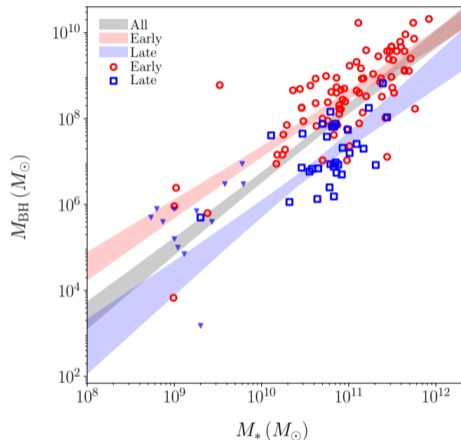


A Machine-learning Approach to Assessing the Presence of Substructure in Quasar-host Galaxies (CN, Silverman, Hartwig et al. ApJ...947...30N)

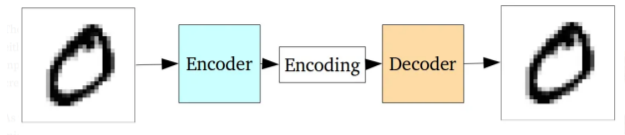


Chris Nagele, Department of Astronomy, University of Tokyo

Figure from Greene+20

Autoencoders

How to classify images of handwritten numbers (0, 1, 2...)?



0s will be near each other in the latent space

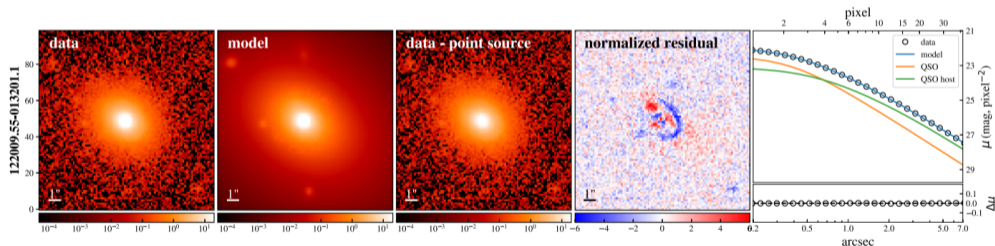


- ▶ Classification
- ▶ Morphology
- ▶ Outlier/anomaly detection
- ▶ Interpolation
- ▶ Mock data

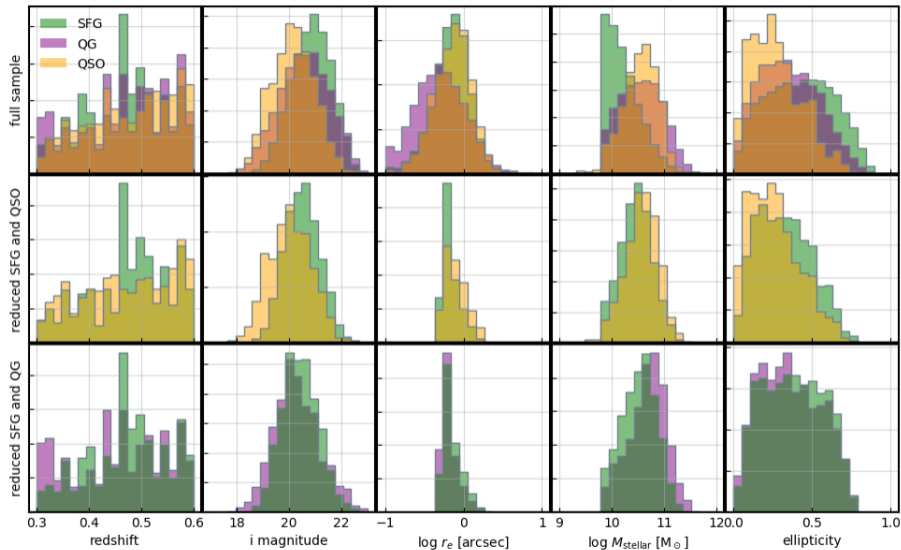
Is there sub-structure which correlates with quasar activity?

The Sizes of Quasar Host Galaxies with the Hyper Suprime-Cam Subaru Strategic Program

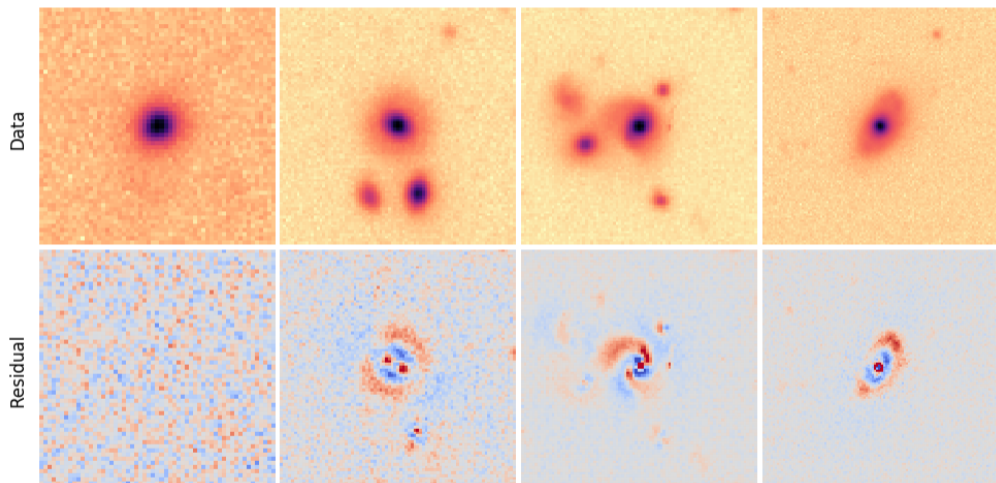
JUNYAO LI,^{1,2,3} JOHN D. SILVERMAN,^{2,4} XUHENG DING,² MICHAEL A. STRAUSS,⁵ ANDY GOULDING,⁵ SIMON BIRNER,⁶ HASSEN M. YESUF,^{7,8} YONGQUAN XUE,^{1,3} LALITWADEE KAWINWANICHAKIJ,² YOSHIKI MATSUOKA,⁹ YOSHIKI TOBA,^{10,11,9} TOHRU NAGAO,⁹ MALTE SCHRAMM,¹² AND KOHEI INAYOSHI⁸

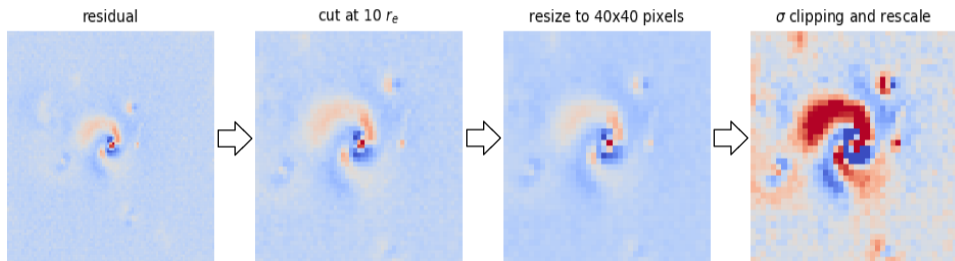


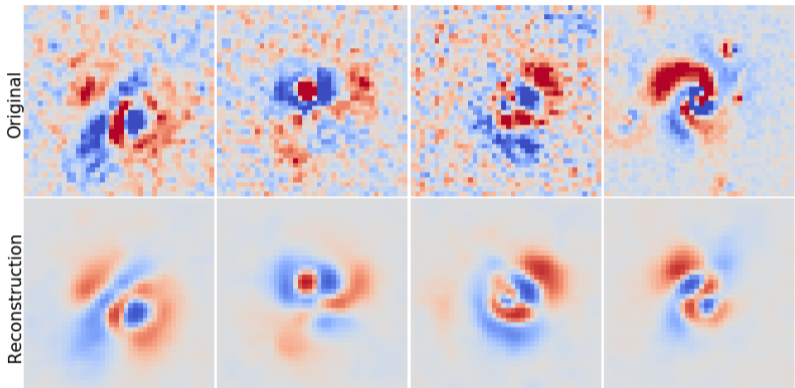
The idea: put quasars (QSO) and non quasars (SFG) into a VAE



Residual images

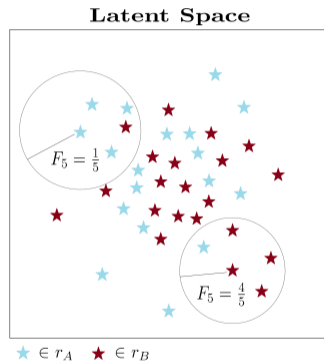






The VAE doesn't know that there are two populations
→ will the latent space split into two?

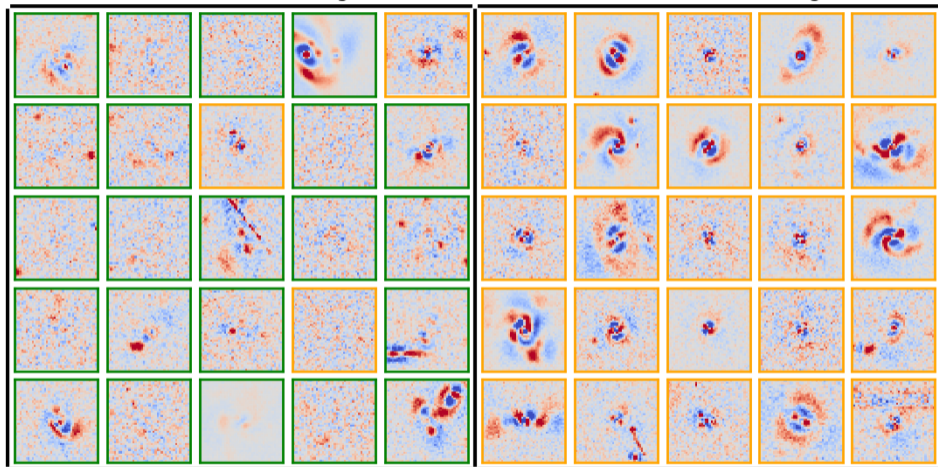
- ▶ Compute nearest neighbor QSO fraction
- ▶ Find regions with very high/low QSO fraction



Results: star forming galaxies vs quasar hosts

A SFG dominated region

A QSO dominated region

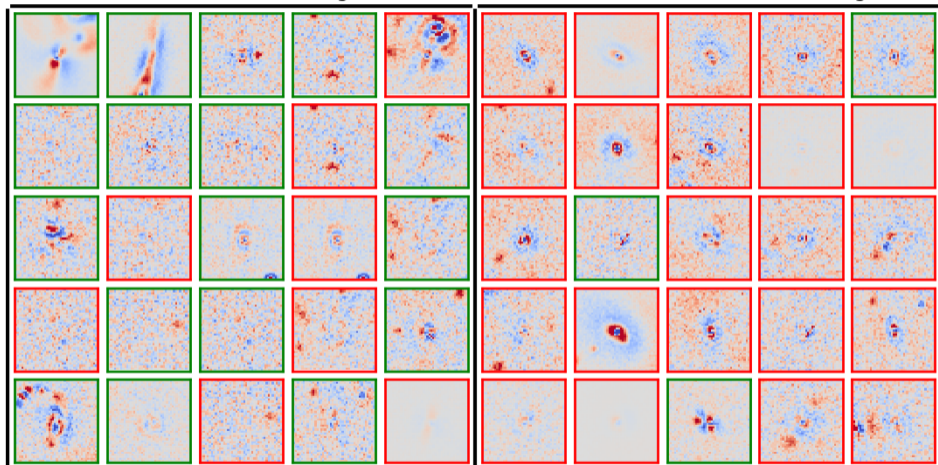


Green borders SFG, orange borders QSO

Results: identifying a point source subtraction artifact

A SFG dominated region

A SIM-QSO dominated region

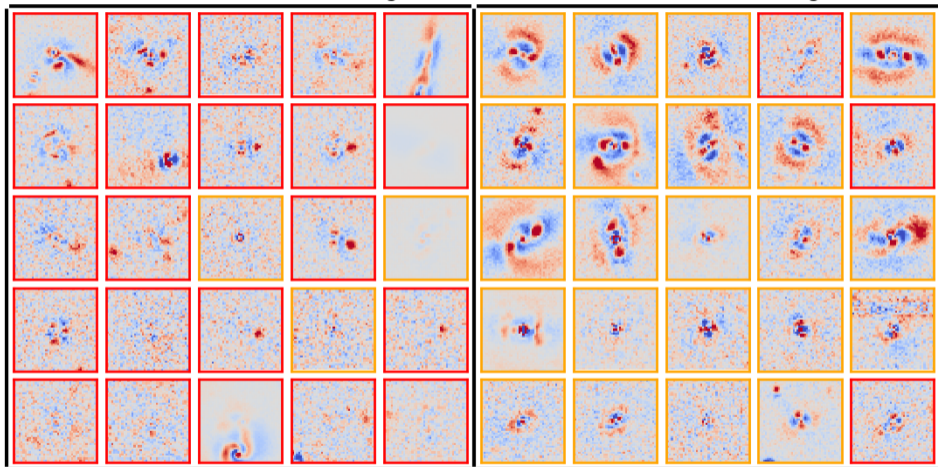


Red borders SIM-QSO, green borders SFG

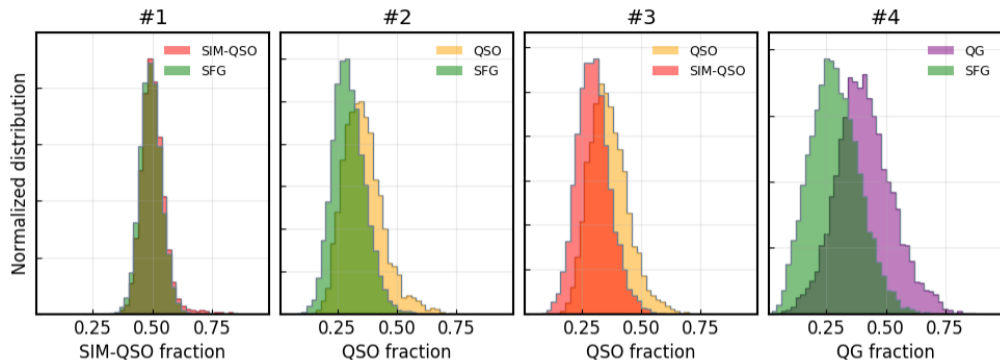
Results: simulated quasar hosts (SFGs with point source artifact) vs quasar hosts

A SIM-QSO dominated region

A QSO dominated region

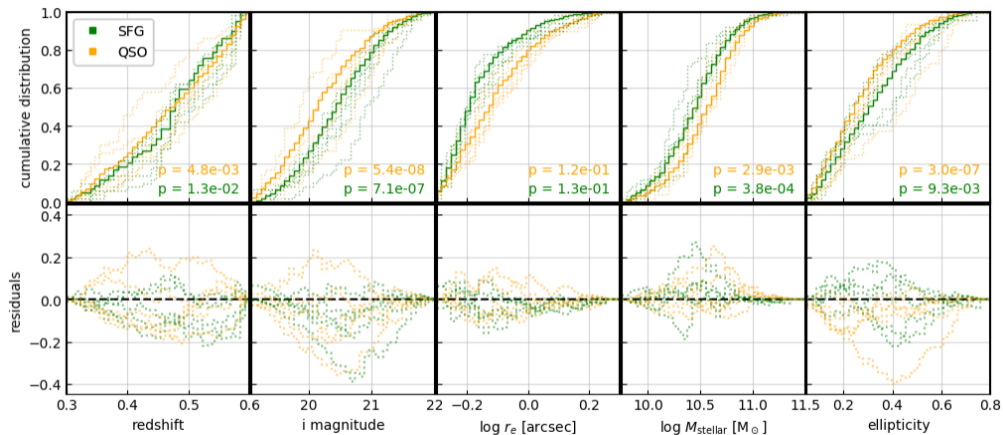


Red borders SIM-QSO, orange borders QSO



| | Purpose | Samples | # of images | KS distance | KS p |
|----|------------------|--------------|-------------|-------------|-----------|
| #1 | Test-PSF removal | SFG, SIM-QSO | 1387 , 1387 | 0.051 | 3.30e-13 |
| #2 | Experiment | SFG, QSO | 1387 , 483 | 0.296 | 9.69e-223 |
| #3 | Experiment | SIM-QSO, QSO | 1387 , 483 | 0.325 | 2.15e-269 |
| #4 | Experiment | SFG, QG | 1826 , 1136 | 0.430 | <1e-300 |

Results: is the VAE really using morphology?



- ▶ Trained a VAE on Subaru-HSC residual images
- ▶ Identified a subtraction artifact
- ▶ Clear separation of the quasar and star forming galaxy morphologies