



# A Multiwavelength Study of Astrometrically-Variable Quasars: A New Population of Dual AGN?

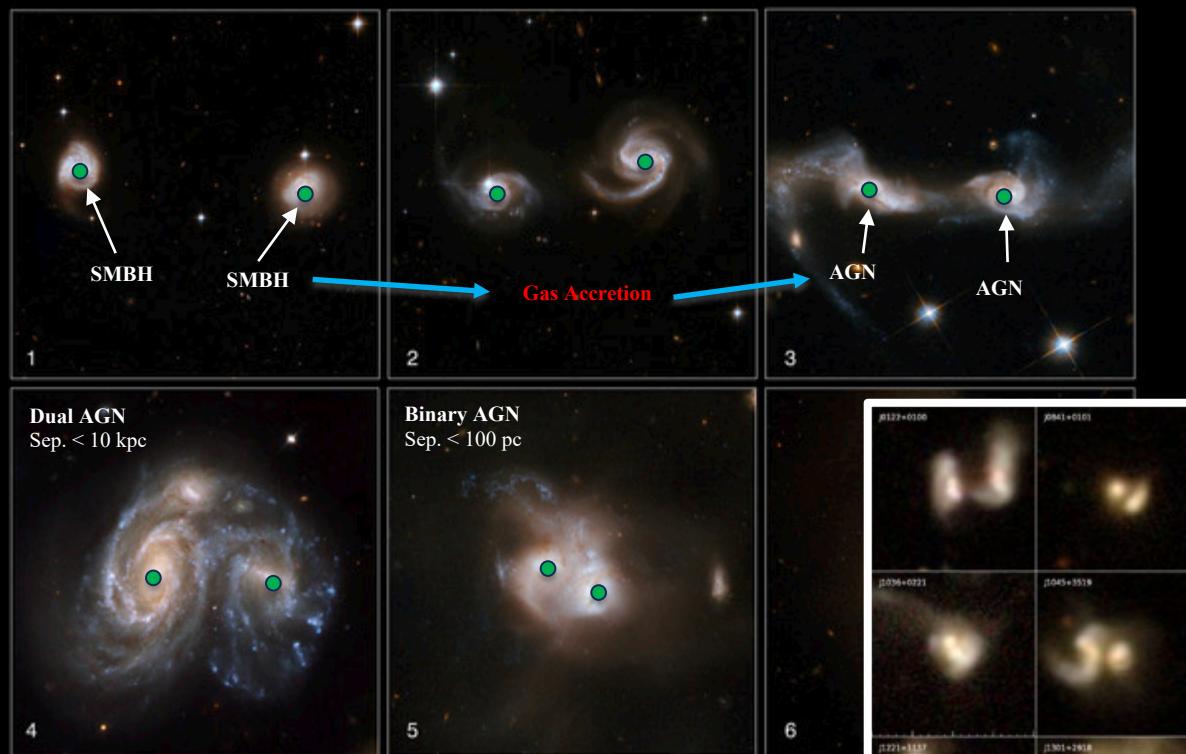
Emma Schwartzman

George Mason University  
US Naval Research Lab



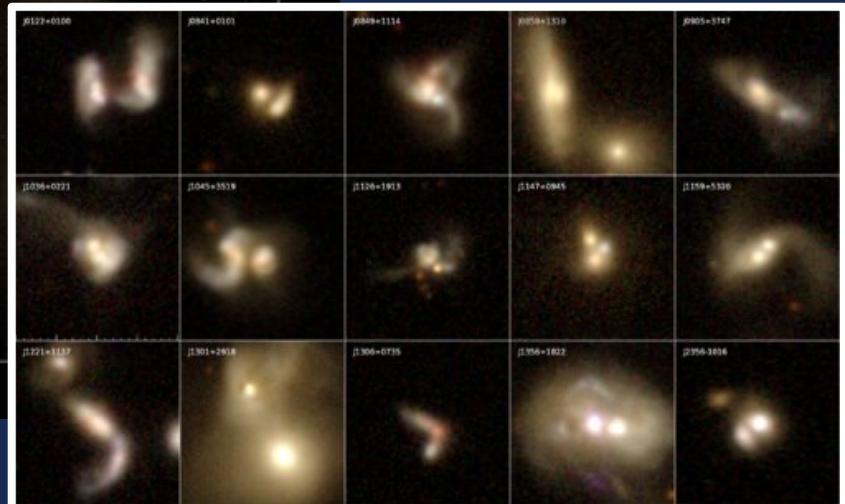
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## Evolution of a Galaxy Merger



ESA

Galaxy mergers can result in pairs of gravitationally-bound supermassive black holes.

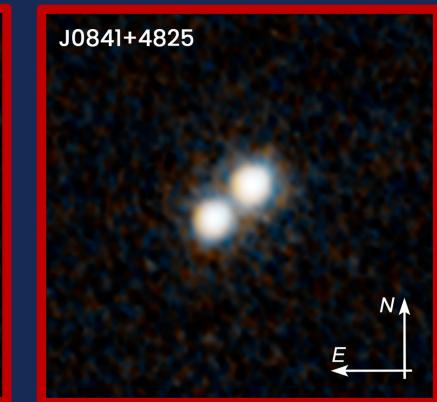
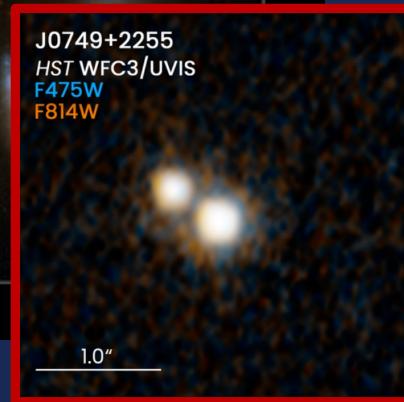
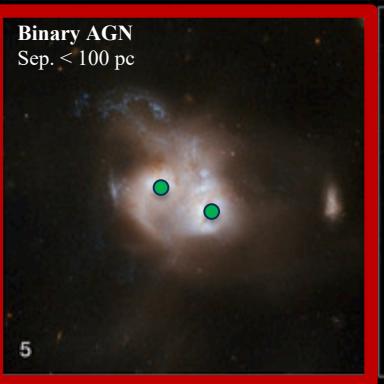
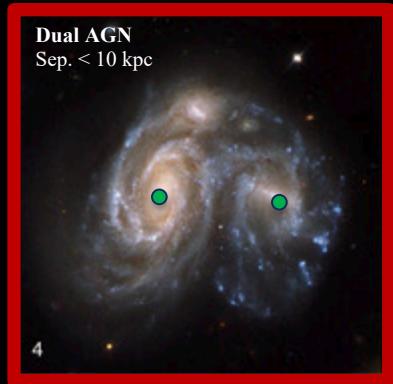
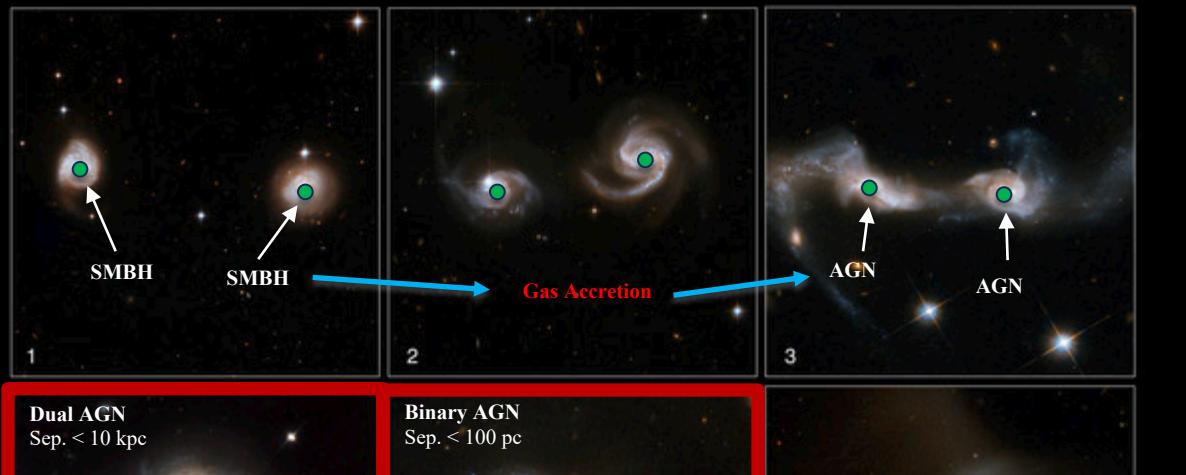


Pfeifle et al. 2019

A Multiwavelength Study of Astrometrically-Variable AGN

AAS241 - Emma Schwartzman

## Evolution of a Galaxy Merger



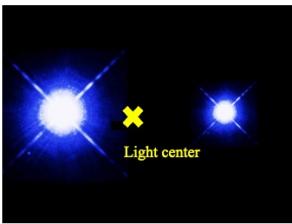
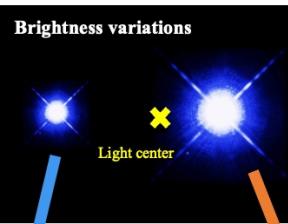
## AGN Pair Systems:

Only 40-50 confirmed...

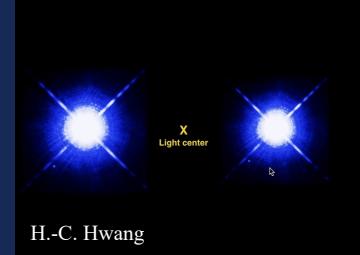
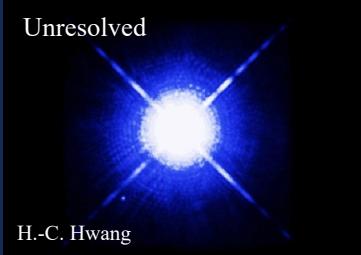
Is there a systematic method that can be used for their detection?

A new method pairs precise astrometric measurements with high-resolution radio observations.

Hwang et al. ApJ. 2020.



AGN pair, unresolvable with *Gaia*, light center appears to shift

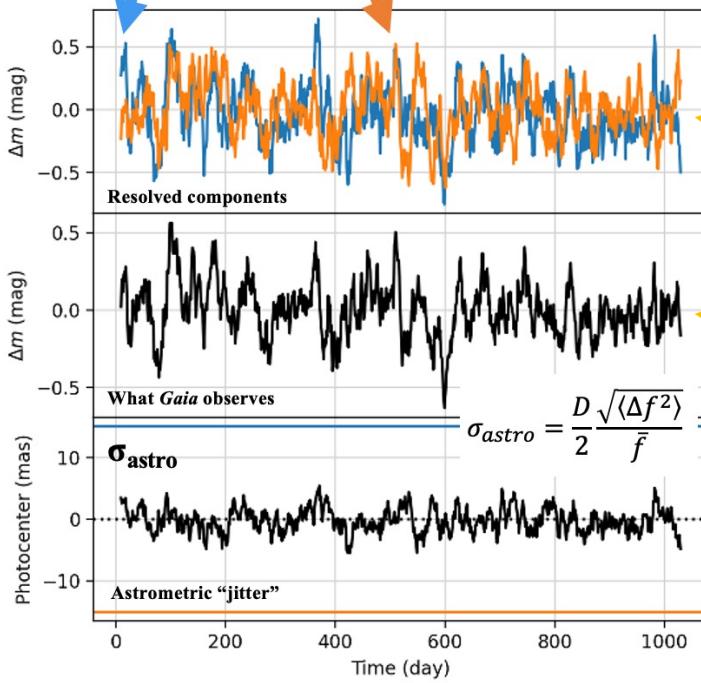


If it was resolvable with *Gaia*, we might observe  
a lightcurve for both AGN

Instead, we see a joint-variability lightcurve,  
indistinguishable from a slightly variable single  
AGN

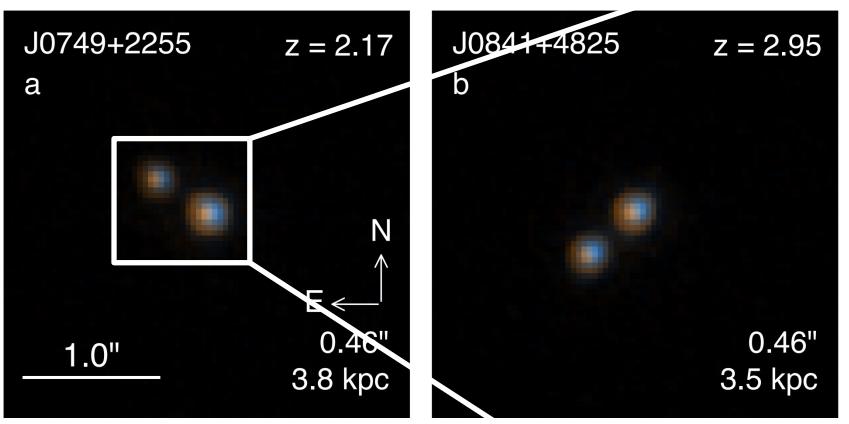
Shifting light center manifests in photometric  
data – excess “jitter”

Variability + astrometry = **varstrometry!**  
**Hwang et al. 2019**



N. Secrest – private communication

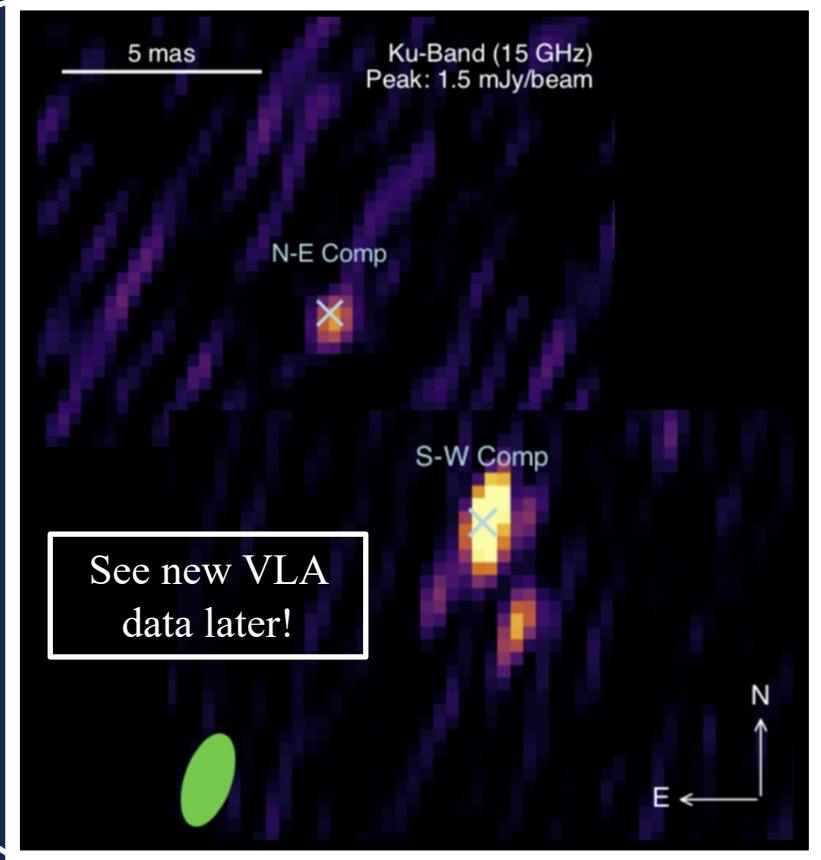
# Varstrometry



Chen et al. ApJ. 2021

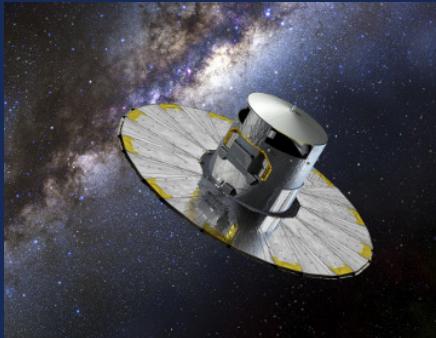
Varstrometry targets have been observed with HST – successful identification of AGN pair systems

Some further observed with VLBA



Adapted from Shen et al. *Nature*. 2021.

# Radio Varstrometry



ESO/Gaia

+



NRAO/VLA

Our project:

Use VLA observations of astrometrically-variable quasars to place constraints on the drivers of astrometric variability.

Can high resolution radio observations, combined with precise astrometry, discover a new population of AGN pair systems?

**Is the varstrometry method a possible systematic method for identifying AGN pair systems with radio observations?**

# VLA Observations

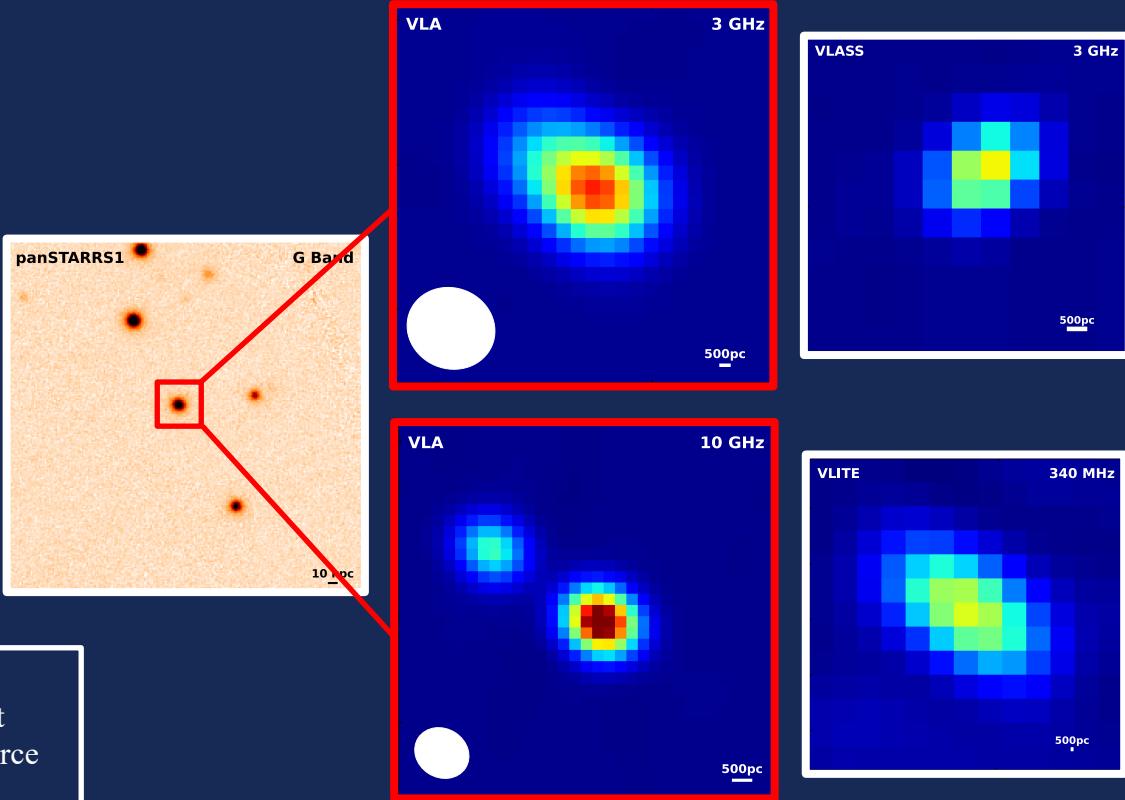
## Sample:

18 quasars (SDSS DRQ16), cross-matched  
with *Gaia* EDR3 (within 1.5'')  

- *astrometric\_excess\_noise\_sig* > 5
- $z > 0.5$
- *Gaia G* magnitude < 20  
= 148 QSO
- radio survey catalog fluxes
  - VLASS, VLITE, etc.= 18 QSO

## Observations:

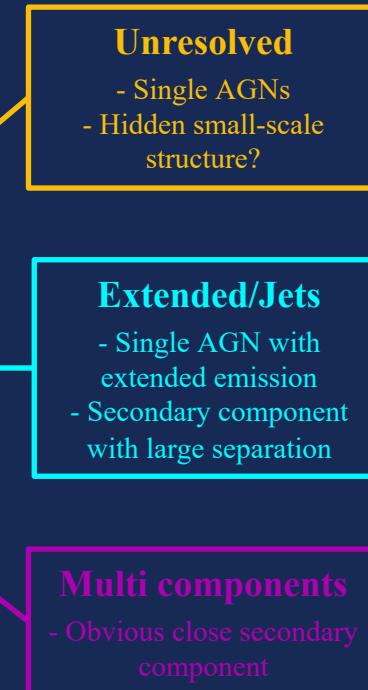
VLA – A configuration  
S-band (2-4 GHz, 0.65'', LAS 18'')  
X-band (8-12 GHz, 0.2'', LAS 5'')



Schwartzman et al. in prep

# Preliminary Results:

18  
targets



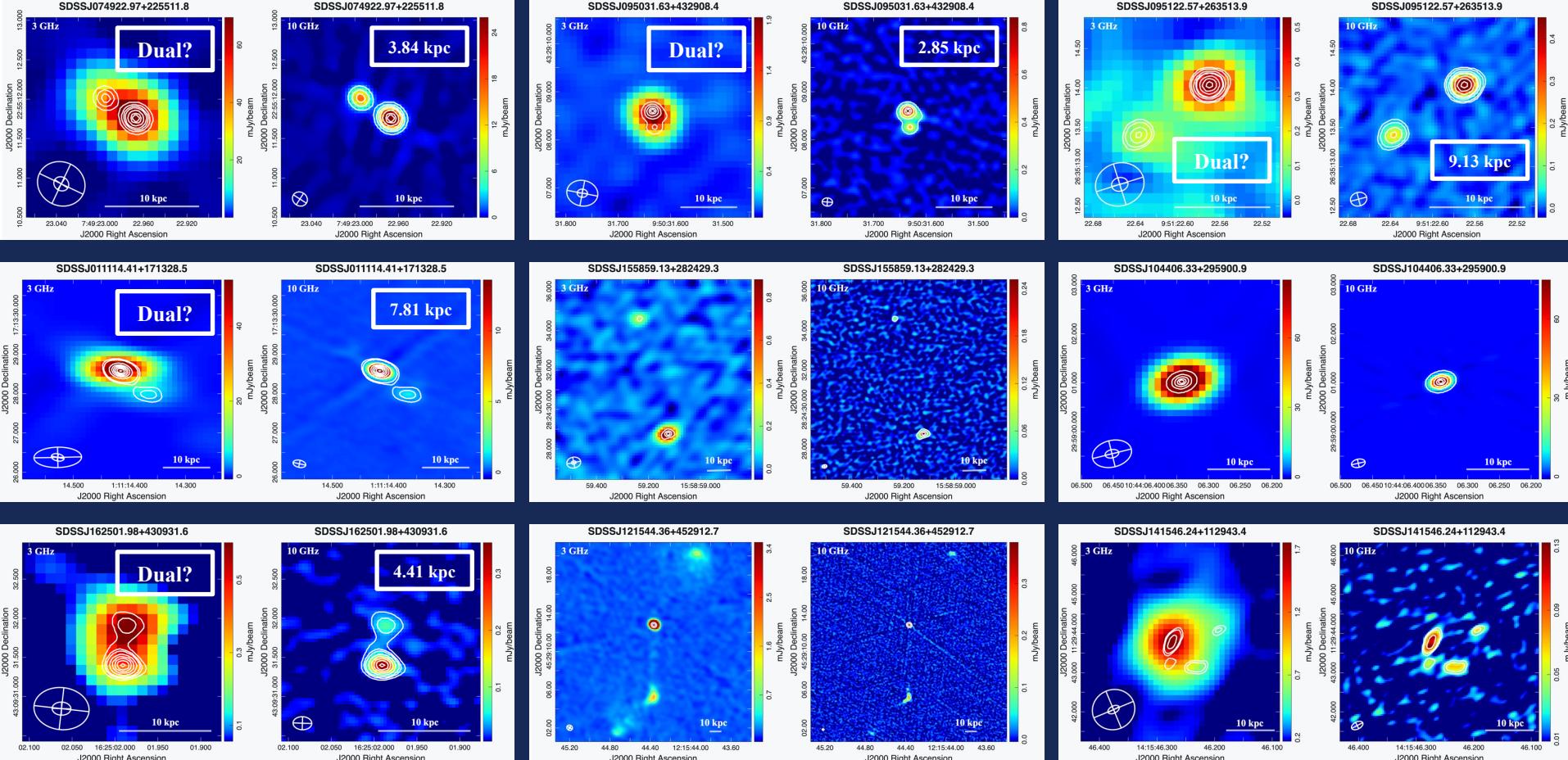
Morphology  $\neq$   
Astrometric Driver!



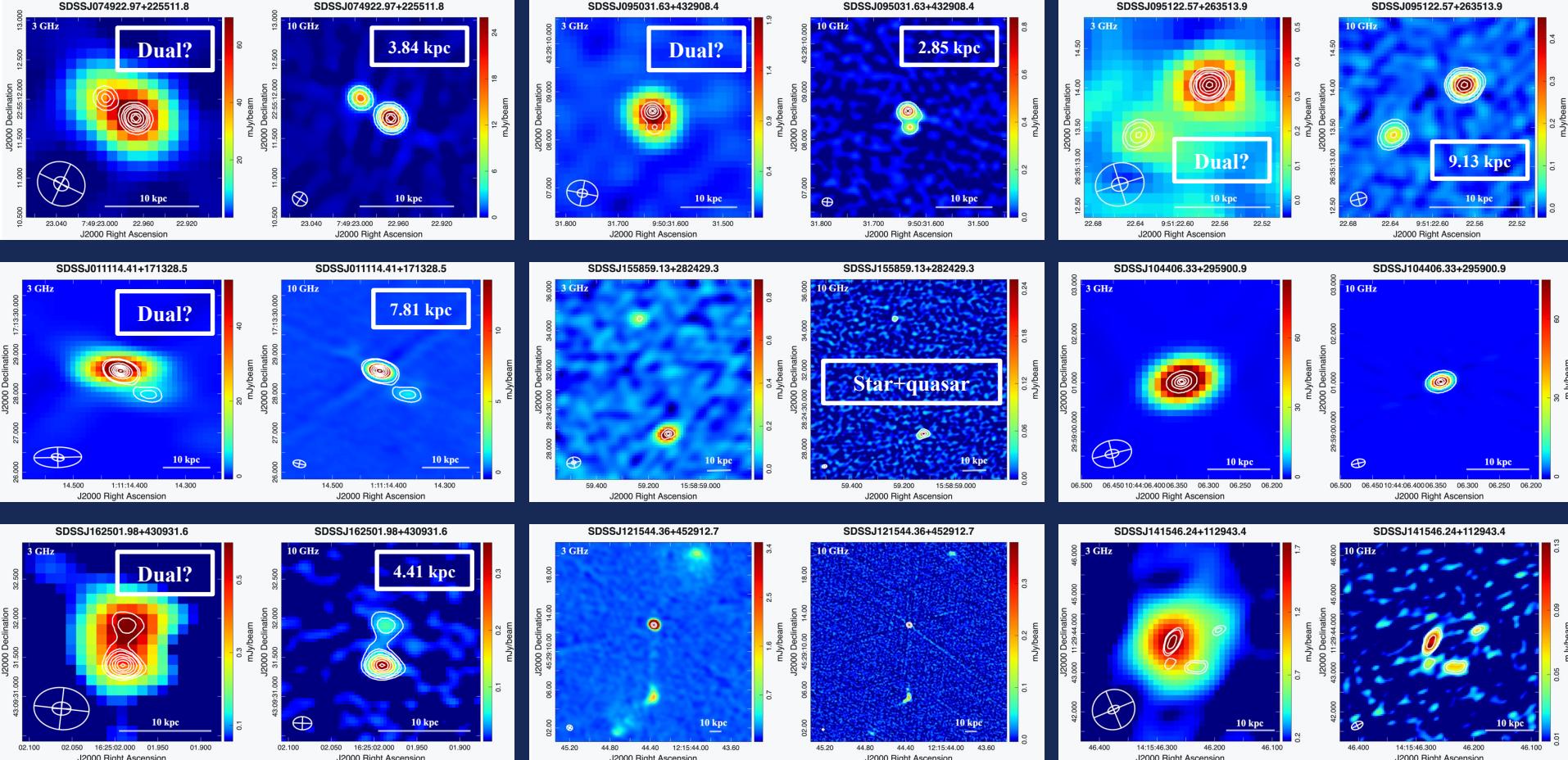
Further Analysis:

- spectral indices
- spectral plots
- SDSS spectral lines
- follow up observations

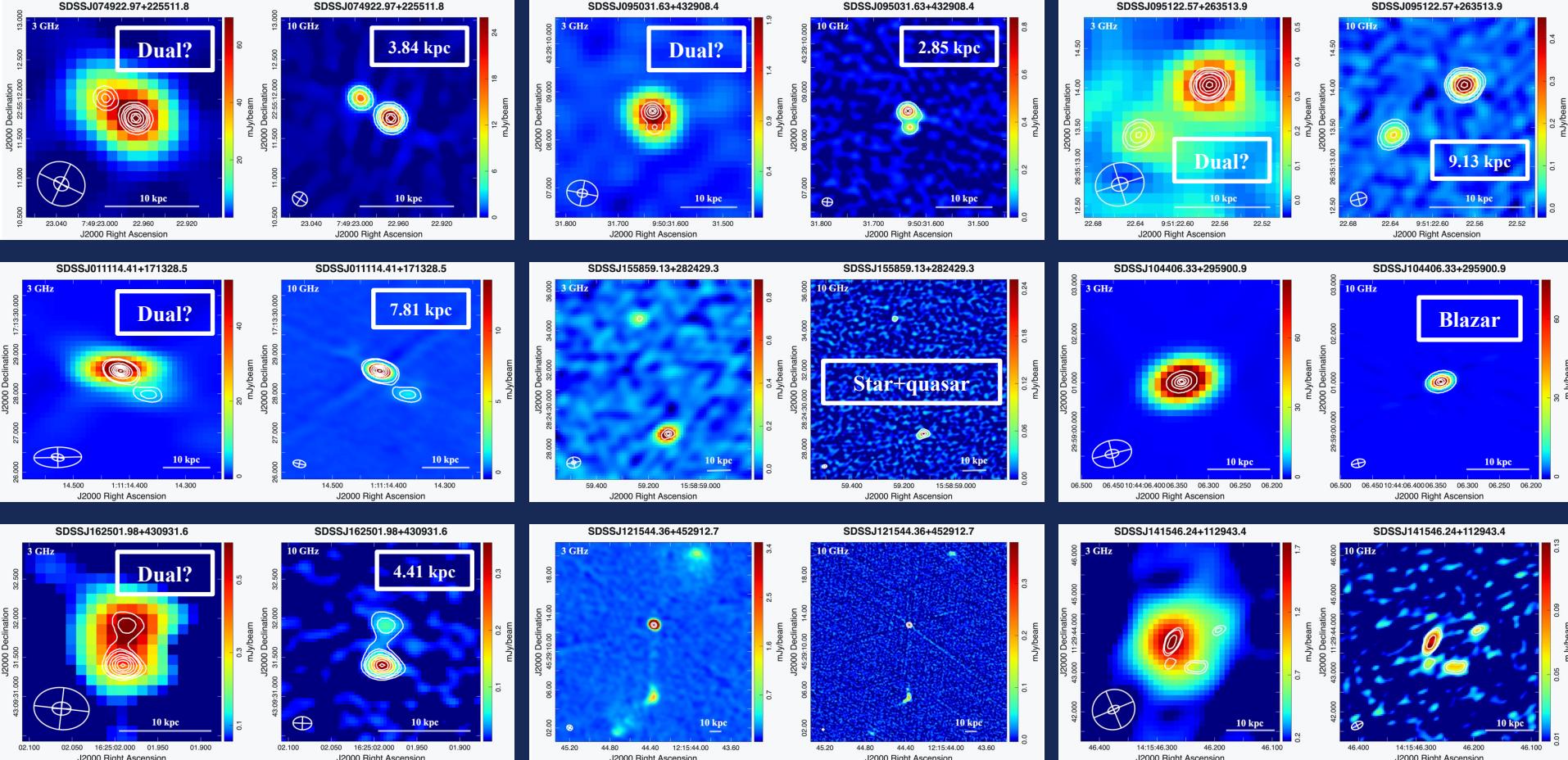




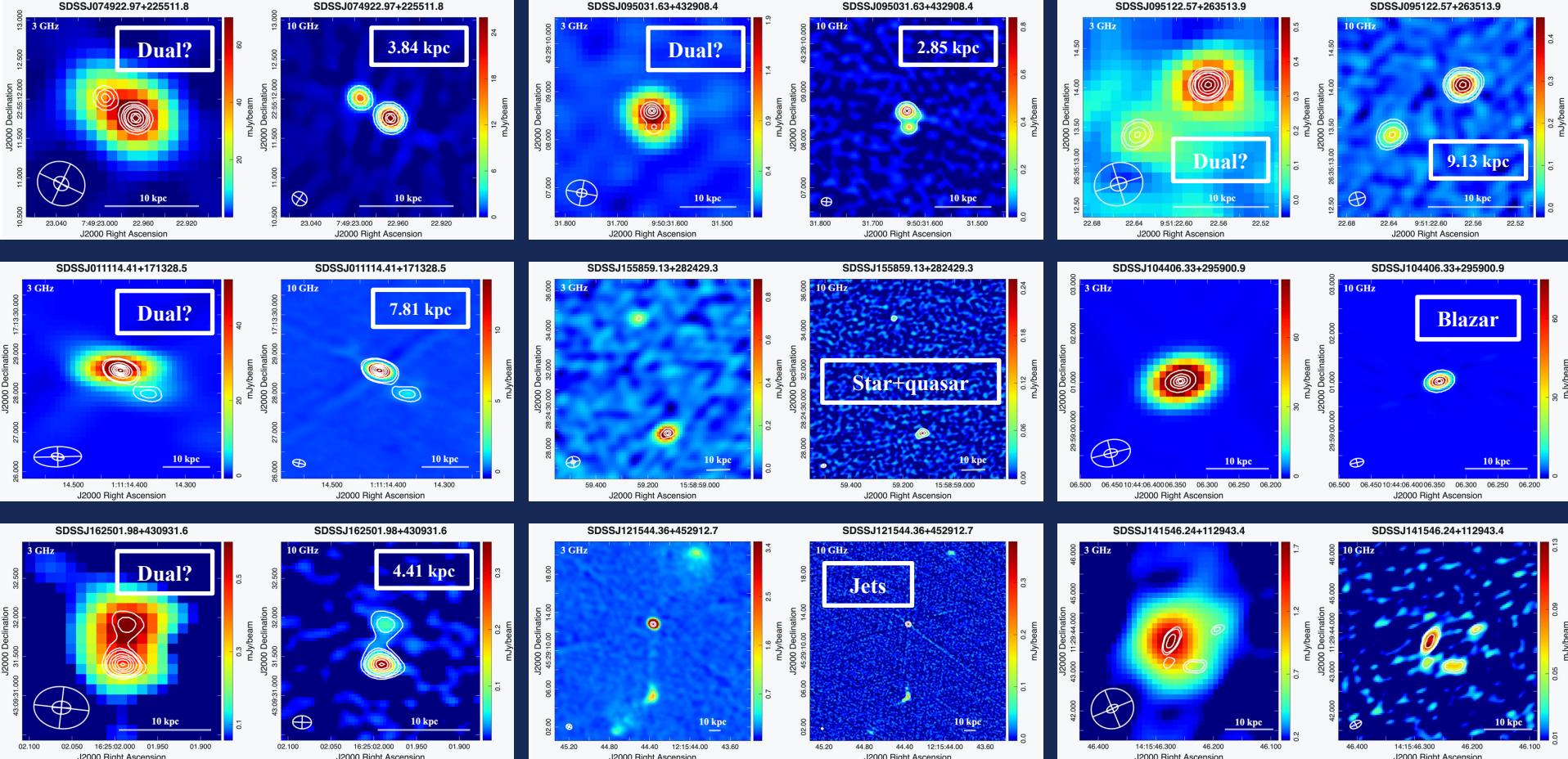
Schwartzman et al. in prep.



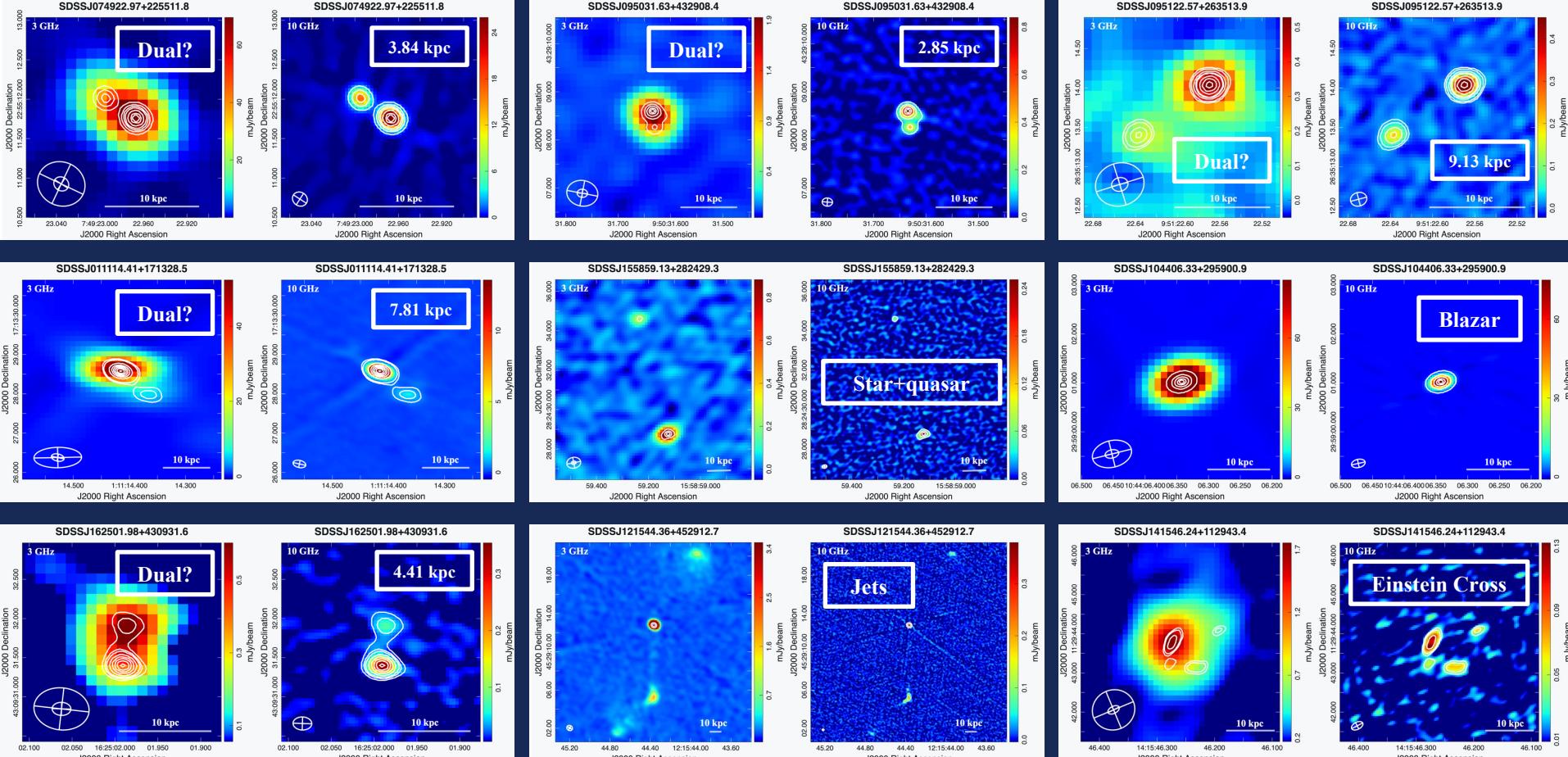
Schwartzman et al. in prep.



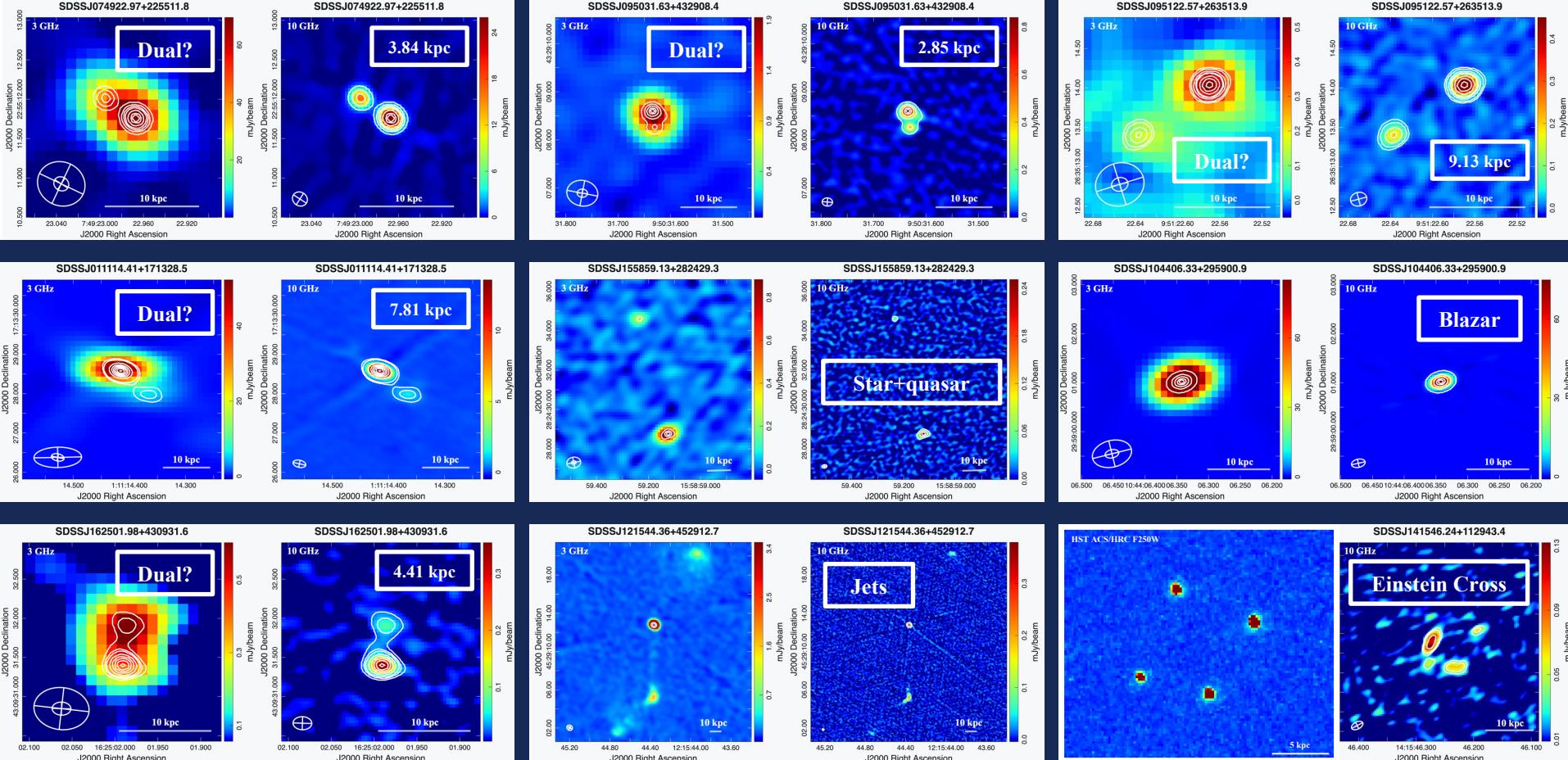
Schwartzman et al. in prep.



Schwartzman et al. in prep.



Schwartzman et al. in prep.



Schwartzman et al. in prep.

# Preliminary Results:

18  
targets

8 display  
unresolved  
morphology

3 display  
jets/extended  
emission

7 have multi-  
component  
signatures!

7 for VLBA  
follow-up

1 likely a  
blazar

1 identified as  
Einstein Cross

2 likely  
star+quasar  
superposition

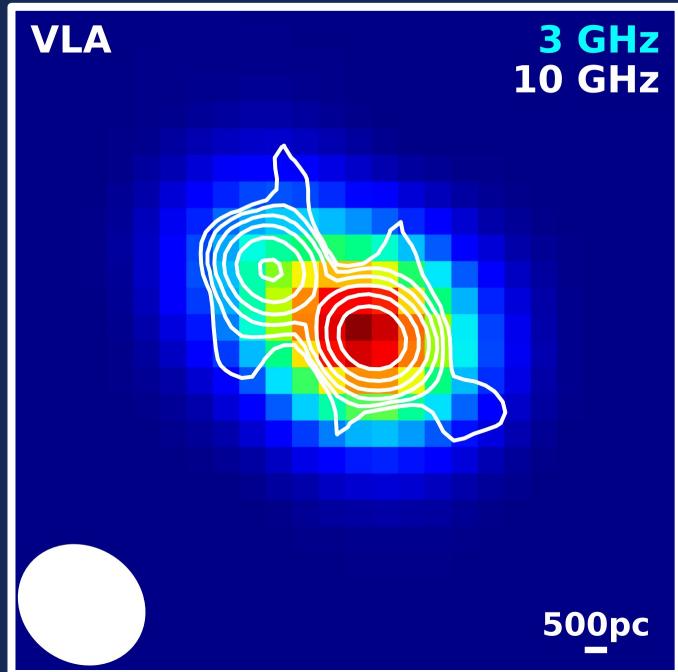
4 dual AGN  
candidates

# Main Takeaways:

*Gaia* varstrometry + multifrequency radio observations are a promising technique for systematic identification of AGN pair systems.

*Gaia* varstrometry selects for a diverse sample, and is an effective means of preselection for identifying new candidate AGN pair systems.

[ More detail? – [emma.schwartzman@nrl.navy.mil](mailto:emma.schwartzman@nrl.navy.mil) ]



Questions?