The Role of Mergers in Galaxy Formation

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MPIA Student Workshop
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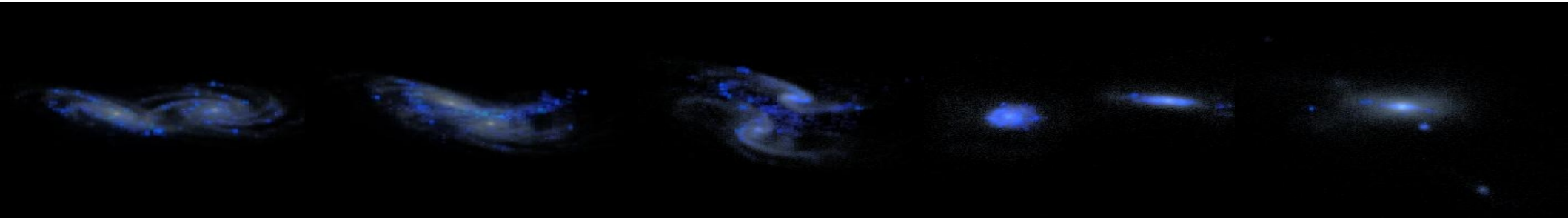


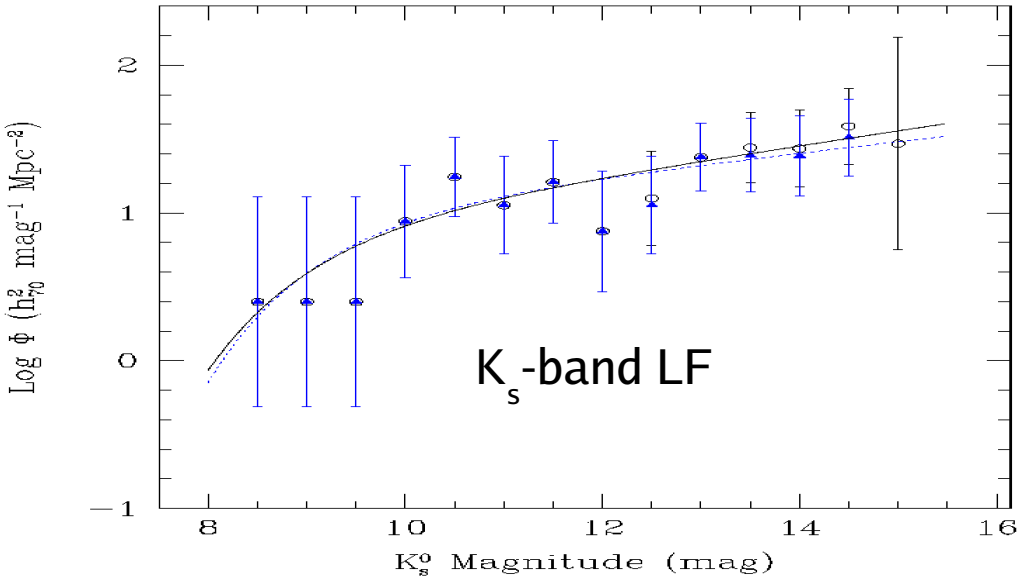
Overview

- A bit about me: My Master's, Astronomy in South Africa
- Galaxy formation and evolution: Some important questions
- SAMs: Recipes and Results
- Mergers in SAMs
- Current status and goals

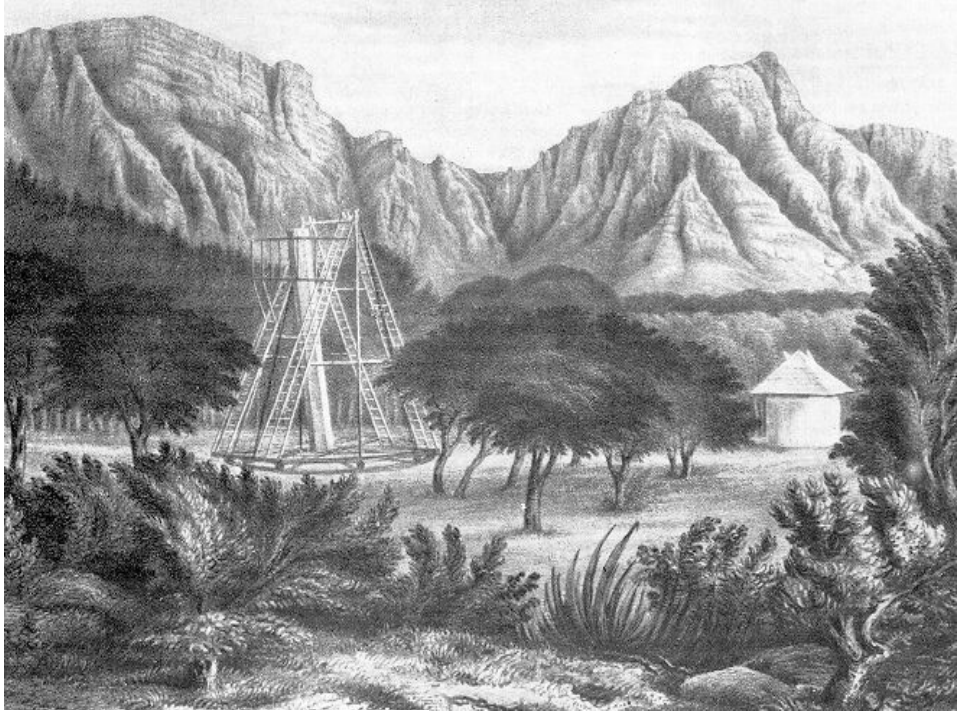
Some background about me...

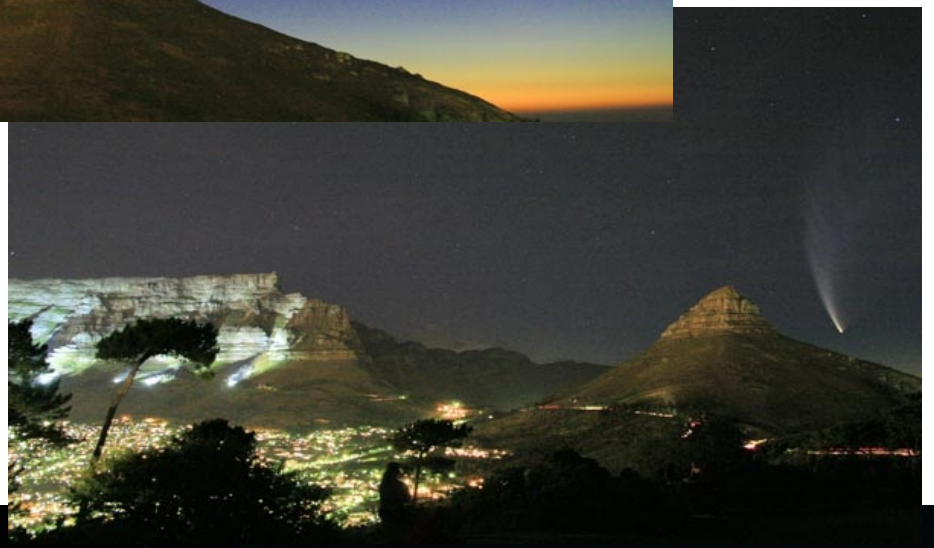
Master's at the University of Cape Town:
Galaxy photometry ➡ The Near Infrared Luminosity Function of the Norma Cluster

- The nearest rich, massive cluster, hidden in the "Zone of Avoidance"



- Astronomy in the Cape dates back to Sir John Herschel in the 1830s
- SALT: The Southern African Large Telescope (First light 2005)
- A new wave of radio astronomy: SKA and KAT



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Current work: Galaxy Formation and Evolution

- Galaxy mergers in theory and observation: From SAMs to surveys
- Some NB questions:
  - How big a role do mergers play in the formation of galaxies? Do the theories and observations agree?
  - Can the present day population of ellipticals be explained by the merger hypothesis?
  - How recently did galaxies undergo a major merger?
  - How many (major) mergers did a typical galaxy today experience?

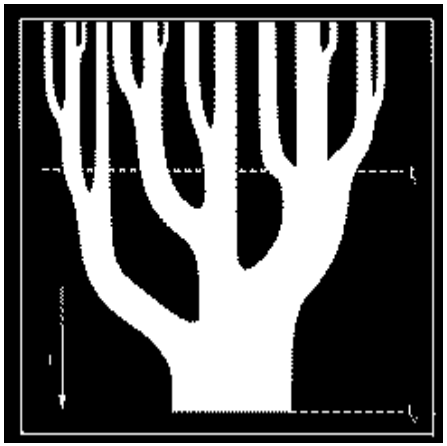
Semi-Analytic Models (SAMs)

- Developed within the Cold Dark Matter paradigm of structure formation in the Universe
- Complicated baryonic physics difficult to reproduce in N-body simulations
- SAMs provide an alternative, with simplified yet physical recipes for gas cooling, star formation, feedback from supernovae and AGNs and galaxy mergers
- Use Monte Carlo techniques to get dark matter halo merger histories

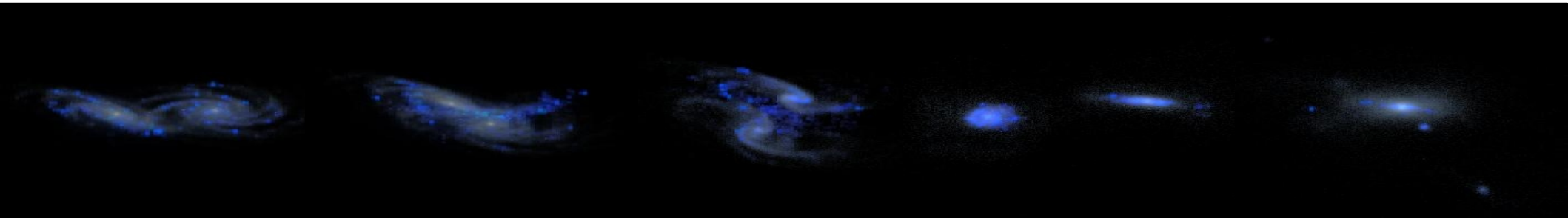
SAMs: Successes & Drawbacks

- Manage to reproduce a number of properties of galaxy populations:
  - Galaxy luminosity function
  - Tully-Fisher relation
  - Morphology-density relation
  - Trends of galaxy colours with morphology and environment
- Remaining problems:
  - More luminous galaxies tend to be bluer than observed
  - Still difficulties with AGN feedback

Investigating mergers in SAMs

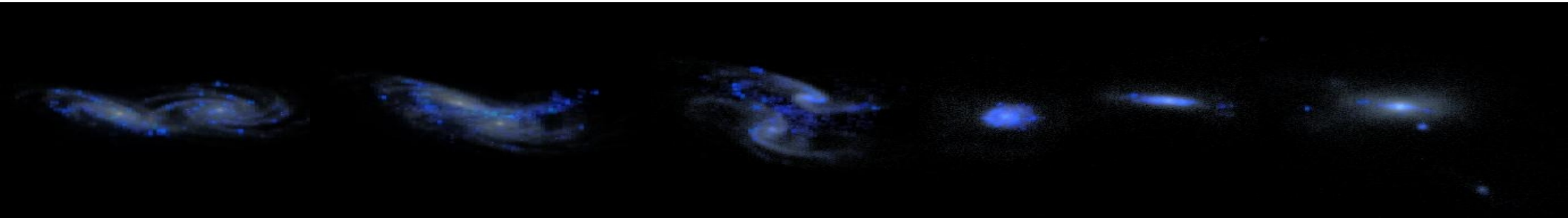


- Dark matter halo merger trees are used as framework for galaxy models
- Create merger trees for the galaxies, to look at merger histories
- Combine output at z=0 with data output at each merger
- Investigate merger fractions for different populations of galaxies and progenitor properties



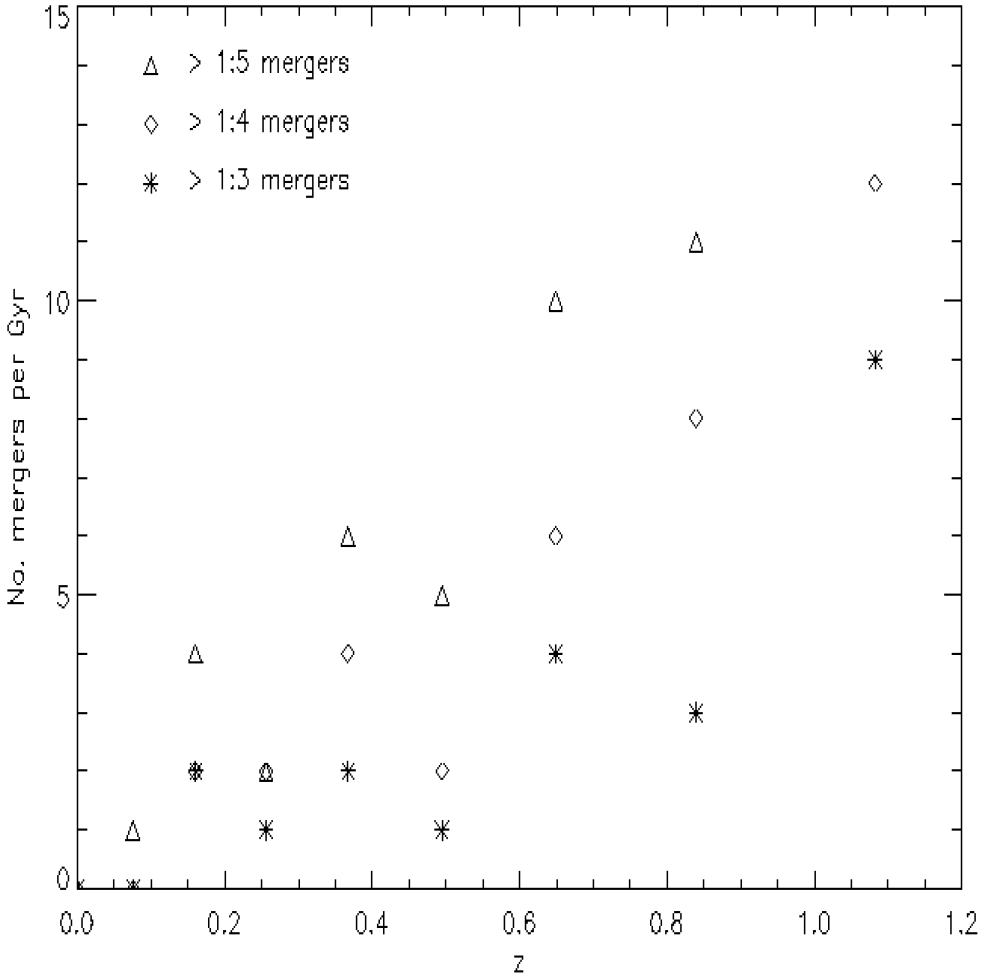
Results & Difficulties

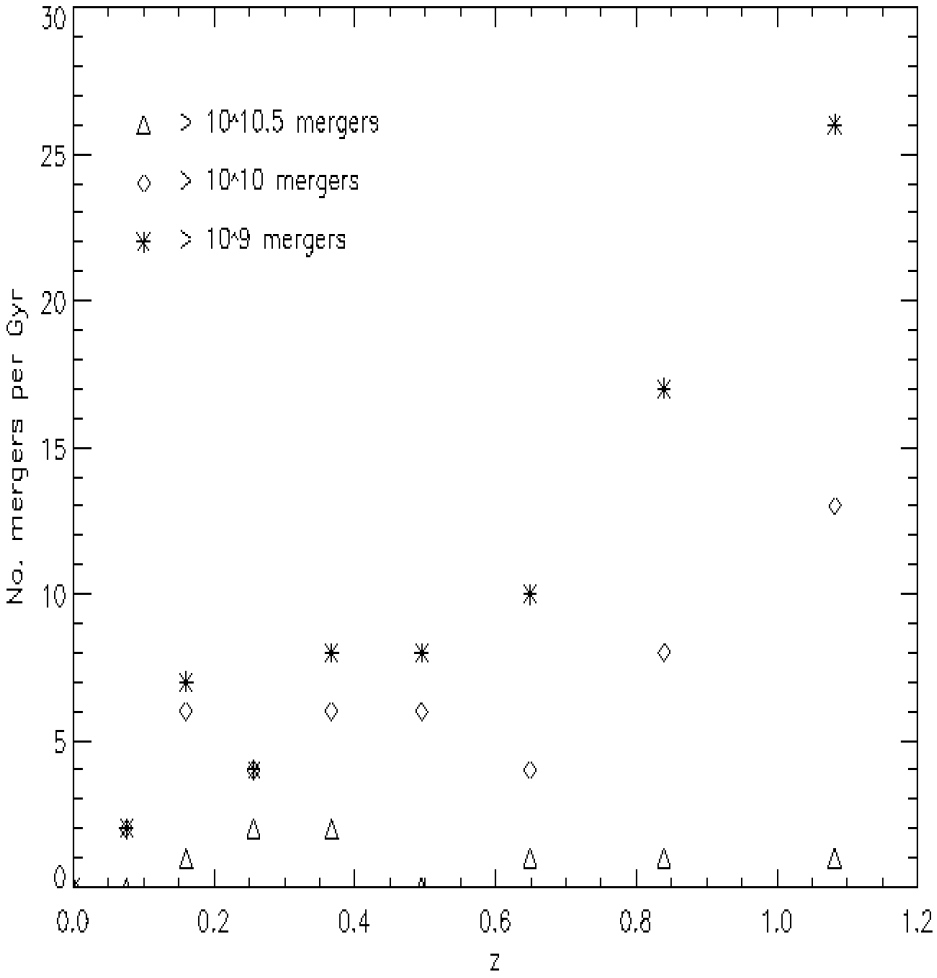
- Written code to create merger trees for galaxies and add information on final galaxy population using SAM output
- This works well for limited output (e.g. 100 Milky Way-type halos) but run into memory and time issues dealing with complete simulations (45000 halos!)
- Need to do it halo by halo for large simulations!



100 Halos of $M = 10^{12}\ M_{solar}$

96 mergers between z = 0 and z = 1,
15 of them major (mass ratio 1:3 or greater)





Aims over the next little while...

- Optimise code to deal with large files and cut out unnecessary information
- Examine properties of progenitors of last major merger (morphology based on Bulge-to-Total luminosities)
- Test idea on dry/wet mergers of early types forming core/cusp galaxies (Kormendy et al. '07)
- Compare results from SAMs with observational merger fractions (GEMS and other surveys) up to $z = 1$ and beyond