The role of galaxy mergers in fuelling active galactic nuclei

Mathilda Avirett-Mackenzie, Carolin Villforth, Marc Huertas-Company, Stijn Wuyts, Dave Alexander, Silvia Bonoli, Andrea Lapi, Ivan Lopez, Cristina Ramos Almeida, Francesco Shankar, et al

BiD4BESt

UNIVERSITY OF BATH

Image credit: ESA/Hubble & NASA

PhD: expectation

Do some science

Write a paper

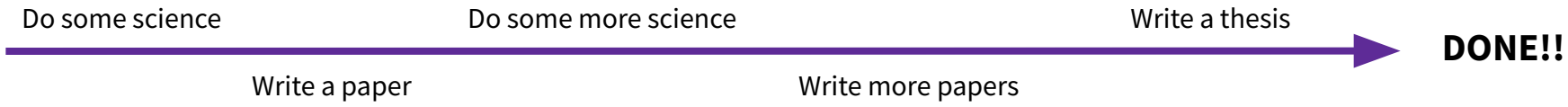
Do some more science

Write more papers

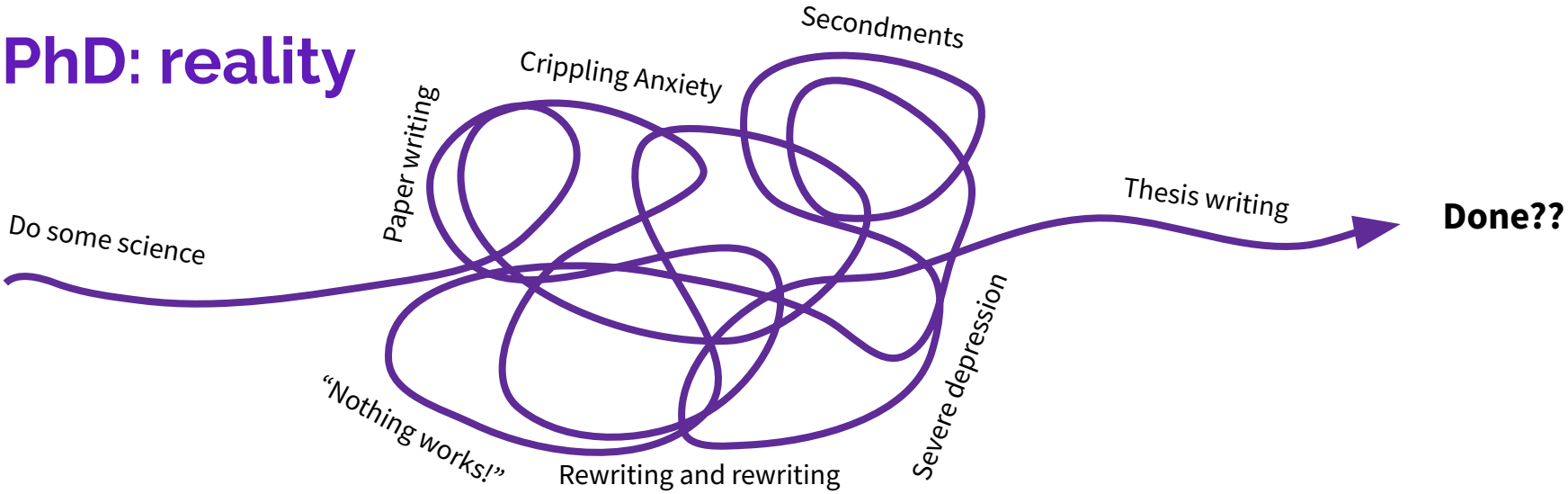
Write a thesis

DONE!!

PhD: expectation

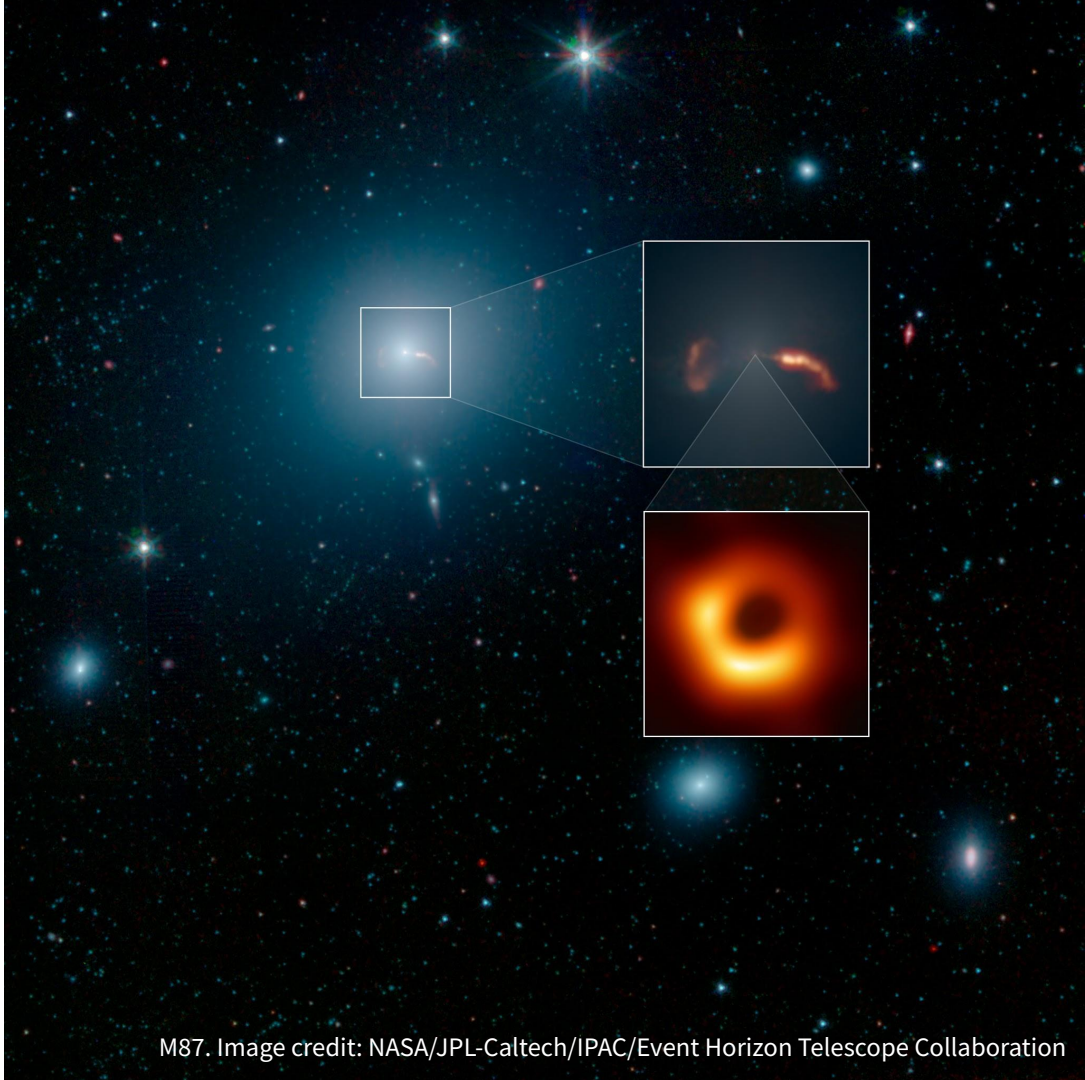


PhD: reality



Why look at mergers?

Galactic gas must lose 99.9% of its angular momentum through some mechanism in order to accrete onto the central black hole.



M87. Image credit: NASA/JPL-Caltech/IPAC/Event Horizon Telescope Collaboration

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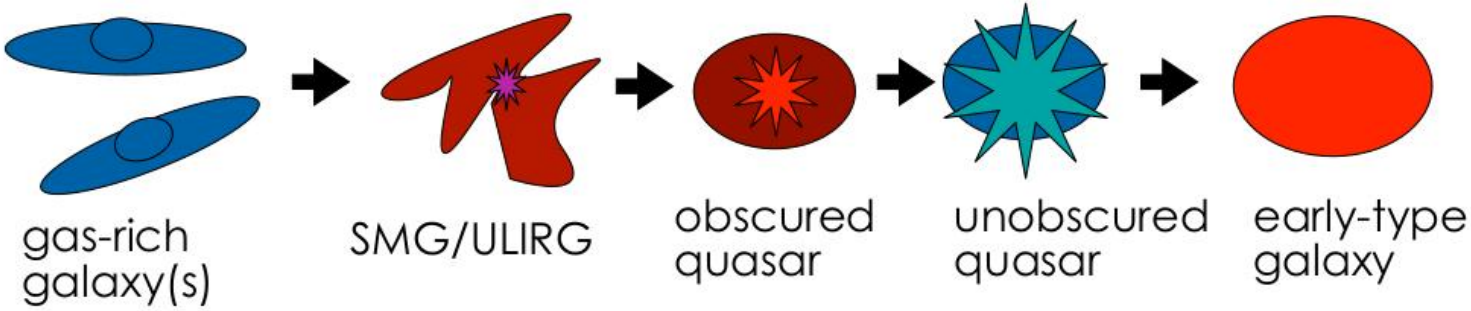

Fig. 6, Alexander & Hickox 2012

Big questions

- Are there correlations between AGN activity and galaxy mergers?
- Are these correlations related to other properties (e.g. SFR, AGN obscuration)?

Big questions and approaches

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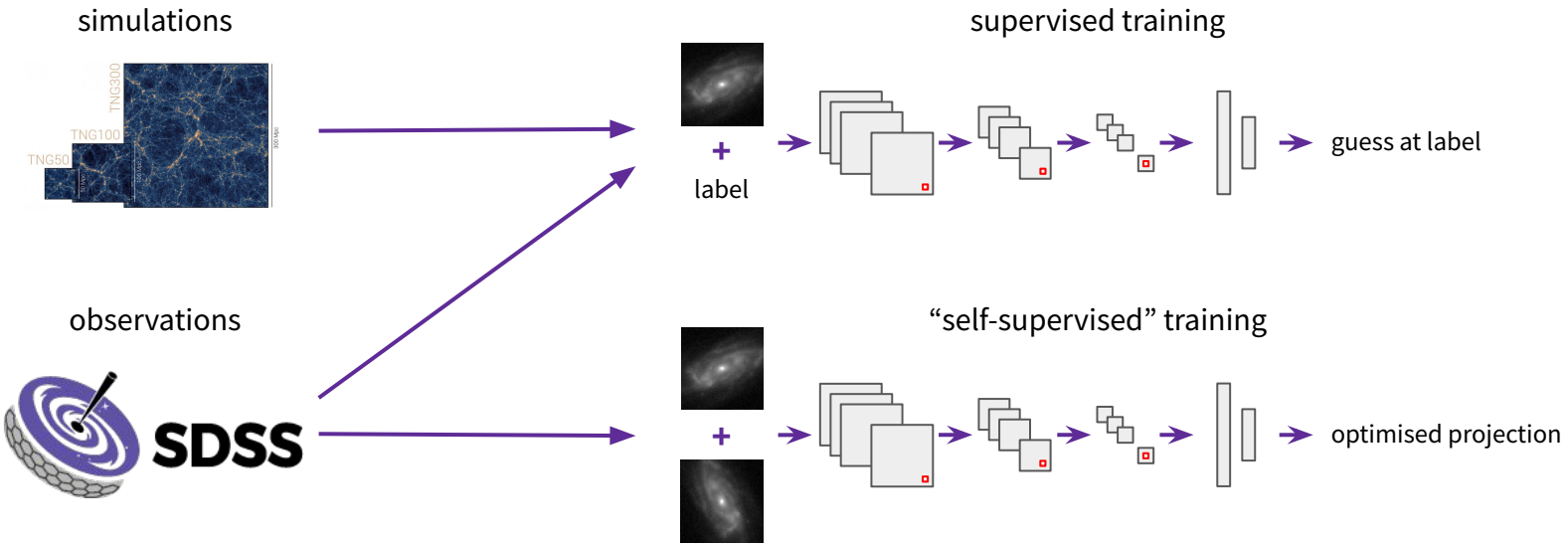
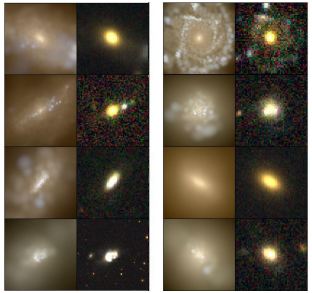
- Are these correlations related to other properties (e.g. SFR, AGN obscuration)?



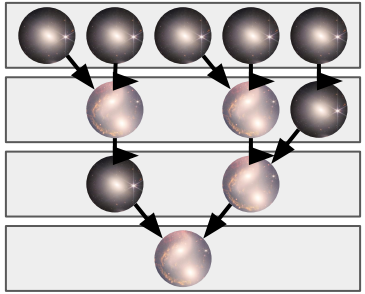
Paper 1: supervised learning on obscured AGN hosts

simulated galaxy images

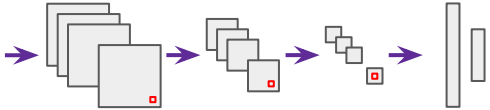


+

physical merger labels



trained neural network



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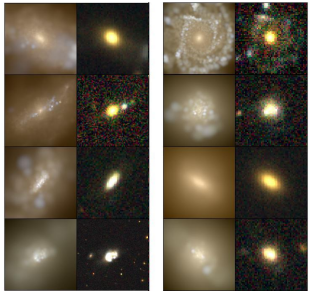

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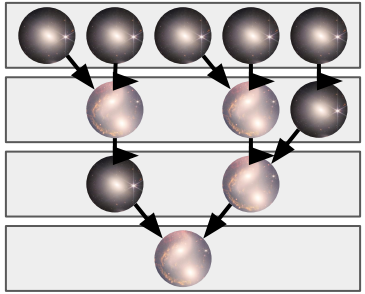

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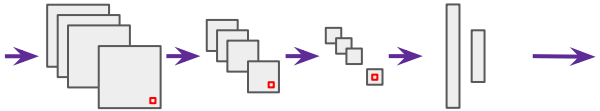
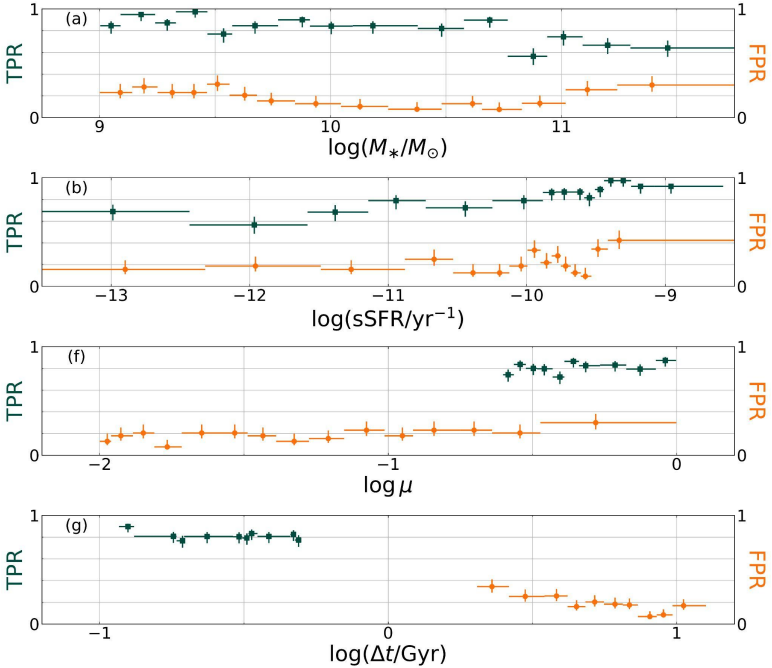
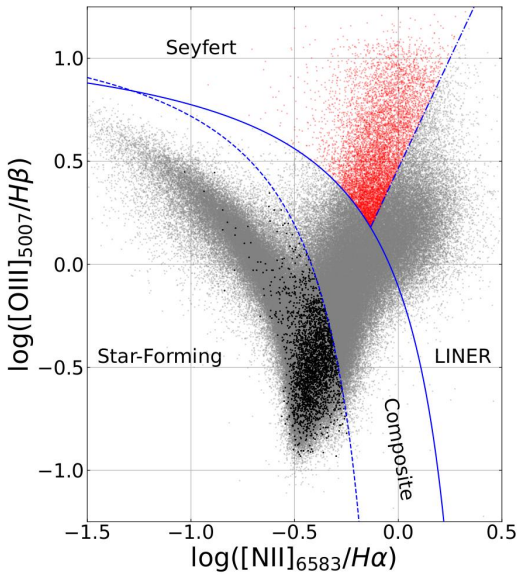




Paper 1: supervised learning on obscured AGN hosts

What does it see on the real galaxies?



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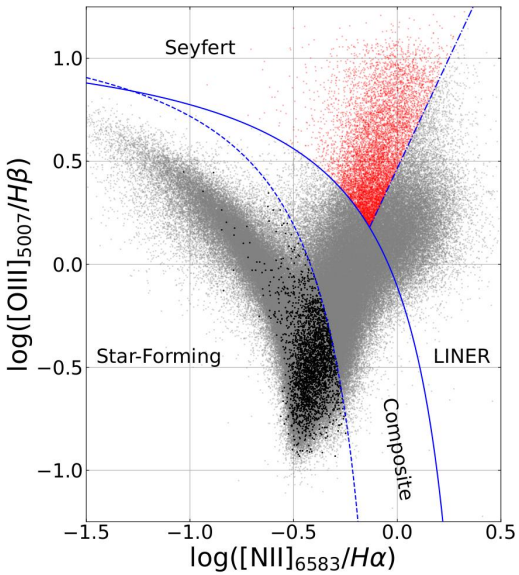

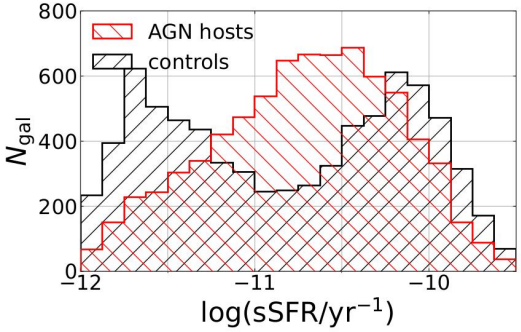

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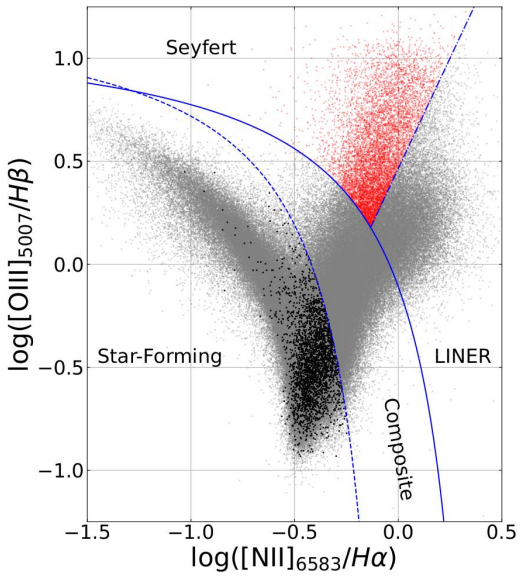
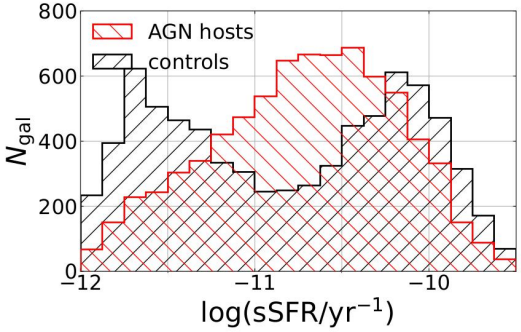
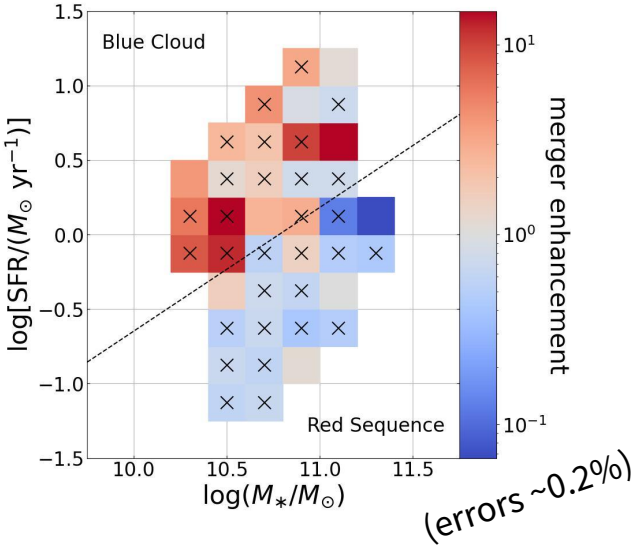




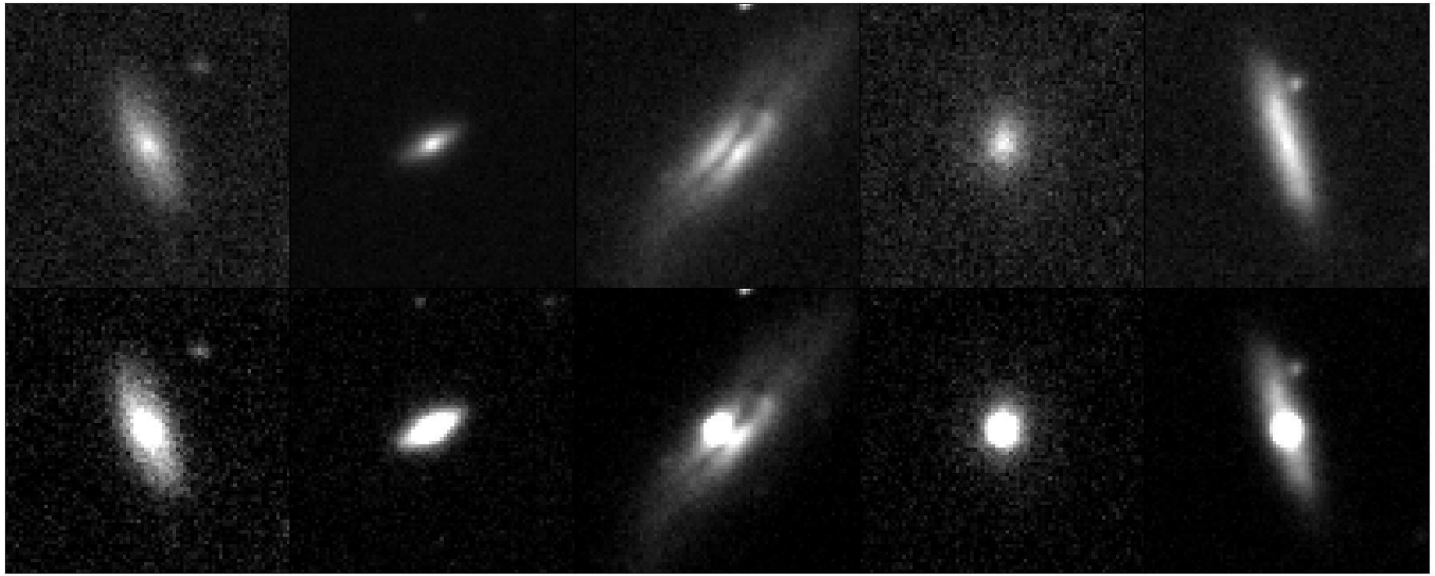


(errors ~0.2%)

check out the paper!

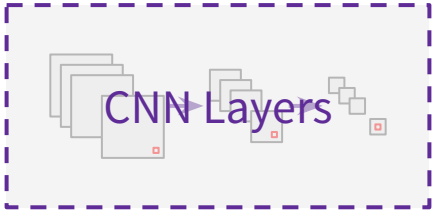
	$f_{merger, AGN}$	$f_{merger, control}$
All	2.2%	3.0%
Blue Cloud	1.1%	0.5%
Red Sequence	3.2%	5.0%

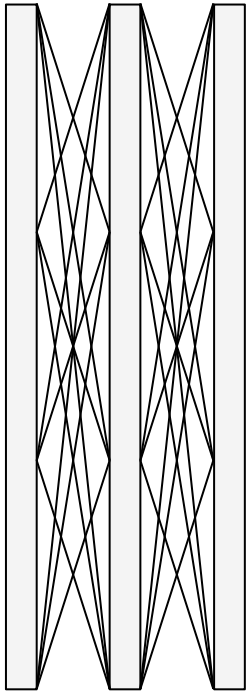
Paper 2: contrastive learning on unobscured AGN hosts



Goal: train classifier that ignores point sources

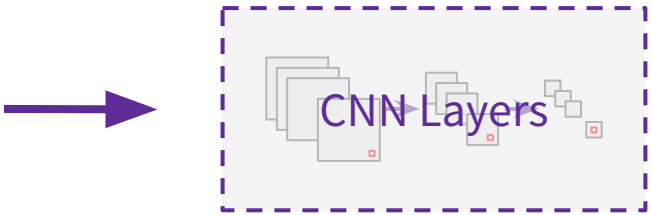
Paper 2: contrastive learning on unobscured AGN hosts

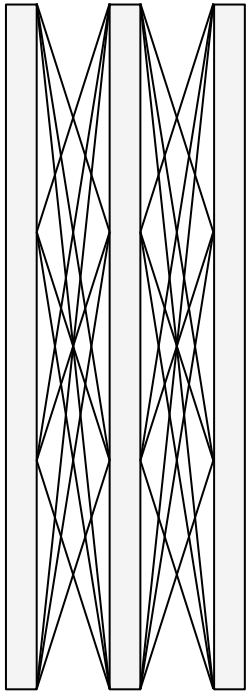




Trained output

Paper 2: contrastive learning on unobscured AGN hosts

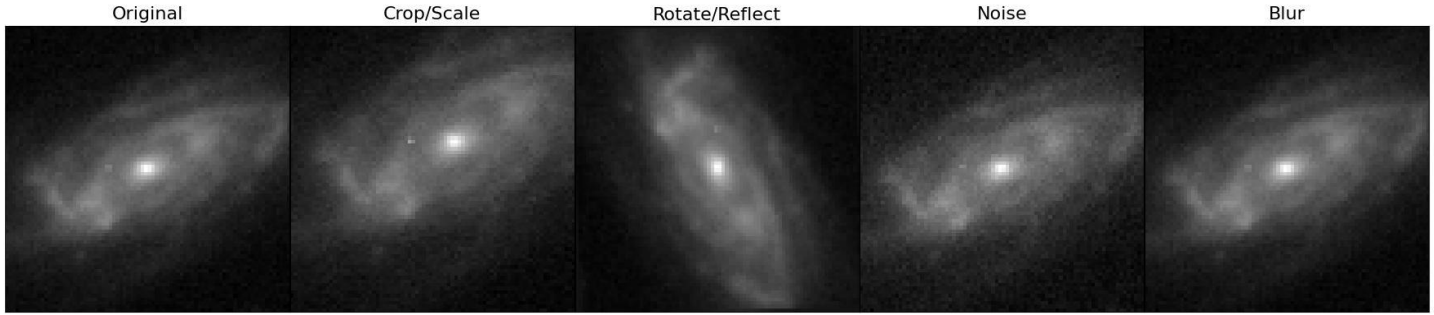




Trained output

latent space!

Paper 2: contrastive learning on unobscured AGN hosts



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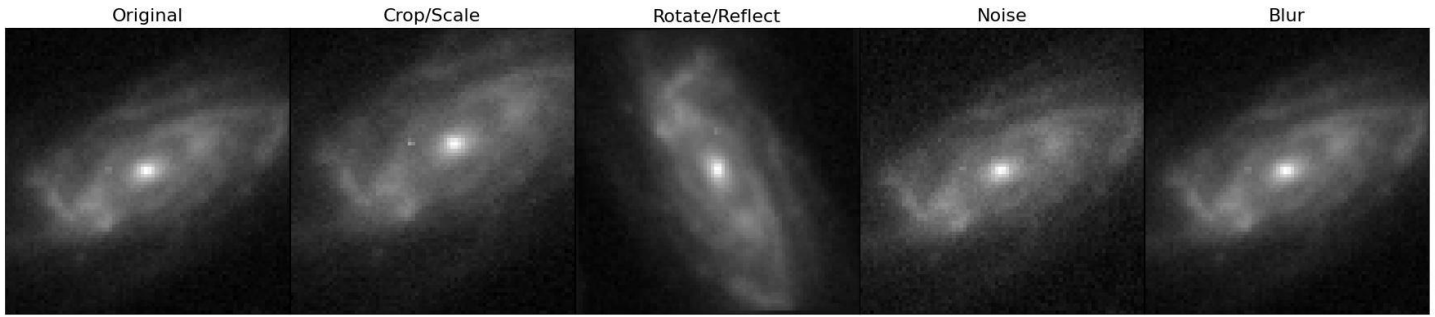

just throw in more augmentations with same labels (supervised)

treat augmentations of the same image the same, but no overall labels (self-supervised)

Paper 2: contrastive learning on unobscured AGN hosts

Let’s look at some latent spaces.

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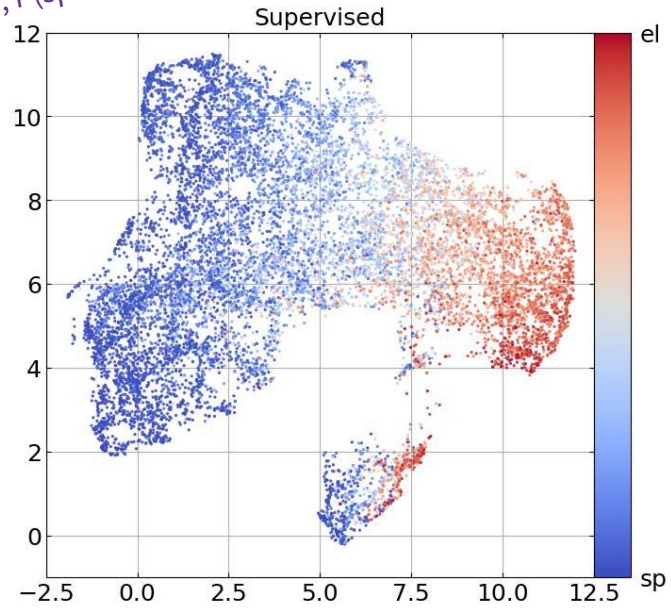
Let's look at some latent spaces.

training labels: Galaxy Zoo P(elliptical), P(spiral)



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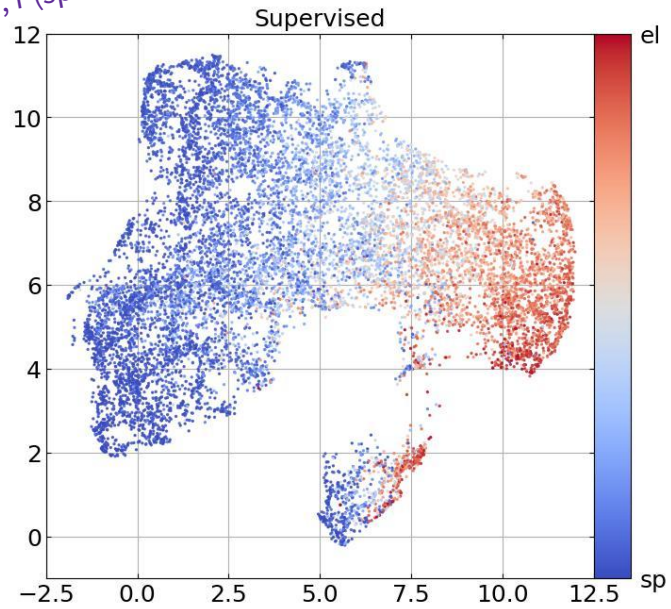
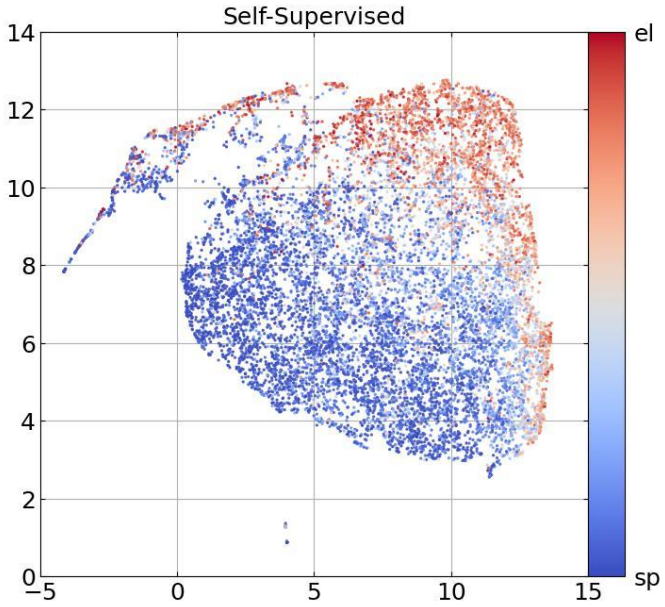
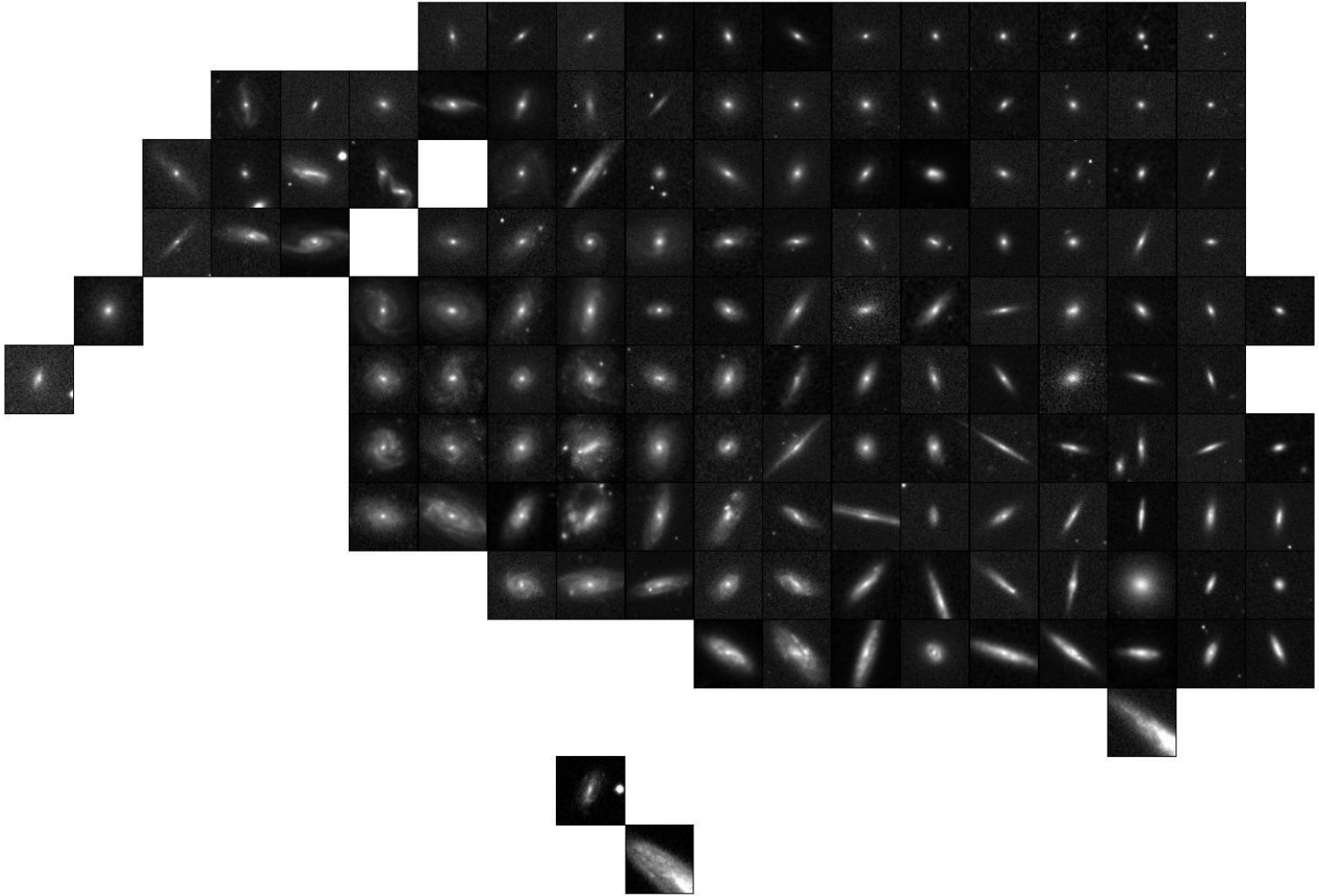


Trained without labels!!





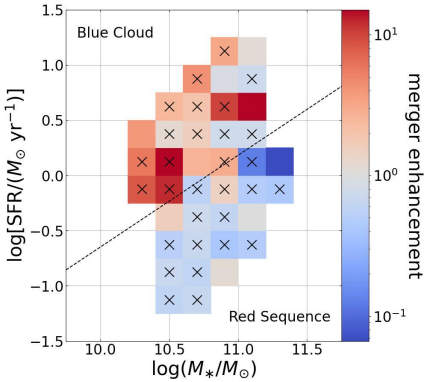
Paper 2: contrastive learning on unobscured AGN hosts

Outstanding questions:

- Where do the mergers live in latent space? Are they outliers?
- How strong of point sources can we add before the model breaks down?
- What conclusions can we ultimately draw about AGN host morphologies?

Where are we now?

Paper 1: Mergers and star formation in obscured hosts



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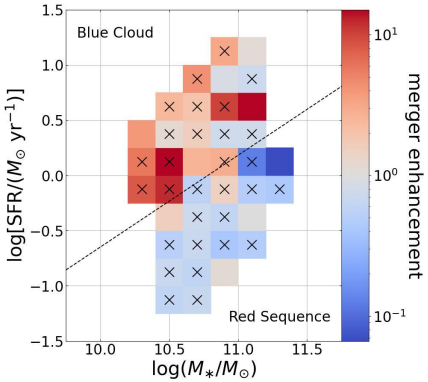
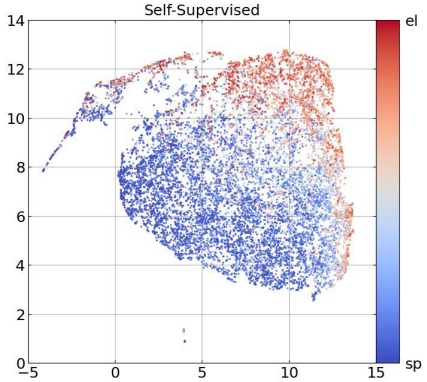


Paper 2: Morphologies of unobscured hosts



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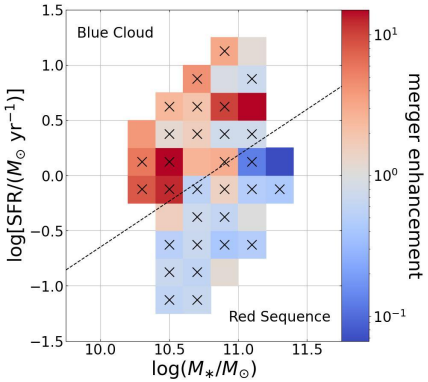

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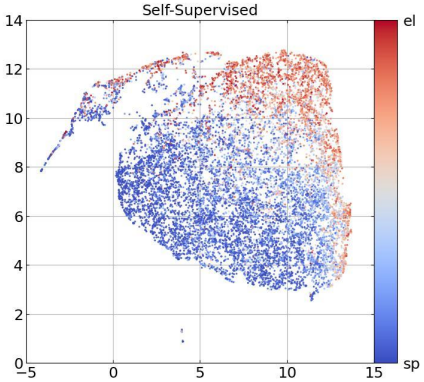
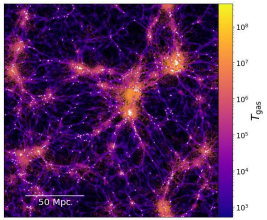
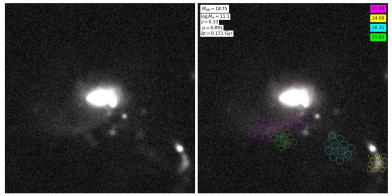
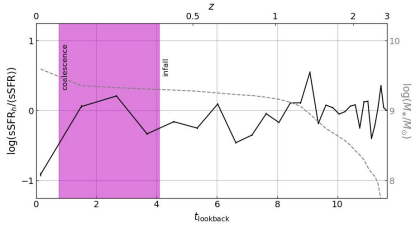


Secondments







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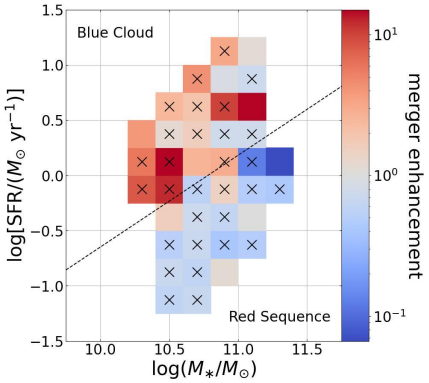

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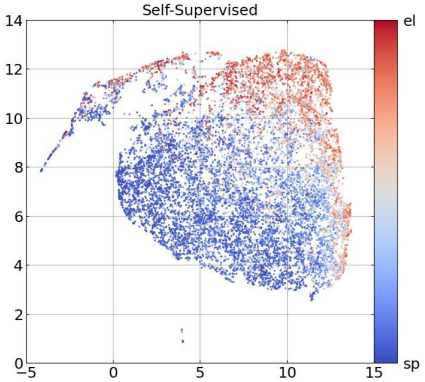

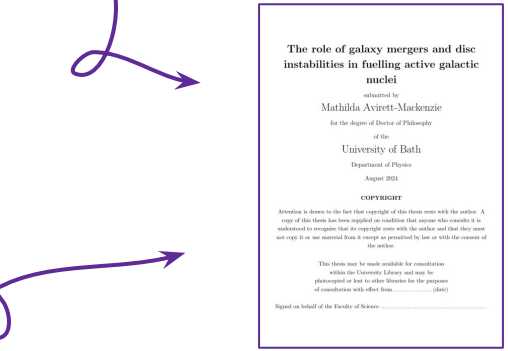

The role of galaxy mergers and disc instabilities in fuelling active galactic nuclei

submitted by

Mathilda Avirett-Mackenzie

for the degree of Doctor of Philosophy

of the

University of Bath

Department of Physics

August 2024

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Secondments