



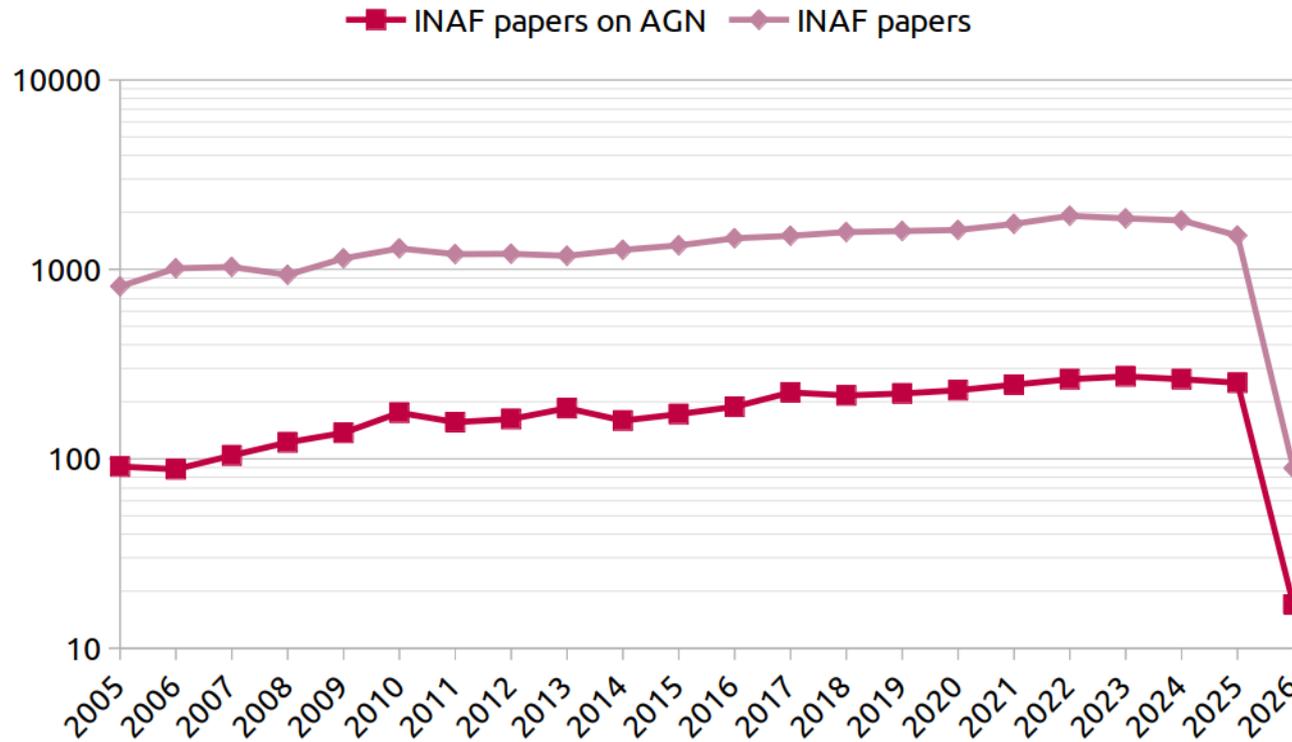
Roberto Decarli
INAF-OAS Bologna

Supermassive black holes:
formation, evolution, and feedback

AGN studies in INAF

NASA ADS query

inst:INAF and year:20XX and (abstract:"AGN" or abstract:"quasar" or abstract:"QSO" or abstract:"radiogalaxy")

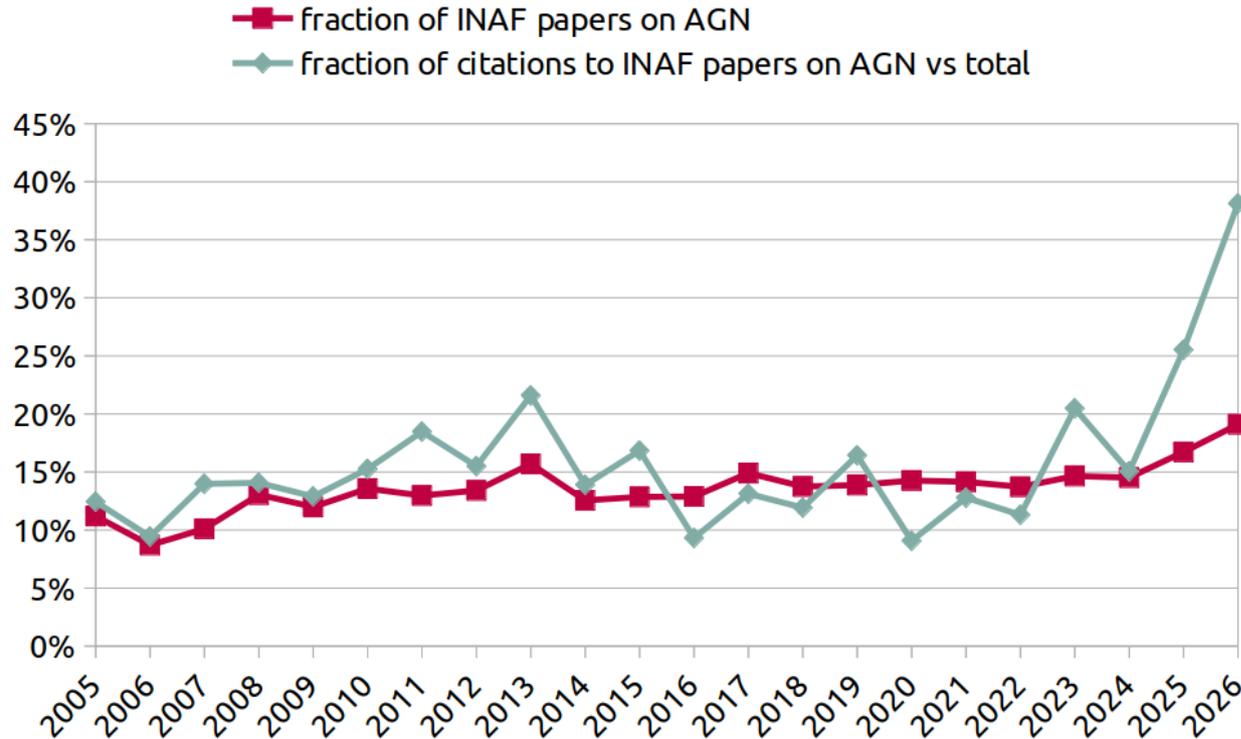


~250 paper/yr,
increasing

AGN studies in INAF

NASA ADS query

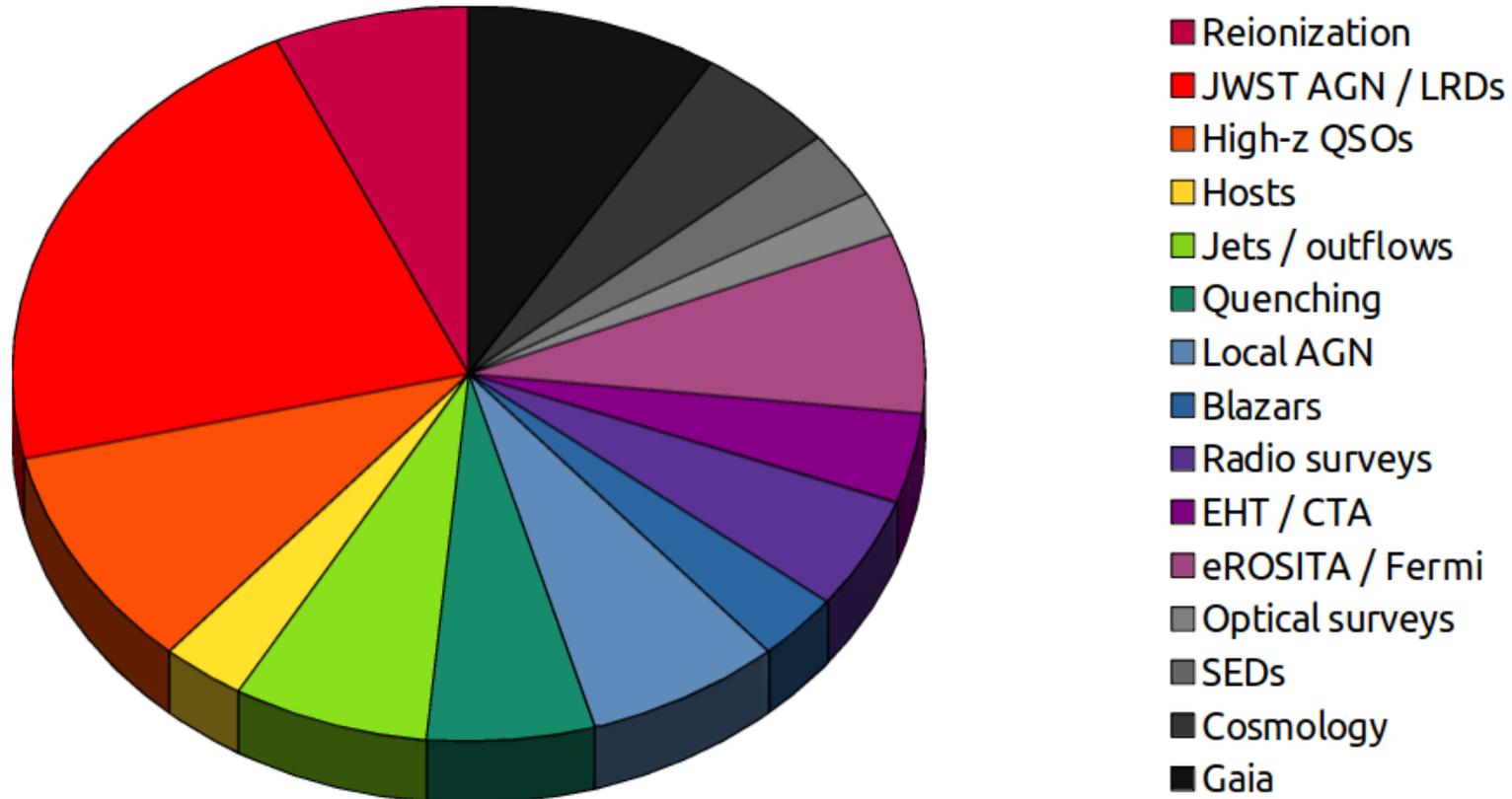
inst:INAF and year:20XX and (abstract:"AGN" or abstract:"quasar" or abstract:"QSO" or abstract:"radiogalaxy")



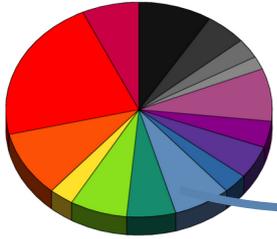
Slow but steady
increase in
contribution within
INAF

AGN studies in INAF

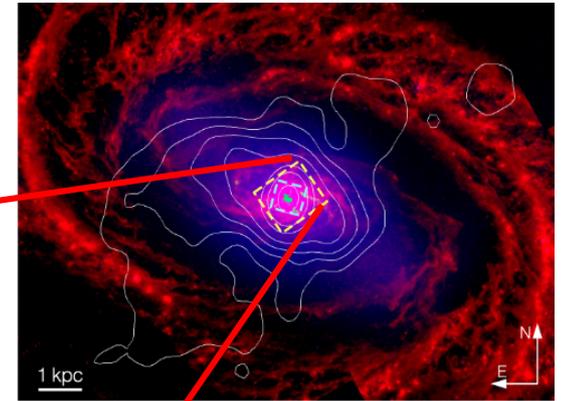
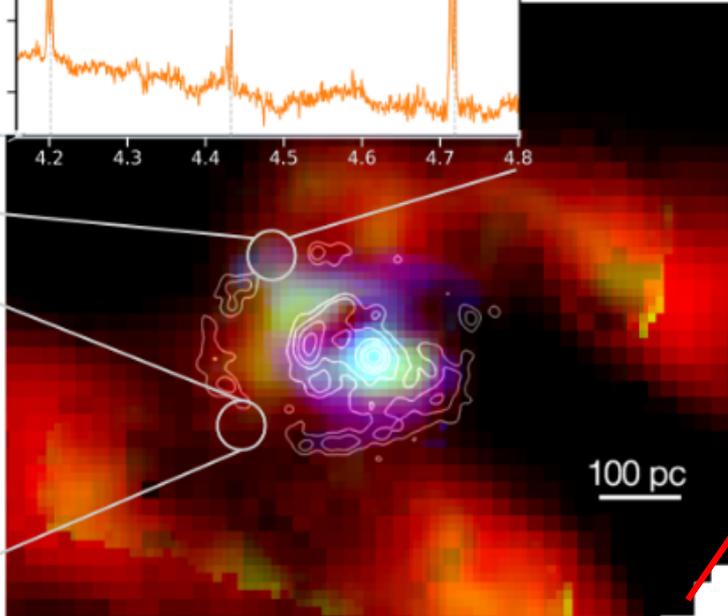
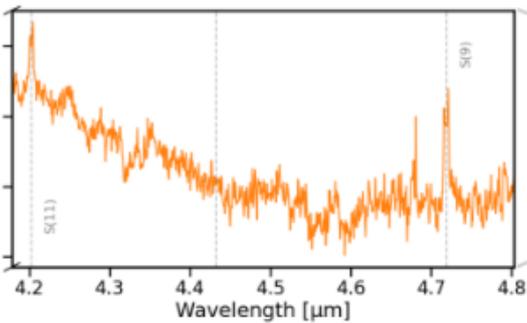
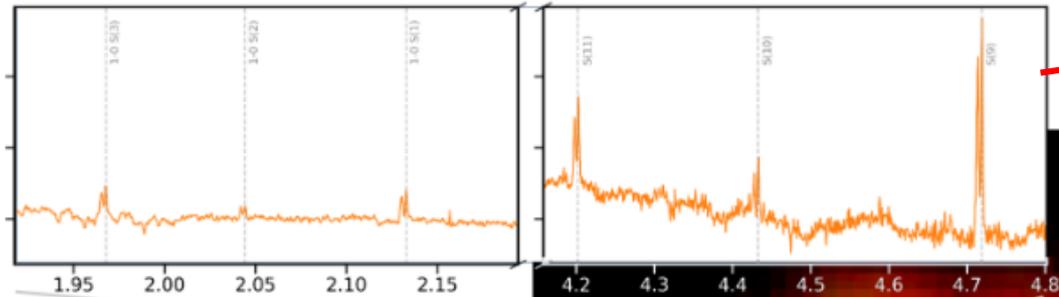
100 most cited refereed papers on AGN including INAF authors in 2021-25



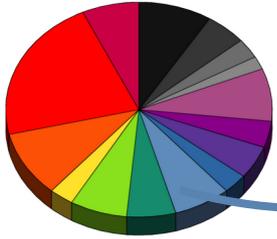
Local AGN



Low-luminosity AGN
excitation conditions

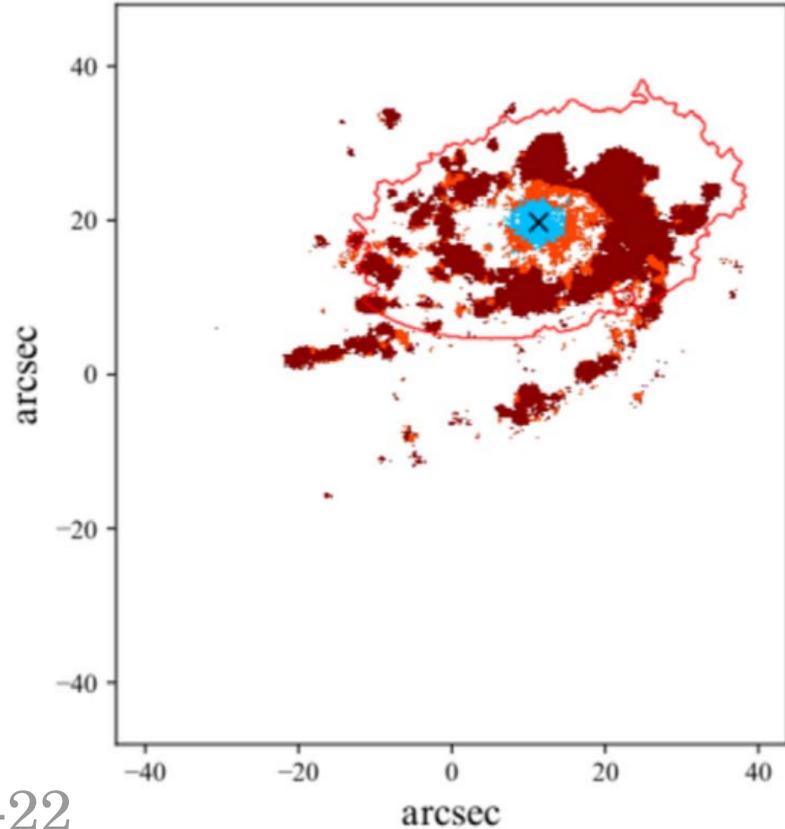


Local AGN

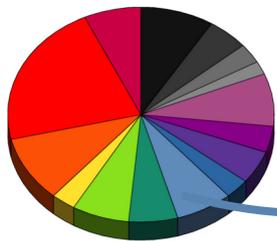


AGN excitation
conditions in
ram-pressure
galaxies

■ Star forming ■ Composite ■ AGN ■ LINER



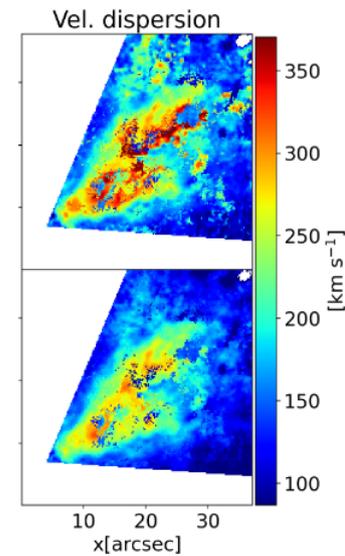
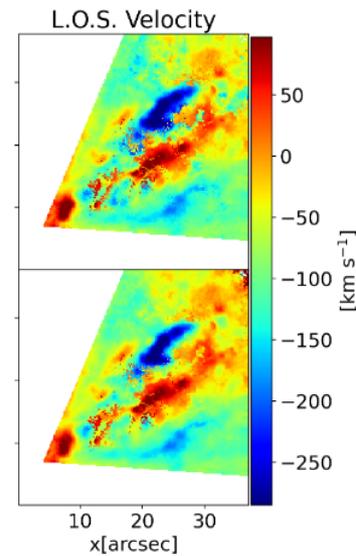
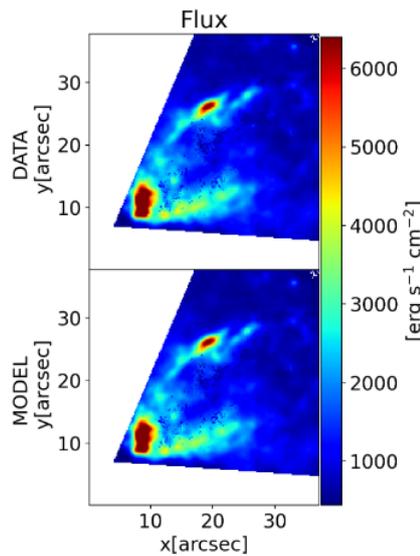
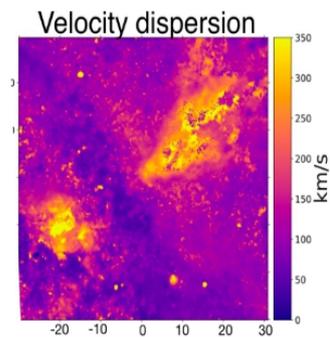
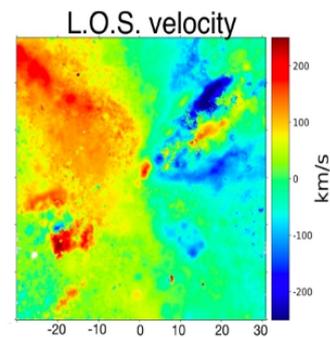
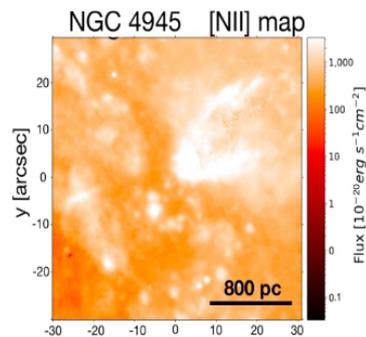
Peluso+22

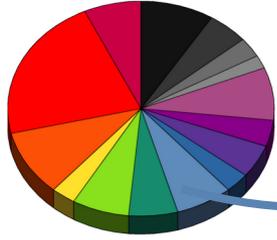


Local AGN

3D map of the
biconal outflow

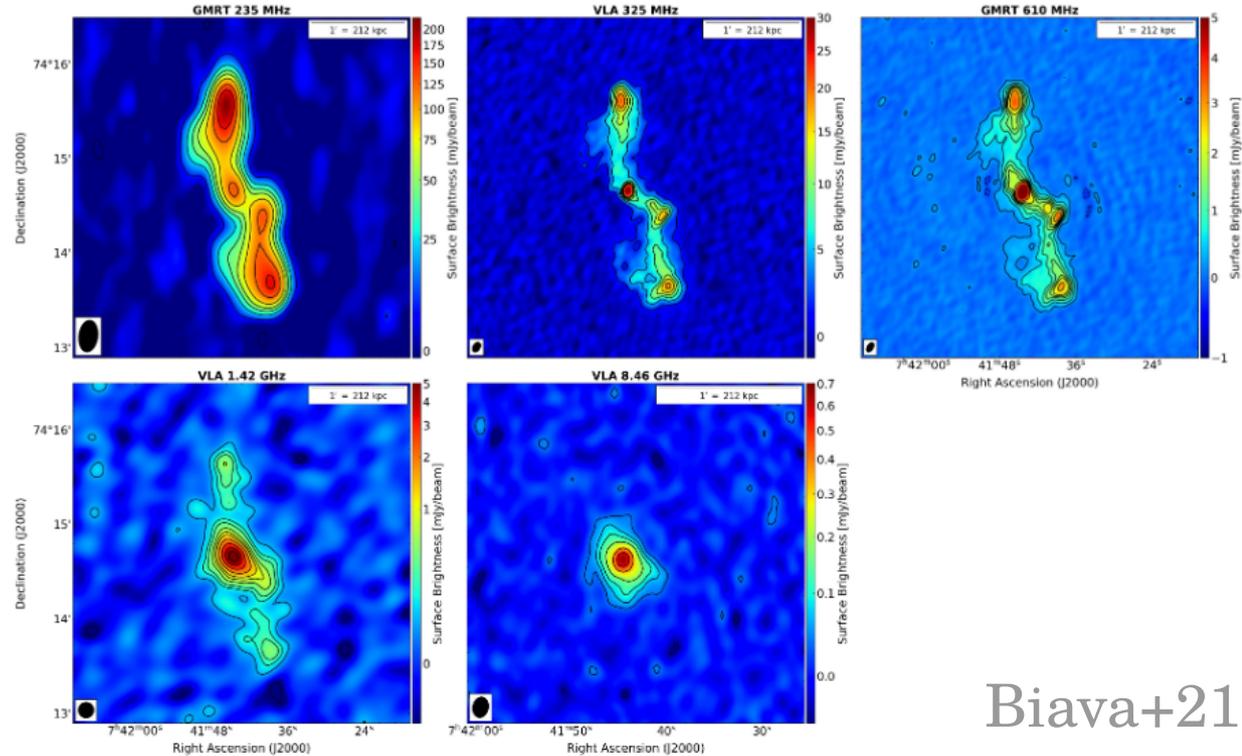
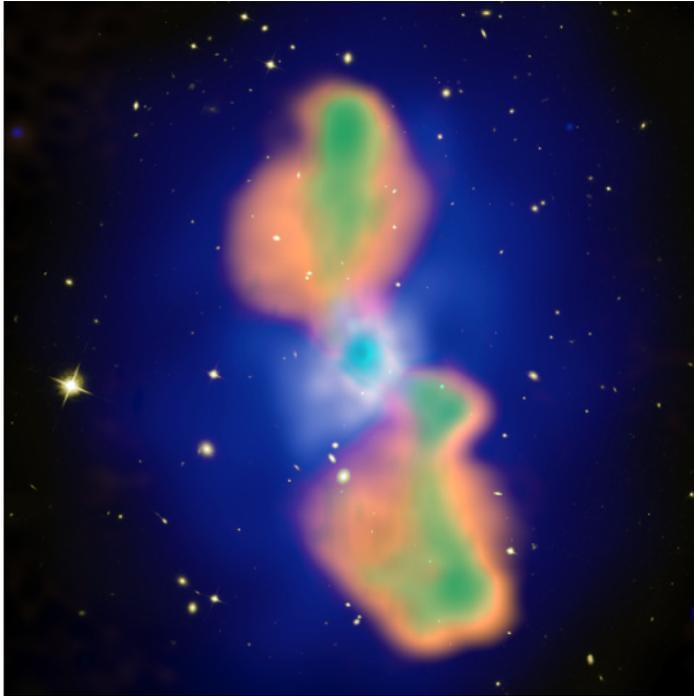
Marconcini+23



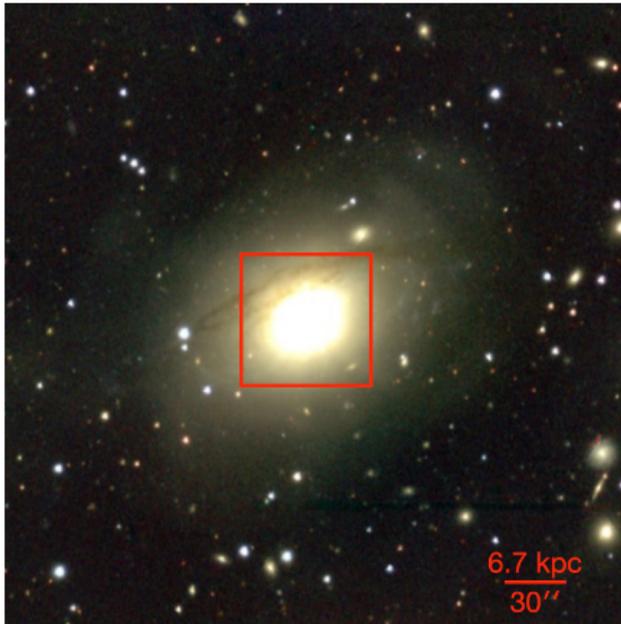
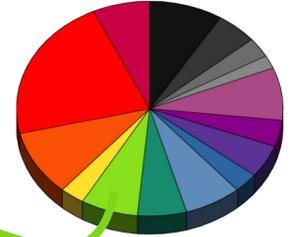


Local AGN

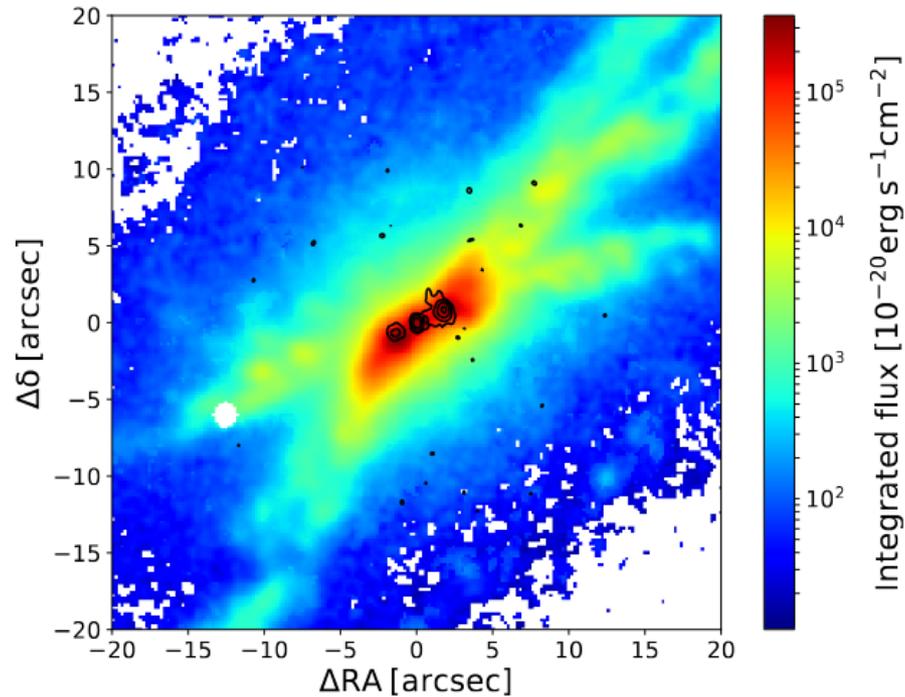
MS0735 cool-core cluster and AGN duty cycle



Jets / outflows

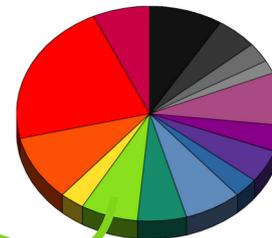


[OIII] map

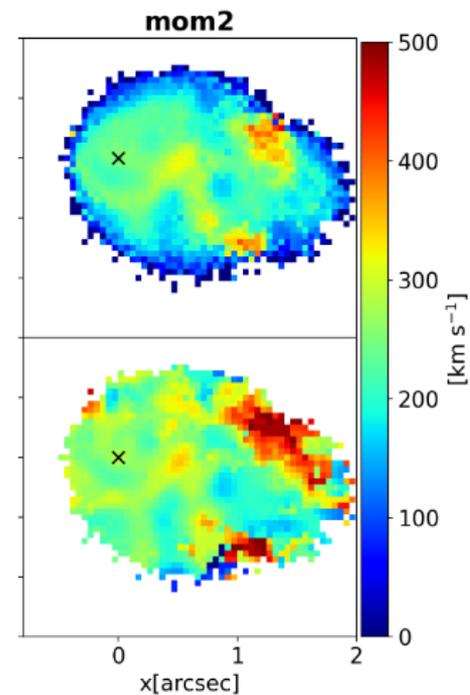
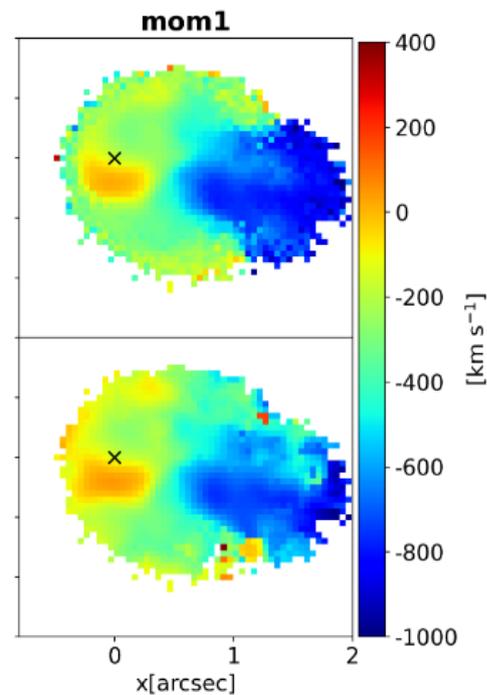
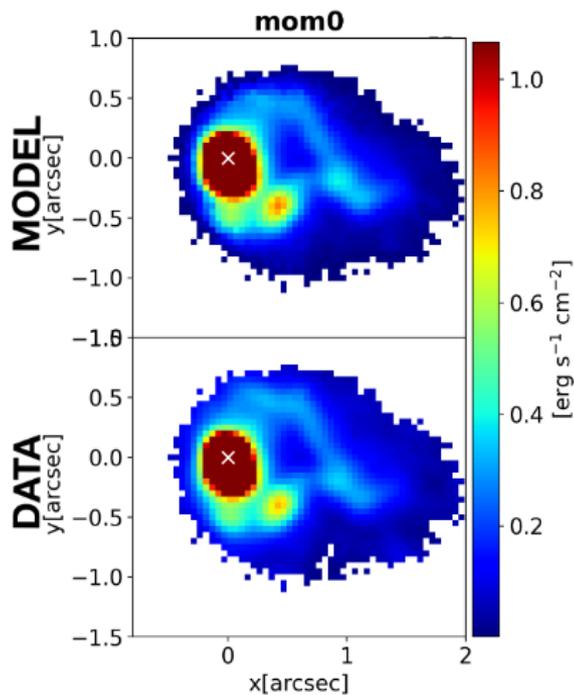
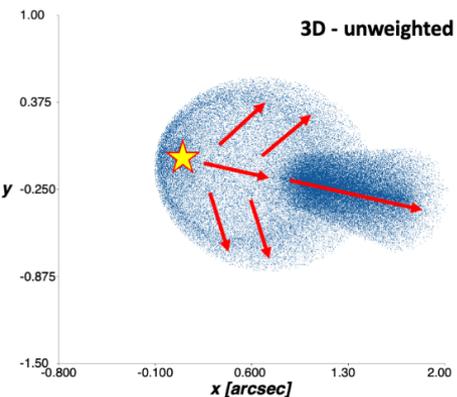


MUSE IFU
imaging of
lines

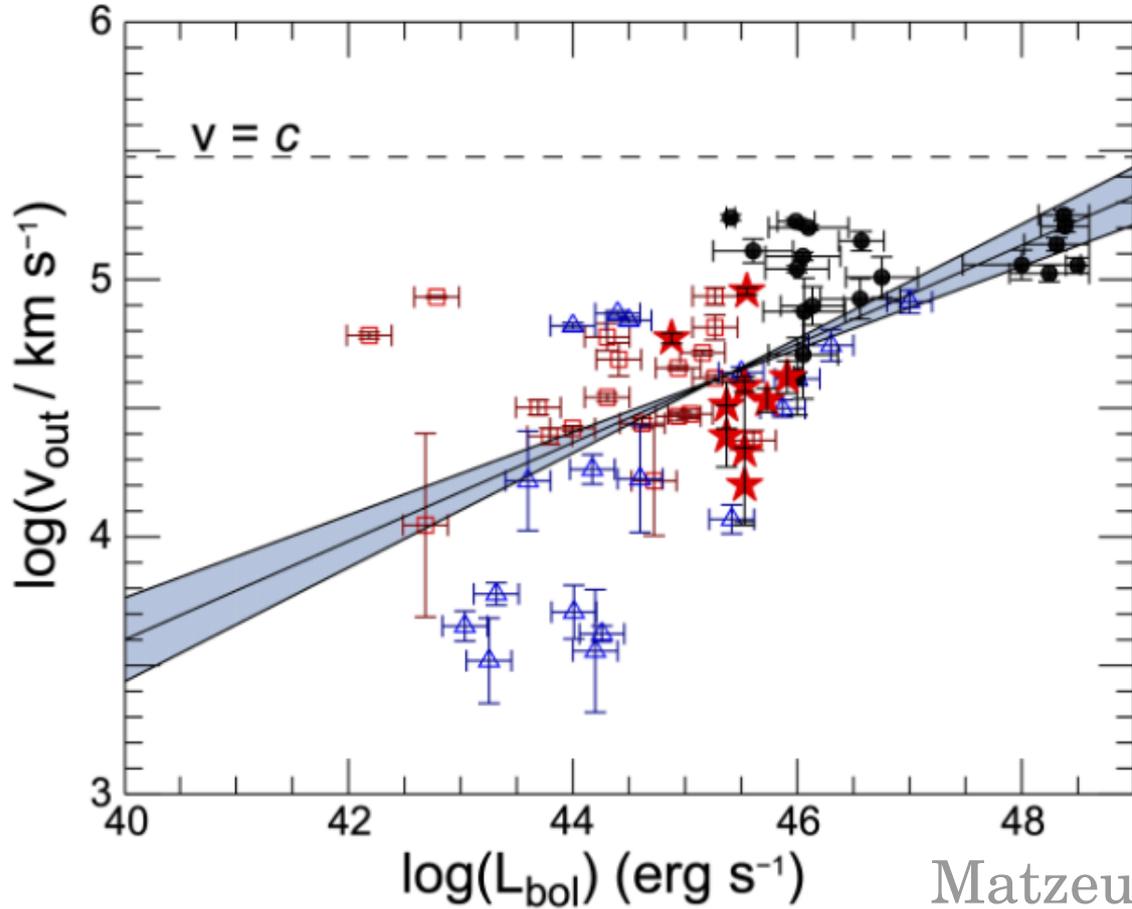
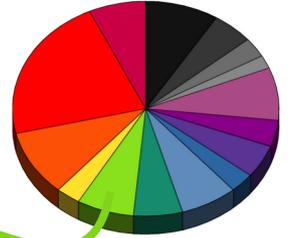
Jets / outflows



NIRSpec IFU
observations of
XID2028 at
 $z=1.59$



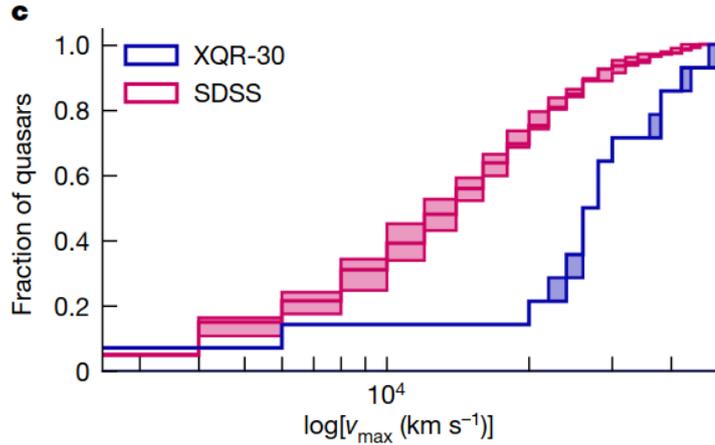
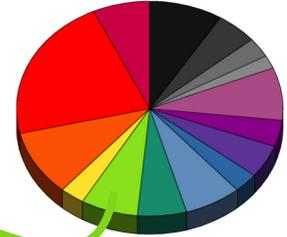
Jets / outflows



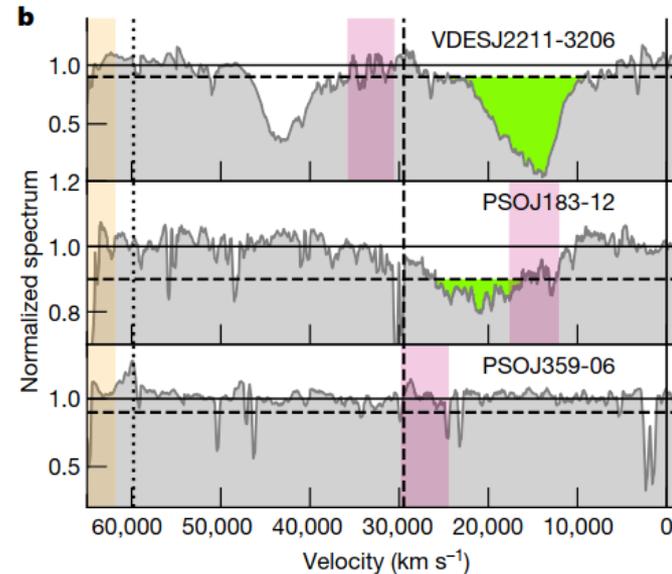
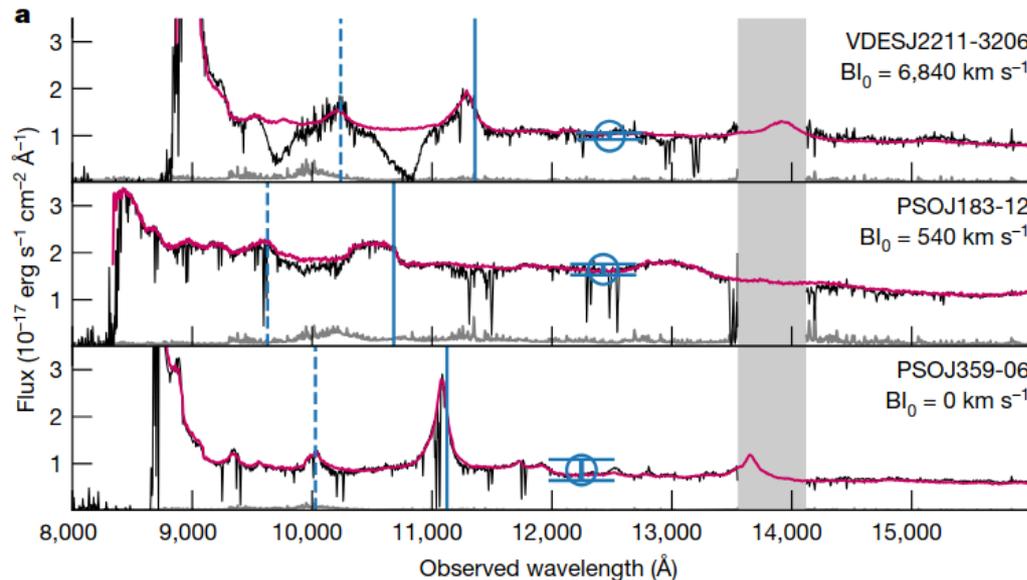
Matzeu+23

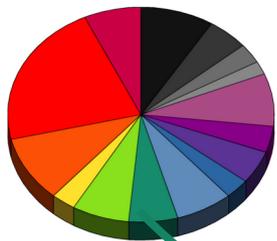
X-ray spectra
reveal UFOs in
SUBWAYS
quasars

Jets / outflows



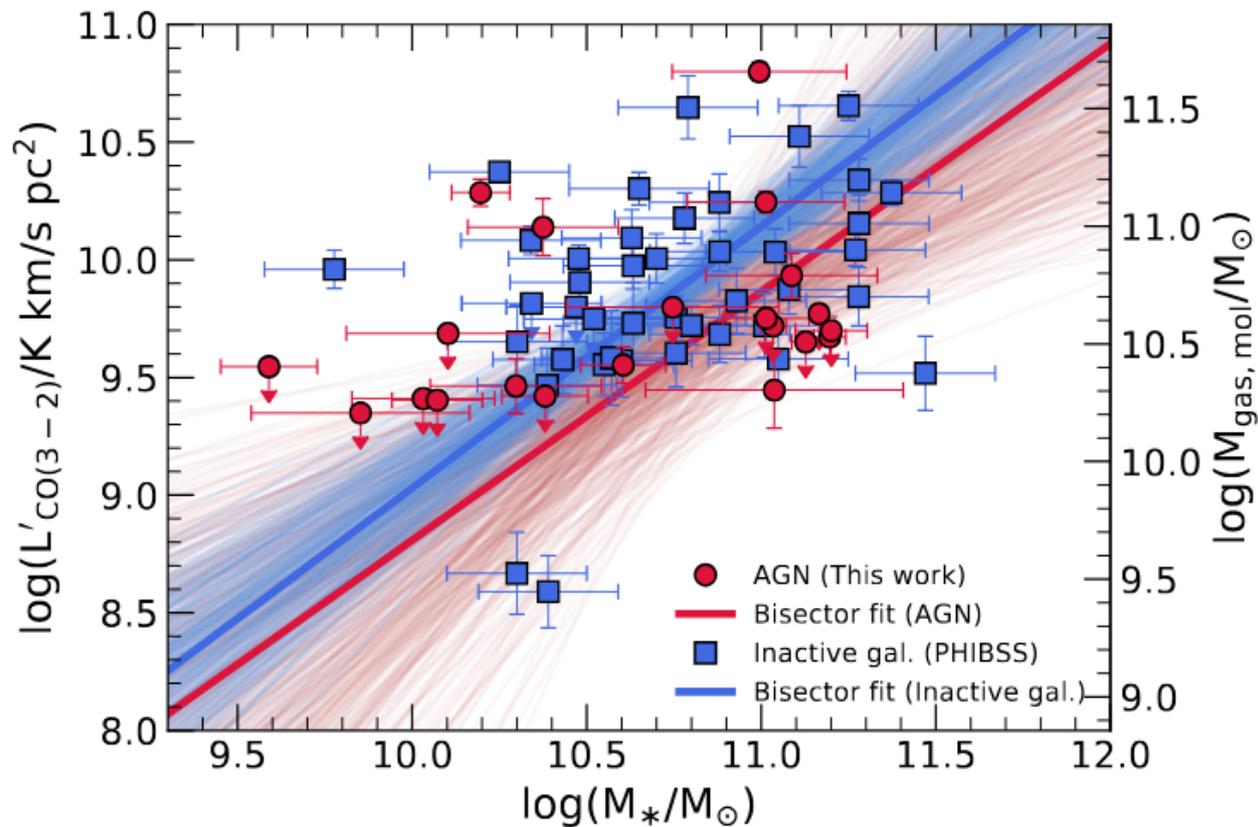
Broad absorption lines
are more frequent in
luminous, high-z QSOs

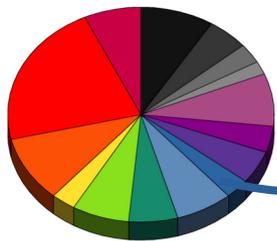




Quenching

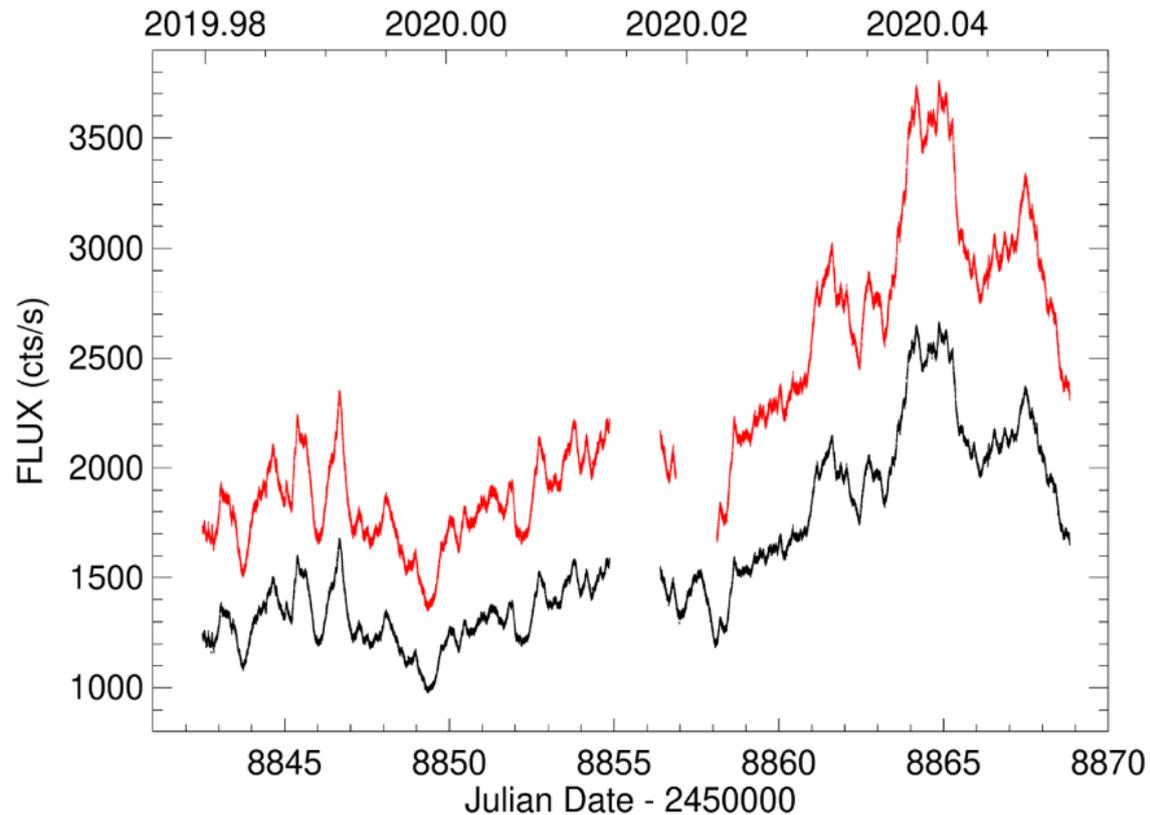
Molecular gas
content of AGN
at cosmic noon.
Lower content?

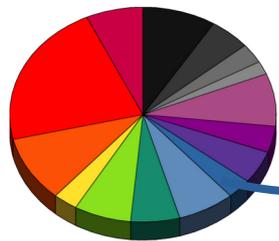




Blazars

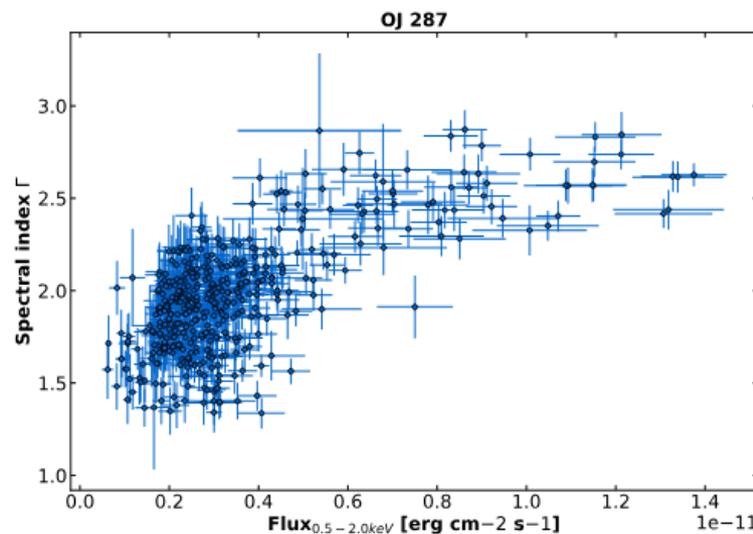
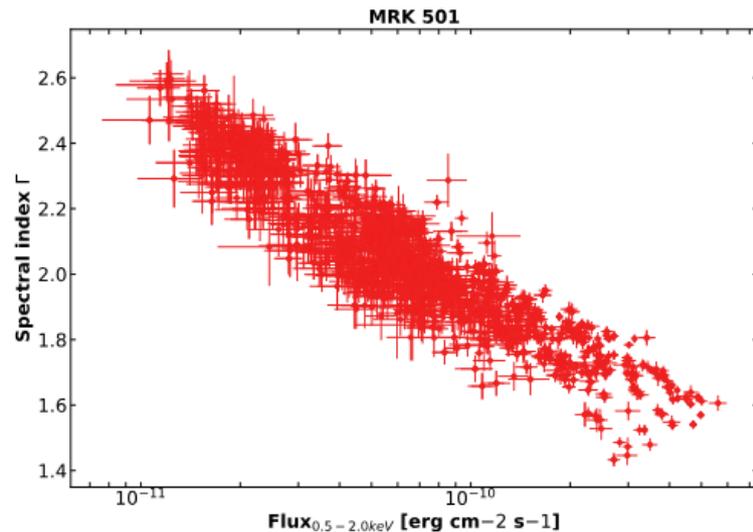
2 min sampling
of optical flux
in blazar S5
0716+714
($z=0.31$)





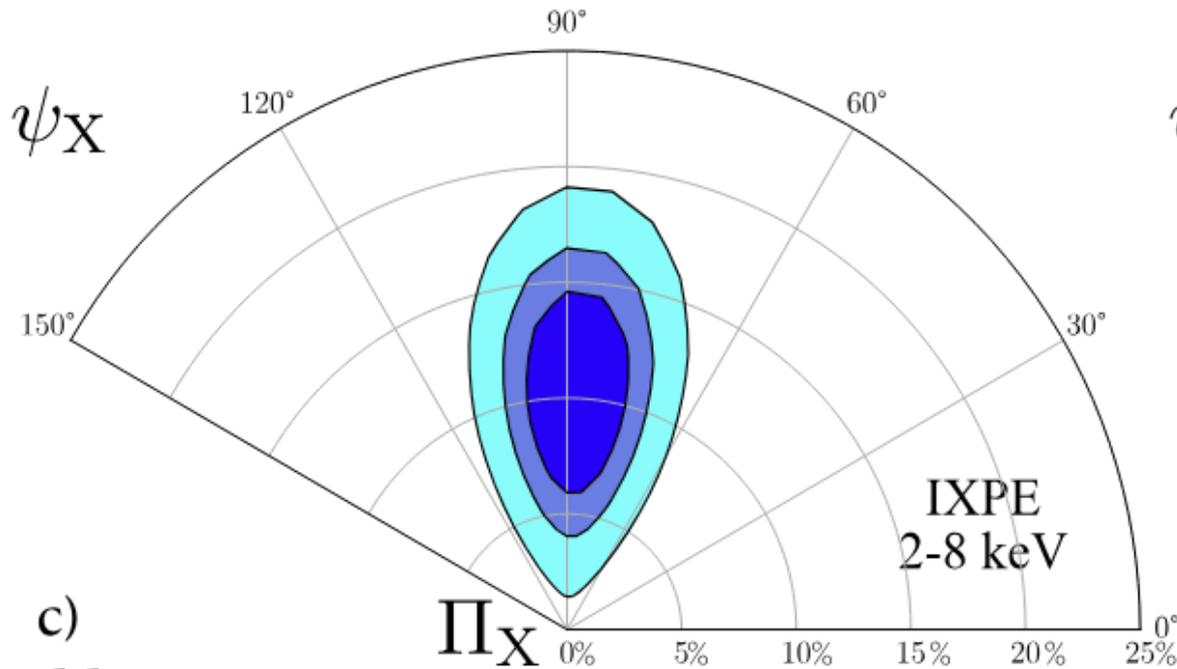
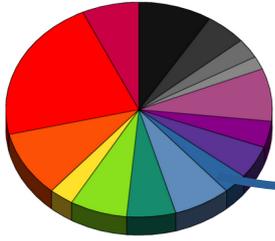
Blazars

Multi-band monitoring
&
SED variations



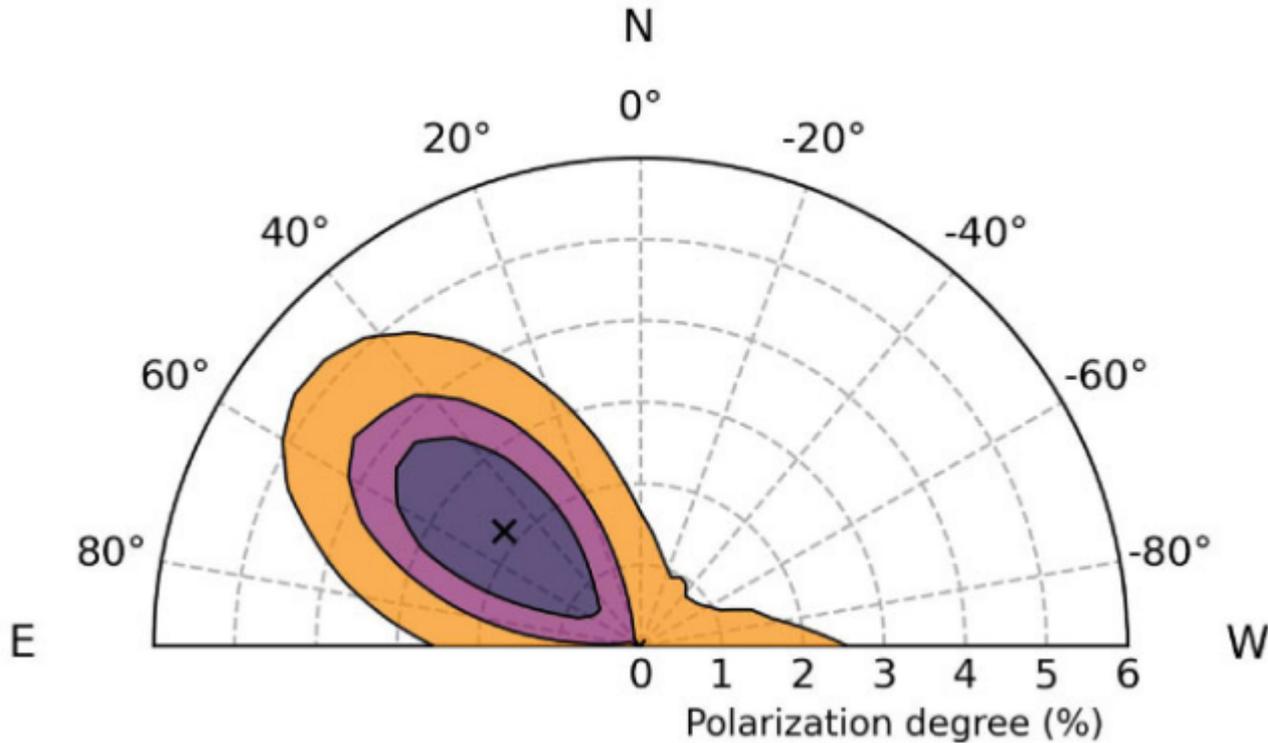
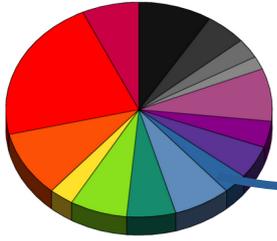
Giommi+21

Blazars

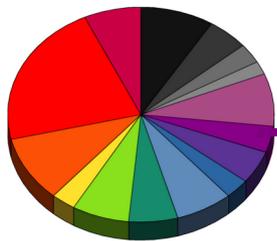


Polarized X-rays in
PG 1553+113:
X-rays from
shock-accelerated
electrons

Blazars



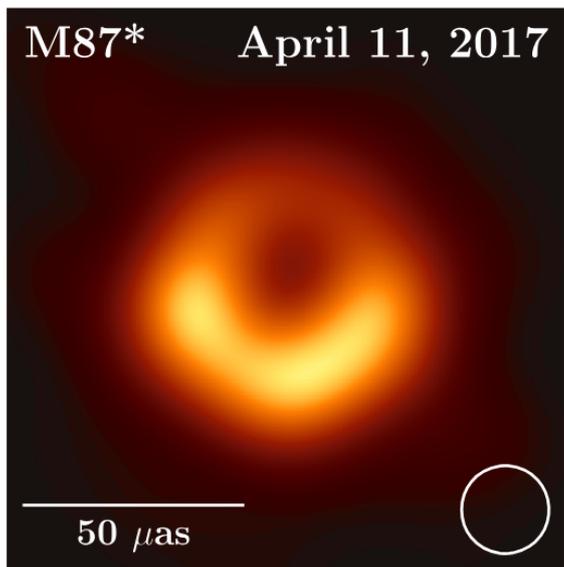
Polarized X-rays
reveal hot corona
geometry in radio-
quiet Seyfert 1.9
galaxy



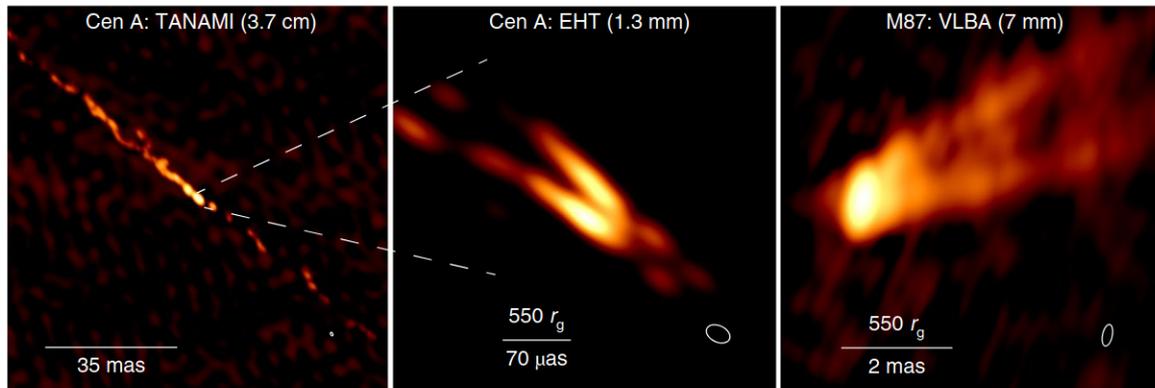
EHT

Pushing angular resolution
at mm wavelengths

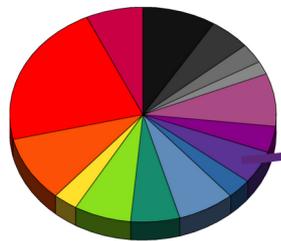
General relativity, BH science,
magnetic fields, jets



EHT+19



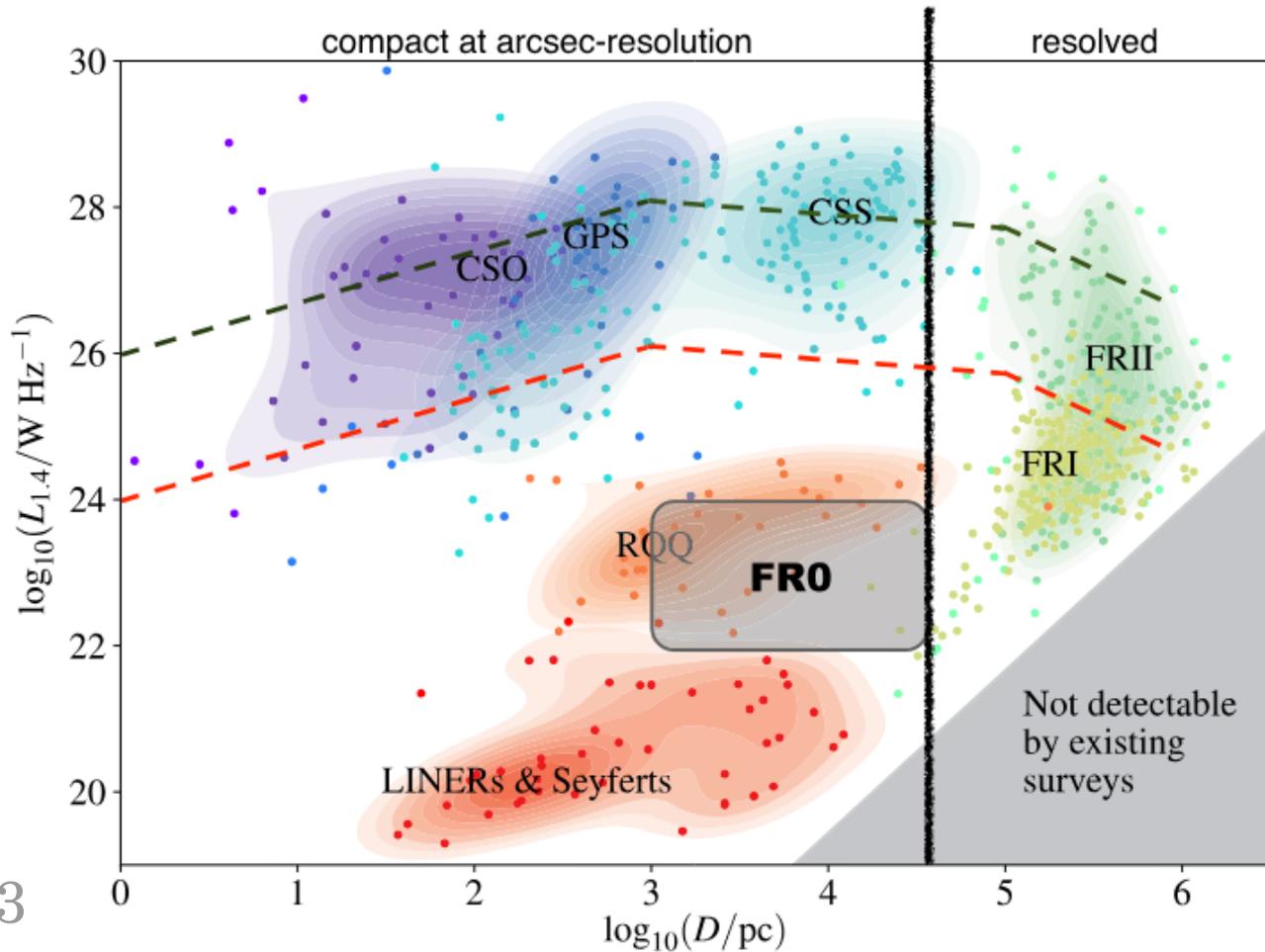
Janssen+21



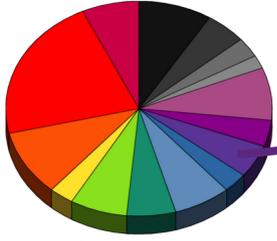
Radio surveys

Review on
compact
radio
sources

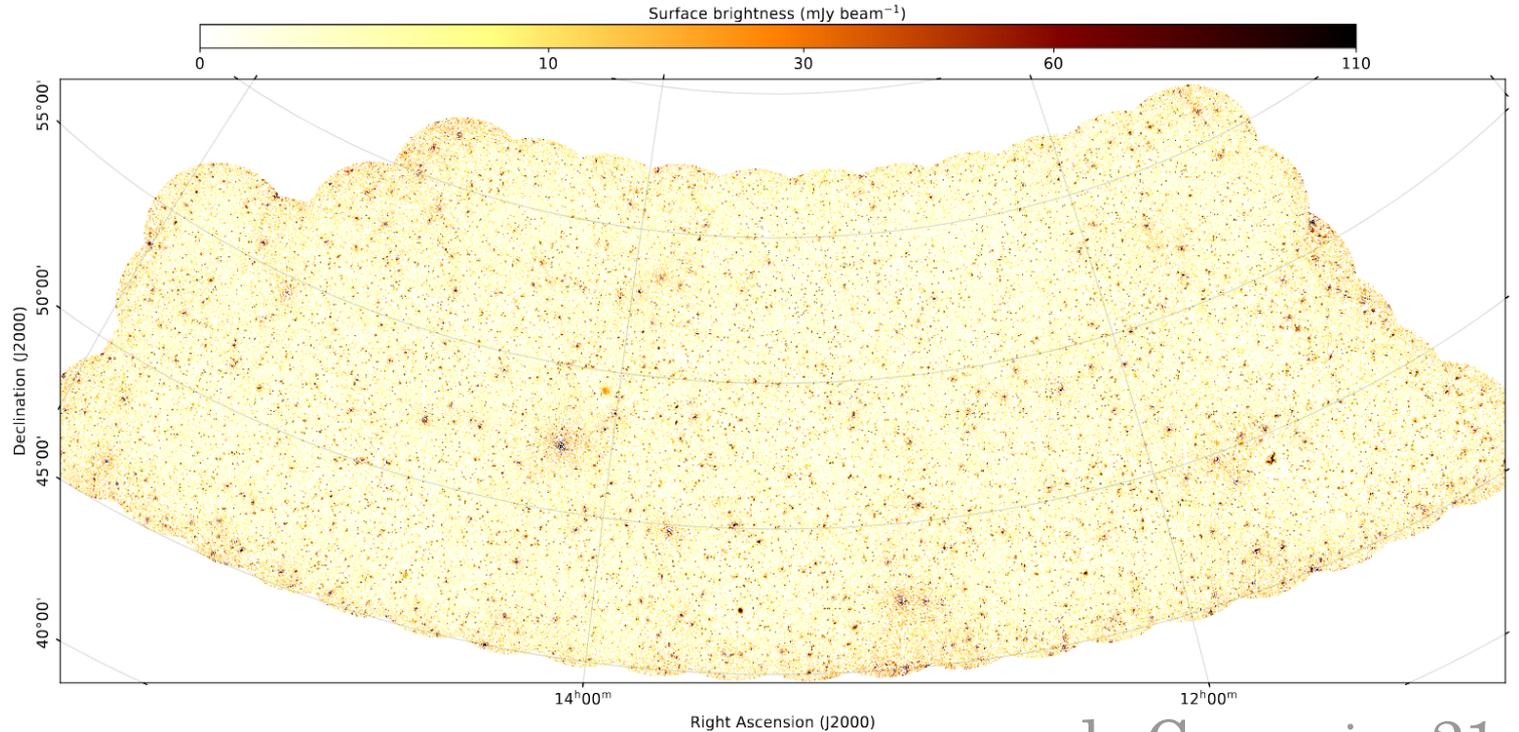
Baldi23



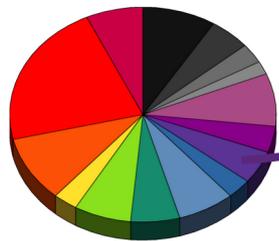
Radio surveys



LOFAR LBA
sky survey
>25,000
sources

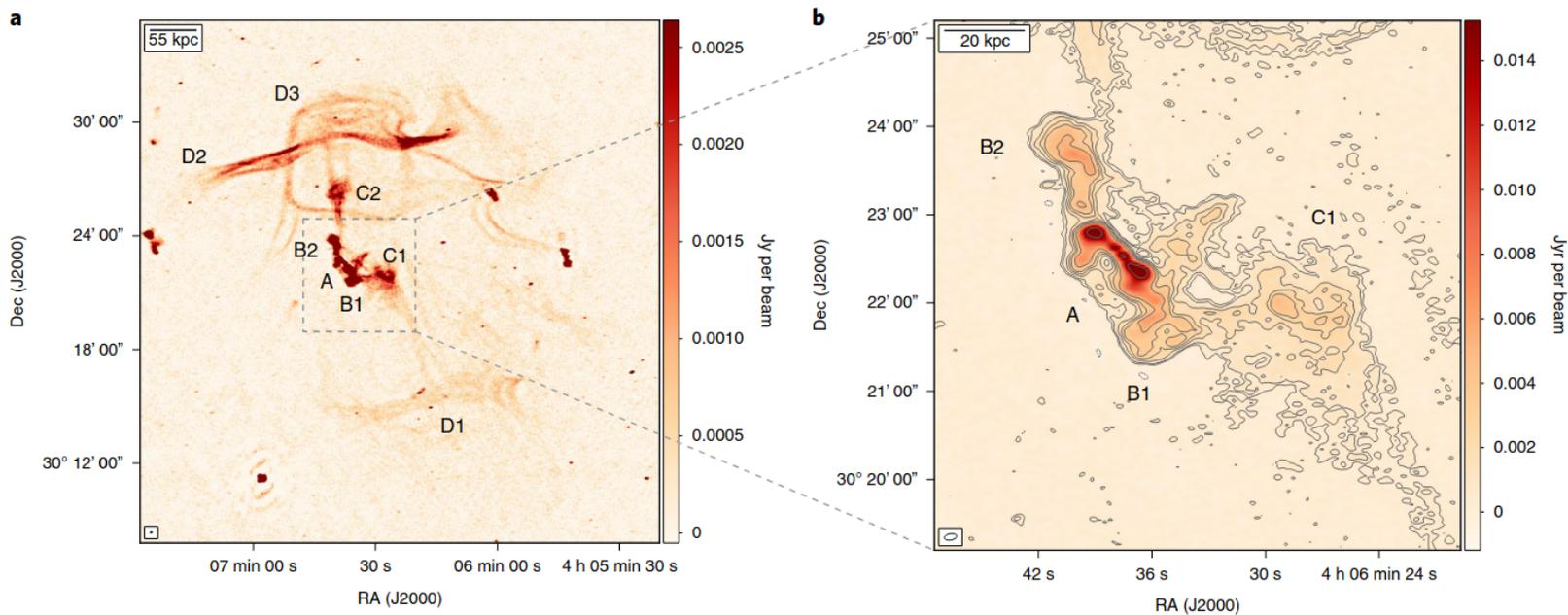


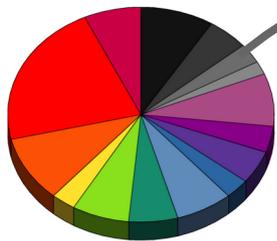
de Gasperin+21



Radio surveys

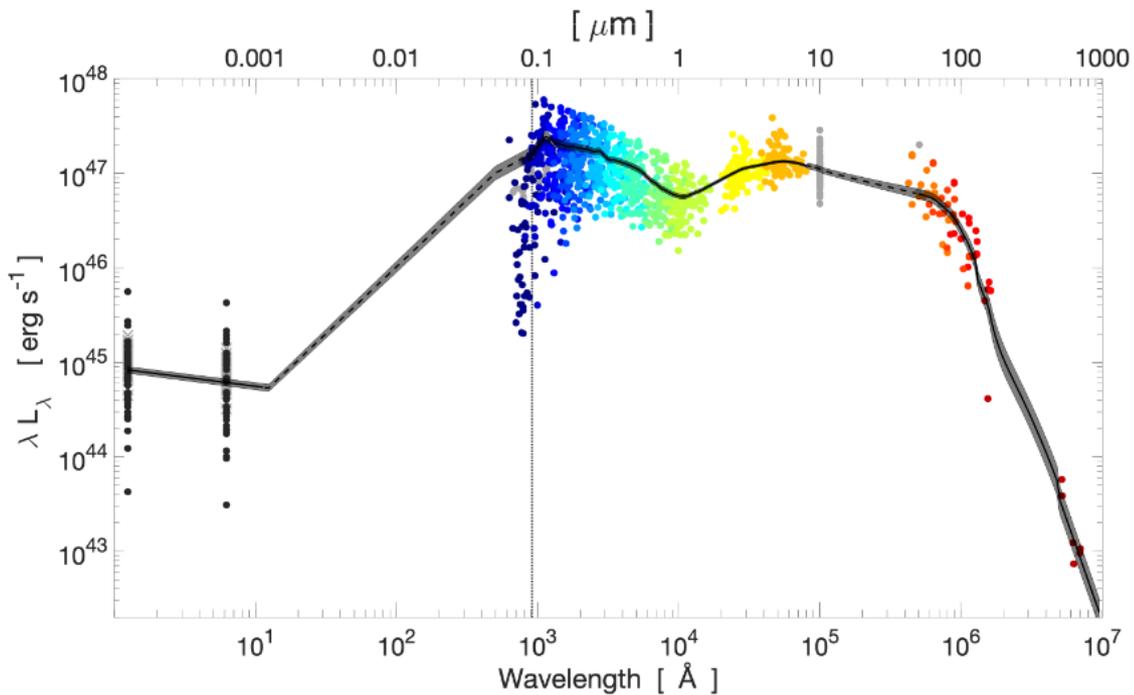
Exquisite
sensitivity
and angular
resolution

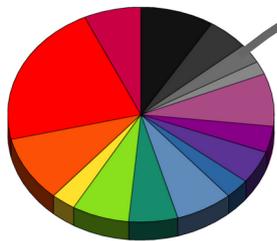




SEDs

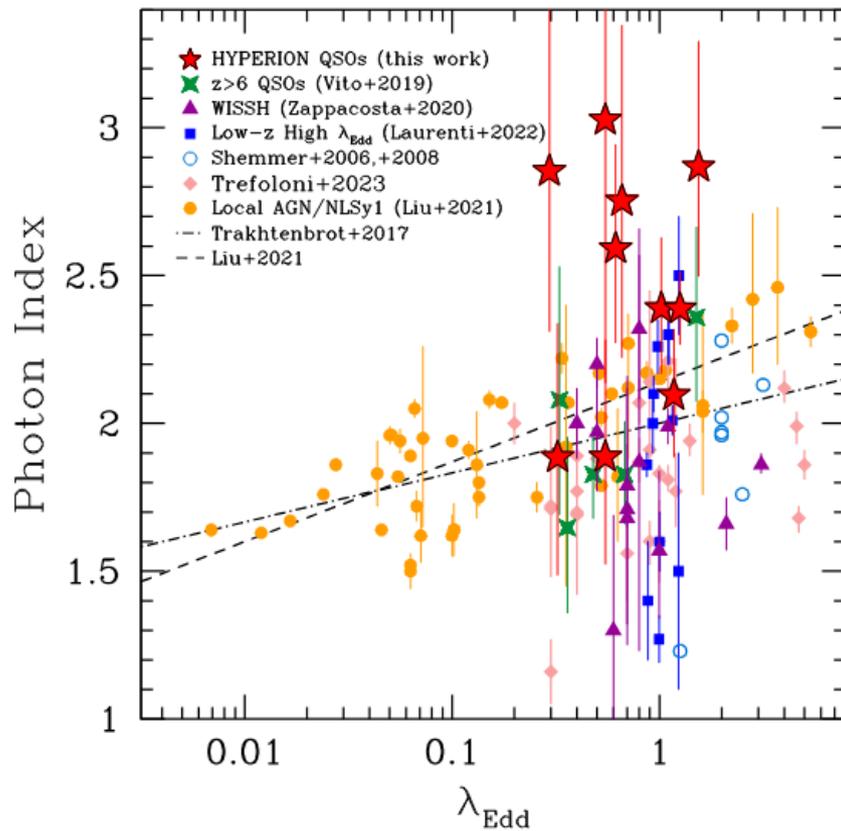
WISSH multi-
wavelength
SED





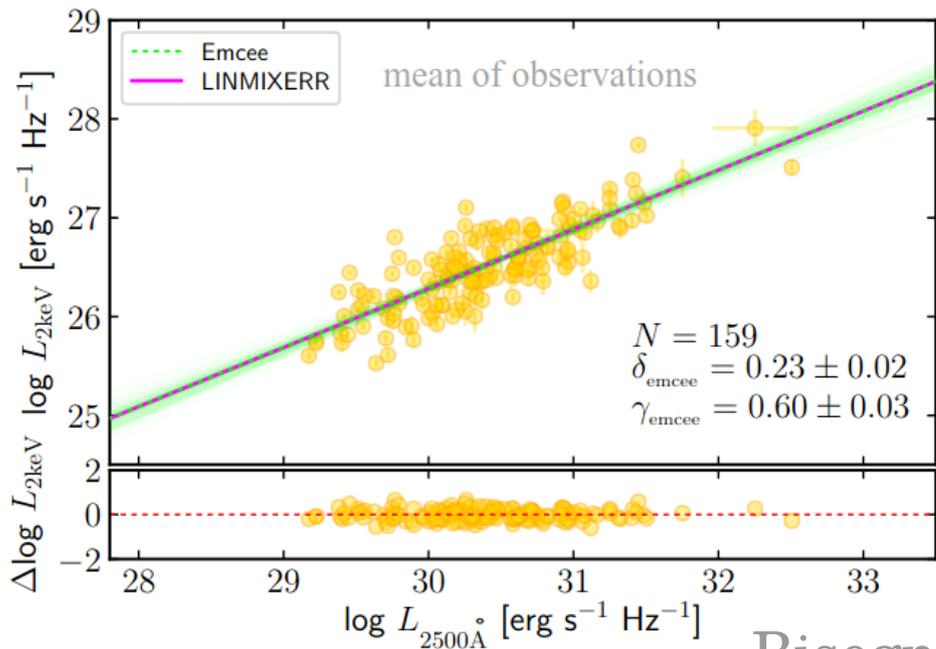
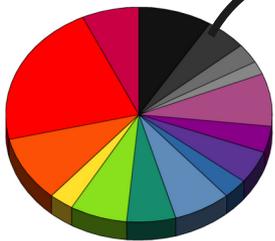
SEDs

X-ray observations of
high-z QSOs:
steeper spectrum for
high-z, fast-accreting BHs

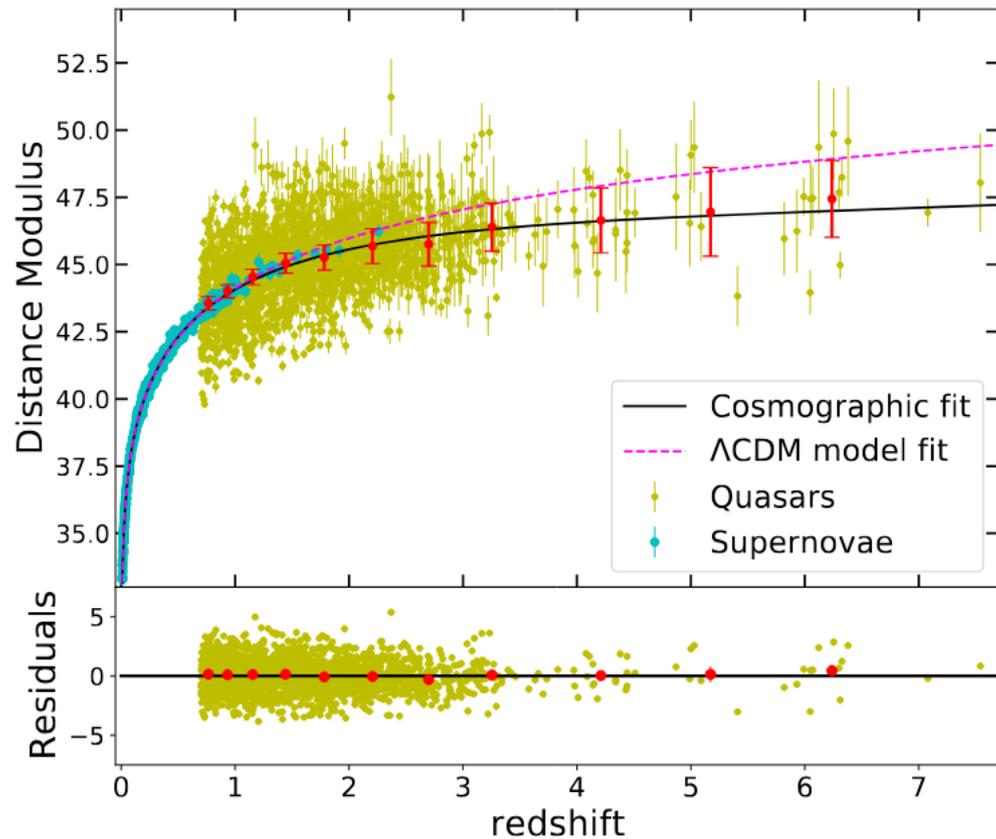


Zappacosta+23

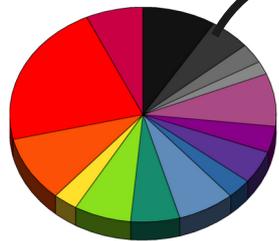
Cosmology



Bisogni+21

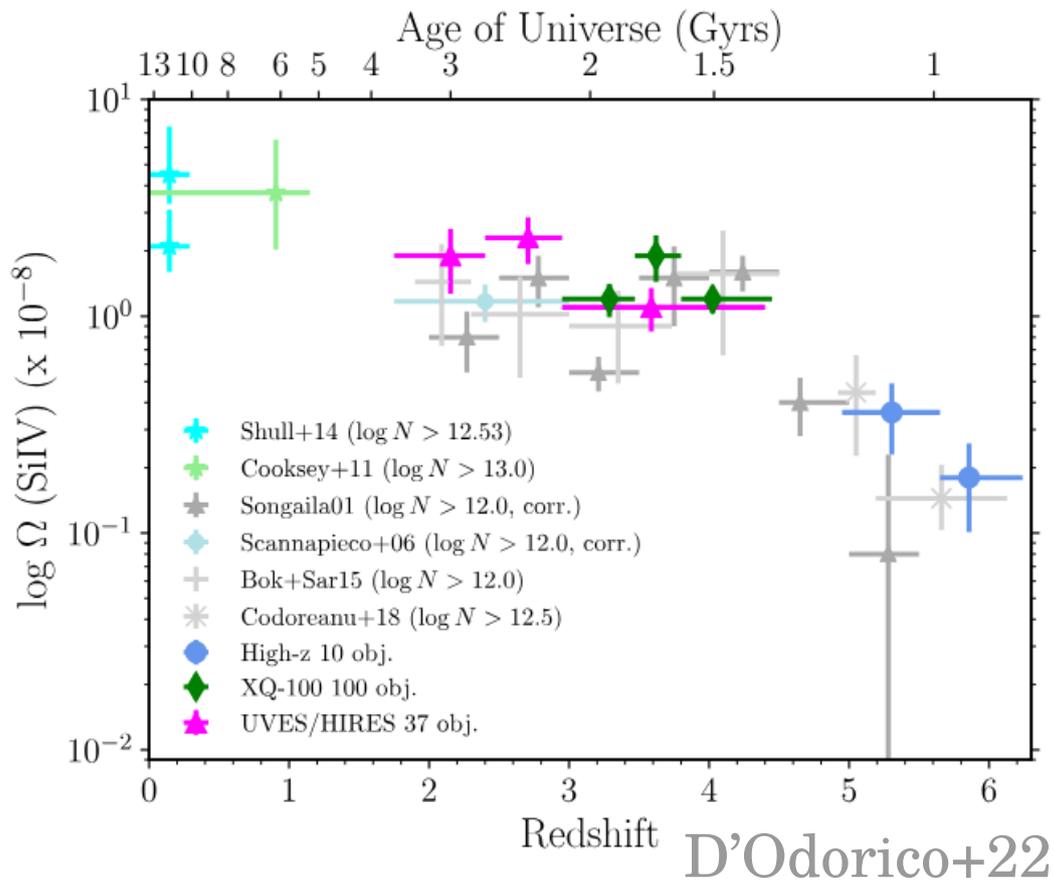


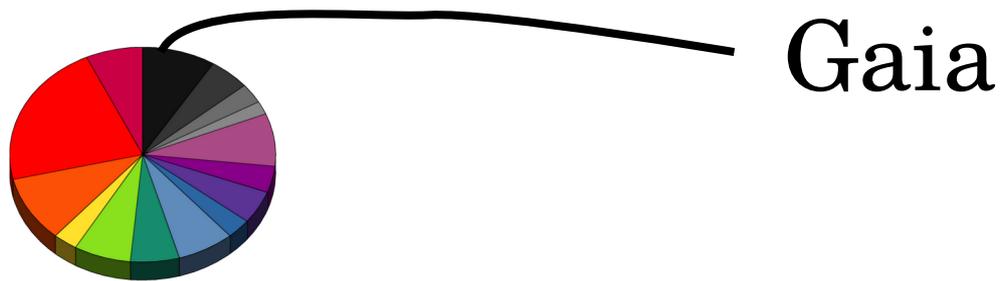
Bargiacchi+21



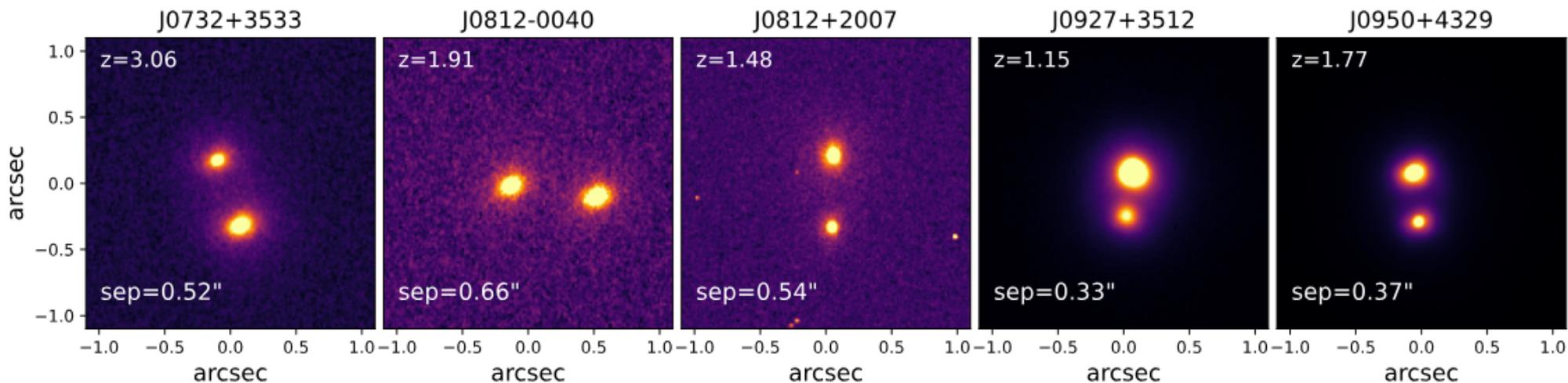
Cosmology

Using high-z
QSOs to study
the foreground
Universe

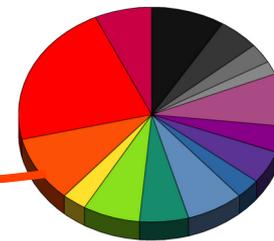




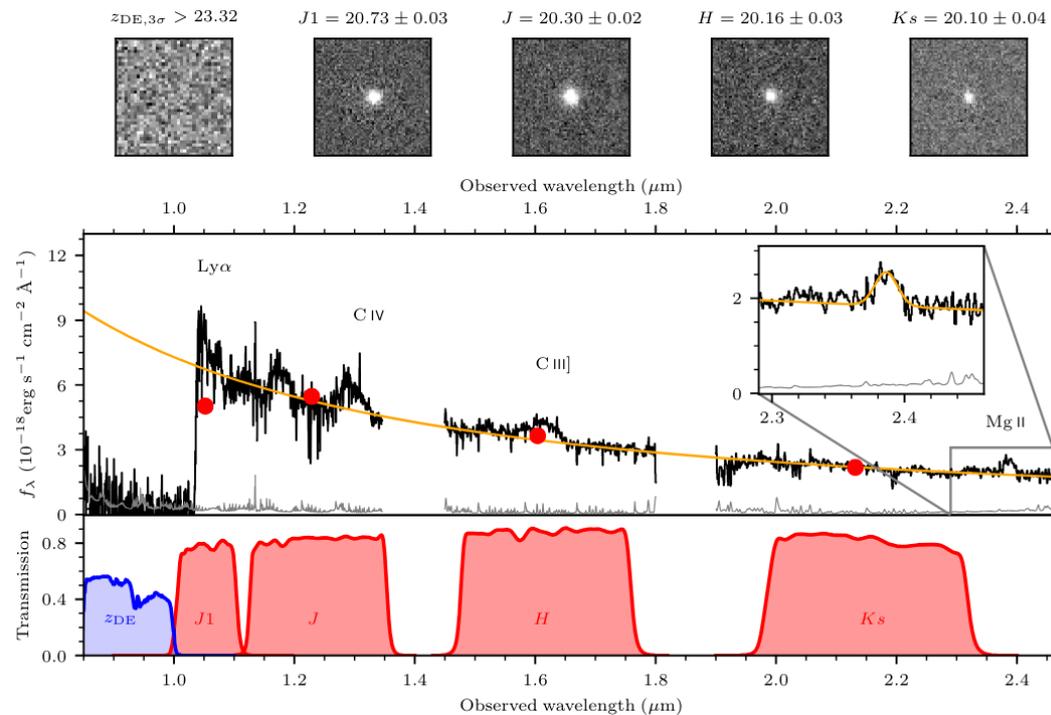
Using Gaia + LBT AO follow-up to spot dual AGN



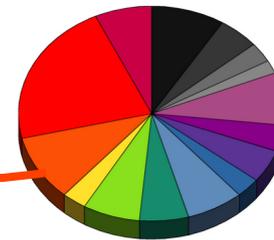
High-z QSOs



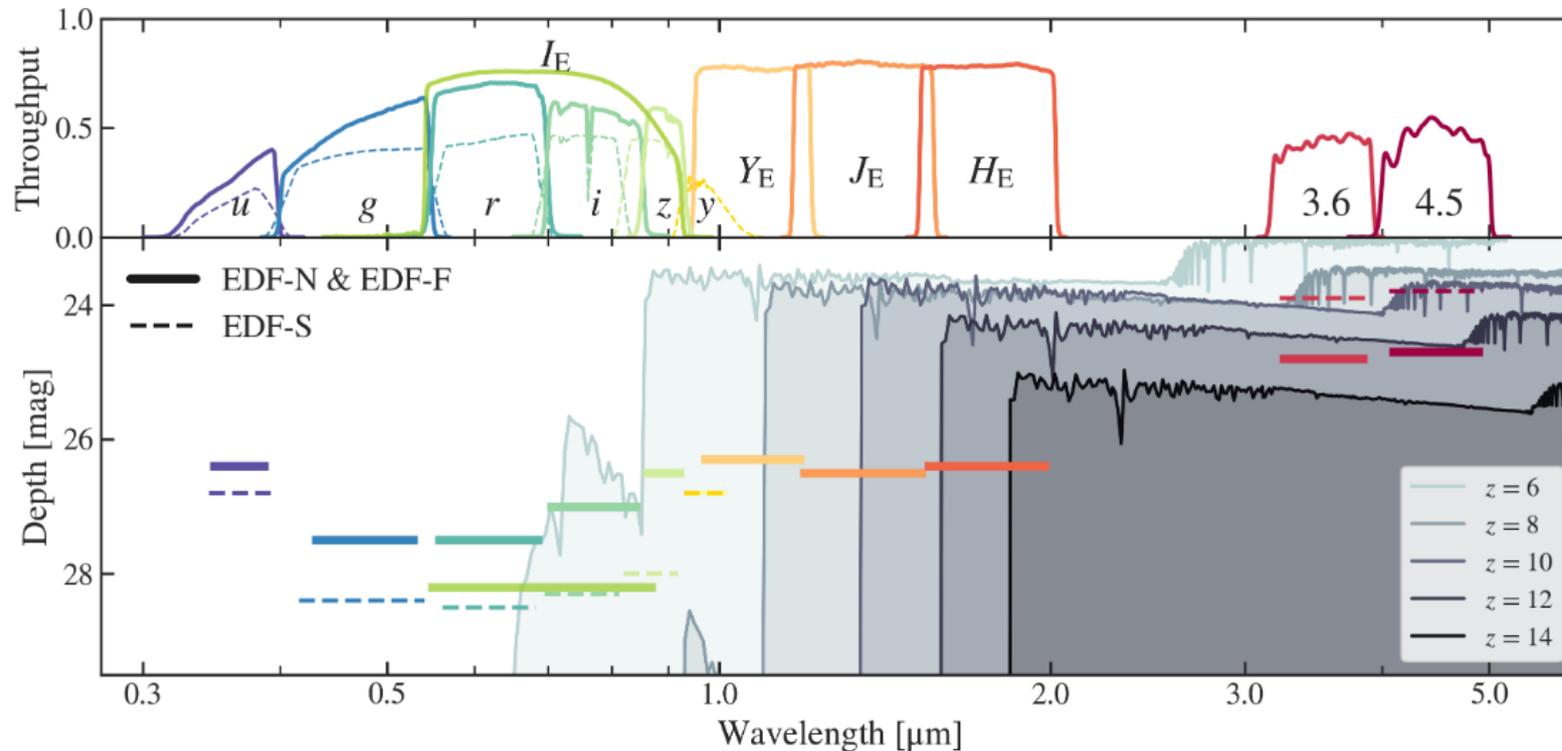
Pushing the redshift frontier



High-z QSOs

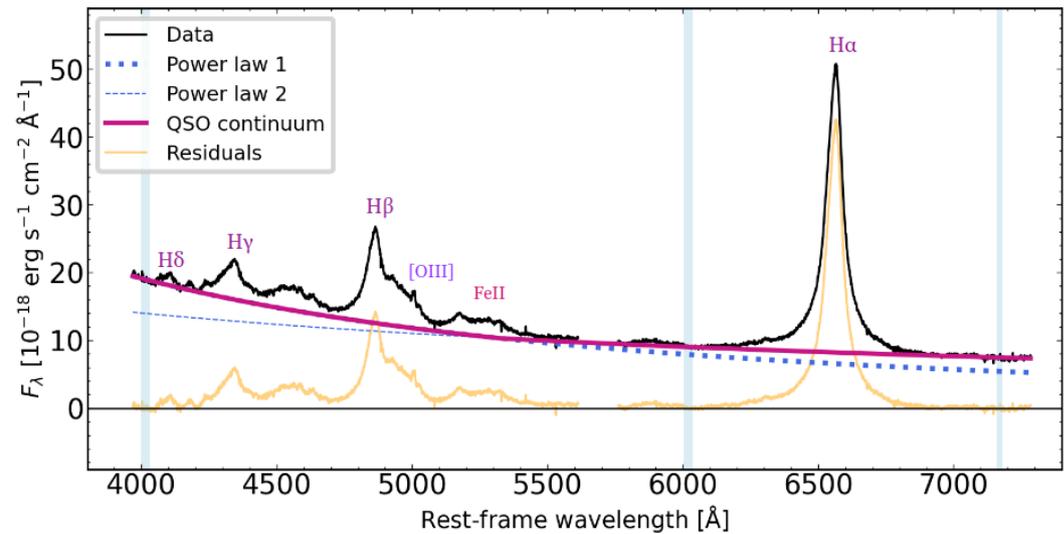
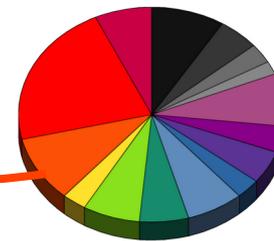


Pushing the redshift frontier



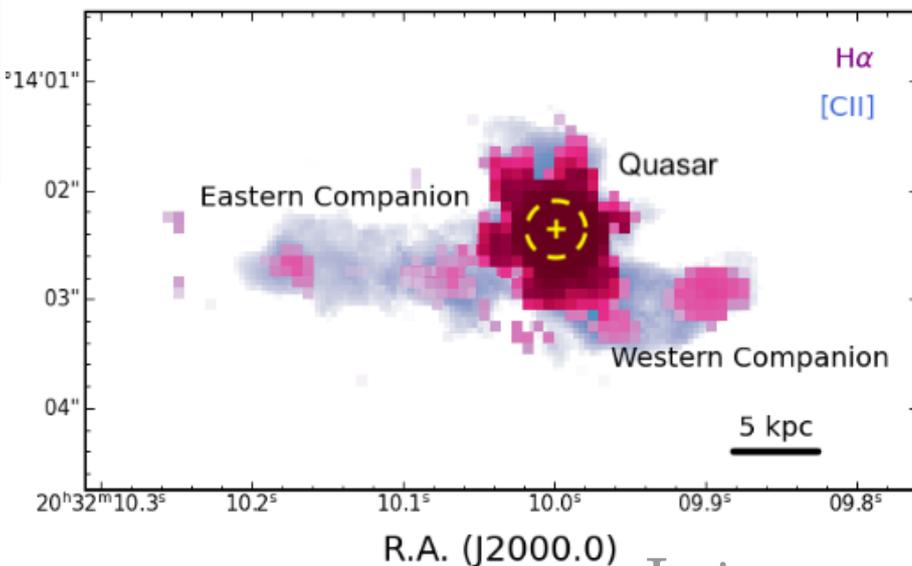
Now also
with
Euclid!

High-z QSOs

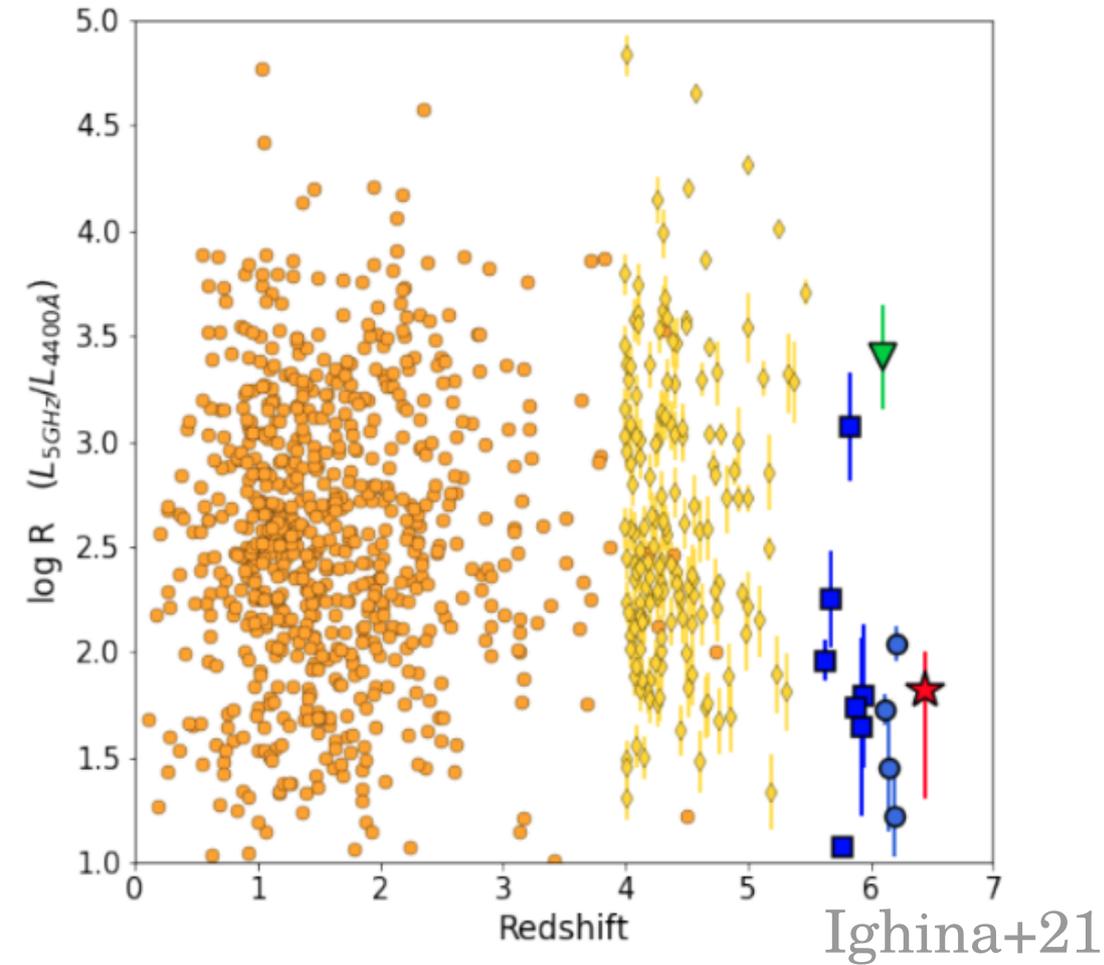
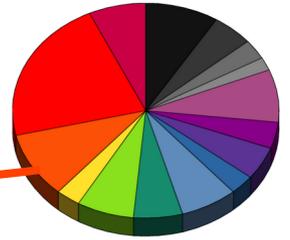


Rest-frame
optical spectra
with JWST →
 $M_{\text{BH}}, L/L_{\text{Edd}}$

Dec. (J2

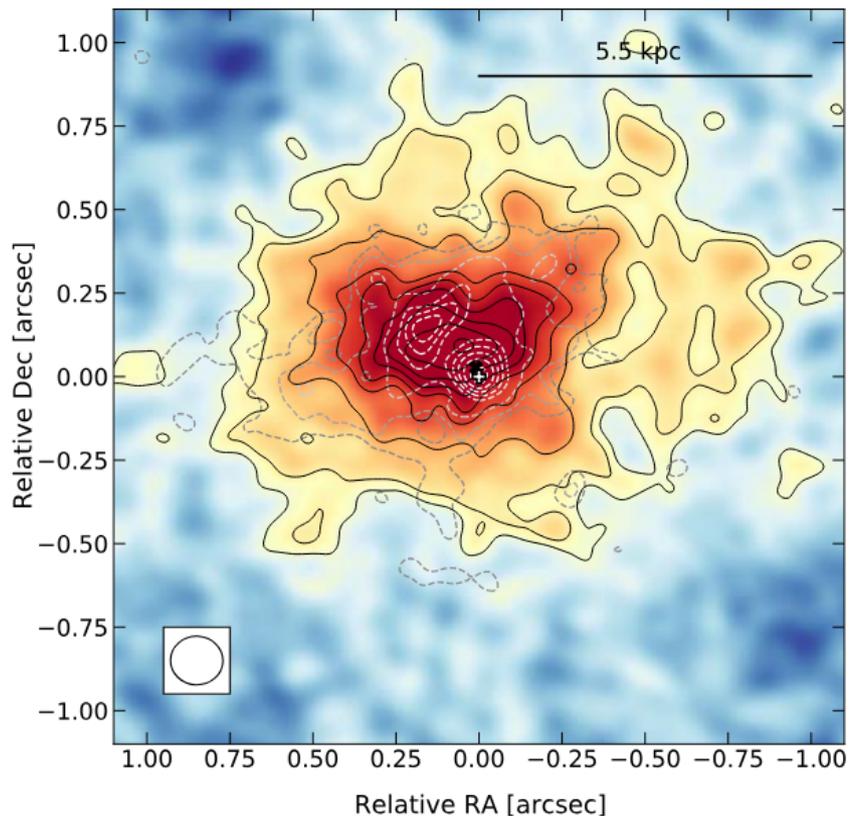
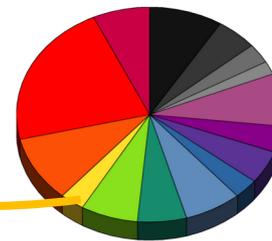


High-z QSOs



Characterizing
radio loudness
in high-z QSOs

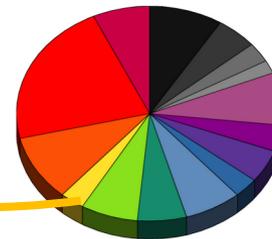
Hosts



High angular resolution
imaging of dust and gas with
ALMA → mass budgets, SFR,
ISM conditions

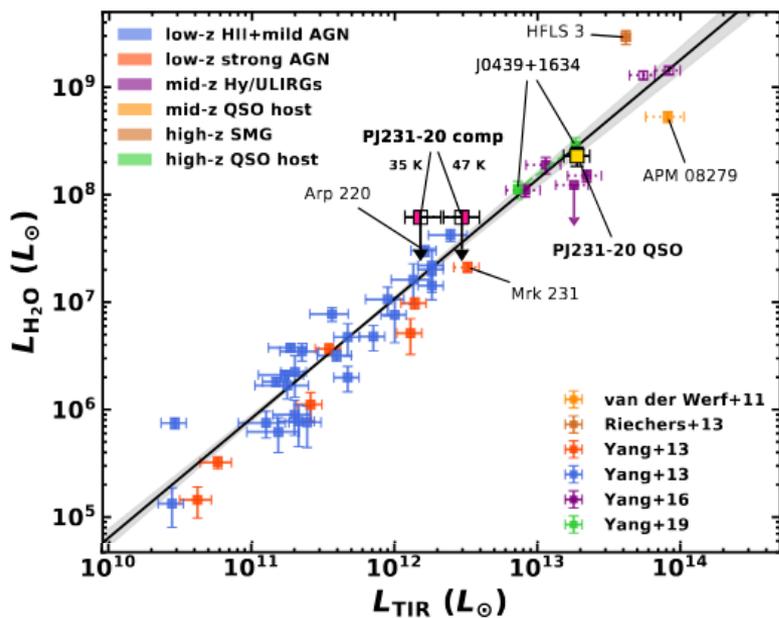
Bischetti+24

Hosts

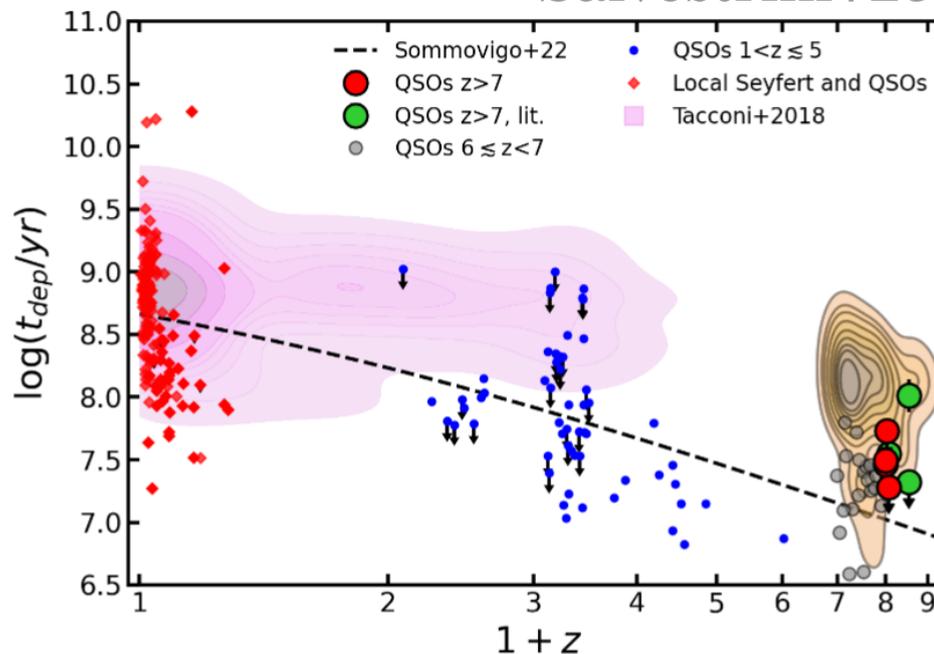


Molecular gas mass budget, star formation efficiency,
excitation conditions

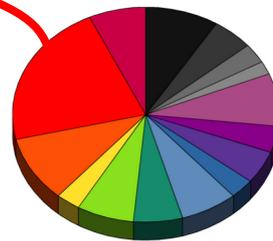
Pensabene+21



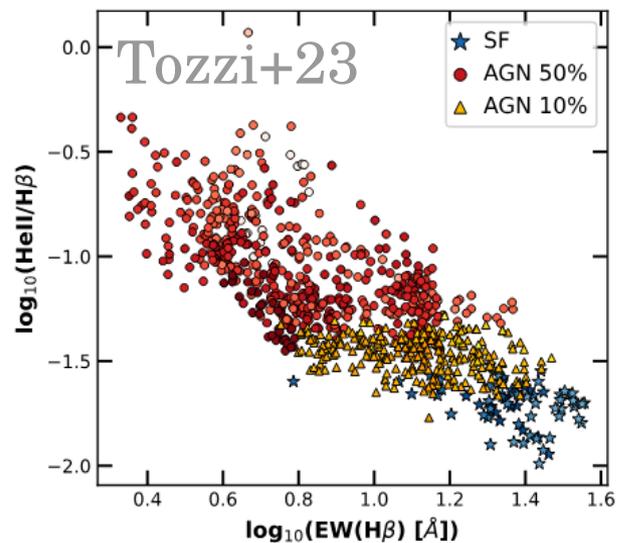
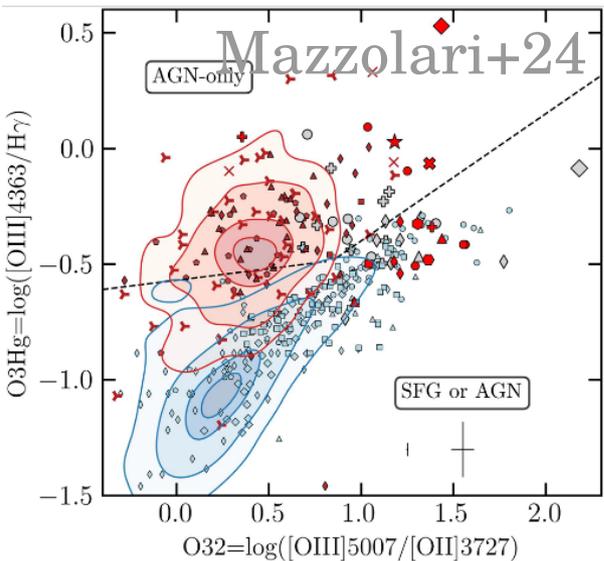
Salvestrini+25



JWST AGN / LRDs

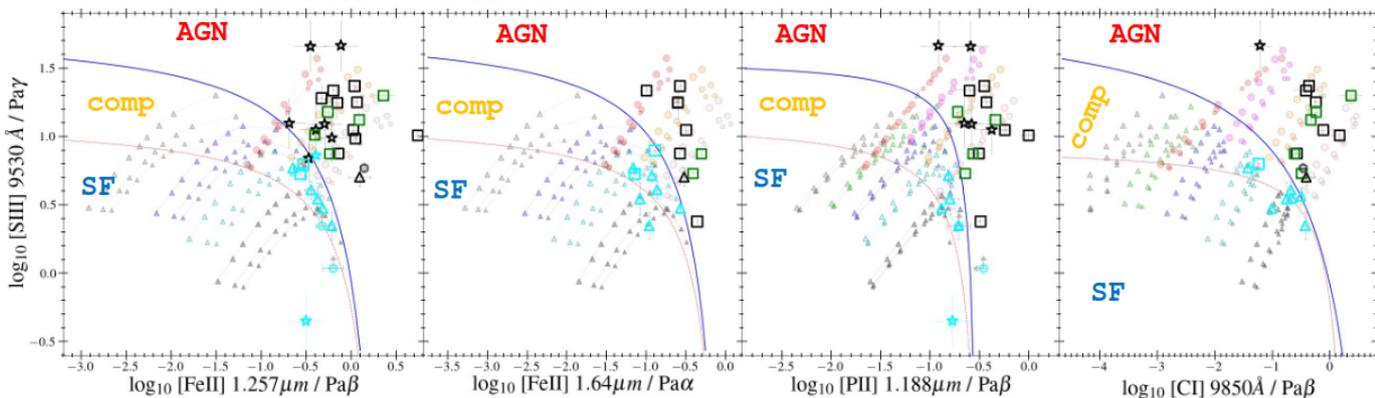


Definition of new AGN tracers

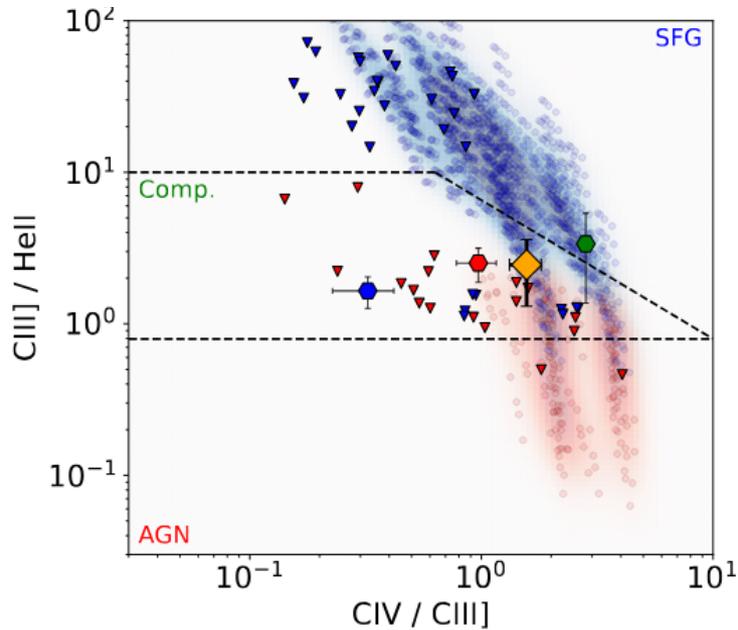
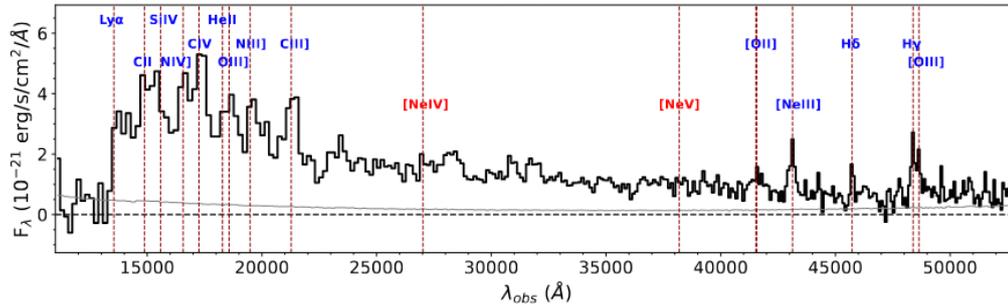
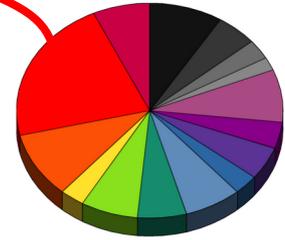


Calabrò+23

- ★ BPT AGNs Onori+17
- Starbursts Riffel+06
- △ Starbursts Riffel+19
- Starbursts z ~ 0.7 Calabrò +18
- maximum star-forming
- maximum AGN
- ★ BPT SF+composite Onori+17
- Type 2 AGNs Riffel+06
- △ Type 2 AGNs Riffel+19
- BPT AGN z ~ 0.7 Calabrò +18
-
-
- ★ Type 1 AGNs Riffel+06
- △ Type 1 AGNs Riffel+19
-
-



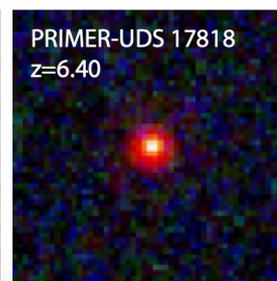
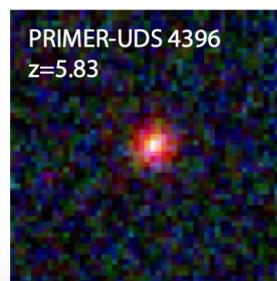
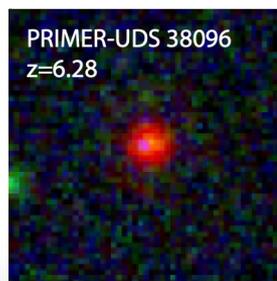
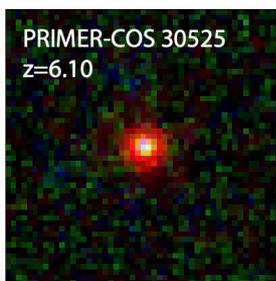
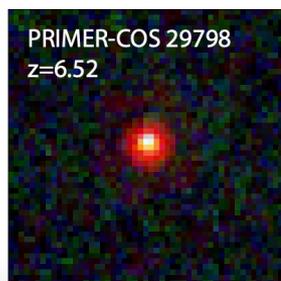
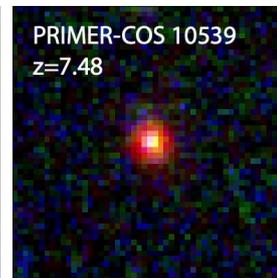
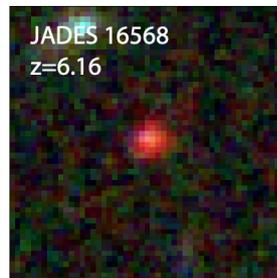
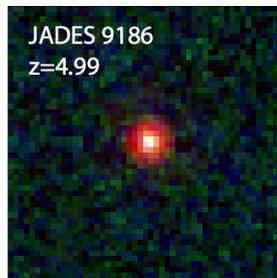
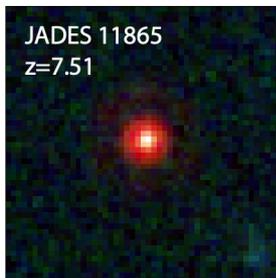
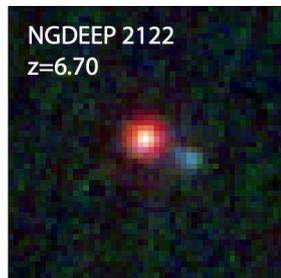
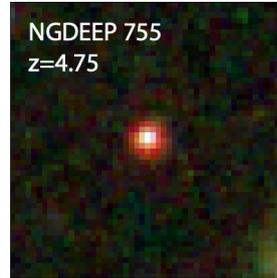
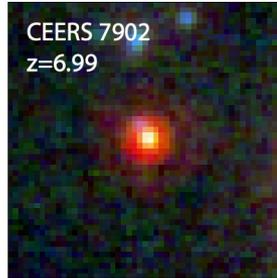
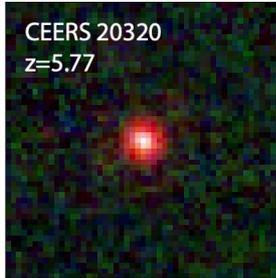
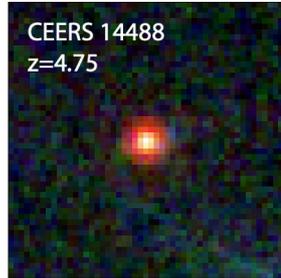
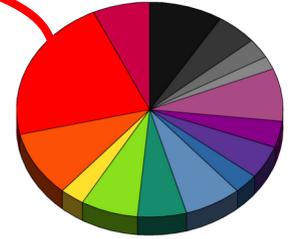
JWST AGN / LRDs



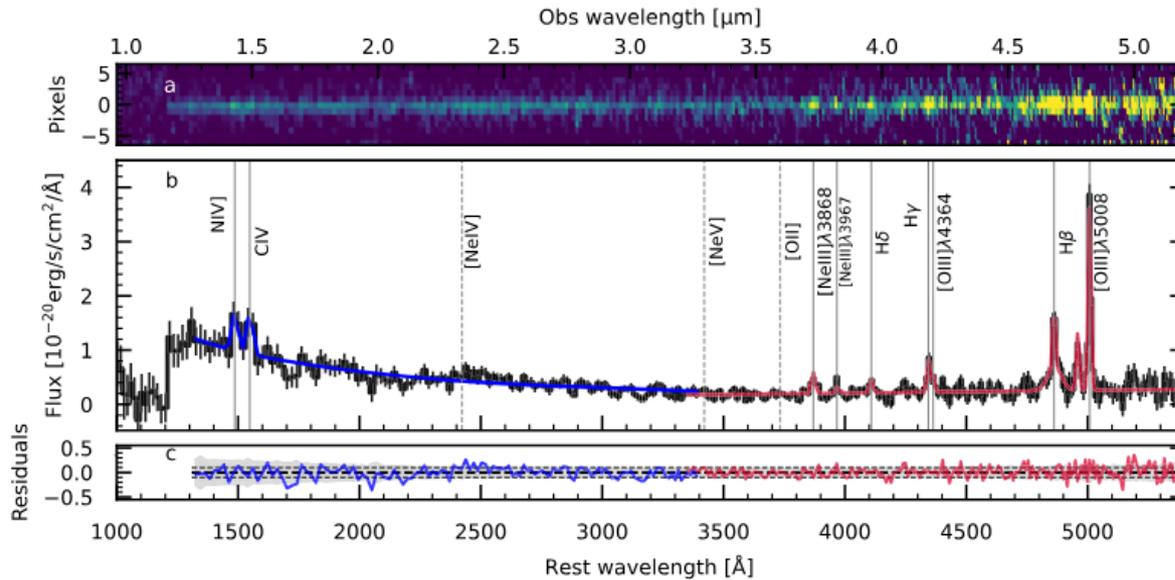
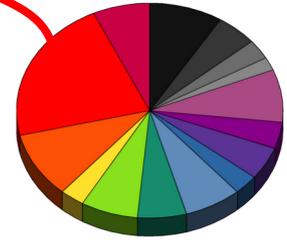
$z > 10$ galaxies
with AGN-like
spectral
features?

Napolitano+25

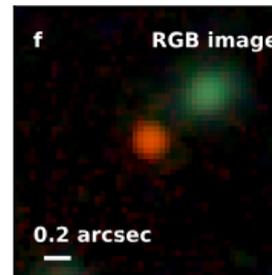
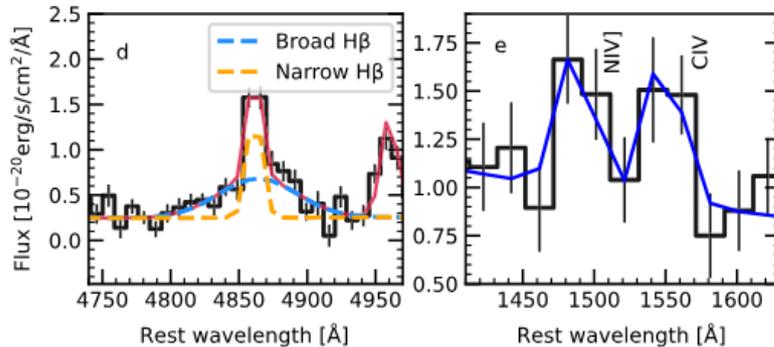
JWST AGN / LRDs



JWST AGN / LRDs



Broad emission lines → AGN



Tripodi et al. (2025)

Outlook

ELT → High-contrast, high spectral resolution

Rubin/LSST → Time domain

Wide-area spectroscopic surveys → Massive datasets

CTAO (and others) → Multi-messenger study of jets

ALMA WSU / 2040 → Sensitivity, superior ang.resolution

SKA → High-resolution jet imaging, sensitivity

Athena → Superior sensitivity

Open questions

How do SMBHs form?

Can they exceed Eddington?

How does feedback work as a function of:
AGN luminosity, cosmic time, ...?

Do we know BH masses?

What is the structure and origin of jets?