Using Streams and Shells to Trace the Dynamical Evolution of Massive Galaxies

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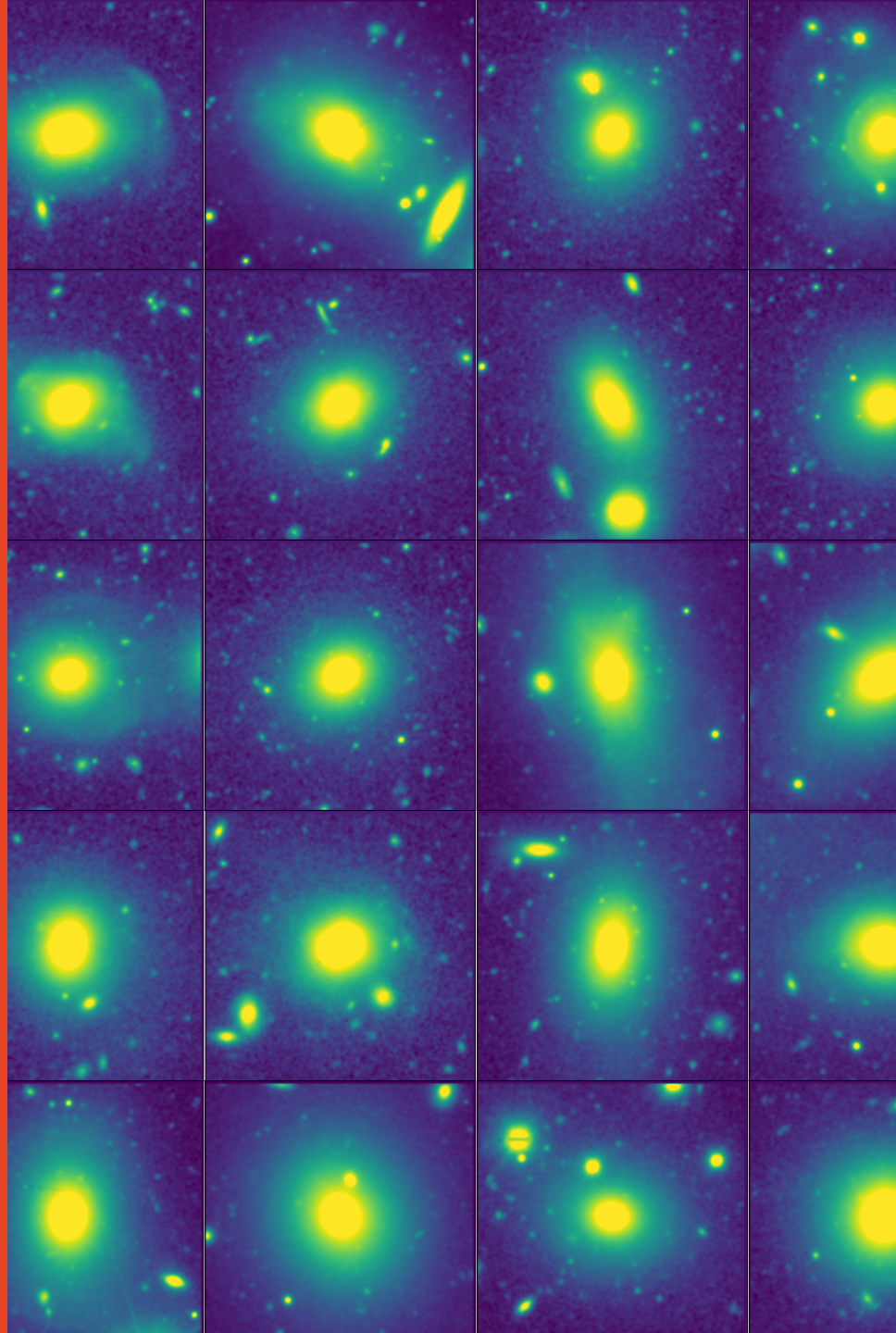


Galaxy Mergers as a Formation Pathway of Slow Rotators

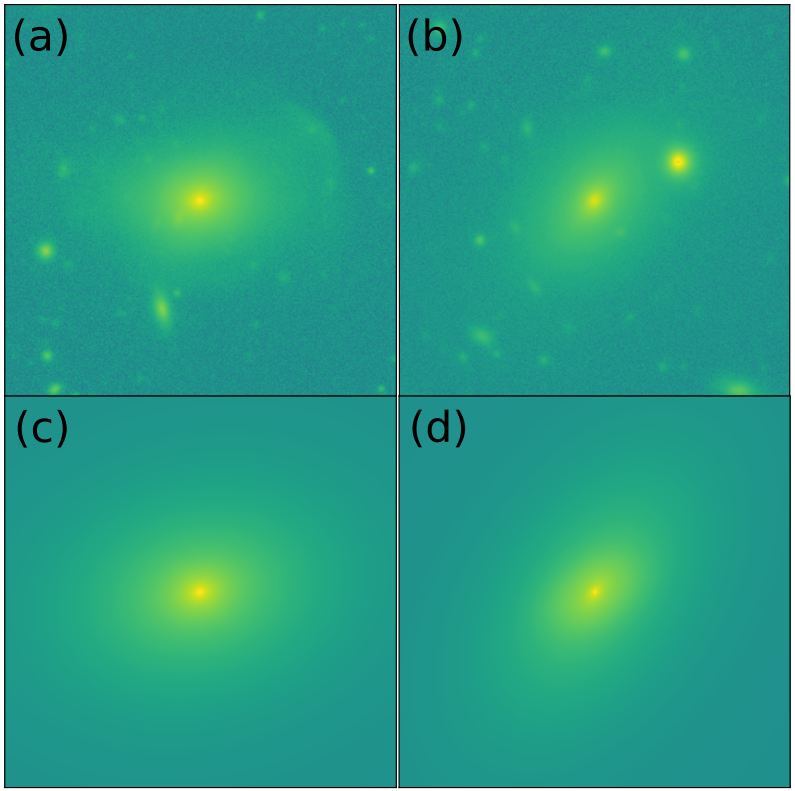
- Slow rotators are galaxies characterised by low spin parameter λ_{R_e}, large stellar mass and old stellar age.
- Unclear which processes cause the morphological (spin-down) and quenching transformation of galaxies into slow rotators.
- Simulations suggest galaxy mergers are capable of kinematically transforming galaxies.
- If slow rotators are formed through a series of galaxy mergers, we expect to see a higher fraction of recent merger features around them.
- SAMI's kinematic data and Hyper-Suprime Cam's (HSC) imaging allows us to compare populations of slow rotators and galaxies with tidal features respectively.

Target Selection

- **Sample is taken as non-cluster SAMI ETGs, with a stellar mass cut of $M > 10^{11} M_{\odot}$.**
  - Fraction of slow rotators increases significantly above $10^{11} M_{\odot}$, our work wants to investigate rates of photometric features in a population with a large proportion of slow rotators.
  - Completeness of SAMI kinematics and HSC imaging is very high above $10^{11} M_{\odot}$.

Model-Subtracted Residual Images

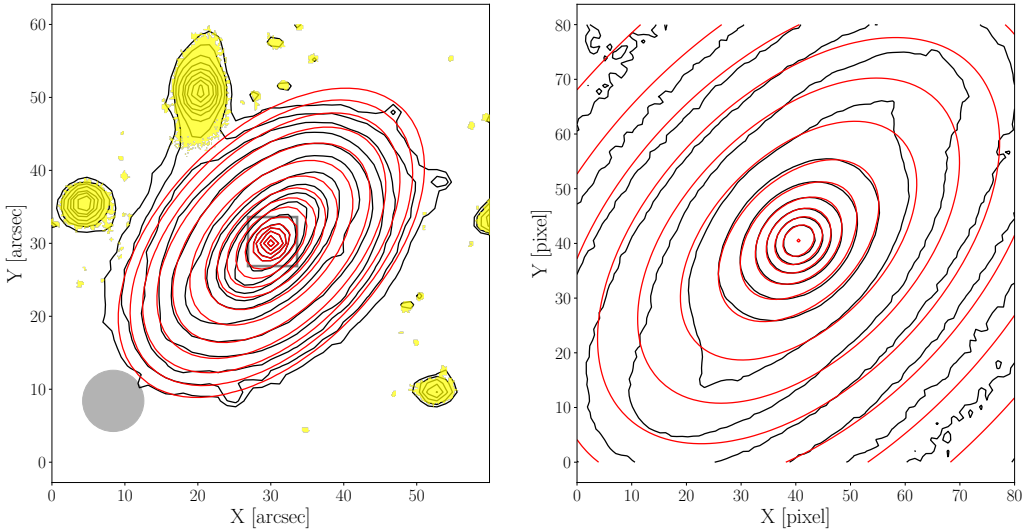
- Identifying low surface brightness tidal features is difficult.
- We use the technique of model subtraction.
- Create a 2D flux ProFit model.
- 2D Bayesian galaxy profile modelling[1].
- 3 Sérsic components, all parameters allowed to vary.



[Robotham et al. 2017]

MGE Modelling

- **Multi-Gaussian Expansion (MGE)[1] modelling also done.**
- **High efficiency algorithm fits only sectors of a galaxy.**
- **Convolves analytically with Gaussian PSF.**
- **~20 times faster than ProFit.**
- **Helpful in confirming LSB features at large radii.**



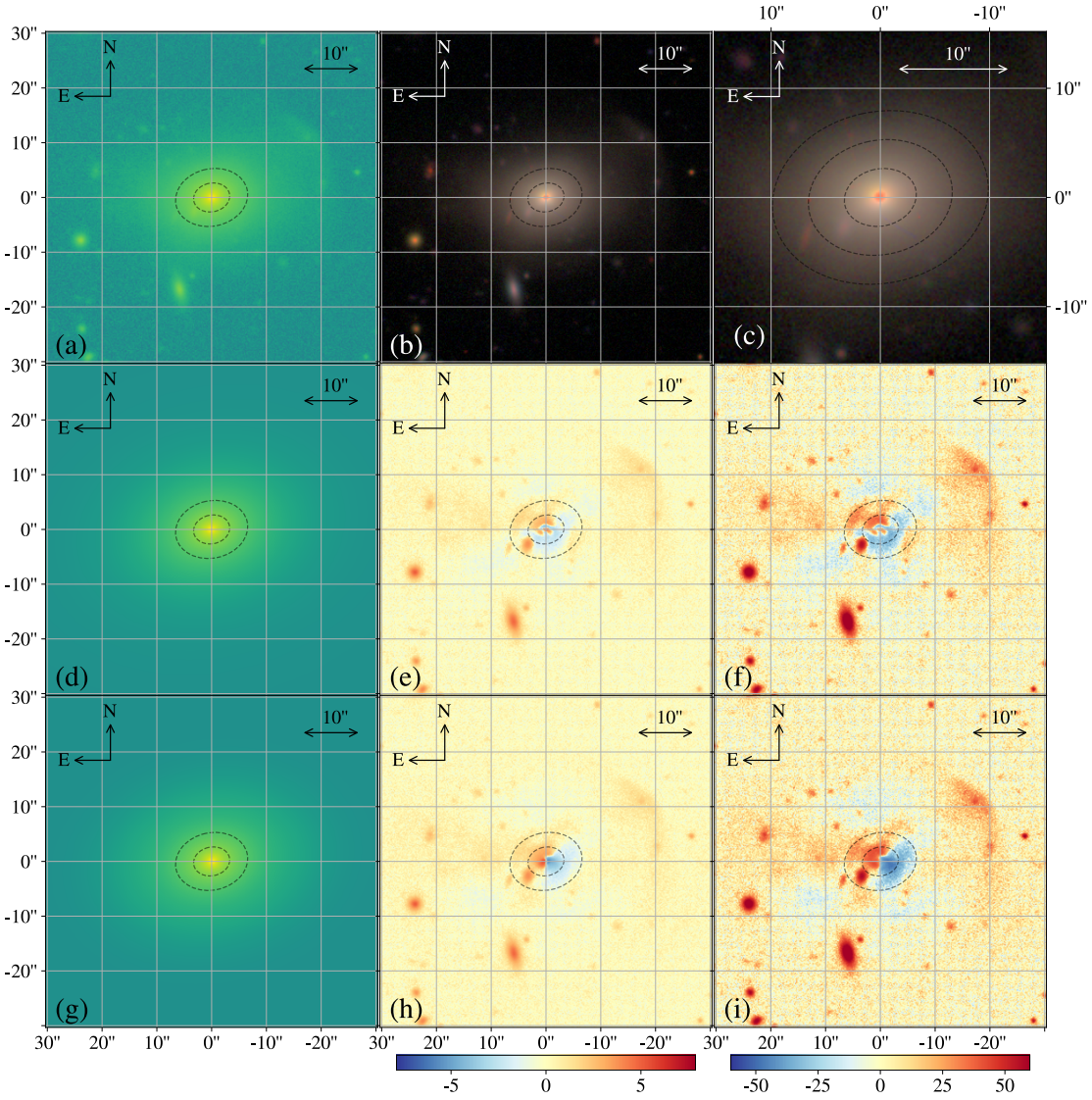
[Cappellari 2002]

Model Subtraction

- MGE and ProFit model of HSC imaging.
- Subtract the model.
- Identify tidal features as remnants after subtraction.
- ProFit centering is better, and as such is the primary residual used for visual inspection.

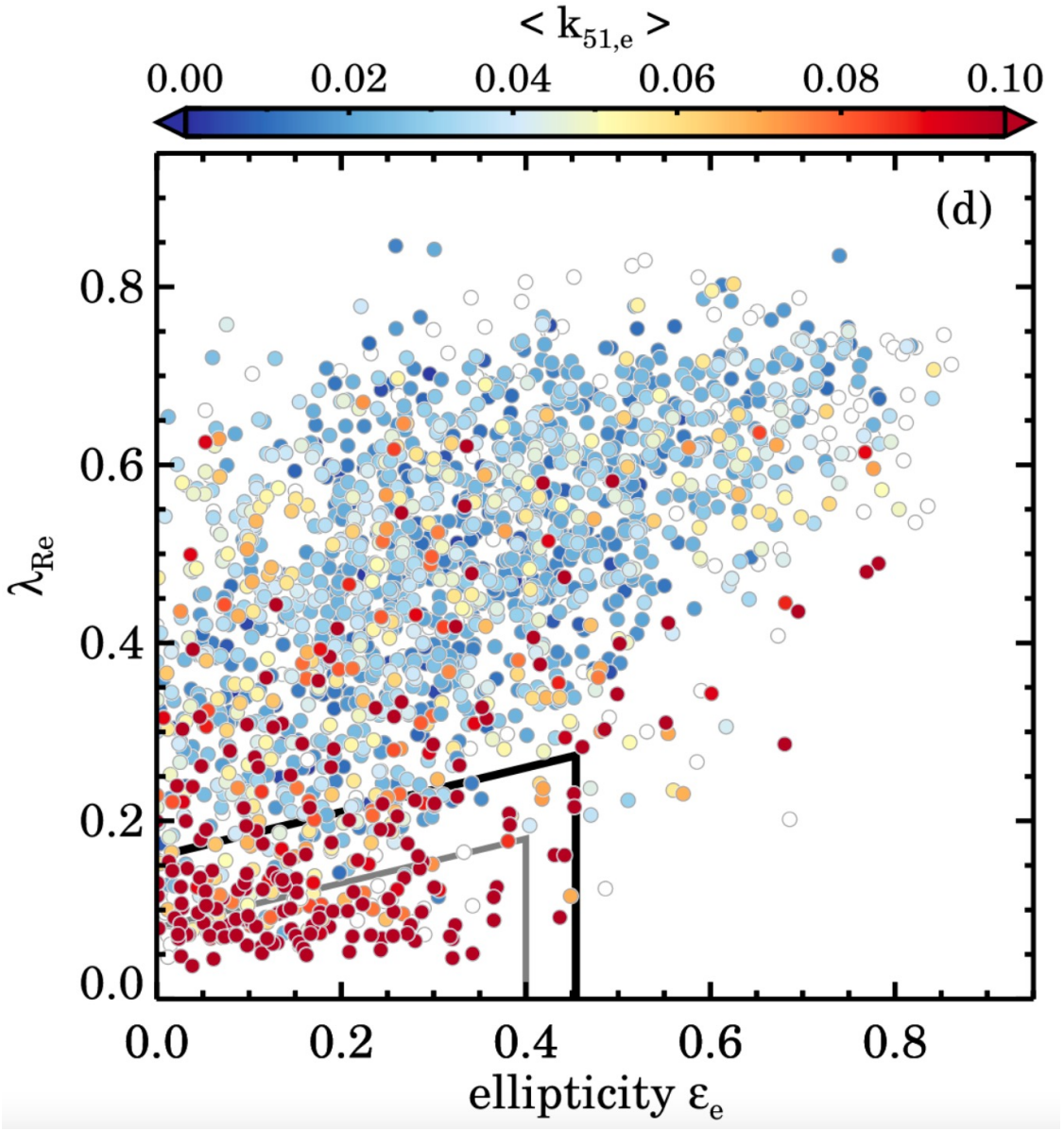
Visual Inspection

- Visual inspection completed individually by three people, “strength” of feature decided too.
- Features determined to exist if >1 person identified them.
- Strength taken as average.



Slow Rotators?

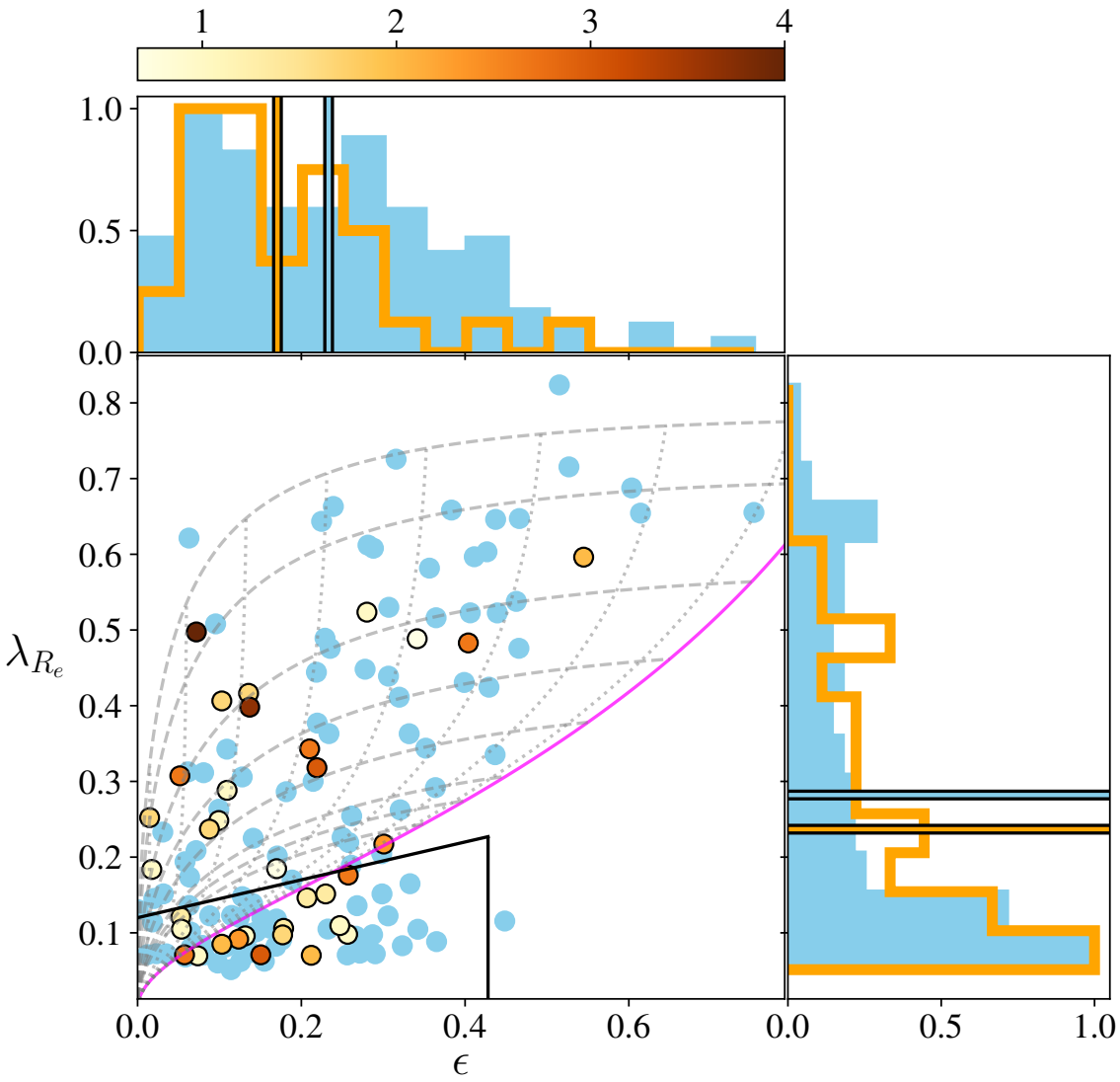
- We are left with a population of “feature galaxies” and “regular galaxies”.
- If slow rotators are formed by mergers and we can detect their remnants, our feature galaxies should be correlated with the slow rotator population.



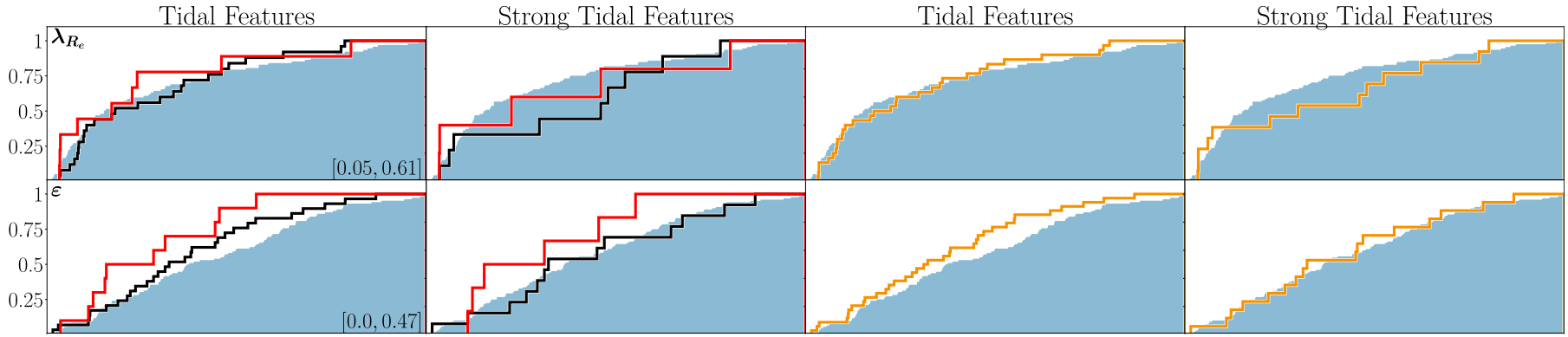
[van de Sande et al. 2022]

Slow Rotators?

- **We find no correlation between our feature galaxies and the slow rotator population.**
- **No significant difference in the proportion of feature or regular galaxies defined as slow rotators.**
  - $53.33^{+8.62}_{-7.53}\%$ vs $51.16^{+5.31}_{-5.36}\%$



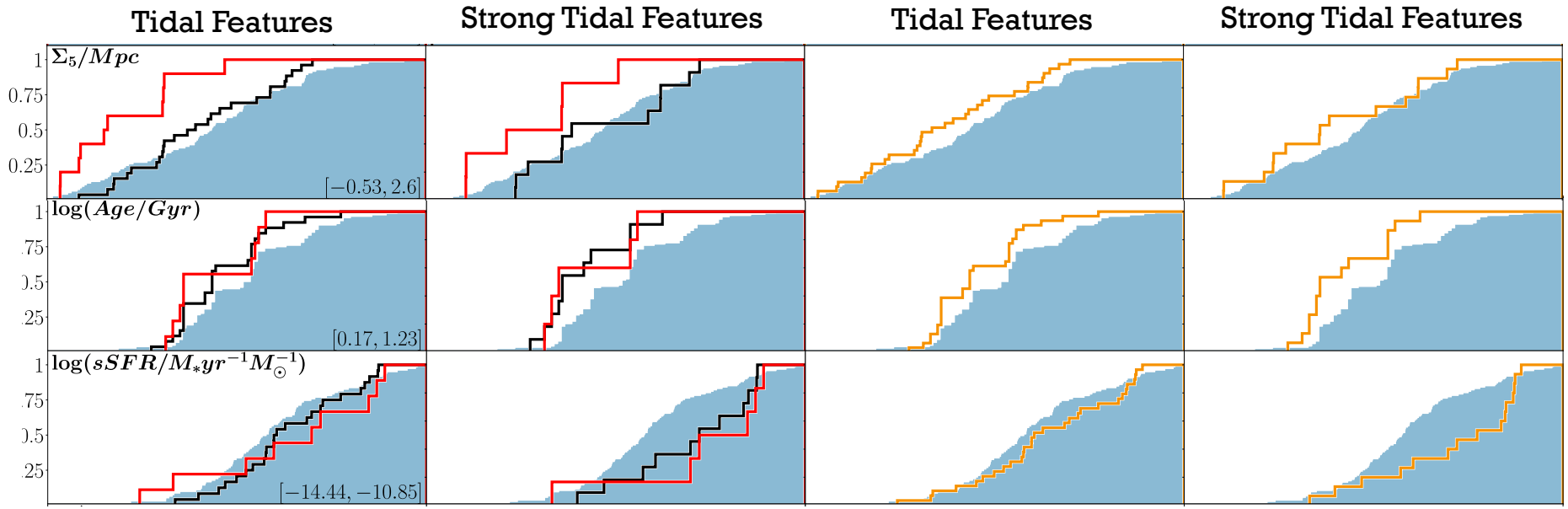
Do mergers spin down galaxies?



- **We find no difference in the λ_{R_e} or ε distributions between feature and non feature galaxies.**
- **There does not appear to be any correlation between identifiable tidal features and λ_{R_e} or ε.**

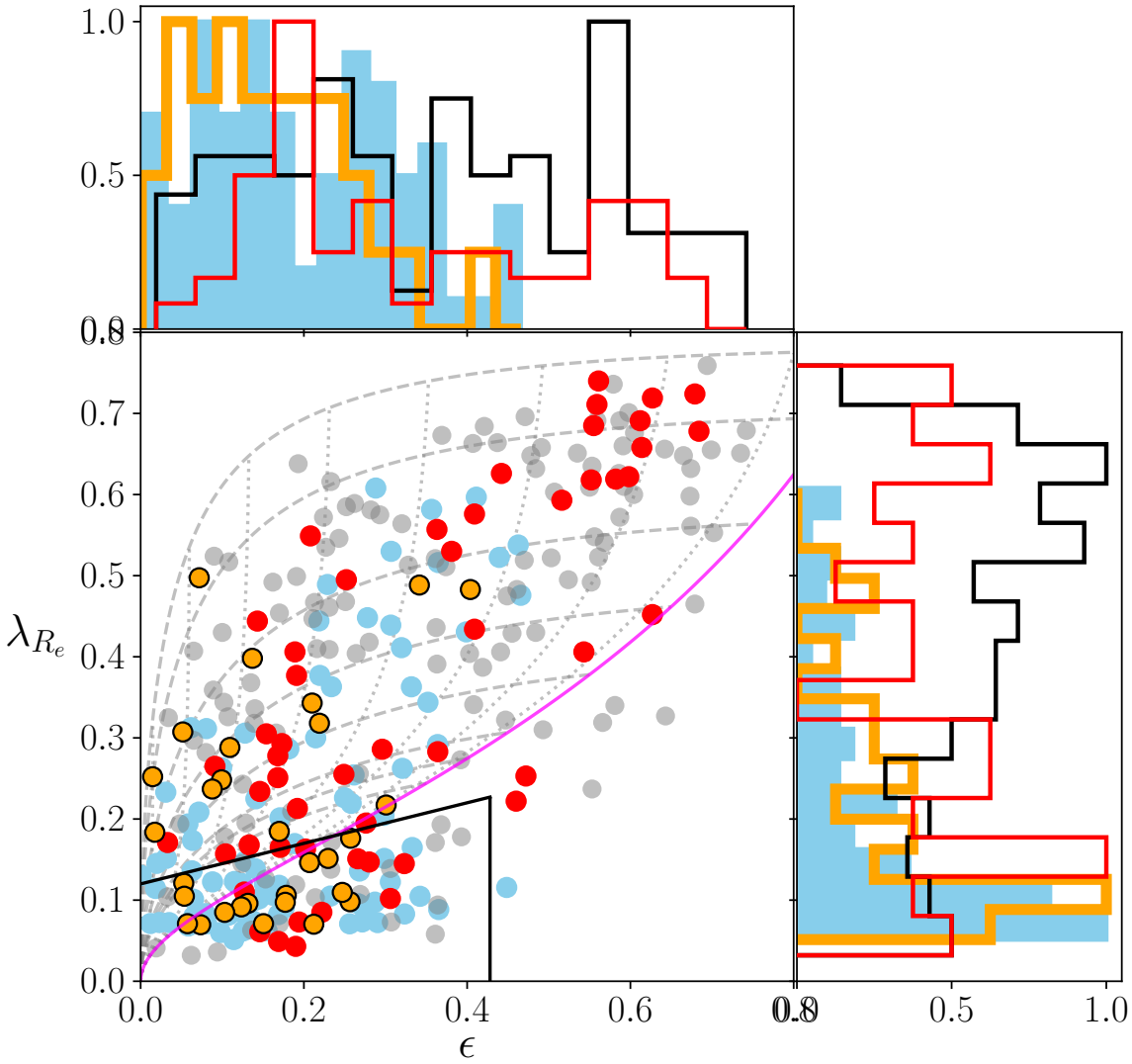
Age, sSFR and Σ_5

- **Of the parameters tested, only age, sSFR and Σ_5 showed significant differences between the feature and regular sample.**



Comparison with Other Studies

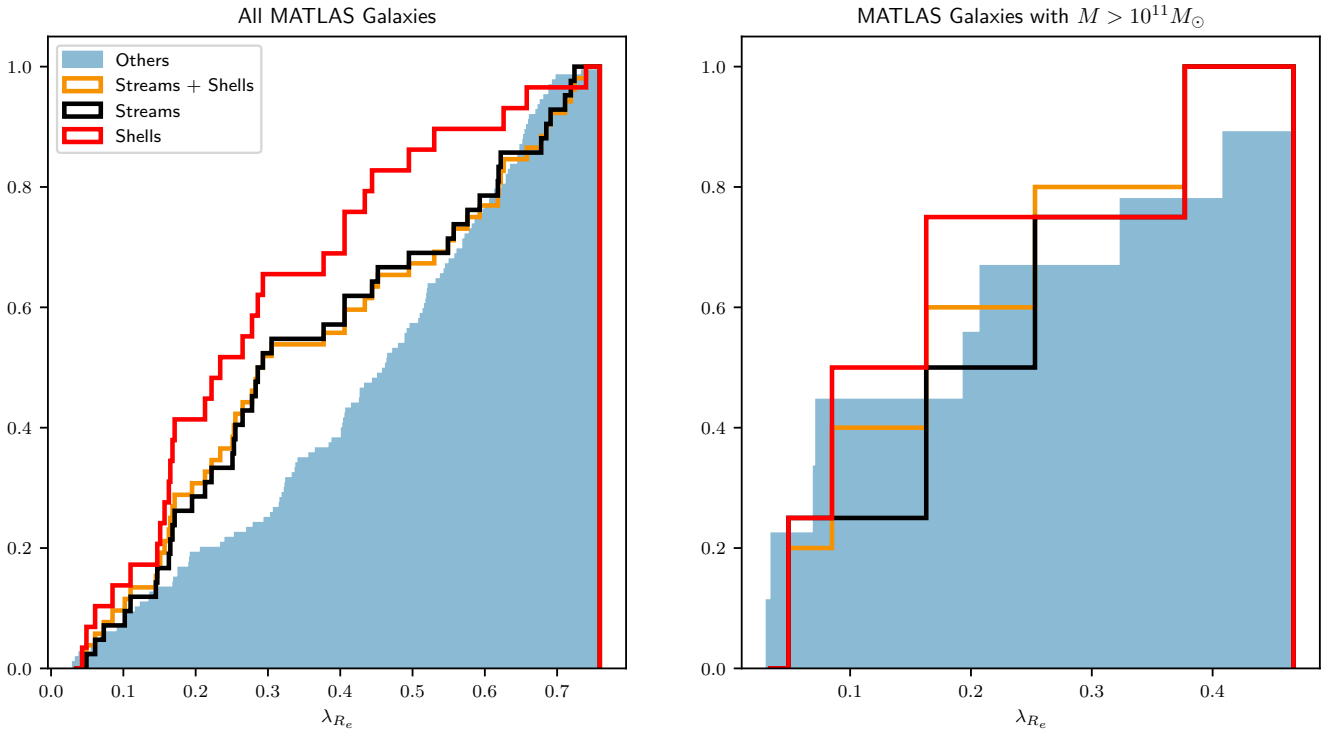
- **The MATLAS survey consists of 177 ETGs with deep imaging from the ATLAS^{3D} survey.[1]**
- **A visual analysis to determine tidal features was performed.**



[Valenzuela & Remus 2022]

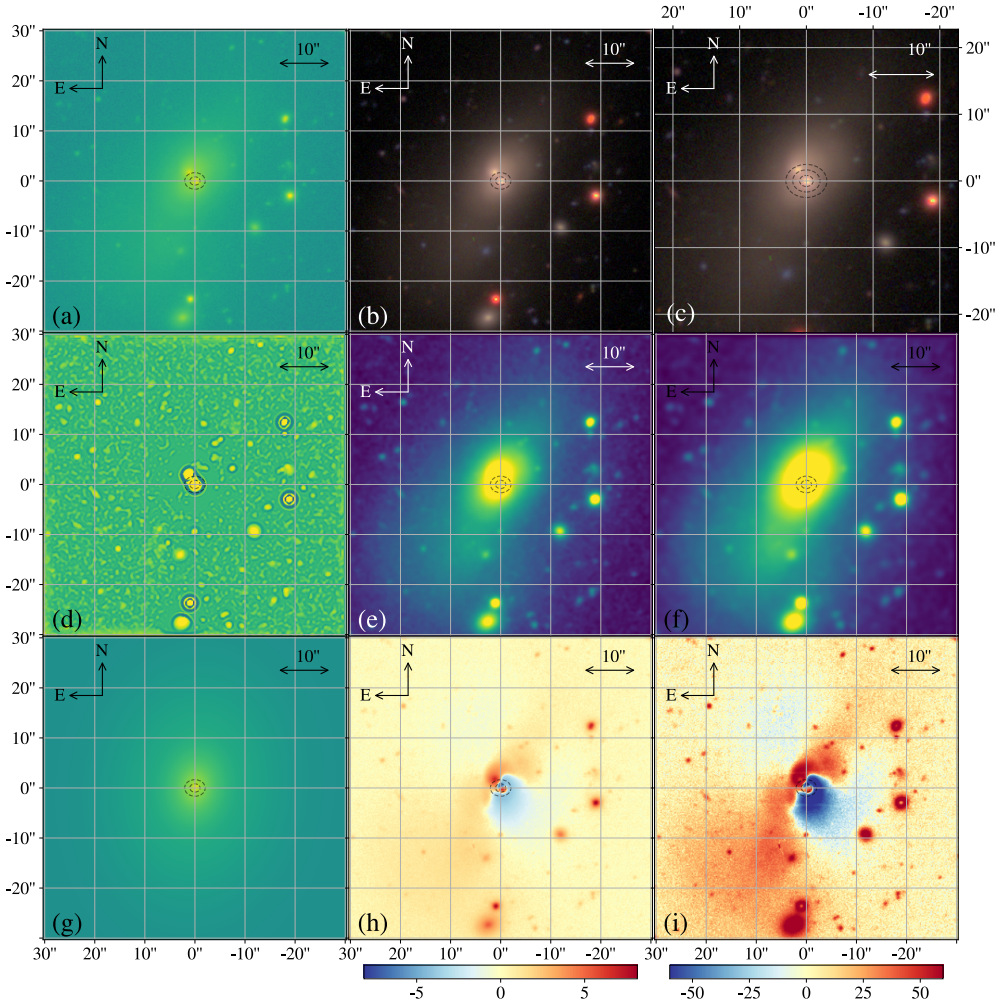
Difference in Highest Mass Galaxies?

- **MATLAS finds a correlation between spin down and tidal features.**
- **They go to a lower stellar mass, however.**



Continuing work…

- We are currently analysing ~350 non-cluster ETG SAMI galaxies down to $10^{10} M_{\odot}$.
- ProFit models take too long to create for a large sample, so high contrast images are used instead in inspection images.
- Image convolving/stacking technique also used.



Conclusions

- **Our analysis finds no correlation between slow rotators and tidal features.**
- **Strong tidal features are correlated with a lower age, higher sSFR and shells are correlated with low density environments.**
  - Wet mergers leave features for longer timescales[1,2], can recreate spinning disc[3,4], and induce star formation.
- **MATLAS found a spin correlation, but only significant when including galaxies below $10^{11} M_{\odot}$.**
- **Further analysis of ~350 SAMI galaxies between $10^{10} M_{\odot}$ and $10^{11} M_{\odot}$ ongoing…**

[1 Hood et al. 2018] **[3 Naab et al. 2014]**
[2 Lotz set al. 2010b] **[4 Lagos et al. 2018]**