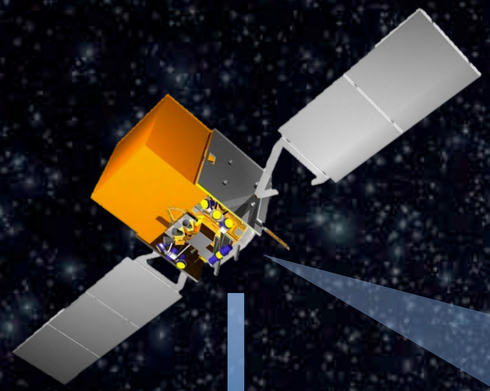
GPU-based Computation of Dark Matter Annihilation

L.F. Yang, J. Silk, A.S. Szalay, R.F.G. Wyse, B. Bozek, P. Madau

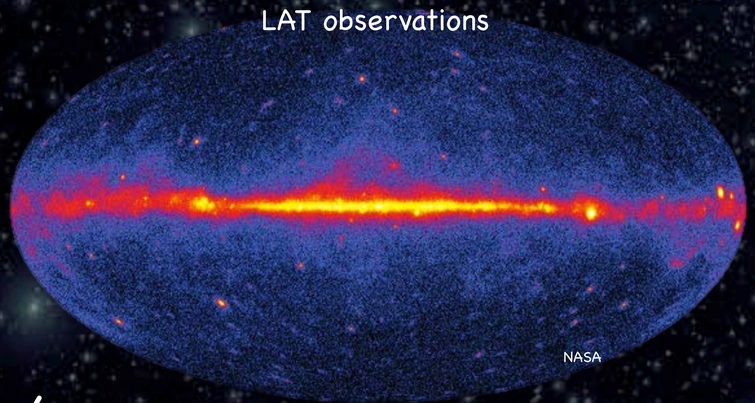
JOHNS HOPKINS UNIVERSITY

idies



1. Fermi-LAT is a Gamma Ray satellite that observes the all-sky gamma-ray emission from the Milky Way. These emissions could be possibly from Dark Matter annihilation/decay. **Dark Matter** may be a large fraction of all the matter in the Universe. Until now, this mysterious particle has not been confirmed observationally, including Fermi-LAT. They can be only studied numerically. **Does Dark Matter Contribute to the gamma rays?**

LAT observations



NASA

2. Modern N-body cosmological numerical simulations can take millions of CPU hours and contain hundreds of billions of particles. The background of this poster is data from the Via Lactea II simulation, containing a Milky Way-like galaxy using about 10^9 particles. To produce an all-sky map of simulated Dark Matter annihilation, **a traditional CPU algorithm integrating through the simulation box takes 8 hours.**

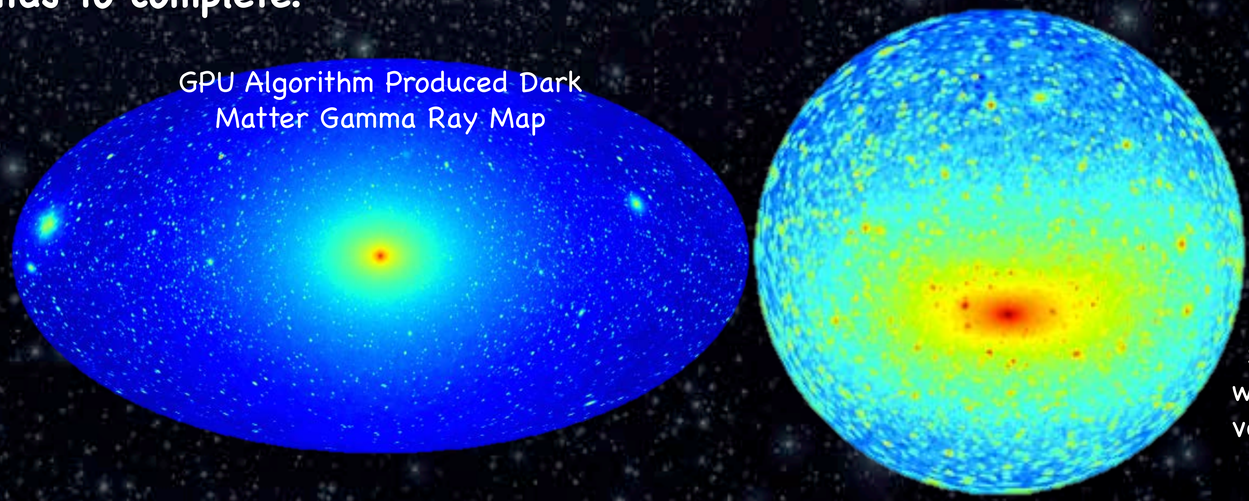
8 hrs

40s

Line of sight integration → Gaussian Profile to sphere → Stereographic projection → Graphics Pipeline

3. We reduce the problem of Dark Matter Particle annihilation to stack Gaussian density profiles around each particle onto a plane, using a stereographic projection. This reduces the problem to be a computer graphics problem – rendering a billion particles with a given profile. GPUs are designed to perform such computations very efficiently. **Our GPU algorithm takes 40 seconds to complete.**

GPU Algorithm Produced Dark Matter Gamma Ray Map



Scan to play with the cloud version of this algorithm.

4. This fast algorithm allows us do many numerical experiments and produce different predictions for the Dark Matter emission for different physics. These predictions could serve as templates for future studies of Dark Matter. We demonstrated how Dark Matter may contribute to the Fermi observations.

References: Diemand et al 2008, Yang et al 2014, Yang et al 2012