Rubin Commissioning and Early Science

Cressida Cleland

2nd Year PhD student
Supervisor: Sean McGee

Possibilities with the Legacy Survey of Space and Time

- **Main science goals:**
  - The nature of dark matter and dark energy
  - Cataloguing the solar system
  - The structure of the Milky Way
  - Exploring the changing Universe (time domain)
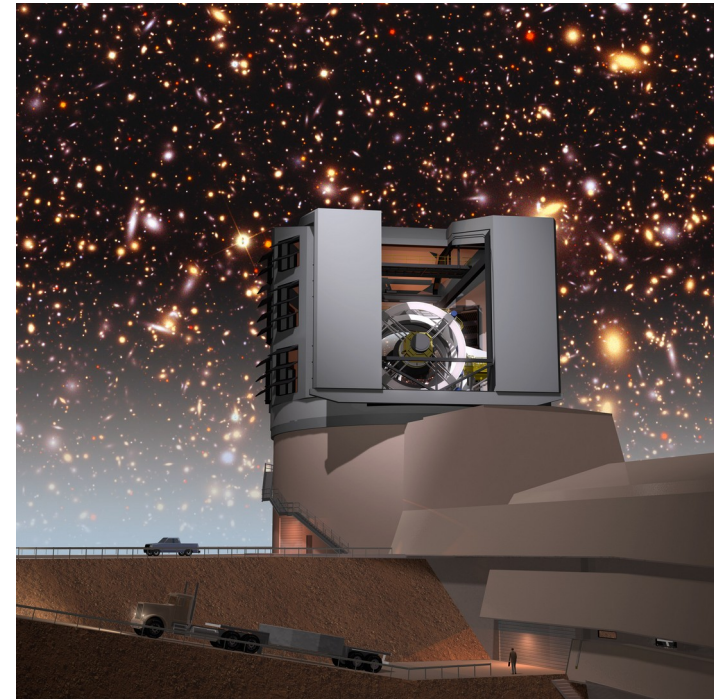- **My work:**
  - Variability in galaxies caused by AGN

*Image: Rubin Observatory*

What is variability?

Image: NASA/JPL-Caltech

- **An active galactic nucleus (AGN) is a luminous region at the centre of a galaxy.**

- **The luminosity is a result of accretion of matter by a supermassive black hole.**

- **AGN can vary in luminosity over both short (minutes ~ years) and long (million years ~ billion years) timescales (see Caplar et al. 2020 and references therein).**

- **AGN feedback is thought to have links to galaxy star formation quenching (see Fabian 2012 for a review).**

3

What is variability?

- **Time domain data from Zwicky Transient Facility (ZTF) matched with SDSS spectroscopic data**

- **LSST will provide more data at higher cadence**

- **Use BPT diagram on galaxies with sufficient SNR to classify emission as SF or AGN**

- **51,000 galaxies → 16,500 that pass cuts**
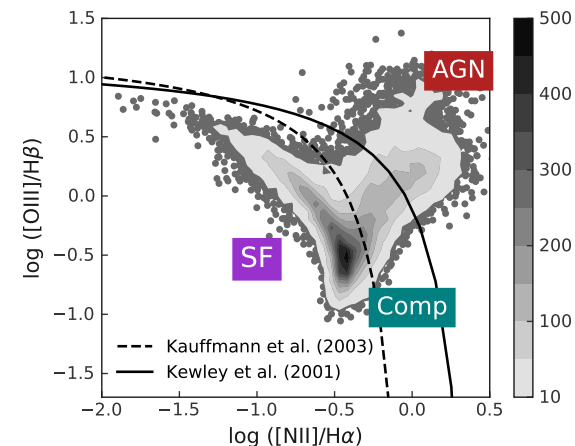
How to calculate variability?

- **Variability = log(χ^2 / d.o.f.)**

- **Under the hypothesis that the galaxy is non-variable, the points would form a flat line.**

- **The reduced χ^2 tests this hypothesis and provides a measure of how scattered the points are around the mean, taking uncertainties into account.**

- **Use simulated variabilities to account for magnitude-dependent uncertainties.**

Results
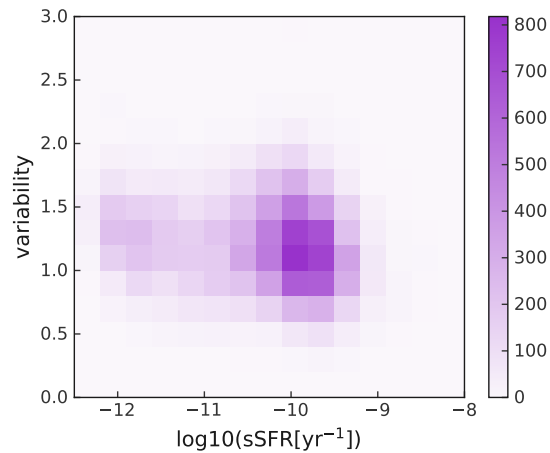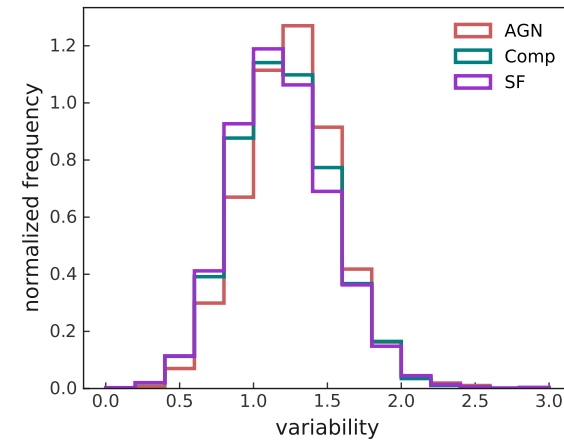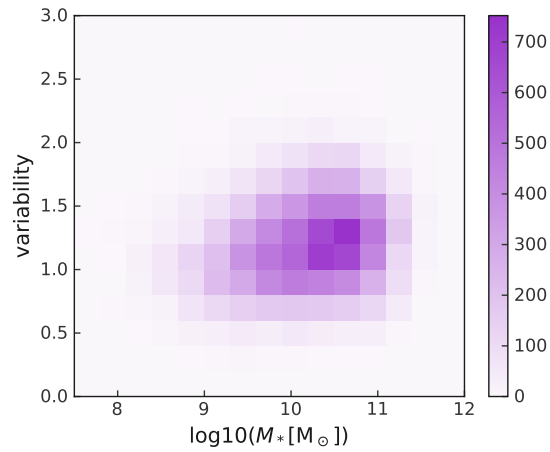
**Fairly similar distribution between AGN and SF**

Stellar mass and environment
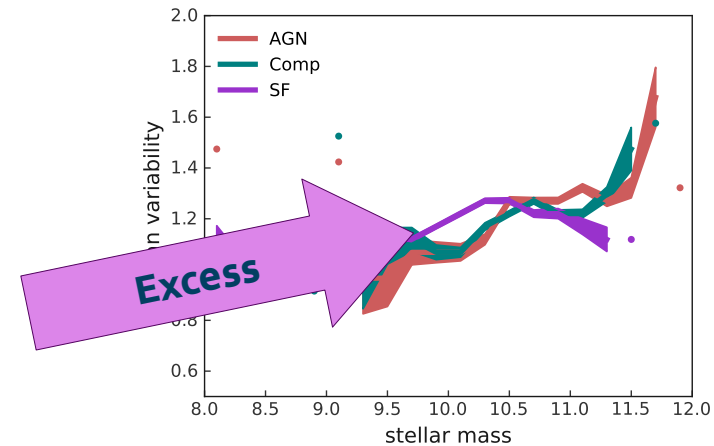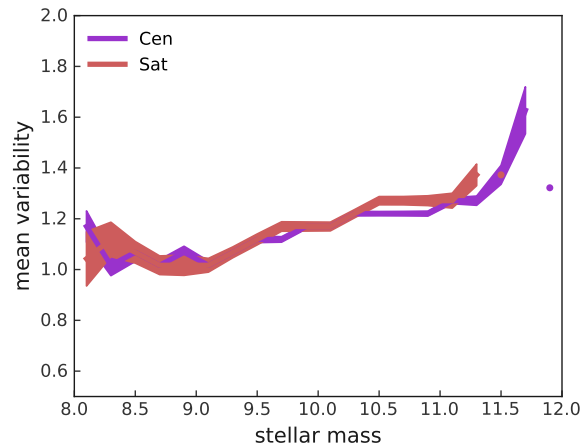
- **Emission type strongest indicator for variability**

- **Excess in variability in SF galaxies compared to AGN**

Is variability simply a function of magnitude?

- **Two categories of AGN: LINERs and Seyferts. Exhibit different magnitude distributions, but have similar variability distributions.**

Cressida Cleland – University of Birmingham
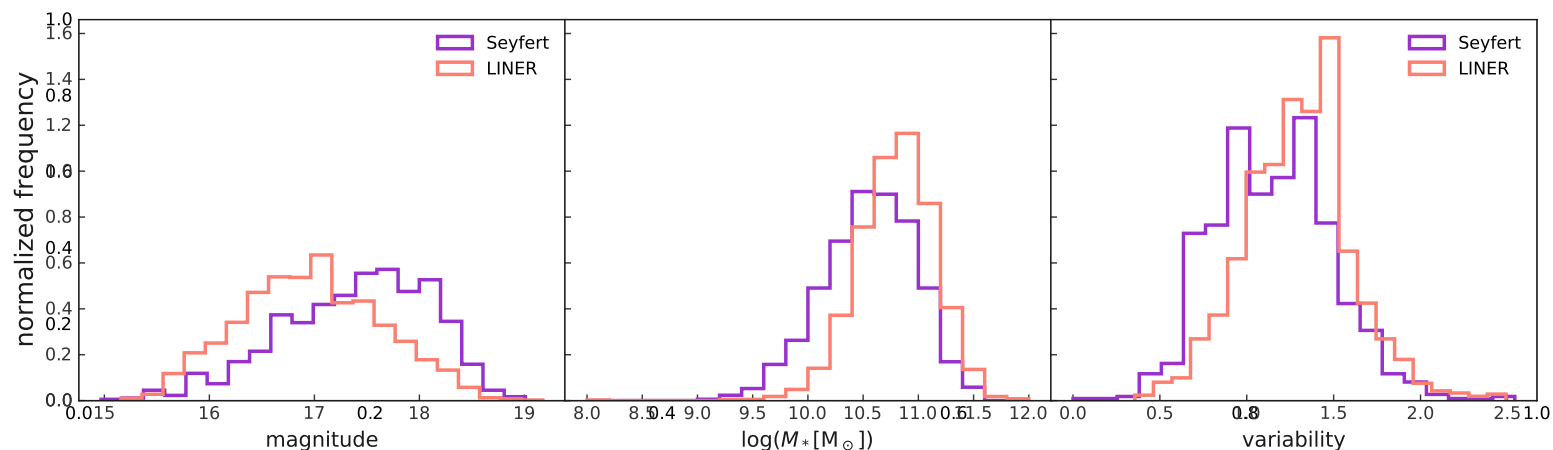
Restrain magnitude range
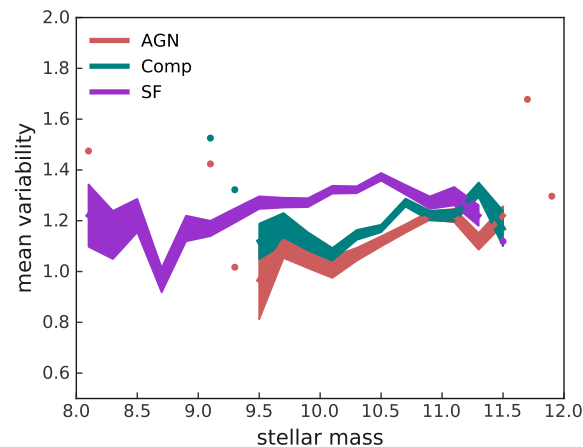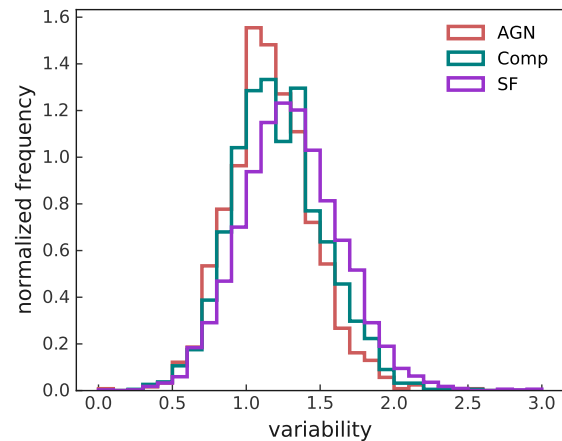
- **With all galaxies in same magnitude range 17<m<18**

- **Slight excess in variability in SF galaxies**

- **Particularly at low mass**

Other galactic properties

- **Region of high variability at intermediate log(sSFR)**

- **Variability decreases with increasing B/T**

- **Suggests possible link to evolutionary processes**
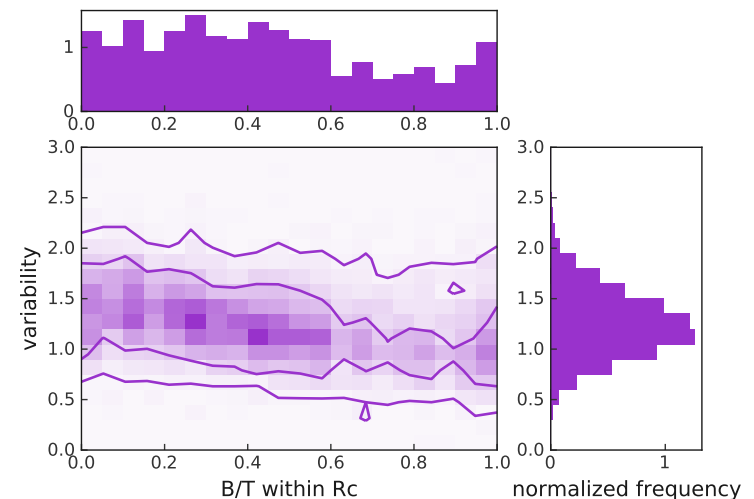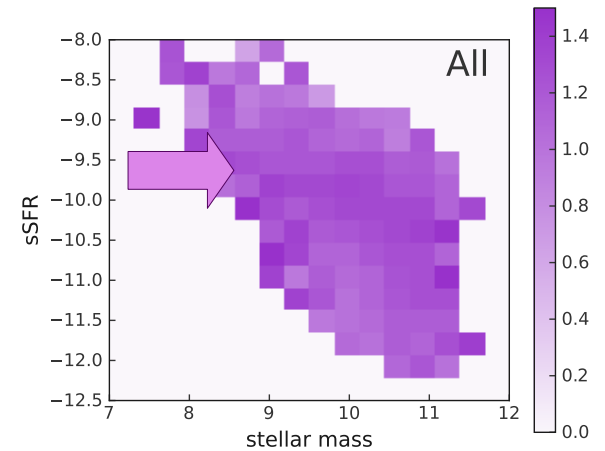
Conclusions

- **Galaxies exhibit variability as a function of stellar mass:**

  – Variability increases in SF objects until about $\log(M_*)\sim10$

  – Variability is lower in AGN until high stellar mass

- **High variability is seen in low mass galaxies at intermediate sSFR**

Conclusions

- **These point to high variability being a pre-cursor to reduced SF**

- **High variability in SF galaxies may indicate presence of AGN** (Baldassare et al. 2018; Pardo et al. 2016)

- **This simple measure of variability proves effective at uncovering some interesting trends.**

- **LSST will offer even more data. For early analysis: well-measured magnitudes at different epochs at high-cadence.**

- **Get in touch: cressidac@star.sr.bham.ac.uk**