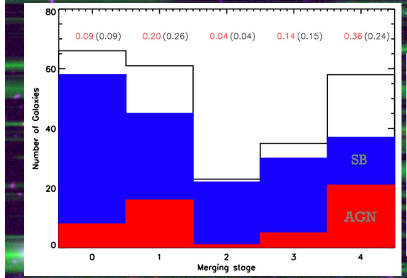
Obscured AGN with Roman

A. Petric (STScI), M.Lacy (NRAO), I. Wold (NASA, Goddard), A. Gabrielpillai (NASA Goddard)., Y. Gordon (U. of Wisconsin-Madison), A. Koekemoer (STScI), K.Nyland (NRL), D. Ilic (U. of Belgrade). S. Ravindranath (STScI), G. de Rosa (STScI), R. Ryan (STScI), C. Lagos Urbina (UWA), X. Liu (U. of Illinois), L. Popovic (U. of Belgrade), J. Rhoads, (NASA, Goddard), Y. Shen (U. of Illinois),Y. Xue, (USTC)

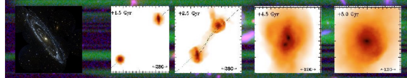
The Nancy Grace Roman Space Telescope has a simultaneous field of view 200 times larger than that of HST WFC3/IR. Roman will survey the NIR sky at a rate of thousands of square degrees per year, with a 5σ detection at magnitudes deeper than 27.5 (mag AB in one hour) with spatial resolutions similar to Hubble (Roman Science Requirements Document). The High Latitude Imaging and Spectroscopic Surveys will detect ~ 30 galaxies per arcmin² and will revolutionize our understanding of general astrophysics problems like how, why, and when galaxies grow super-massive black holes, form stars, and stop forming stars.

What's in a shape ?

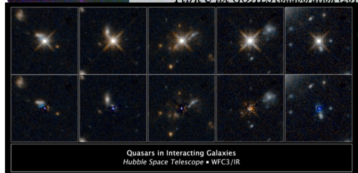
Local Mergers and IR-luminous galaxies



- AGN fraction is relatively higher in mergers than non-mergers
- Gas rich merger trigger AGN.
- Roman, JWST, and ground based facilities can expand the range of such studies to z > 1.



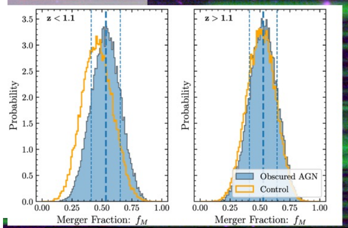
Petric & the GOALS collaboration (2011), see also, Ellison et al. (2019)



NASA, ESA, and E. Glikman + 2012 (Middlebury College, VT)

- Most luminous (log L = 47.8-48.3 erg/s), dust-reddened quasars at z > 0.7 are mergers *(Glikman et al. 2007, 2012, Lacy et al. 2018)*.
- At log(L < 10^{46} erg/s) the fraction of obscured AGN host mergers seems smaller at z > 1.1
- Are we missing the faintest, most obscured AGN at z > ~1.1?
- Roman: find and study the faintest end of the z>1 luminosity function.
- Roman imaging and slit-less spectroscopy can find and study more of such QSOs.

Lambrides et al. 2021

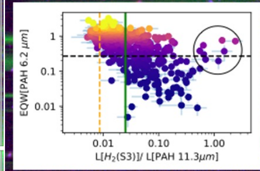


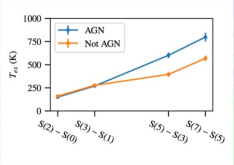
From the Cosmic Evolution Early Release Science survey (CEERS) collaboration. Cutout images (JWST/NIRCam F115W, F150W, F200W F227W, F356W, F444W): S. Finkelstein, M. Bagley, Z. Levay, and J. Kartaltepe.

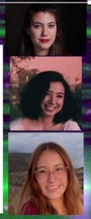
- **Peculiar structures are more common at high mass but fewer than both theoretical predictions and HST observations (e.g., at z~ 2 JWST finds 50% disks while HST found 10%) [Ferreira et al. 2022].**
- **The excess of apparently undisturbed disks may indicate that galaxies grow by mergers but also by other processes such as cold-gas accretion and/or that mergers between high-mass galaxies do not destroy disks efficiently, allowing some galaxies to retain their disk shapes**

What fuels growth?

AGN impact their host's Interstellar Medium



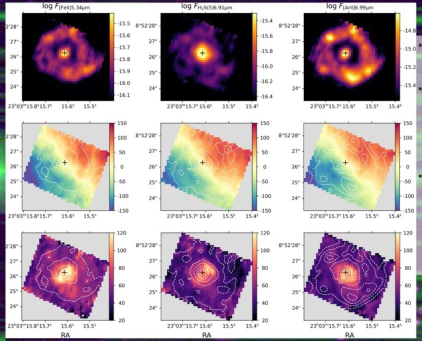




- **The relative fraction of warm H2 to IR/PAHs/[NeII] is higher in galaxies harboring an AGN.** ***Not a merger effect!***
- **Dust features span a wider set of properties in AGN hosts.**
- **H_2 excess <=> [OI],[OIII] outflows** ***(Riffell, Zakamska, Riffell 2020)***
- **Roman can simultaneously study the morphologies and warm-hot gas properties of AGN hosts.**

(AP+ 2018, Lambrides, AP+. 2019, Minsley , AP+ 2020, Dries-Padilla in.prep)

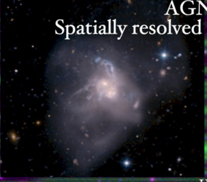
AGN impact their host's Interstellar Medium



- Distributions of molecular and ionized gas emission differ.
- Enhanced velocity dispersion in H_2 and [Fe ii] ~ 180 pc from the AGN that also feature high $L(H_2)/L(PAH)$ ratios.
- U et al. (2022) identify these regions as the locations where the outflow is depositing energy into the dense interstellar gas via shocks, between the nucleus and the starburst ring.

U et al. 2022

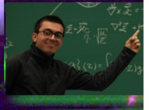
AGN impact on the CGM: Spatially resolved optical spectroscopy of AGN hosts



Karina Barboza UCLA IfA/REU/OSU

Maya Merhi UH IfA REU/PSU

Razan Hamed STScI / Purdue



Damien Beaulieu Universite de Laval

Beaulieu, AP+ 2023

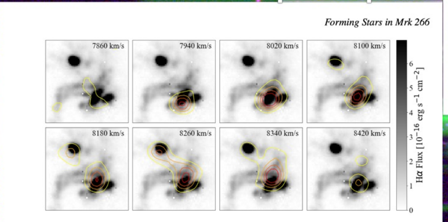
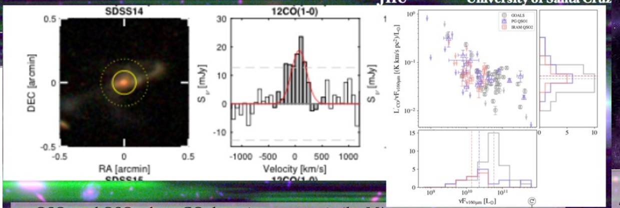


Figure 2. Distribution of the CO gas in the central region of Mrk 266 as a function of velocity from the CARMA datacube. Each panel is 19.2" by 19.2" contains a grayscale image of the Hα flux as observed by SITELLE and the CO emission at a fixed velocity, the contours indicate values of 0.02, 0.04, 0.06 0.08 Jy/beam as observed by CARMA.

Cold gas in QSO Hosts

Yuanze Luo JHU

Jameeka Marshall University of Santa Cruz

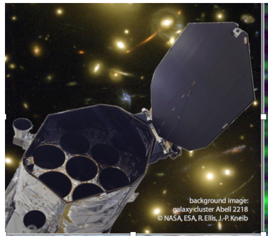


Luo, AP+ 2023

- QSO1 and QSO2s have CO detection rates at similar M*.
- QSO1 and QSO2s have similar FIR/CO ratios.
- SOFIA [CII] 158 micron to measure the amount of dark CO.
- **Massively Multiplexed Spectroscopic Facilities needed to measure reddening and M* for a wider range of AGN bolometric luminosities**

Why Roman ?

Finding the most obscured AGN



- eROSITA all Sky Survey on board of the Spectrum-Roentgen-Gamma satellite will detect about 3 million AGN to z≃ 6 *(Merloni et al. 2012)*

- The Australian SKA Pathfinder's Evolutionary Map of the Universe (EMU) Survey of all of the Southern Sky and up to +30Deg North at ~1.3 GHz
- 10" resolution, 10 microJy/beam sensitivity
- challenge for EMU => spectroscopic redshifts!

(Norris et al. 2011)

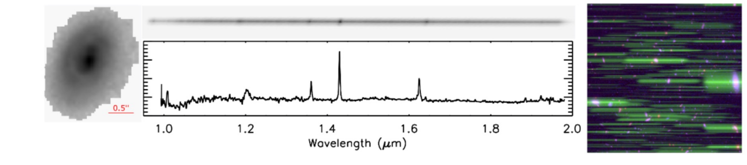
- South Africa's precursor to SKA: MeerKAT
- International GHz Tiered Extragalactic Exploration project (MIGHTEE)
- As of Jan 2019: "early observation of several MIGHTEE pointings have been completed"

(Jarvis et al. 2017, Taylor et al. 2017)

Tier	Frequency (GHz)	Sensitivity (rms)	Resolution (arcsec)	Area (degree²)	Time (hours)
Tier 1	1.4	5.0μJy	8.5	1000	2400
Tier 2	1.4	1.0μJy	8.5/3.5	35	1950
Tier 3	1.4	0.1μJy	3.5	1.0	1700
Tier 4	12	1.0μJy	3.2/0.4	0.25	700
Tier 5	12	0.2μJy	0.4	0.01	440

Roman's Massively multiplexed spectroscopic Surveys

Disentangling the Spectral Components of Obscured AGN with Complex Host Morphologies



EsPRESSO from Gabrielpillai et al. 2022, simulation of the Roman grism spectra of an obscured AGN from Lacy+AP+ 2016.

The Nancy Grace Roman Telescope

In ~5 days, Roman will reach same depth as the influential near-IR grism survey of the 3D-HST Treasury Program: 5σ line flux limits of 5.10^{-17} erg/s/cm2 *(Brammer et al. 2012; Van Dokkum et al. 2013; Momcheva et al. 2016)*, but over an the area more than 100 times larger! *(Wang et al. 2021)*

Roman's superb spatial resolution, sensitivity, grism spectroscopy will allow: a better localization & study of the elusive population of Compton-thick AGN eROSITA will discover.