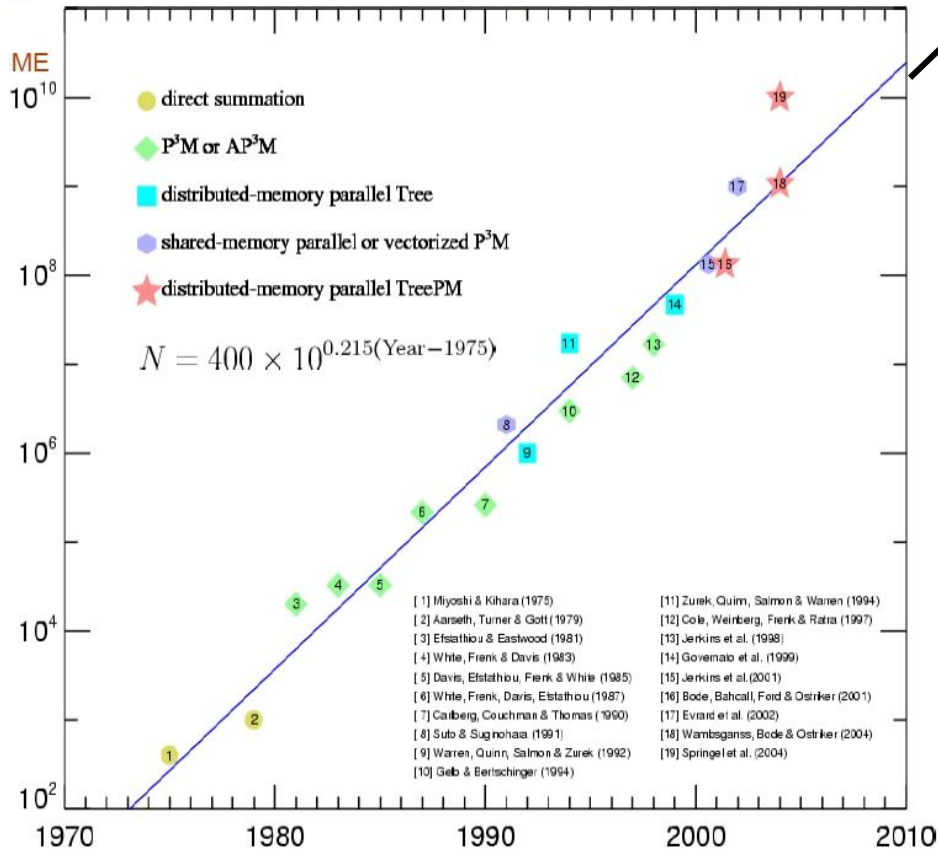
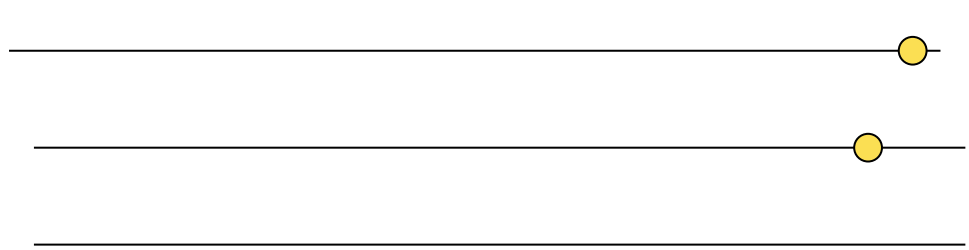
Radiative processes

Star formation

Black holes



10¹³



Kraken – Cray XT5

**100000 cores
NICS-Kraken**

**65000 cores
TACC- Ranger**



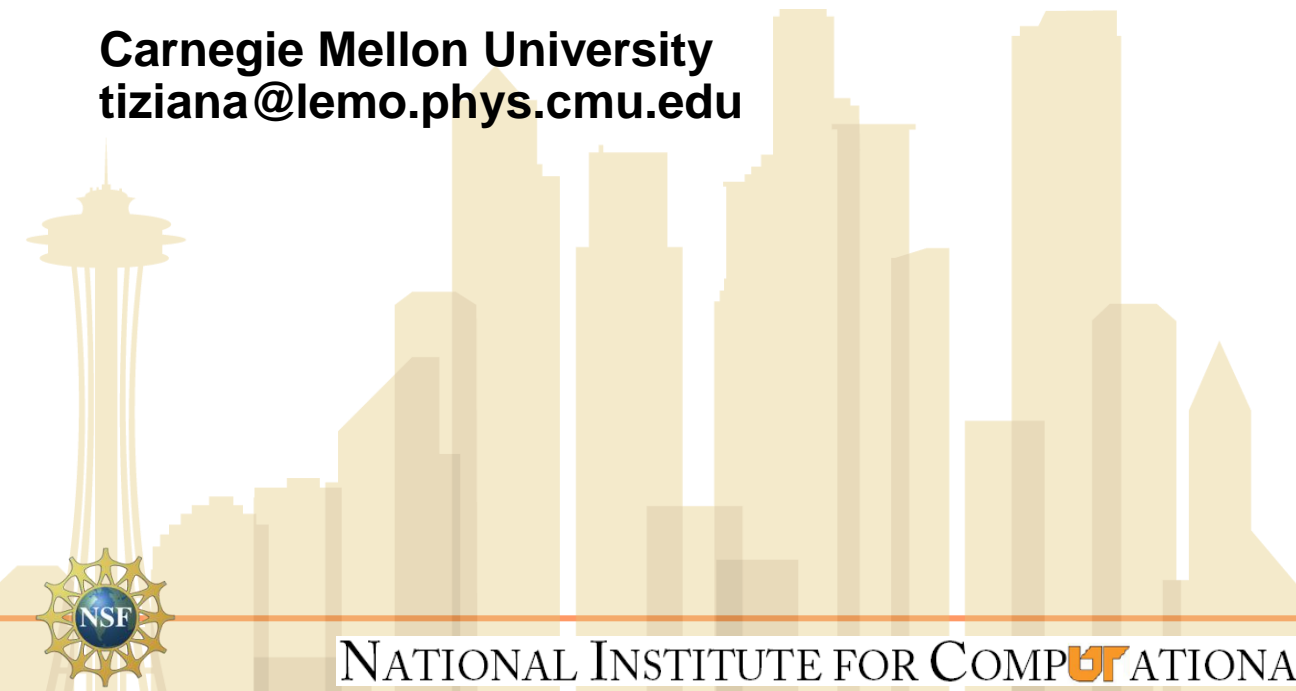


Contact

Tiziana Di Matteo

McWilliams Center for Cosmology

Carnegie Mellon University
tiziana@lemo.phys.cmu.edu



NATIONAL INSTITUTE FOR COMPUTATIONAL SCIENCES

