Large Scale Structure Formation

Marcelo Alvarez

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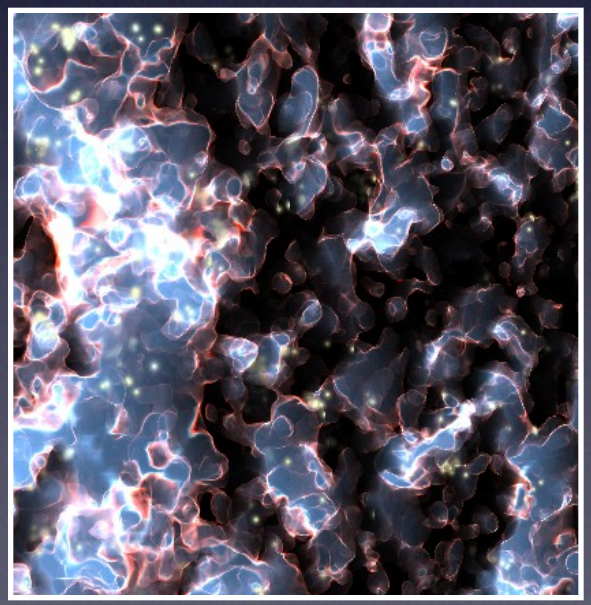
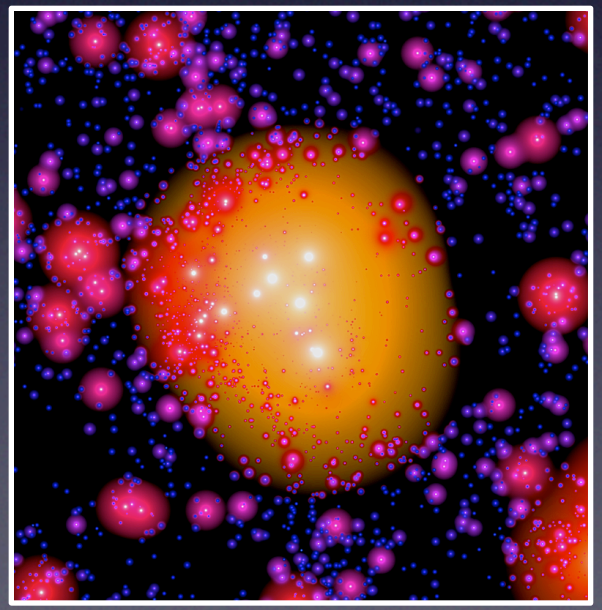
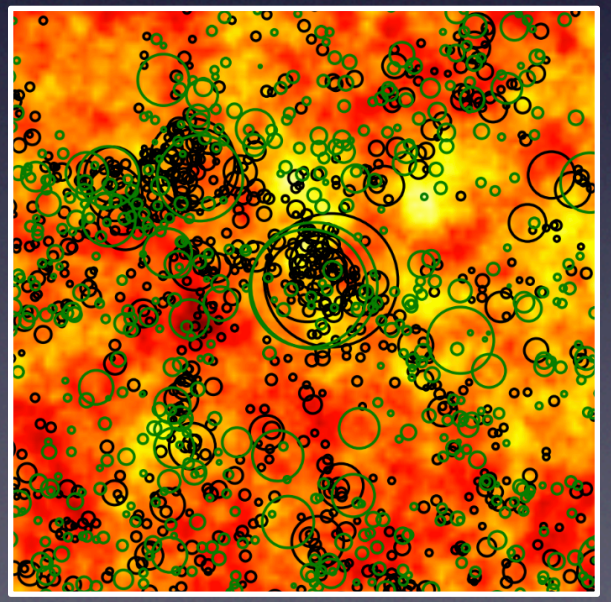


Cosmic Reionization

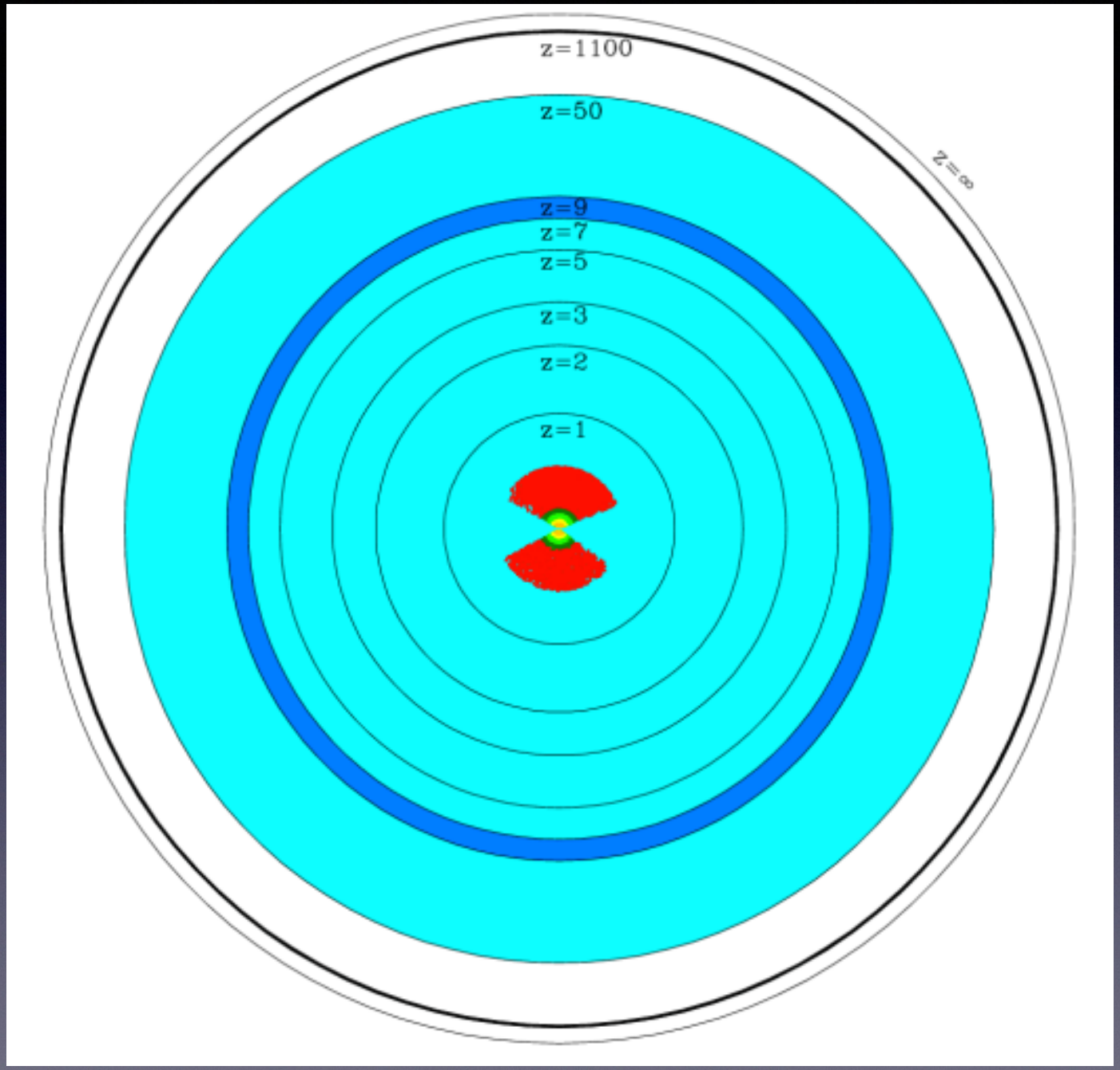


Large N-body Simulations

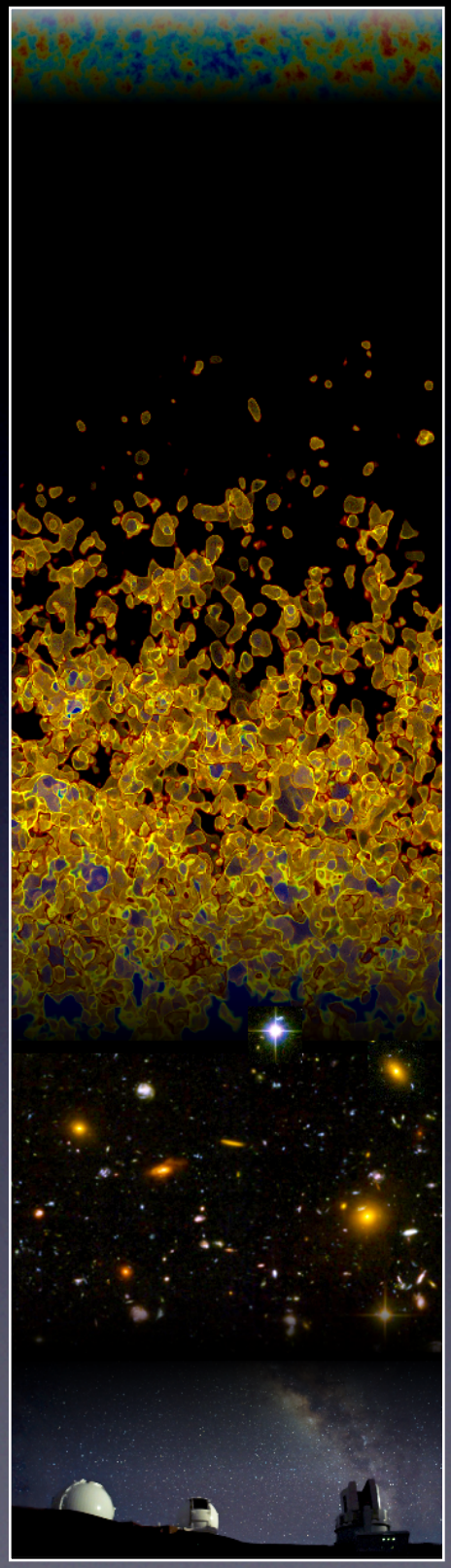


Peak Patches

A Universe of Information



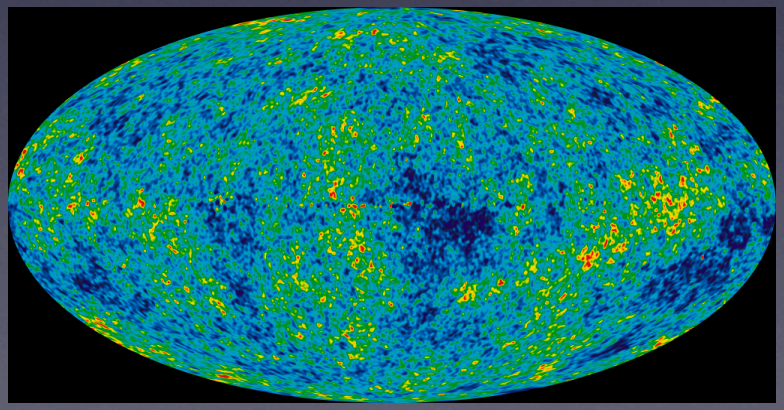
Mao et al. (2008)



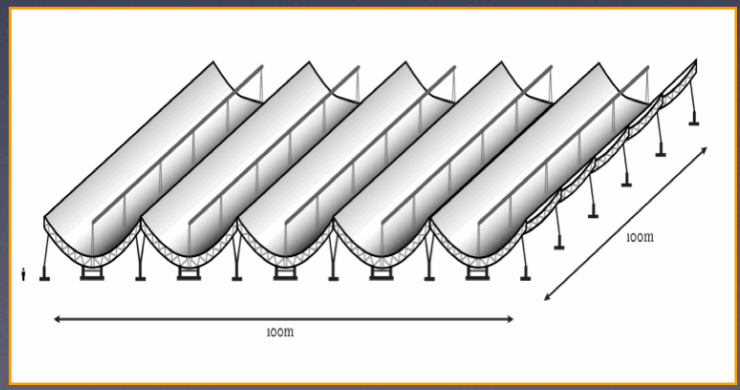
Cosmic Backgrounds

- **Reionization, galaxies, and clusters generate secondary CMB anisotropies (kSZ, tSZ, CIB) and a fluctuating background of line emission (21-cm, CO, CII)**
- **We are developing theoretical tools for current and upcoming observations with ACT, SPT, Planck, CHIME, LOFAR, SKA, etc…**

CMB Secondary Anisotropies



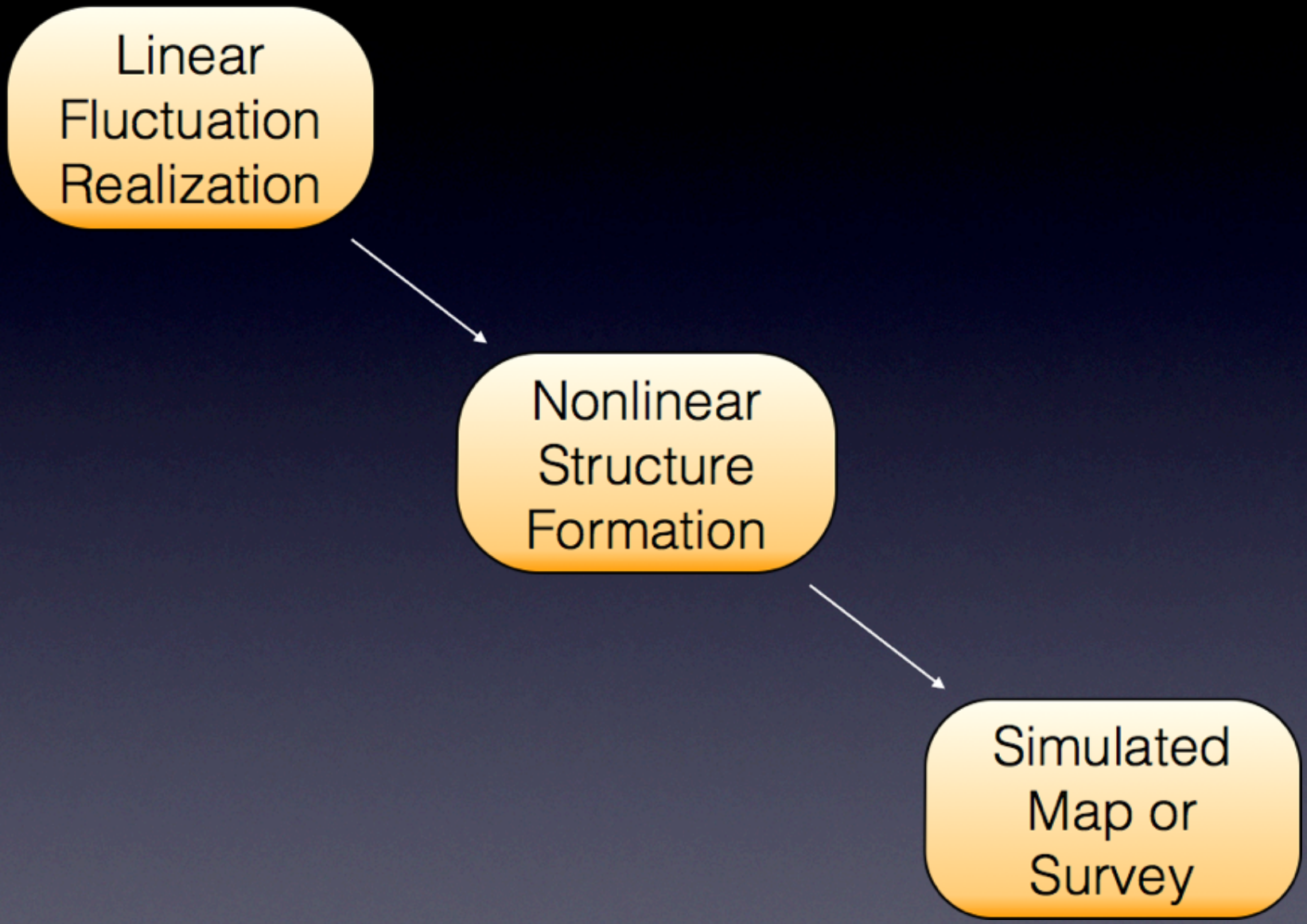
Intensity Mapping with CHIME



Massive N-body Simulation on Blue Gene/Q at Scinet

- Run by CITA grad student JD Emberson
- Used 27,648 cores of BGQ, or ~85% of the whole production system
- Used 24 TB of RAM and took 10 million CPU hours, or about 2 weeks
- 2 Gpc/h box (about 10 billion light years across) containing 6192^3 particles (~240 billion)
- Among the largest N-body runs performed to date -- lots of data to analyze!

An Efficient Alternative to N-body Simulation: Peak Patches



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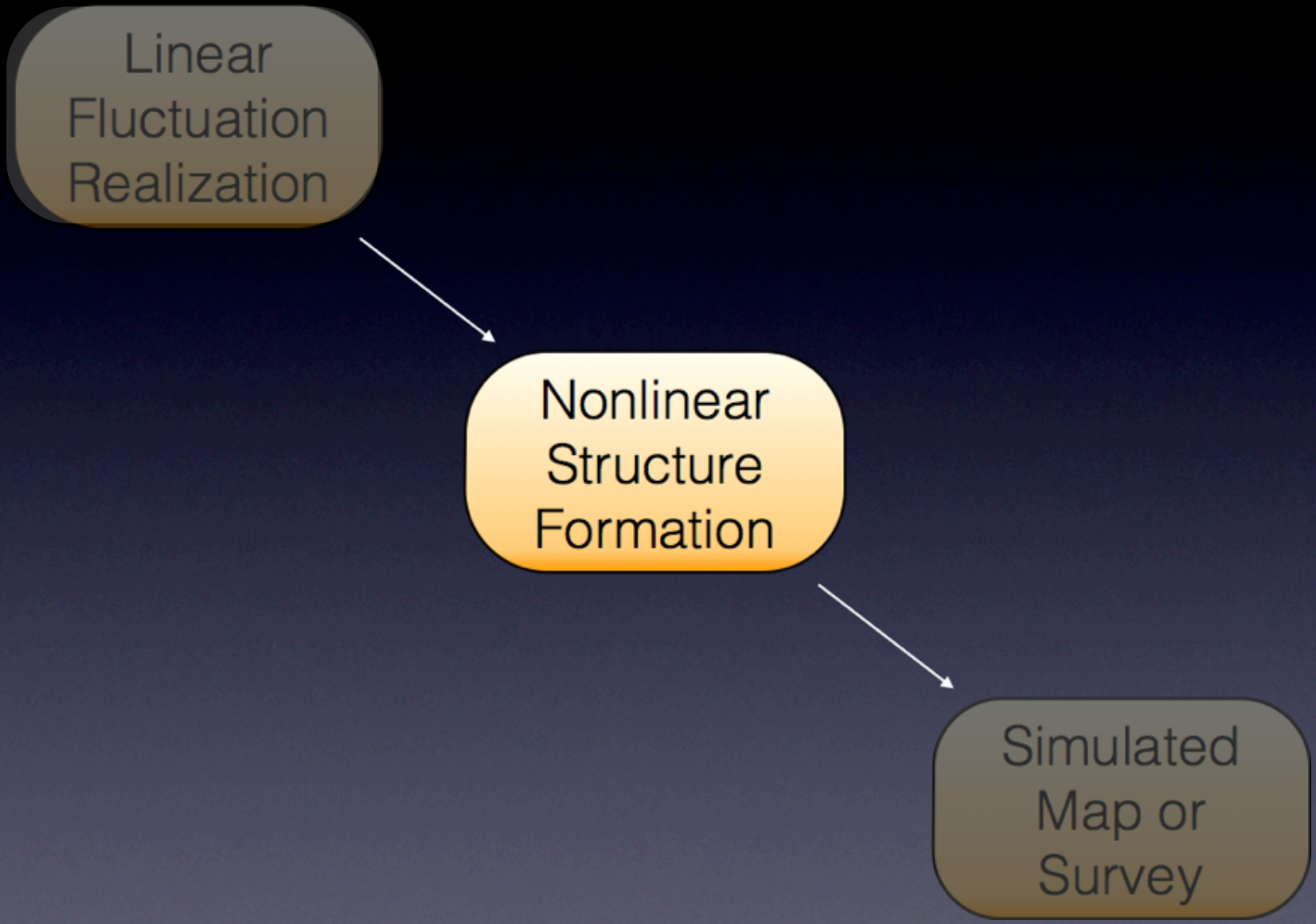

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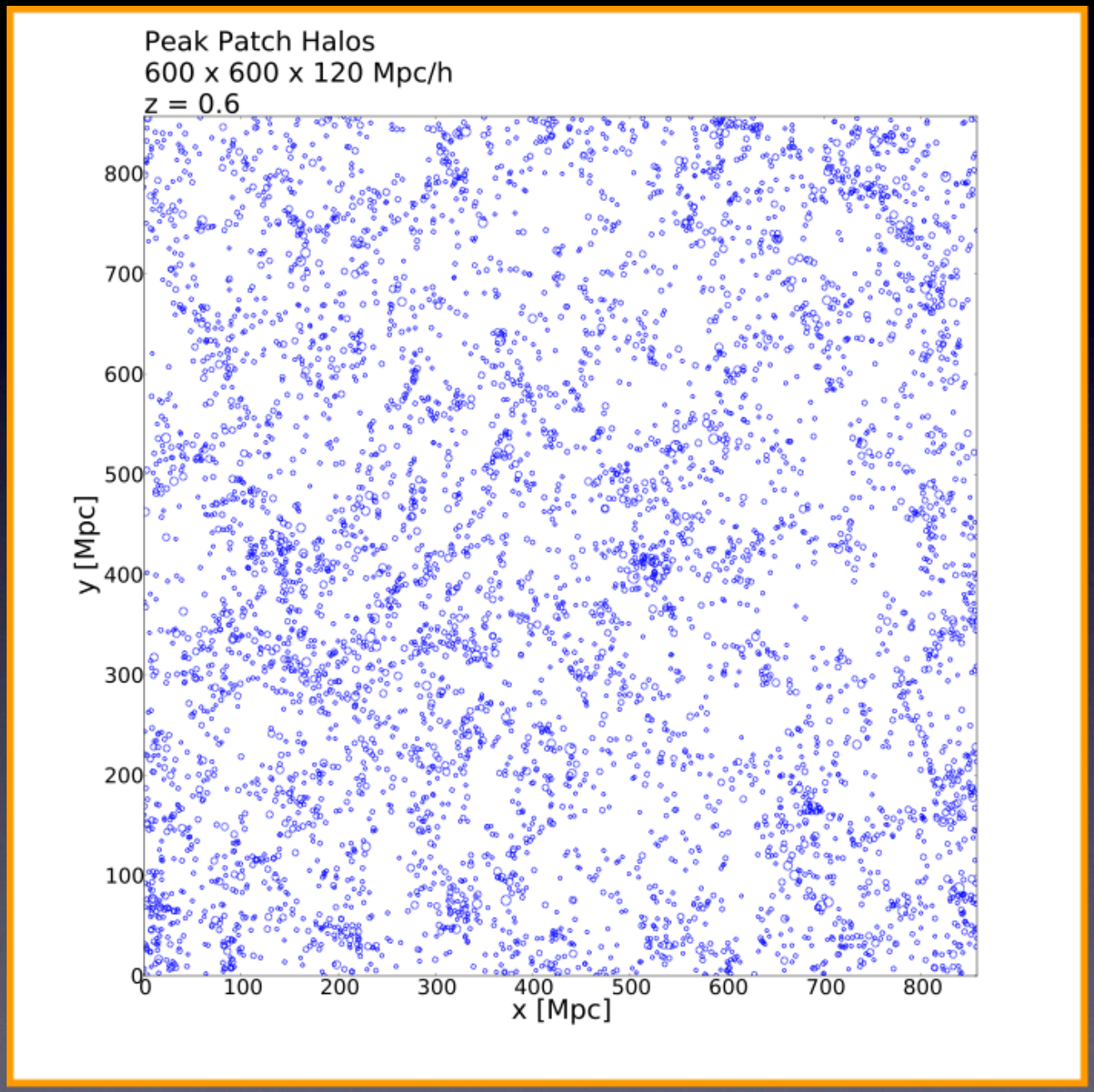

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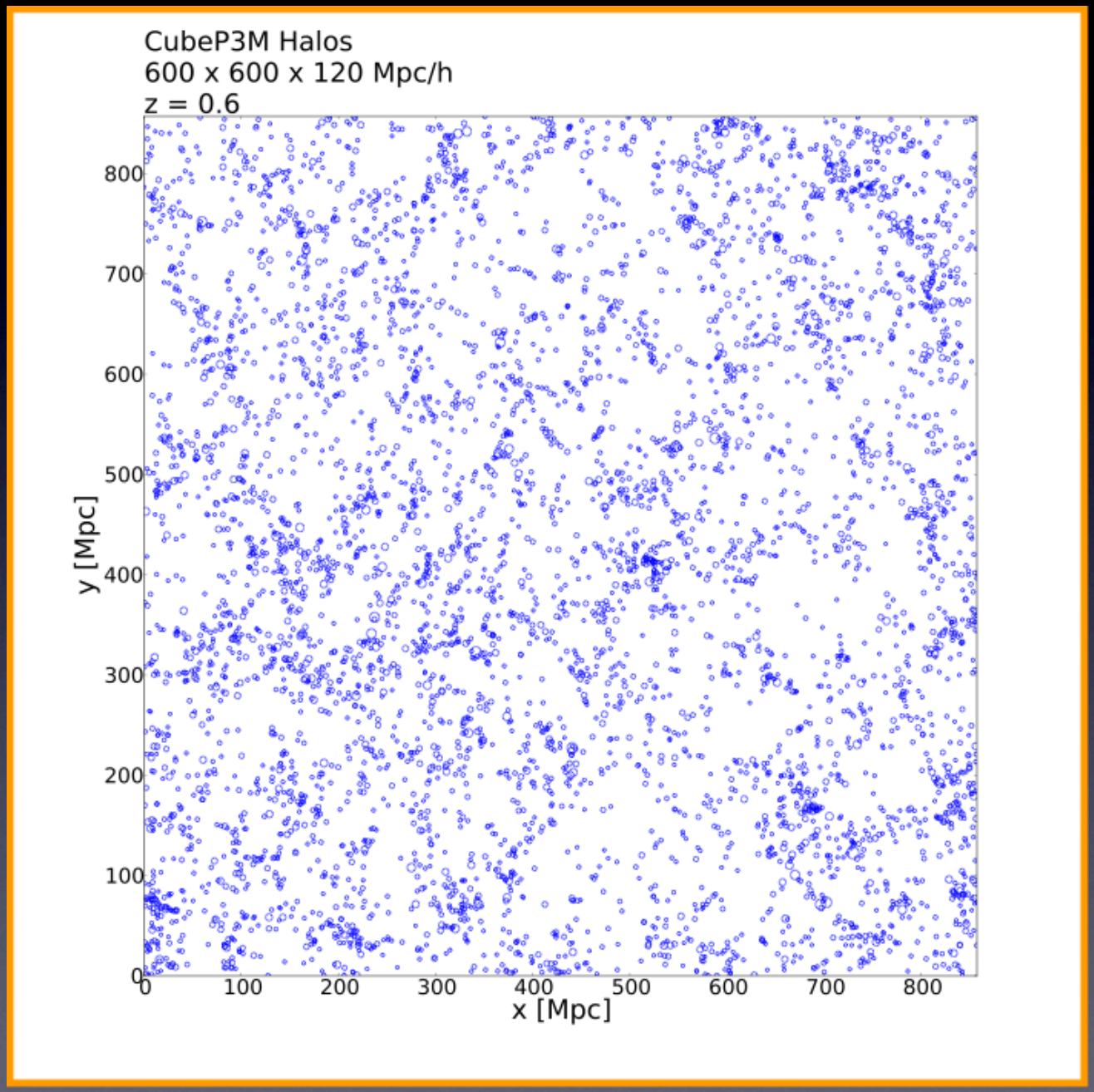

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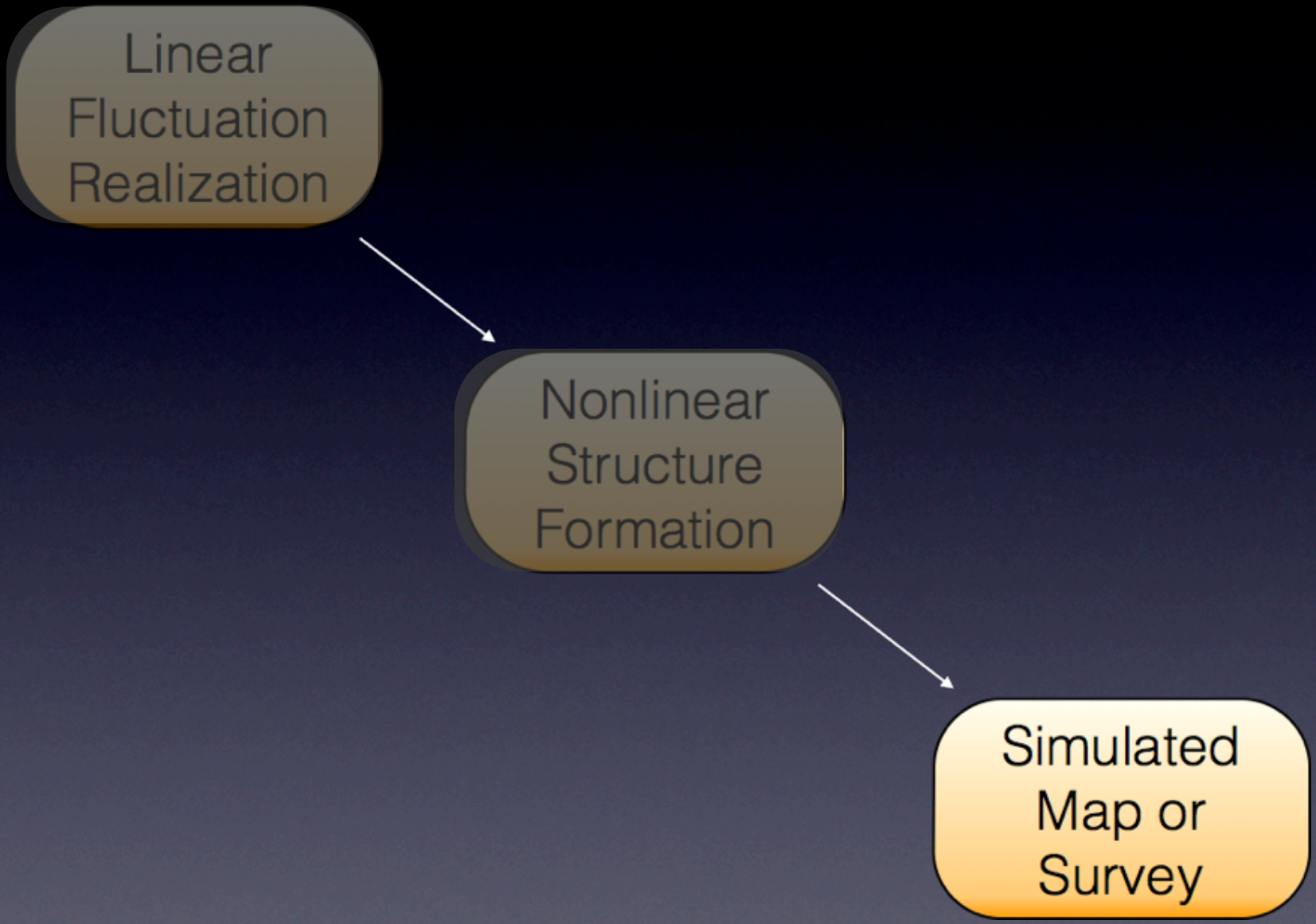
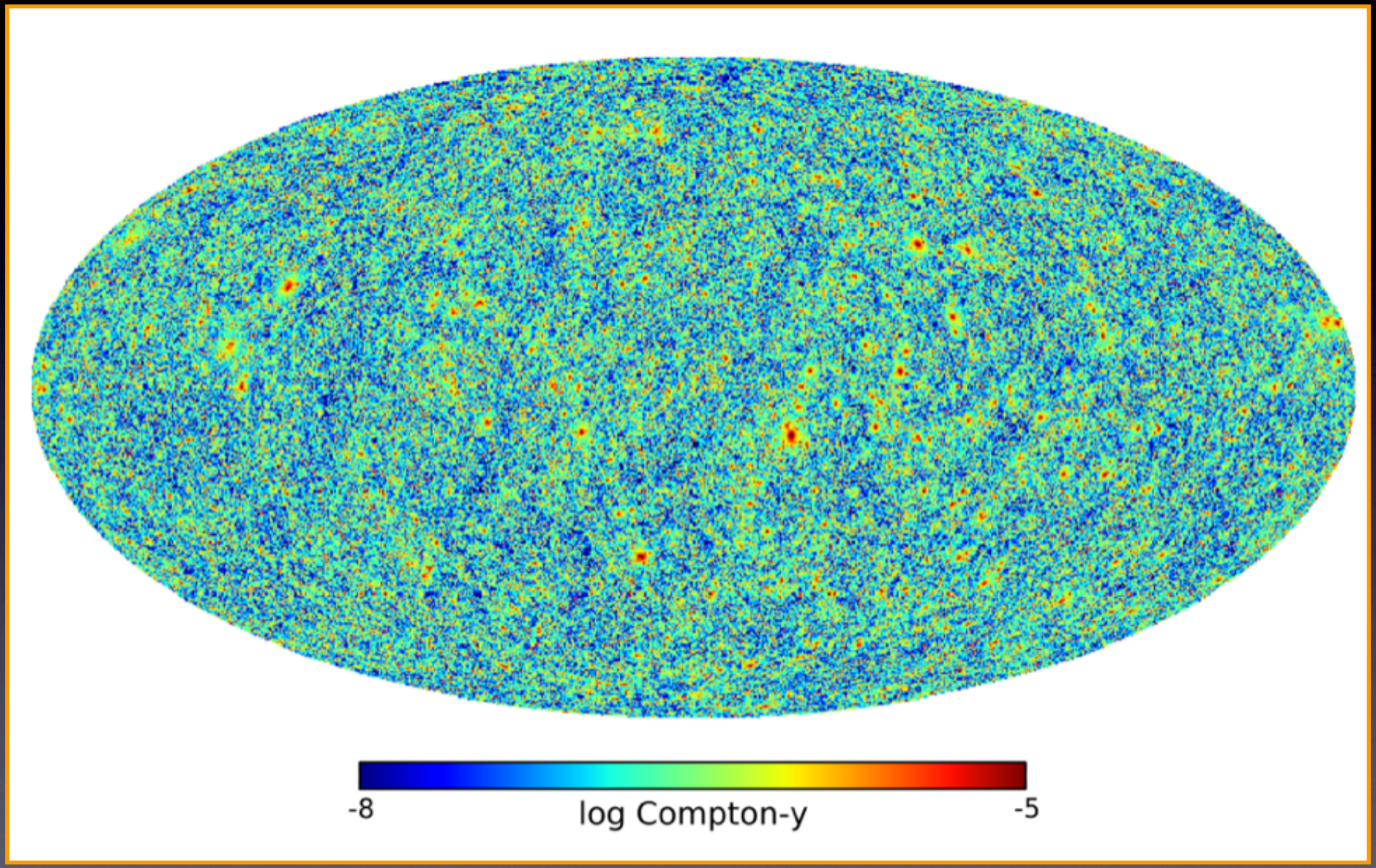


Example Application: All-sky Sunyaev-Zel'dovich Map

(with Bond, Hajian, Stein)



Applications of Large-Scale Structure Formation Calculations

- Modeling the non-Gaussianity from inflation and other signatures of the very early universe
- Studying the process of reionization and how the first stars and black holes formed
- Mock observations for Canadian HI Intensity Mapping Experiment (CHIME) to measure dark energy
- Studying secondary anisotropies in the cosmic microwave background (CMB) via the Sunyaev-Zel'dovich effect
- Modeling of the cosmic infrared background (CIB)
- And much more ...