

Creating a Galaxy Cluster Simulation to Constrain Cosmology

Keenan Fiedler

Dr. Eduardo Rozo, Dr. Andres Salcedo

University of Arizona



Cosmic Structure

- Vast majority of matter is dark matter, invisible to telescopes
- Visible matter cannot form galaxies without help
- Galaxies connect to underlying dark matter, forming at clumps in the dark matter called “halos”
- How can we connect galaxies to dark matter?

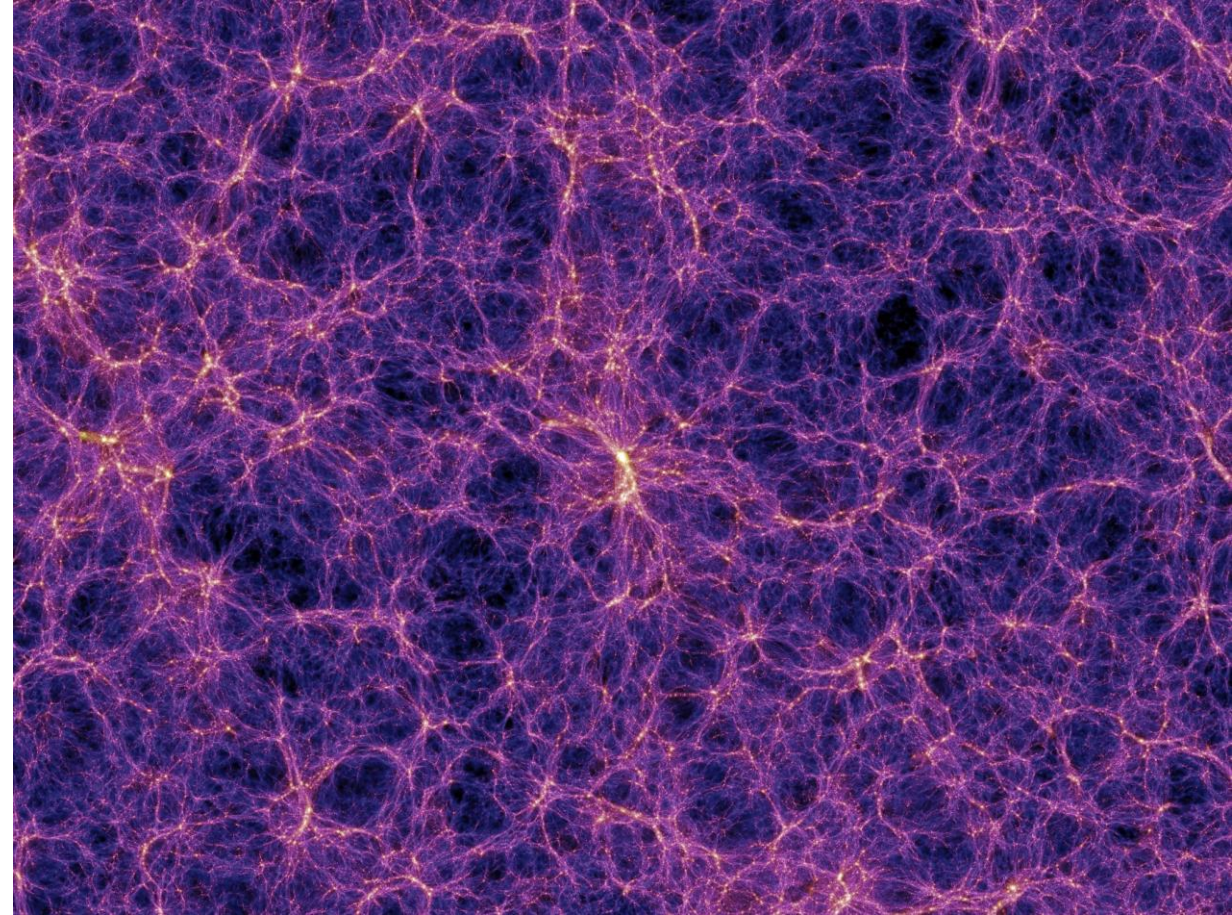


Image Credit: Springel et al. (2005)

Simulation Based Inference

- Use simulations to create a fake universe
- Control all aspects of fake universe to imitate real data
- Infer information by comparing using a galaxy cluster finder

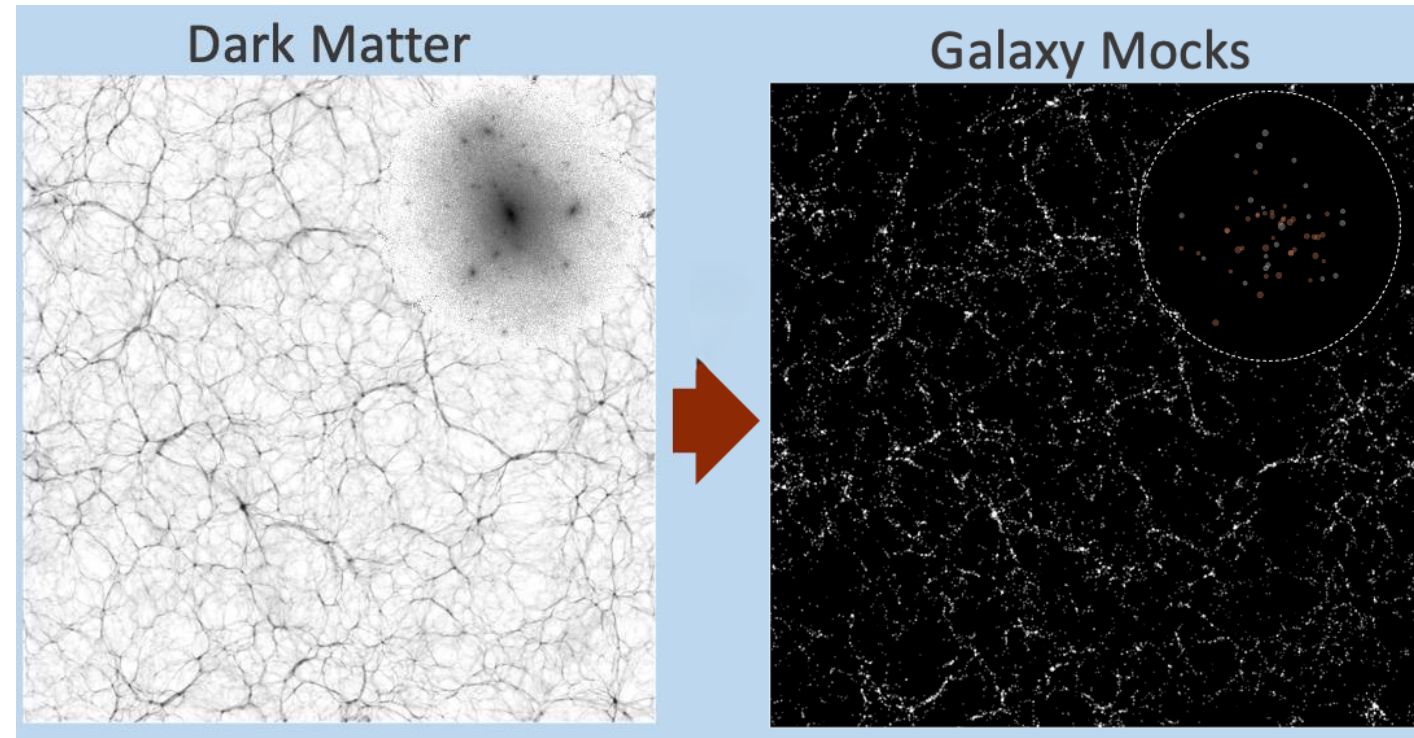


Image Credit: To et al. (2023)

Transforming Dark Matter into Galaxies

- Given a dark matter halo
 - Choose number of galaxies
 - Give each galaxy the data a galaxy survey would have
- Know all properties and parameters of simulation

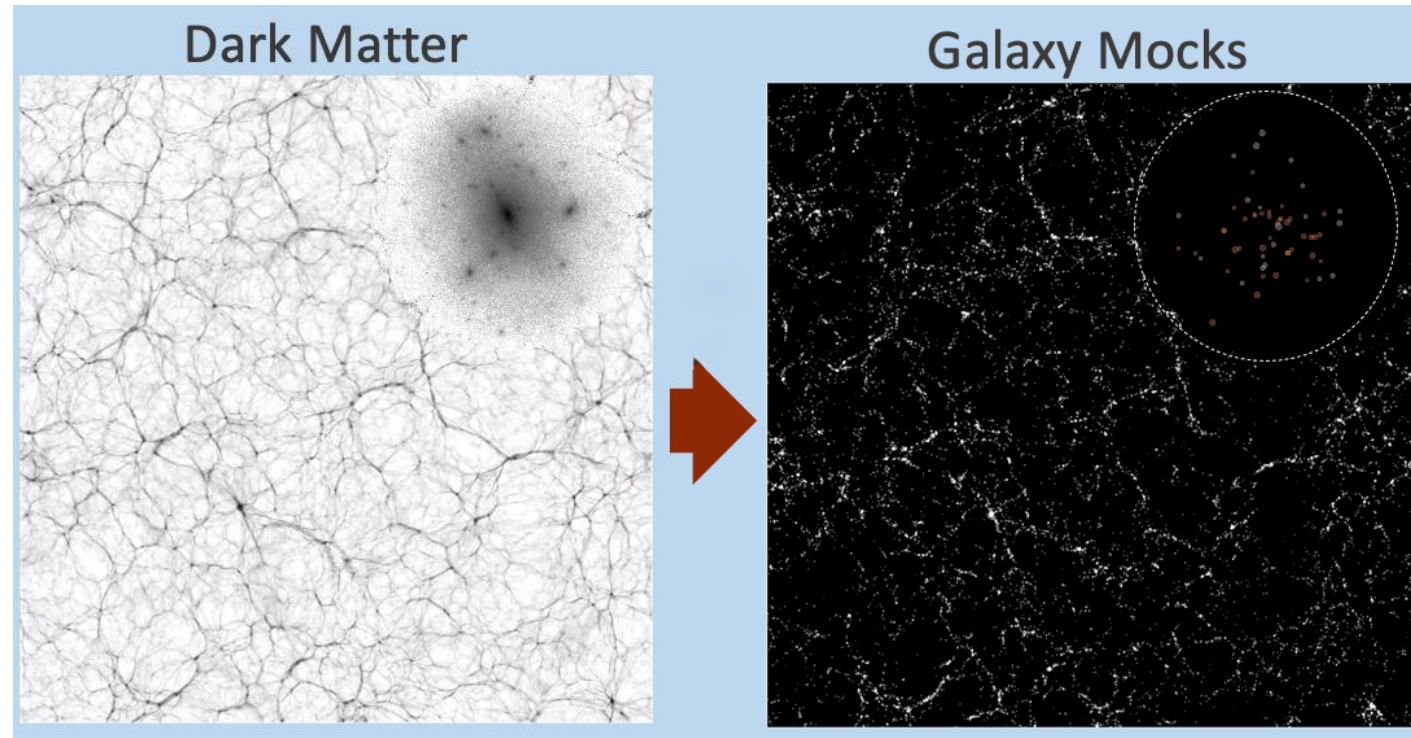


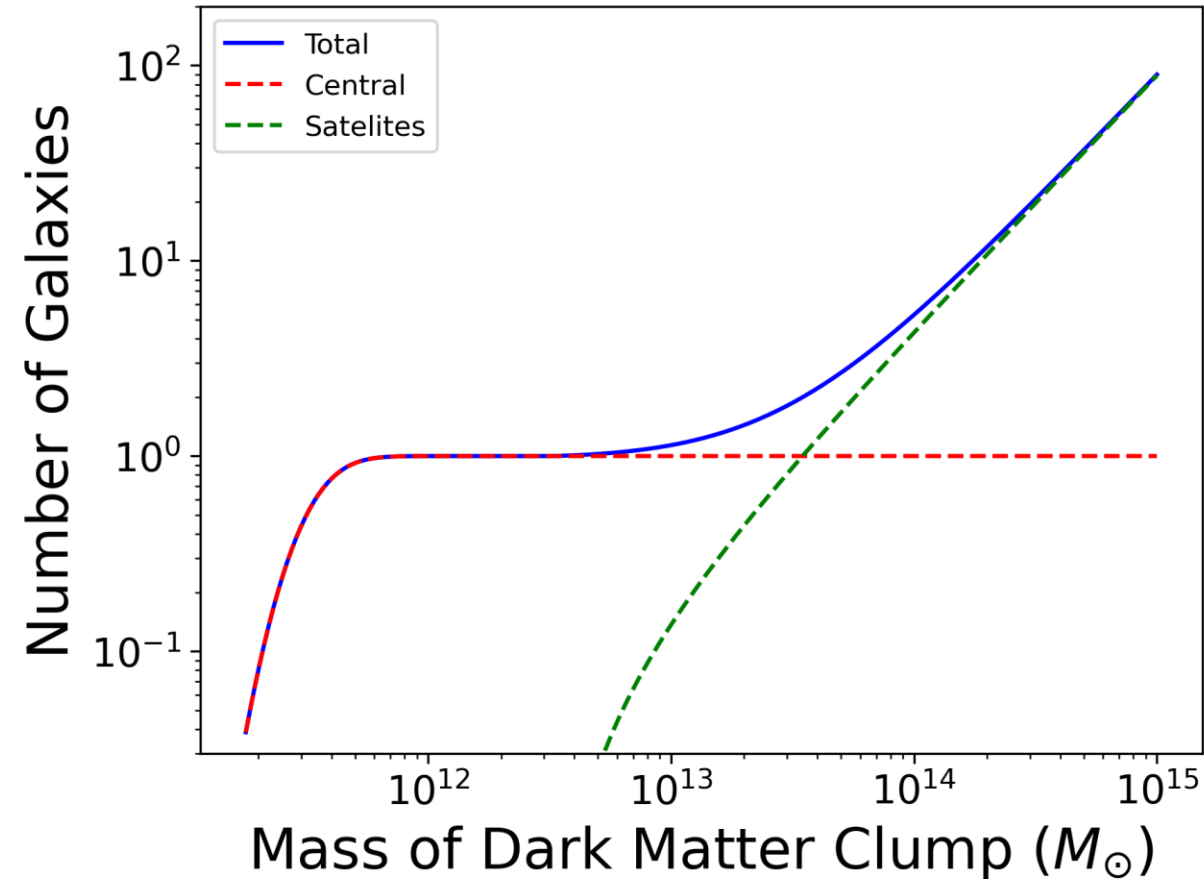
Image Credit: To et al. (2023)

Goals for My Simulation

- Highly accurate to real-world data
- Able to quickly generate many simulations
 - Allows wide parameter range for inference
- Build for specific galaxy cluster finder – redMaPPer
 - Improve function and accuracy of cluster finder
- Build to work with Dr. Salcedo's pipeline of simulation-based inference

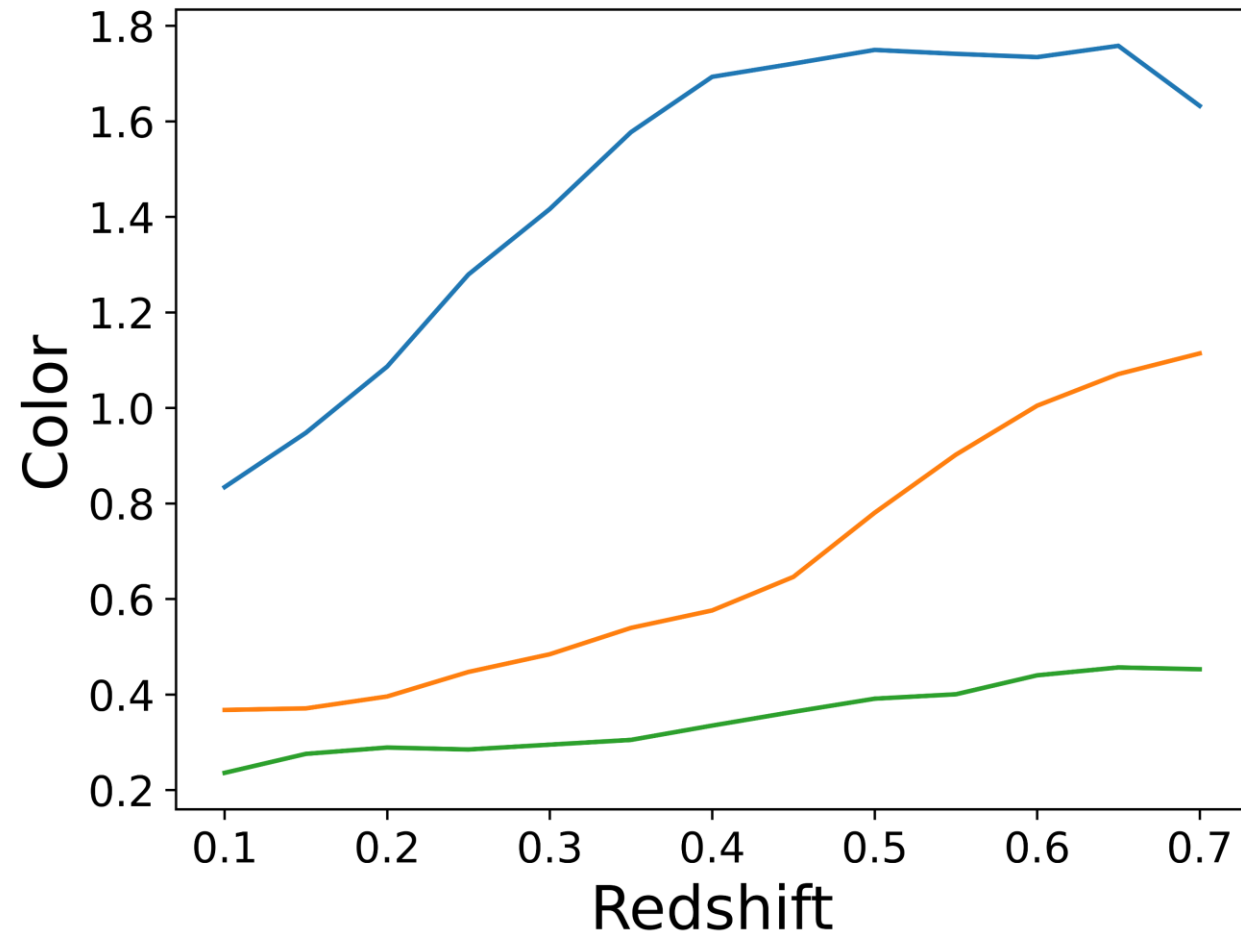
Determining Number of Galaxies

- Entirely based on mass of the dark matter clump
- Centrals, the brightest and most massive galaxies
- Satellite galaxies orbiting the central



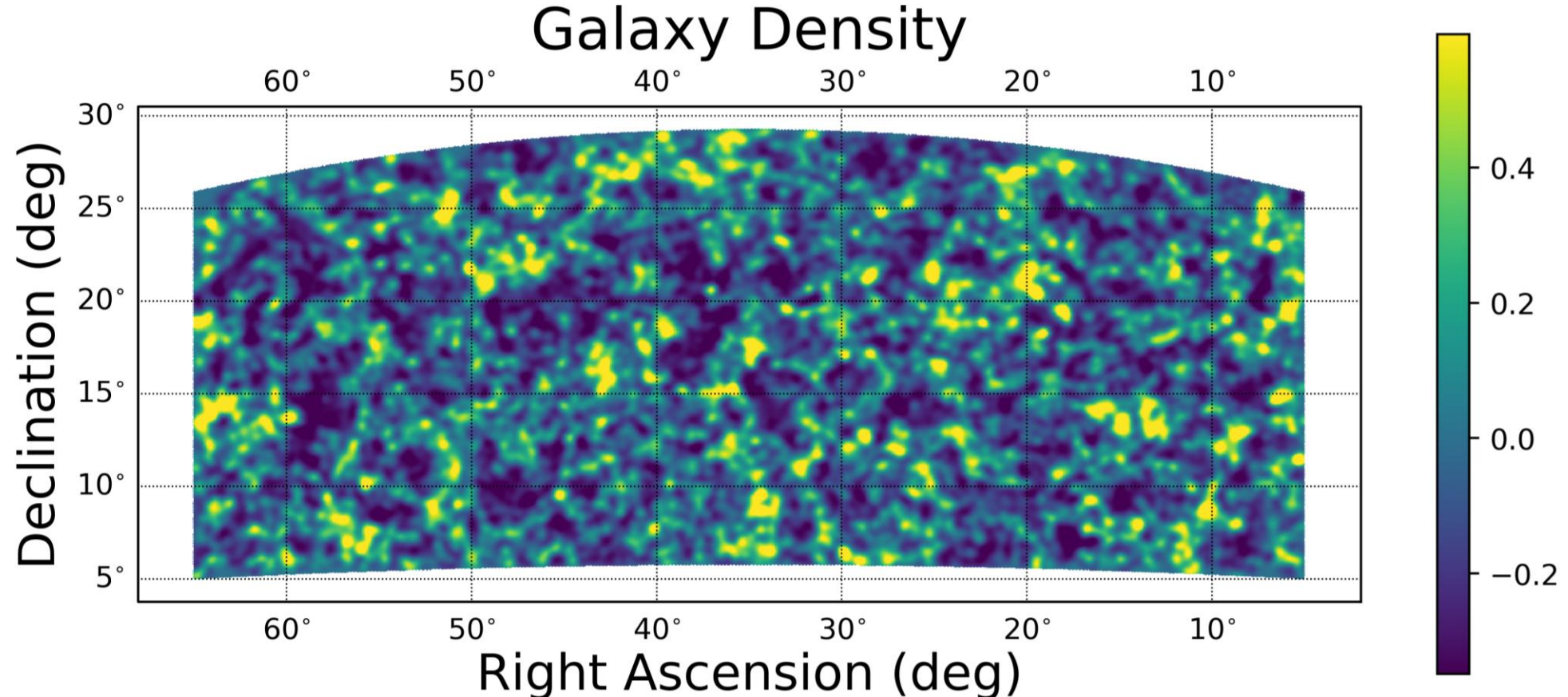
Determining Color of Galaxies

- Color is difference in the brightness of different bands
- Important property for cluster finding with redMaPPer



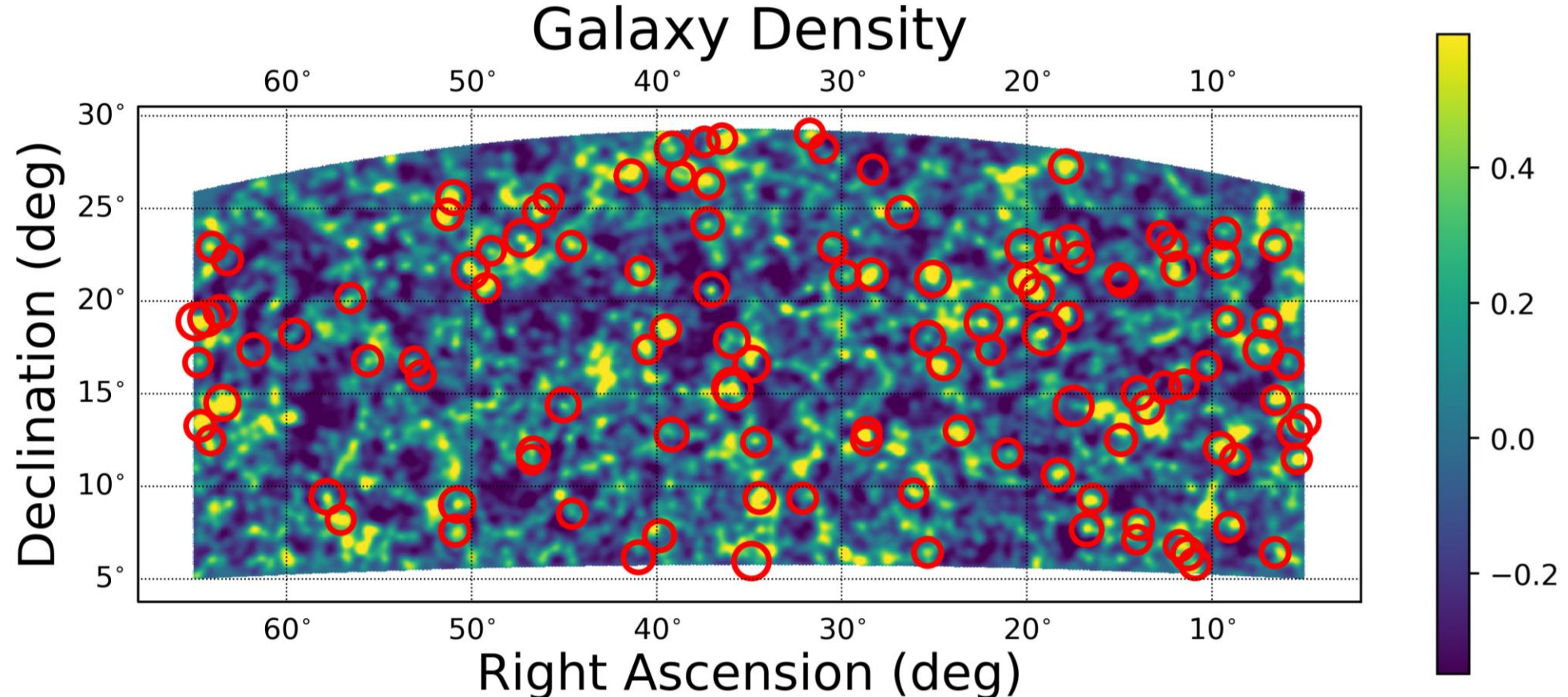
My Galaxy Simulation

- Fast - creates a catalog of galaxies takes minutes, not hours
- Accurate - includes photometric error and central brightening



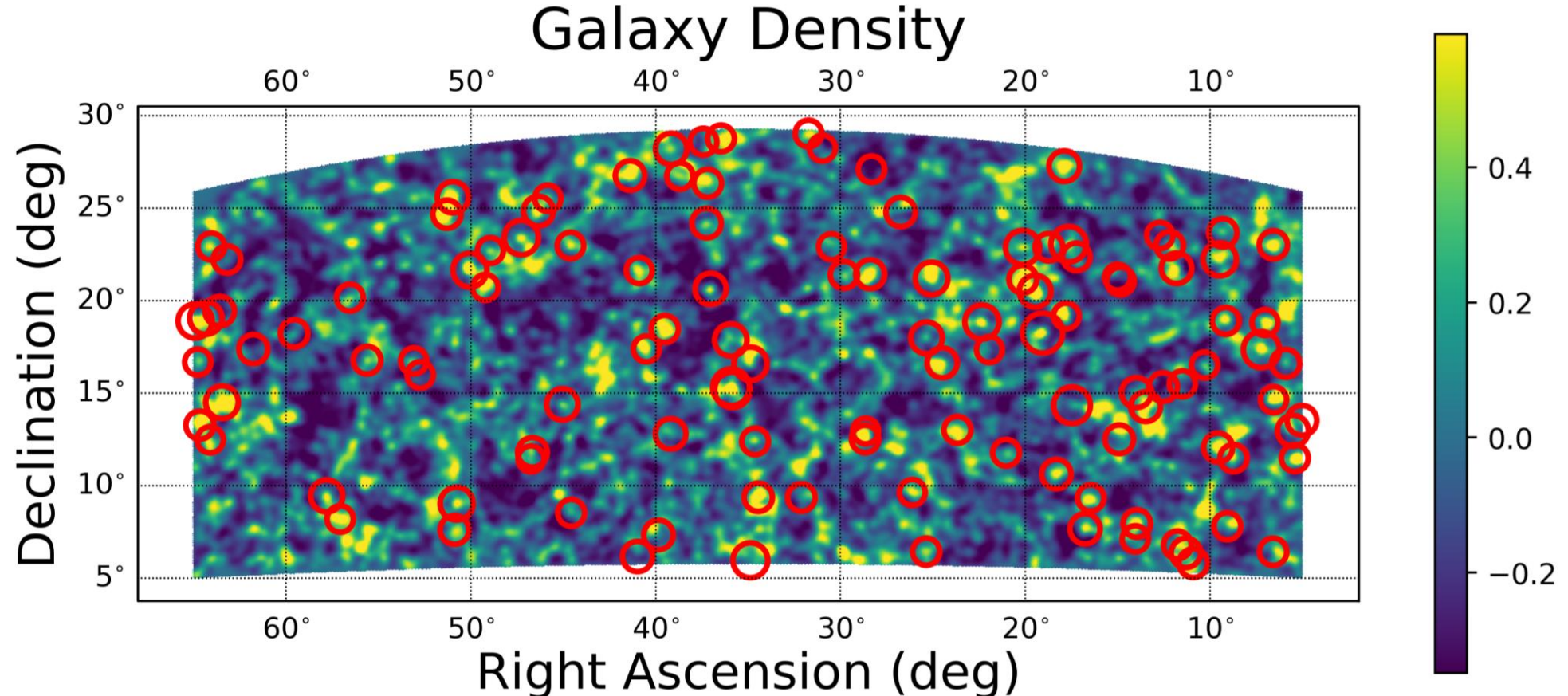
My Galaxy Simulation

- Fast - creates a catalog of galaxies takes minutes, not hours
- Accurate - includes photometric error and central brightening



Next Steps

- Confirm accuracy to real world data
- Use Dr. Salcedo's method to measure cosmology



Thank You

- Acknowledgements
 - Dr. Eduardo Rozo
 - Dr. Andres Salcedo
 - Arizona Space Grant Consortium
 - University of Arizona Department of Physics
- For questions:
 - kfielder@arizona.edu

