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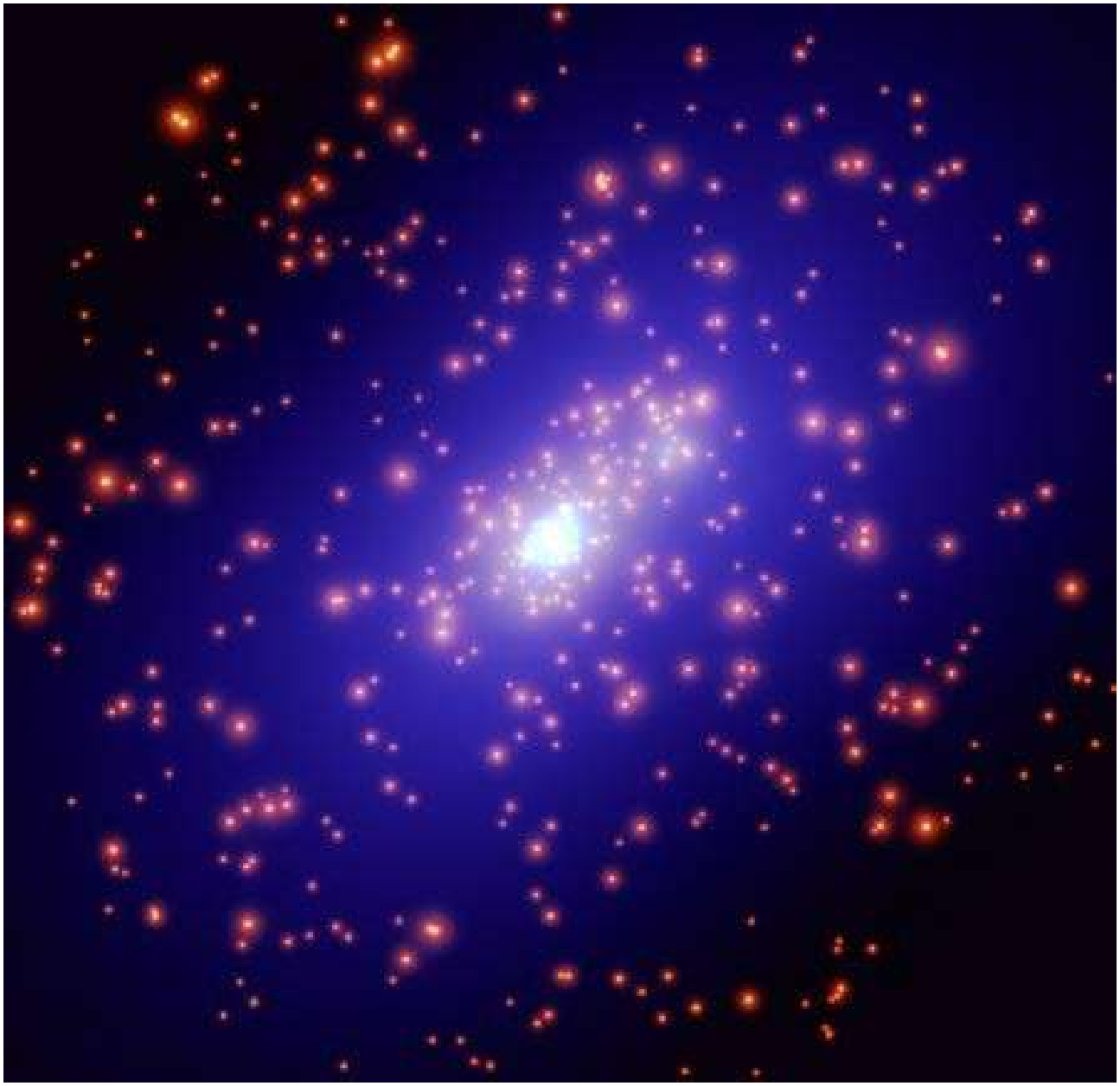
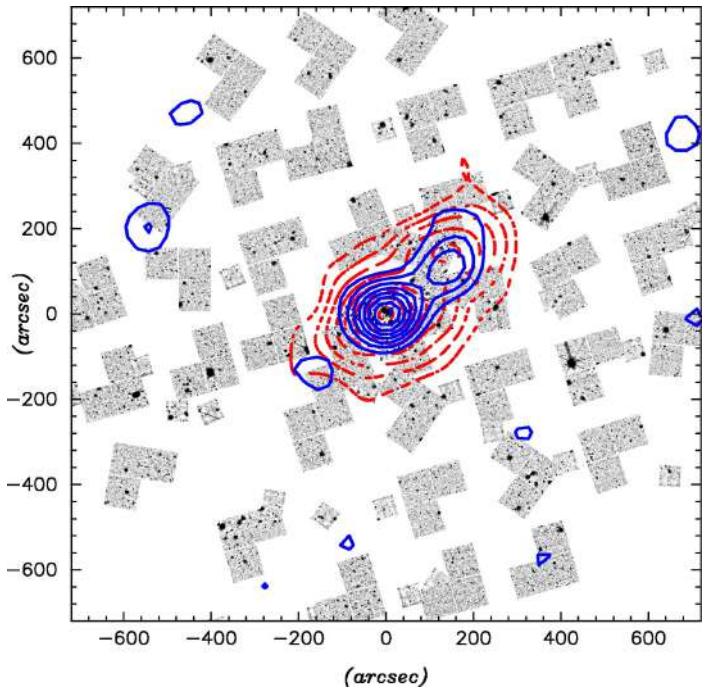
Major Halo Mergers
Investigation of Density Profiles





A cluster of galaxies Cl0024+1654 in red and associated dark matter halo in blue

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Evidence for Cold Dark Matter (CDM)

- Dynamics of galaxies within clusters necessitates associating a dark matter halo with the galactic cluster
- Rotation curves of stars orbiting about the galactic centre requires a large amount of non-visible matter to be associated with the galaxy
- Gravitational lensing
- Rigorous testing on large scales for example by the Wilkinson Microwave Anisotropy Probe examining expansion of universe

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Modelling CDM Halos

- 88% of galactic mass is a CDM halo
- To give the correct rotation curves the halo must have cuspy density profile
- Halo density profile should be stable
- Dark matter obeys the collisionless Boltzmann equation (Jeans equation) since particles move under the influence of the potential generated by all the other particles within the halo

Stable CDM Halos

- Analytic solutions to Jeans equation do not describe the density profile observed when modelling collapse of dark matter cloud with minor perturbations
- A suitable stable density profile takes the NFW form:

$$\rho(r) = \rho_0 \frac{sech(r/r_t)}{(r/r_s)^\gamma (1 + r/r_s)^{3-\gamma}}$$

- Inner logarithmic slope $1 \leq \gamma \leq 1.6$
- Scale radius $r_s = 1$ kpc
- Truncation radius $r_t = 12$ kpc

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Halo Mergers

- In models of universe halos form hierarchically, small CDM halos merge forming larger halos
- Features of galaxies can be explained by merger halos e.g. elliptical galaxies, galaxy pairs
- Examine using N-body computer simulations what happens when two identical NFW profile halos merge
- Model head on collisions with different values for γ
- Model mergers with different impact parameters

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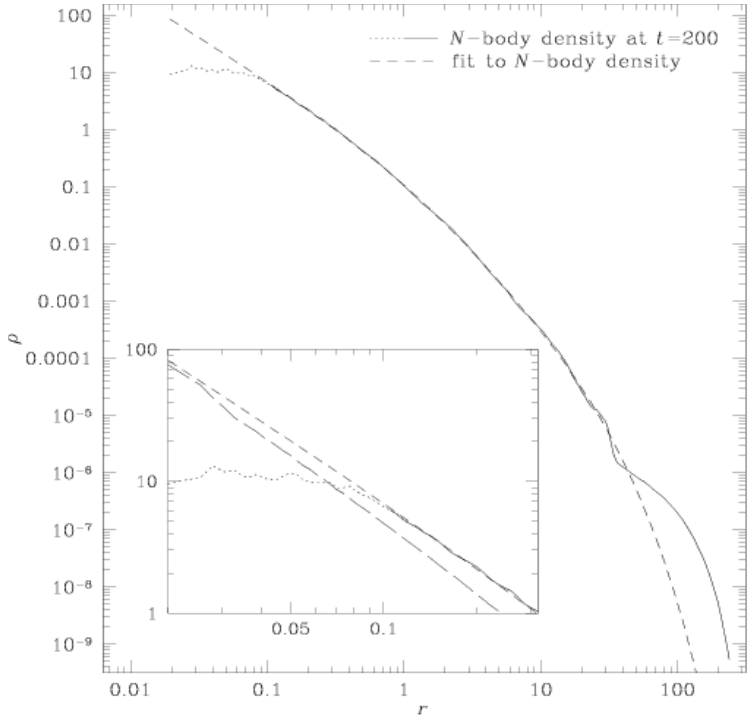
Results of Mergers
Density Profile

- NFW model fits density profile following merger over 3 decades of radius
- Deviation at small radii is due to two body relaxation
- Deviation at large radii is due to a outgoing wave



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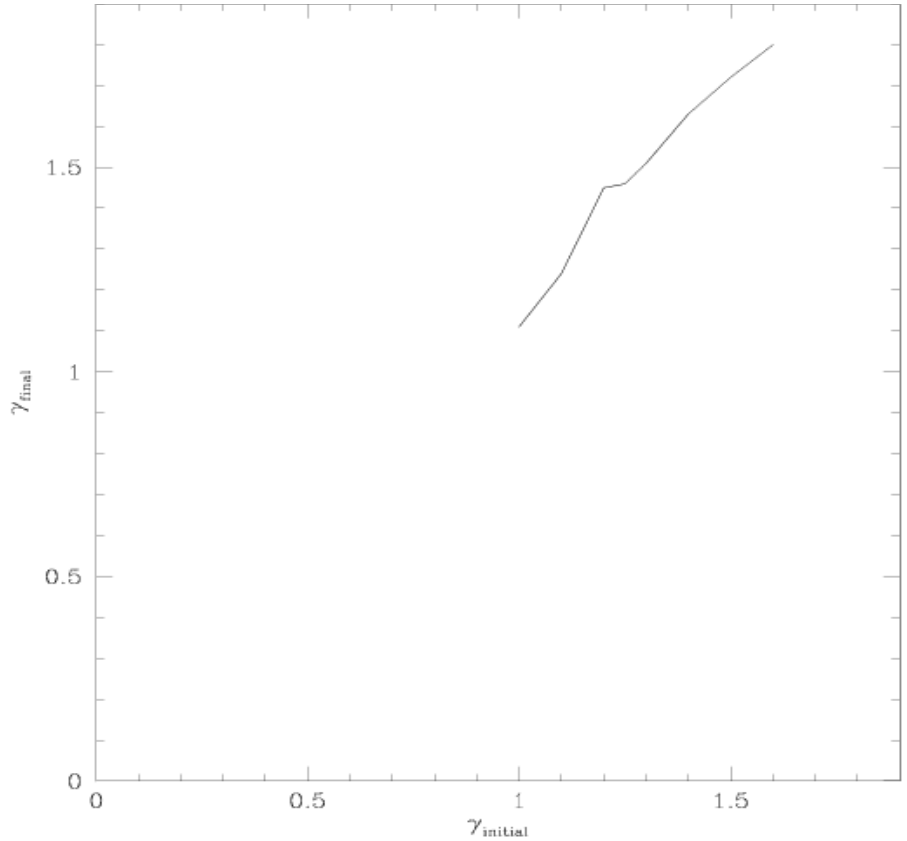
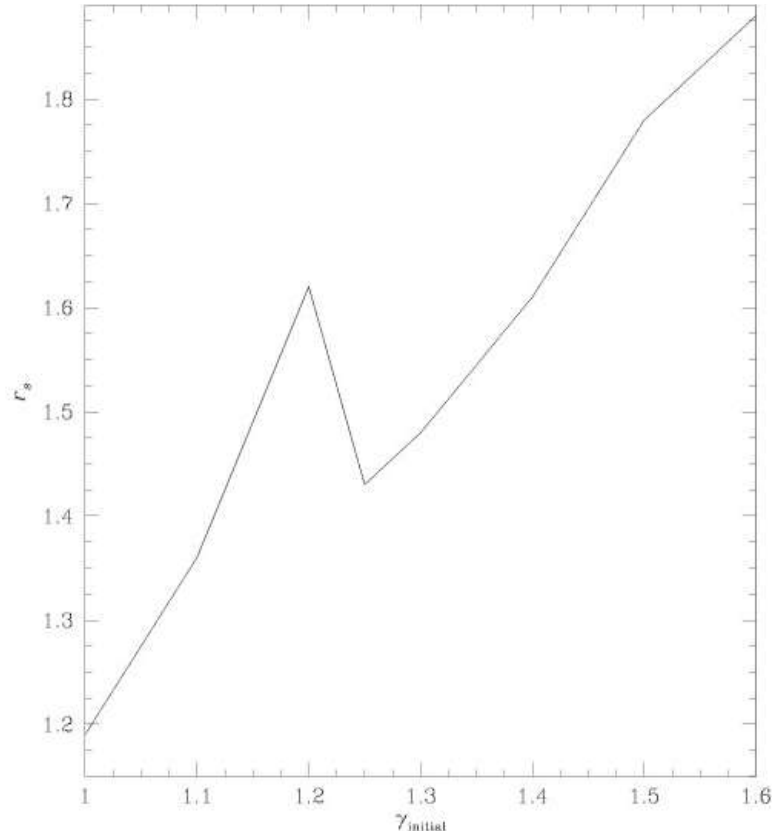
Results of Mergers
Varying Inner Logarithmic Slope γ

- Head on collisions
- Mergers generate halos with steeper cusps and increased scale radius





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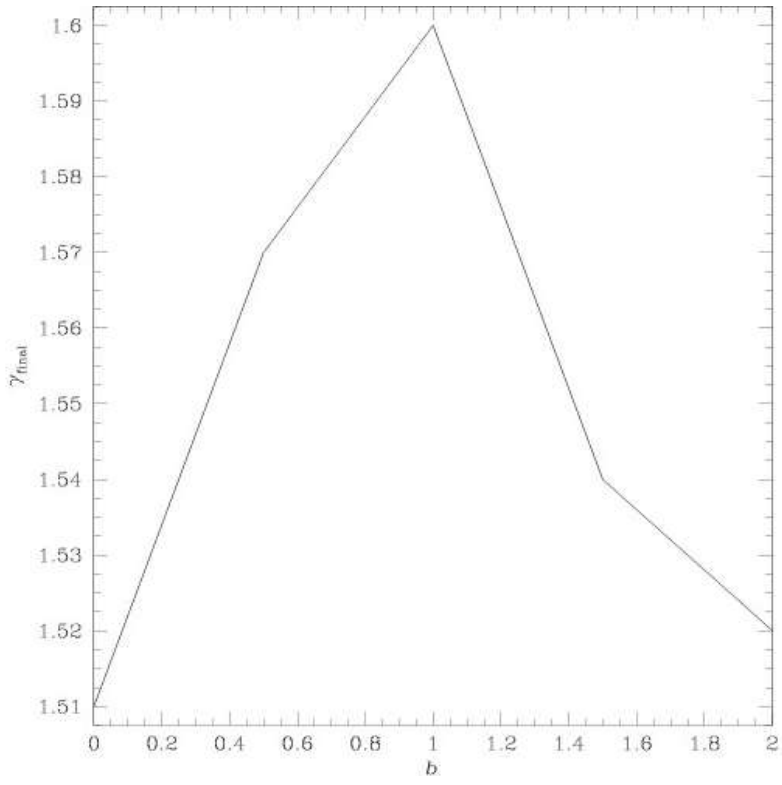
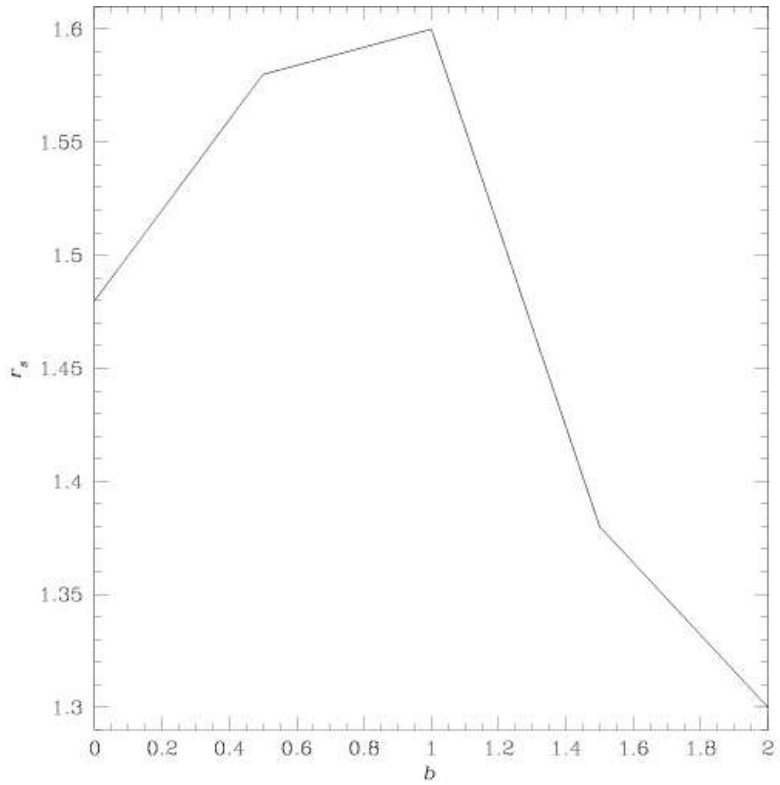
Results of Mergers
Varying Impact Parameter

- Initially halos had inner logarithmic slope $\gamma = 1.3$
- Mergers generate halos with steeper cusps and increased scale radius





Possible Further Work

- Explore relationships found in more detail, using higher resolution and examining non-linearity carefully
- Collisions between halos having different initial parameters (scale radius, truncation radius, mass and inner logarithmic slope)
- Halos having initial angular momentum
- Effects of halo inner structure e.g. bars, satellite halos and continuous accretion of diffuse material
- Alternative density profiles