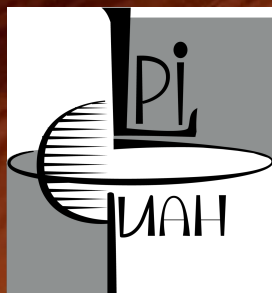


Simulation-to-Real Learning for VLBI Jet Morphology Classification

Dmitrii Zagorulia

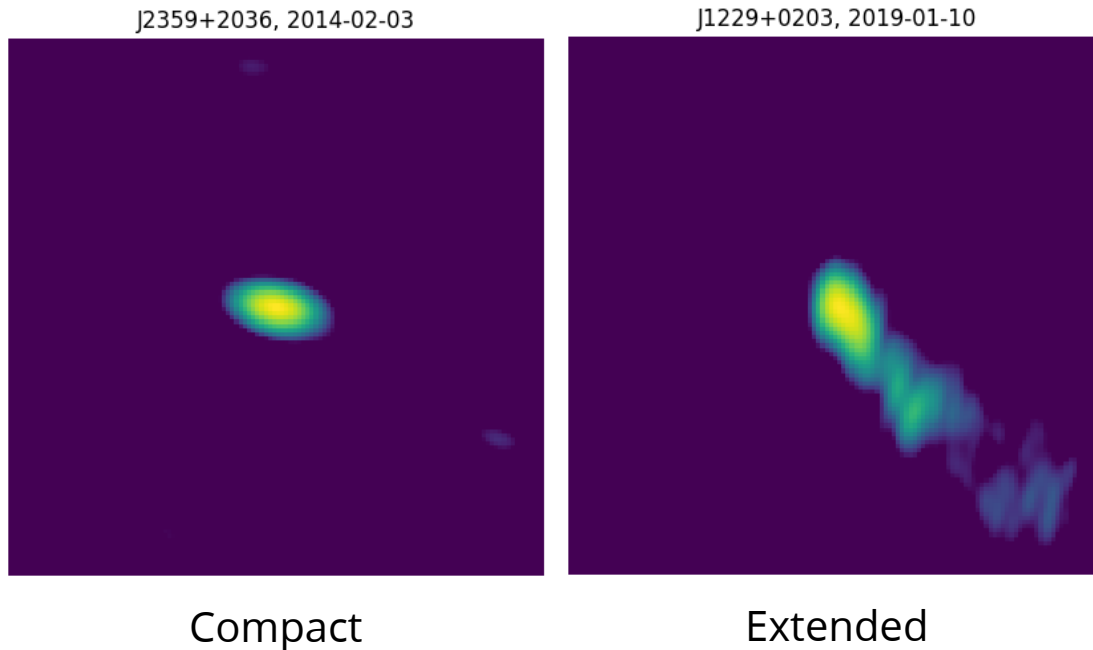
Supervisor: Prof. Mikhail Lisakov



September 2, 2026



Is there a correlation between luminosity and morphology on parsec scales?



134k
VLBI images

20k
radio-loud AGNs

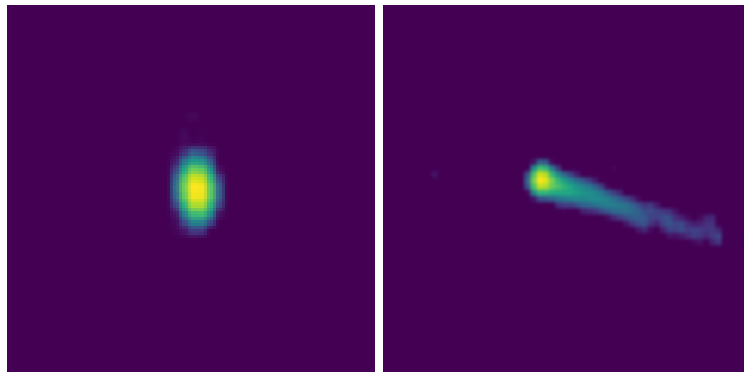
1-90 GHz
frequency range

Astrogeo VLBI FITS image database

Physical simulations provide labels

SIDDA bridges the domain gap

Simulated — Labeled



Compact

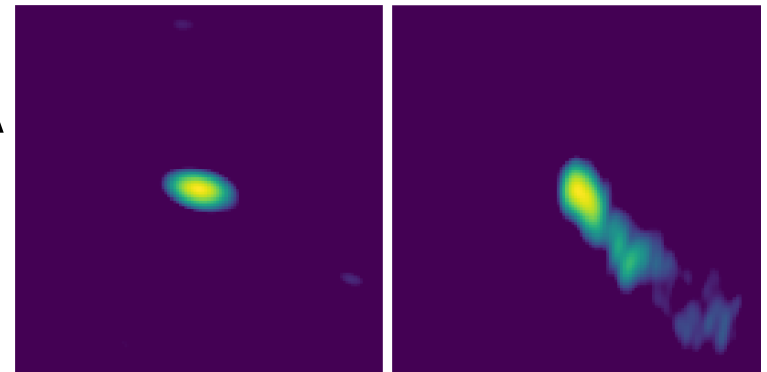
Extended

Blandford-Königl jet model

SIDDA



Observed — Unlabeled



Compact

Extended

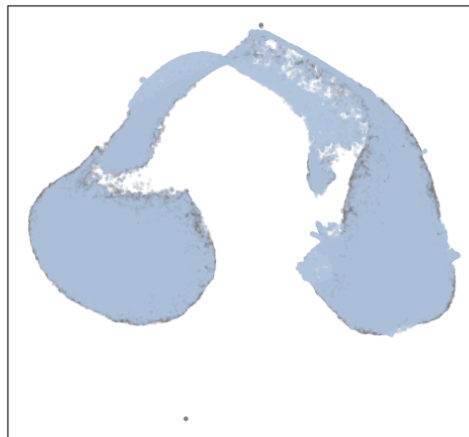
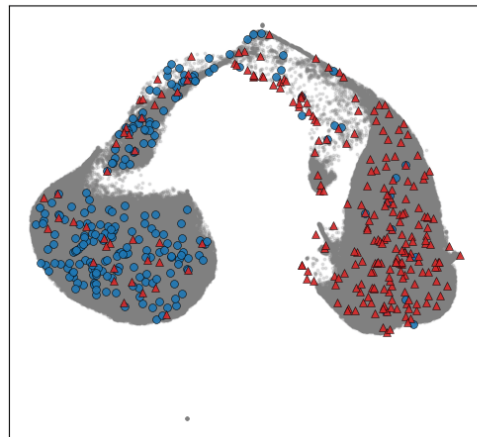
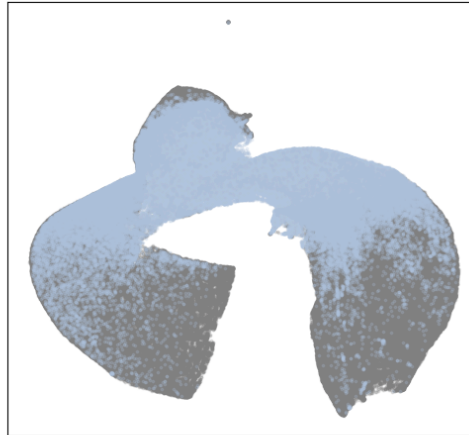
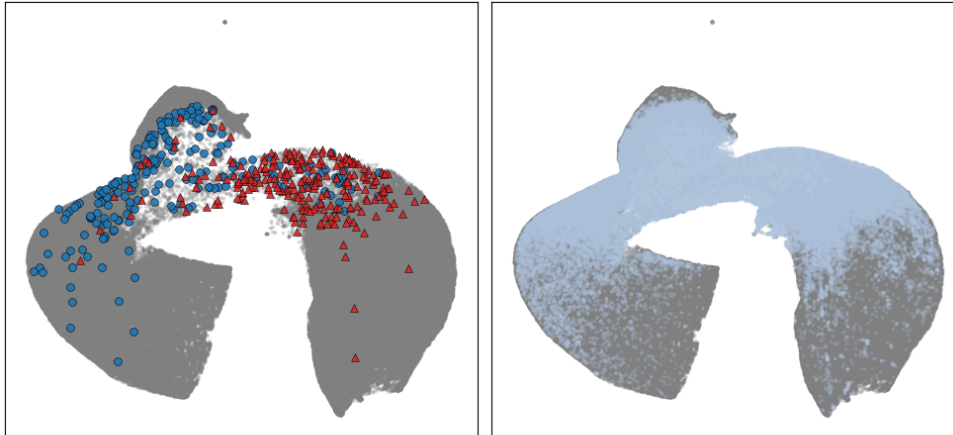
Astrogeo observations

Pashchenko & Plavin 2019

Astrogeo VLBI FITS image database

Domain alignment preserves morphology

Supervised



- Synthetics
- Observations
- Labeled compact objects
- ▲ Labeled extended objects

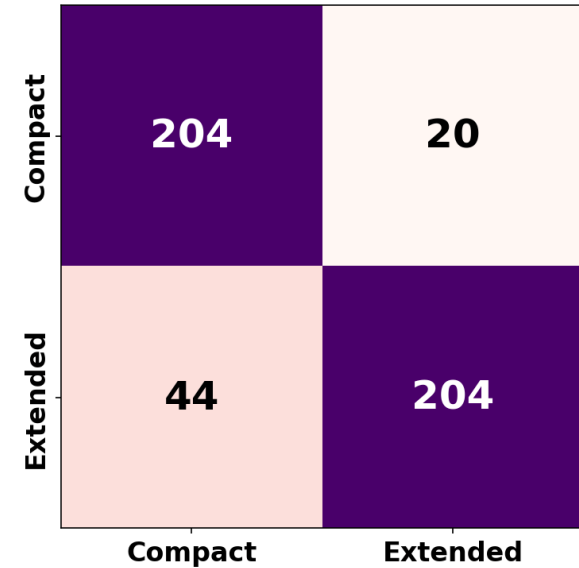
Domain adaptation

McInnes et al. 2018

SIDDA raises test accuracy to 86.4%

Supervised
Self-supervised
Domain adaptation

Model	Test Acc
Scratch	0.799
SSL	0.807
SIDDA	0.864

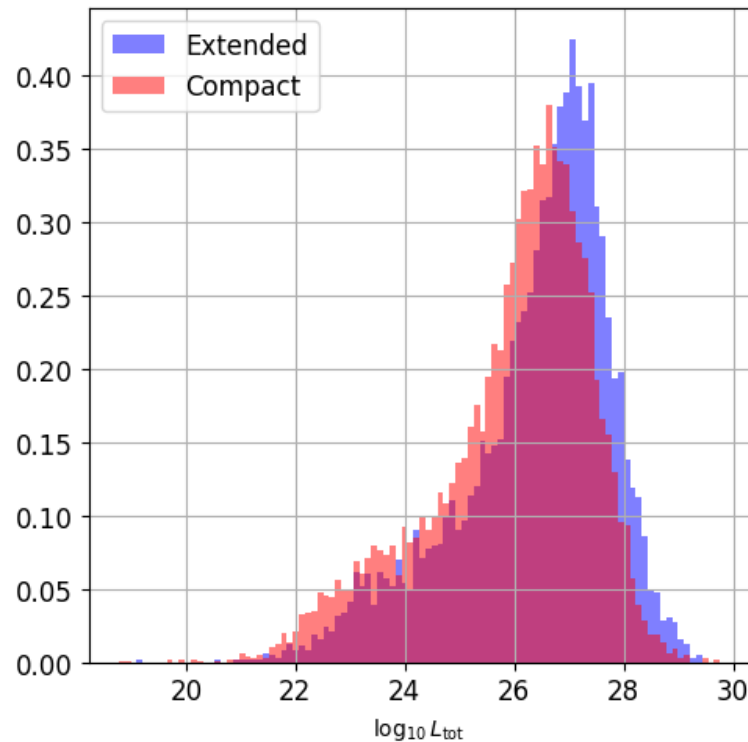


Confusion matrix SIDDA

Compact recall: $204/224 = 91\%$

Extended recall: $204/248 = 82\%$

Extended jets are more luminous on parsec scales



Total radio luminosity [W Hz^{-1}]
Mann-Whitney U test p -value $< 1\%$

Physics-guided domain adaptation enables population-scale VLBI studies

130k

real VLBI images
classified

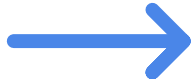
86.4%

accuracy on held-out
observations

60%

$P(L_{\text{ext}} > L_{\text{comp}})$

Next



control for selection effects and link
morphology to multiwavelength emission

zagorulia.ds@phystech.edu