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GALAXY KINEMATICS AS A TEST OF HALO ASSEMBLY BIAS

Star and gas misalignment – implications for halo properties

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Halo clustering

- Historically simple prescriptions for structure growth have assumed that the clustering of dark matter halos are ***only*** dependent on halo mass

- This assumption underpins empirical models which link the statistical properties of galaxies with their surrounding dark matter halos
    - Such as Halo Occupation Distribution (HOD) modelling [Peacock & Smith 2000],[Berlind & Weinberg 2002]

- These are commonplace in mock catalogues for cosmological surveys and a common galaxy evolution tool

- Any deviation away from this assumption must be constrained!

Halo assembly bias

- Typically consider the halo formation time for assembly bias:

  'If we consider halos of the same mass; earlier forming halos are more strongly clustered than their later forming counterparts'

- However the spin and concentration of halos have been shown to be relevant

  e.g. Lehmann, Benjamin V., et al. "The Concentration Dependence of the Galaxy-Halo Connection." *arXiv preprint arXiv:1510.05651* (2015).

Measuring halo age

- To measure assembly bias we need to devise a way of finding halo age from observable properties

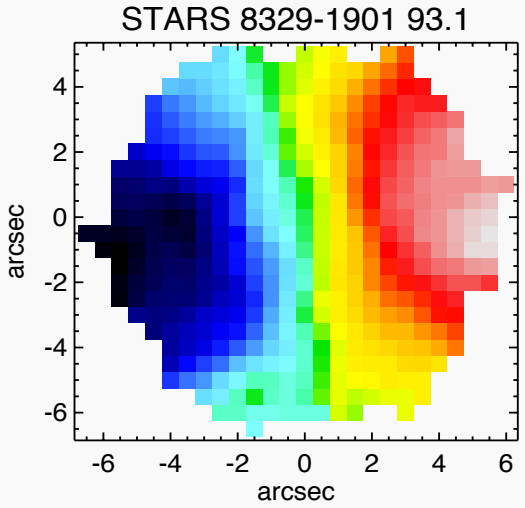
- Galaxies are the obvious observable, however the star formation history has been shown to be difficult to link directly to the halo age

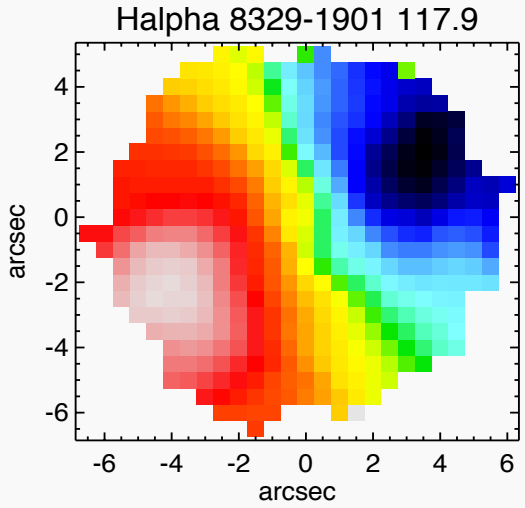
- Conversely, motivated from N-body simulations, the ***total ratio of stellar to halo mass*** has been shown to be a reasonable proxy for halo age [Wang et al. 2011][Lim et al. 2015]

  'Galaxies within an older halo typically have a higher M_s/M_h value'

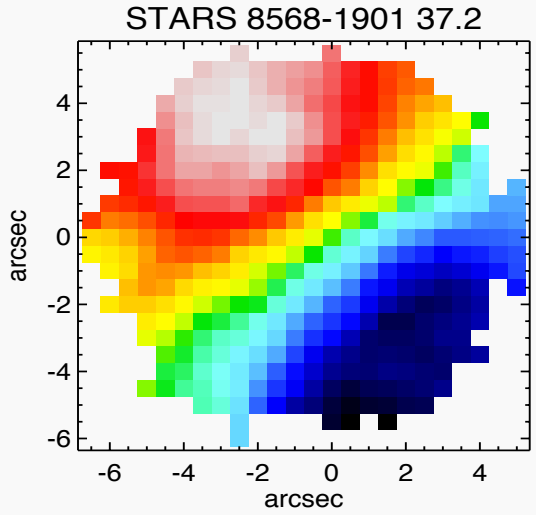
Galaxy kinematics

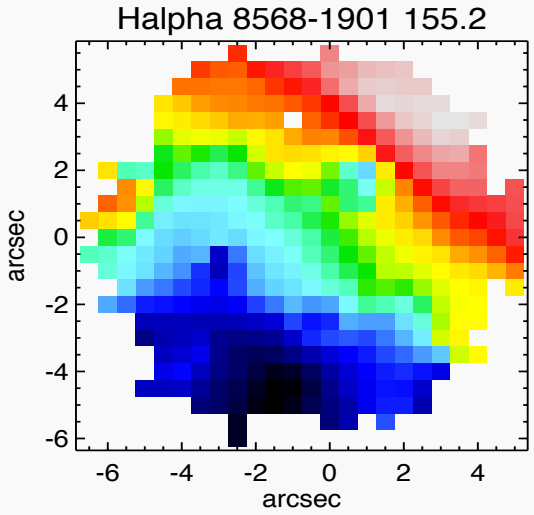
- Using the spatially resolved spectral galaxy maps from MaNGA, individual velocity maps of stellar and gaseous components can be constructed.
- For an undisturbed galaxy, the rotation of the gas and stellar components should align.





Examples of completely (above) and partially (below) kinematically misaligned galaxies.





Why could components decouple?

- Gas accretion from neighboring halos allow misaligned gas to in-flow into another galaxy
- The gas component is gradually unsettled which can lead to a partial or total misalignment with regards to the rotation of the stellar component
- Galaxies in low mass halos in regions of strong tidal interactions may see this accretion halted earlier on, meaning misalignment is stopped on a quicker timescale
- Galaxies within halos subject to lesser tidal forces may have extended periods of misalignment

  See: Yifei Jin et al. 2016 (Galaxy kinematics) & Tojeiro et al. 2016 (Geometric environment)

Relationship between M_s/M_h and galaxy kinematic misalignment?

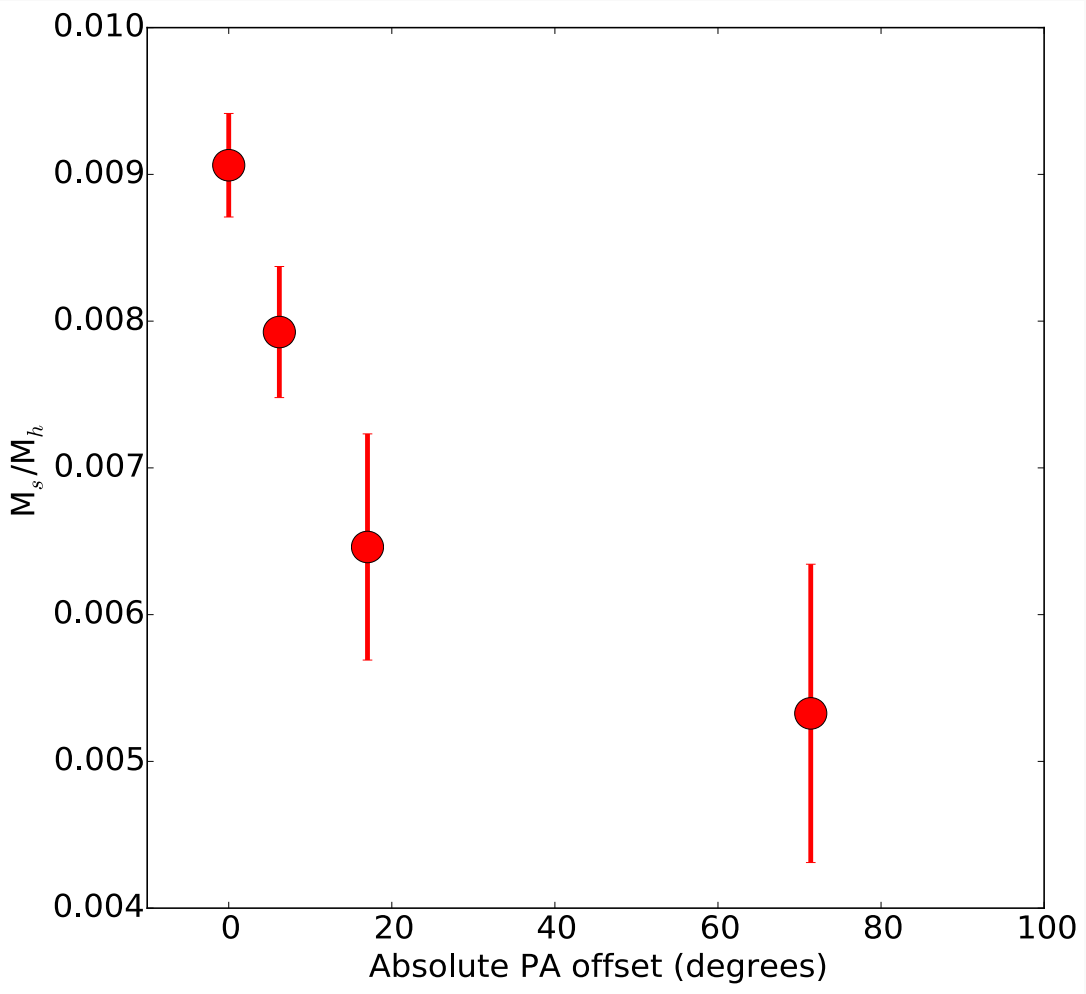
clustering of halos = halo mass + formation time {+ spin + concentration + etc}

older halo = higher M_s/M_h

older halo = earlier quenching in accretion (due to tidal forces)

earlier quenching = less likely to be misaligned

Preliminary Results



Future work

- Re-evaluating plot with weightings implemented and caveats solved
- Investigating timescales of misalignment in simulation
- Investigating other asymmetry signatures in the stars and gas of hosted galaxies