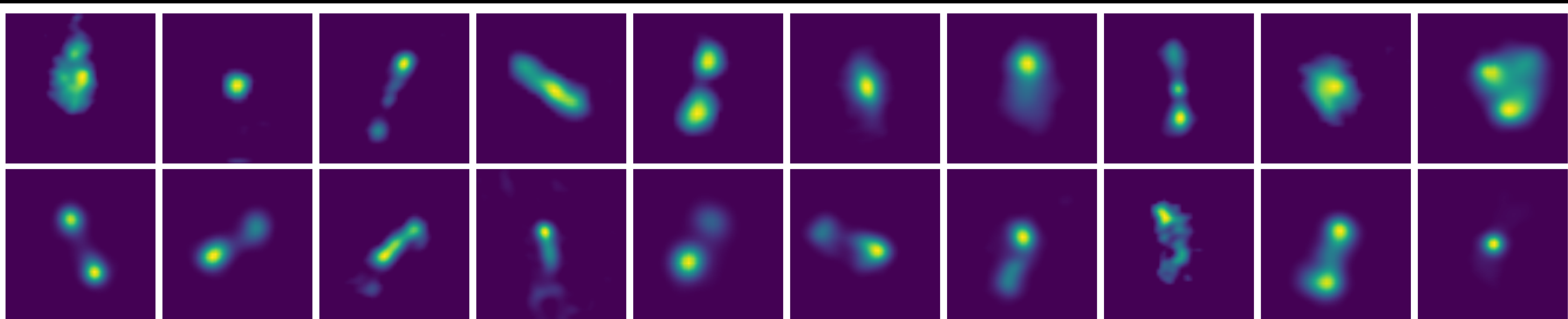# Classification of radio sources through self-supervised learning
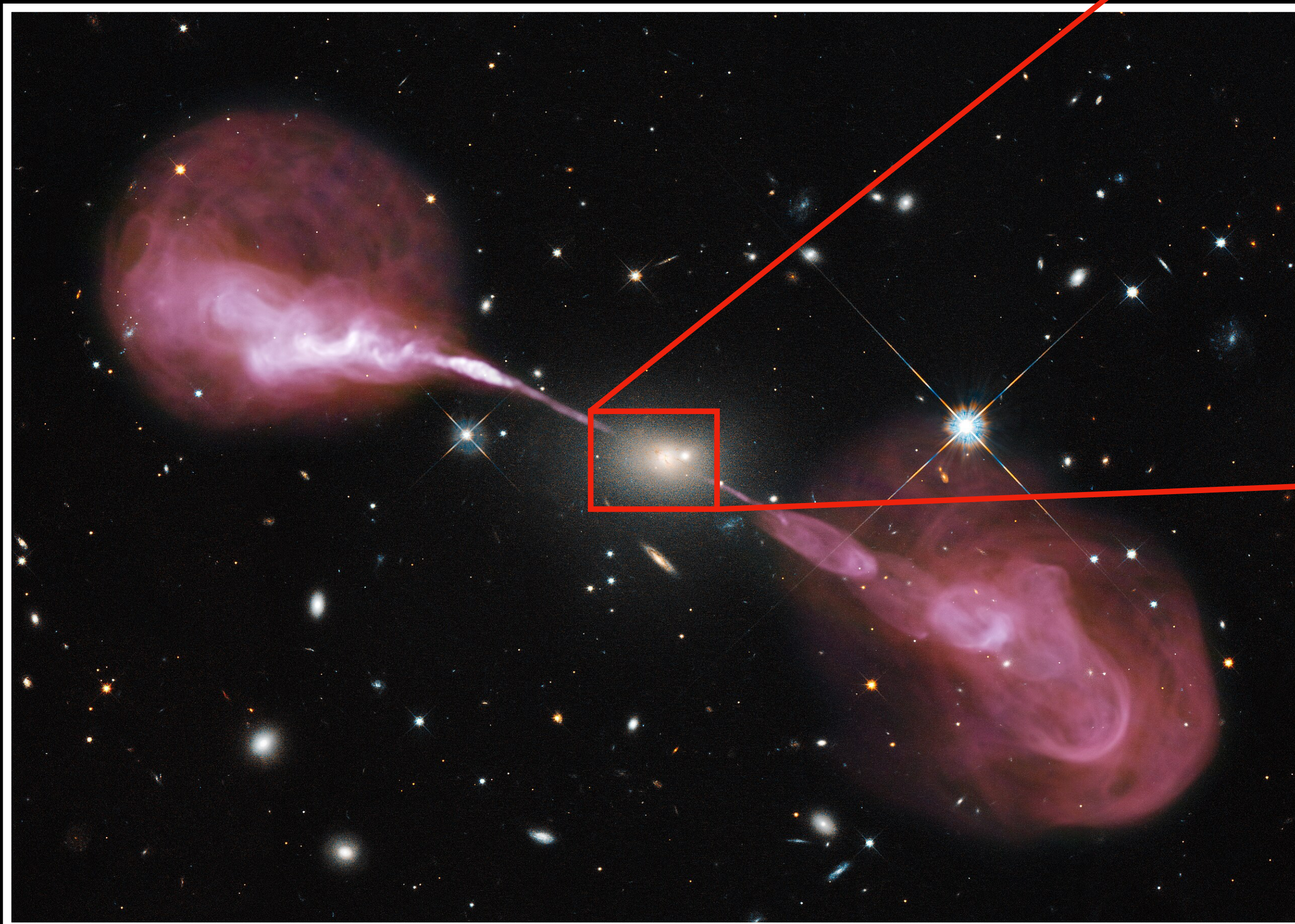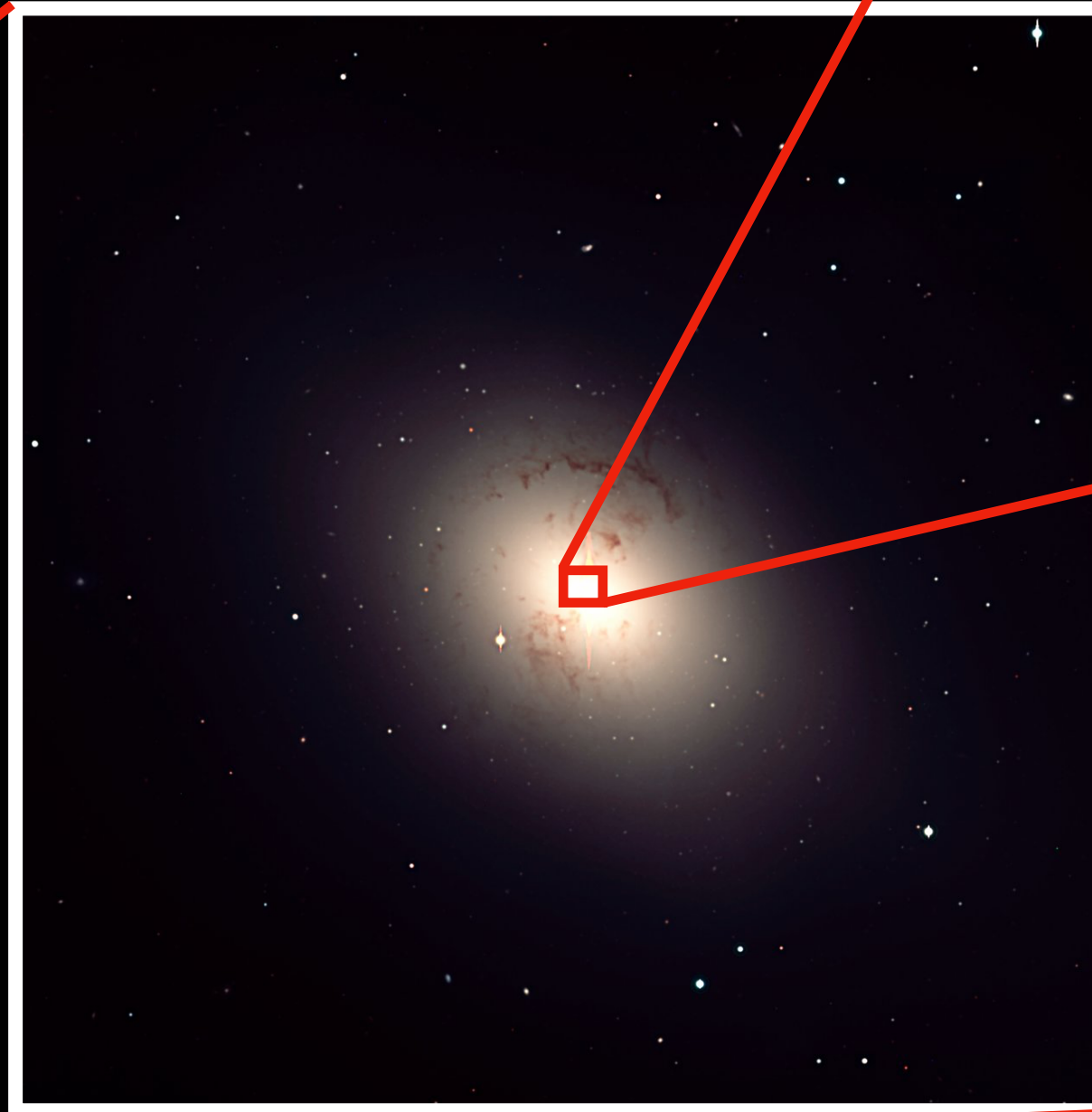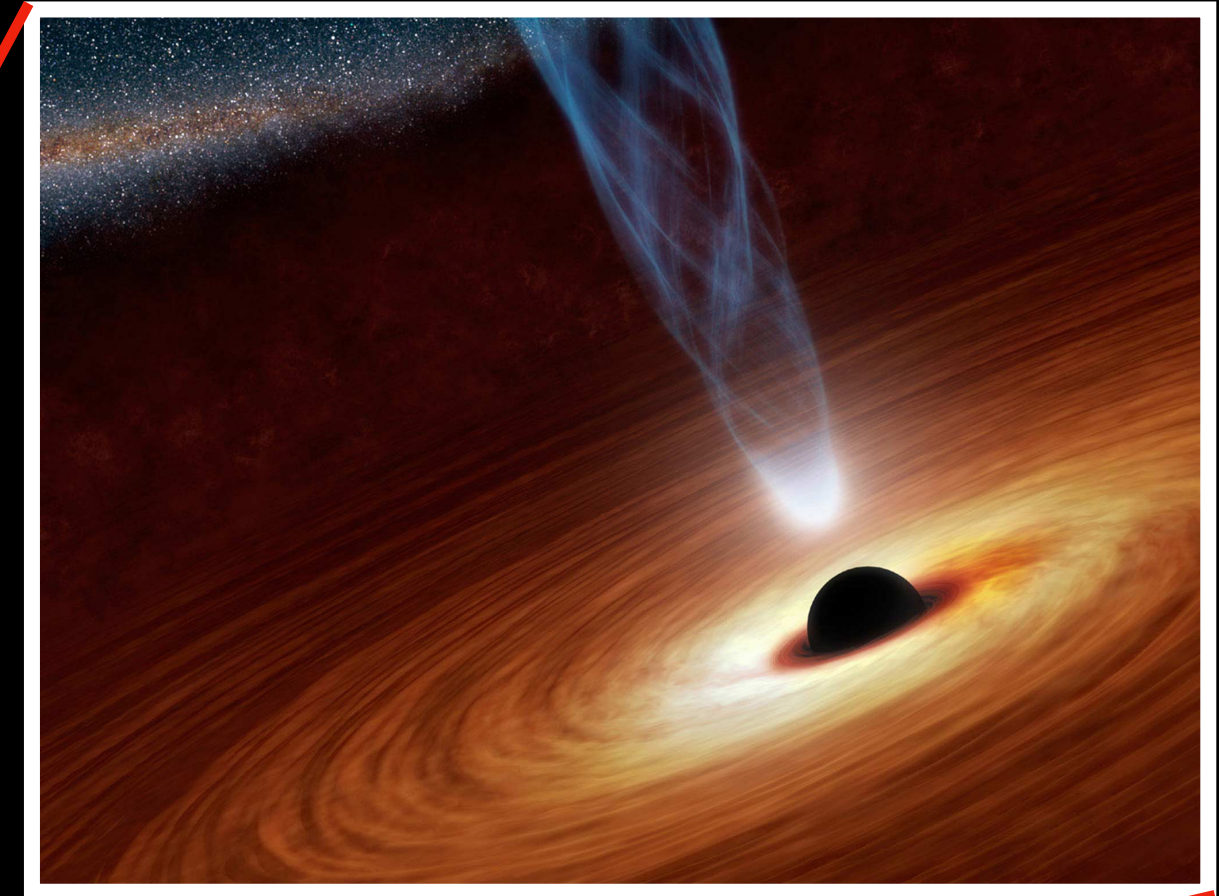
Nicolas Baron Perez, Marcus Brüggen, Gregor Kasieczka, and Luisa Lucie-Smith
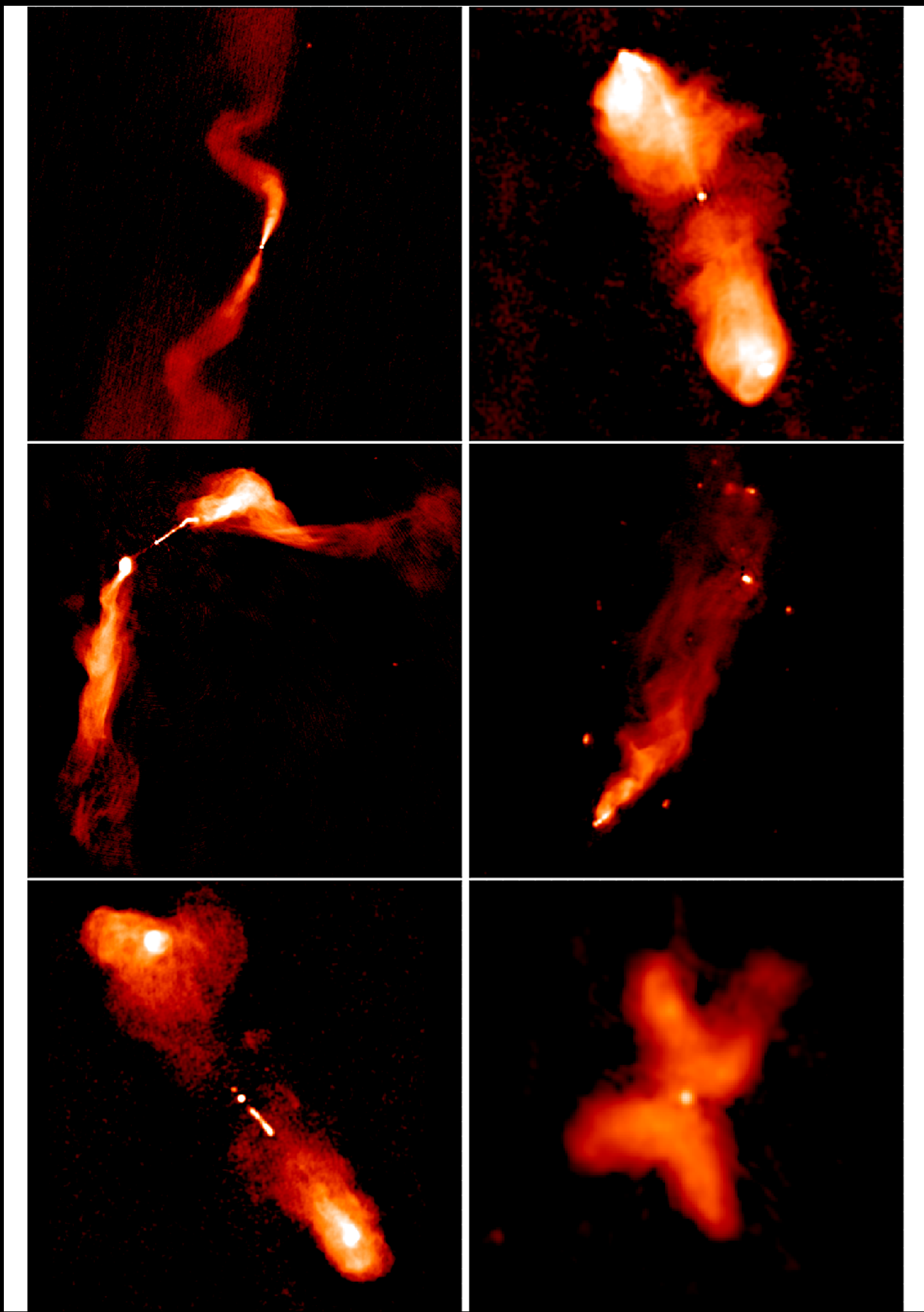
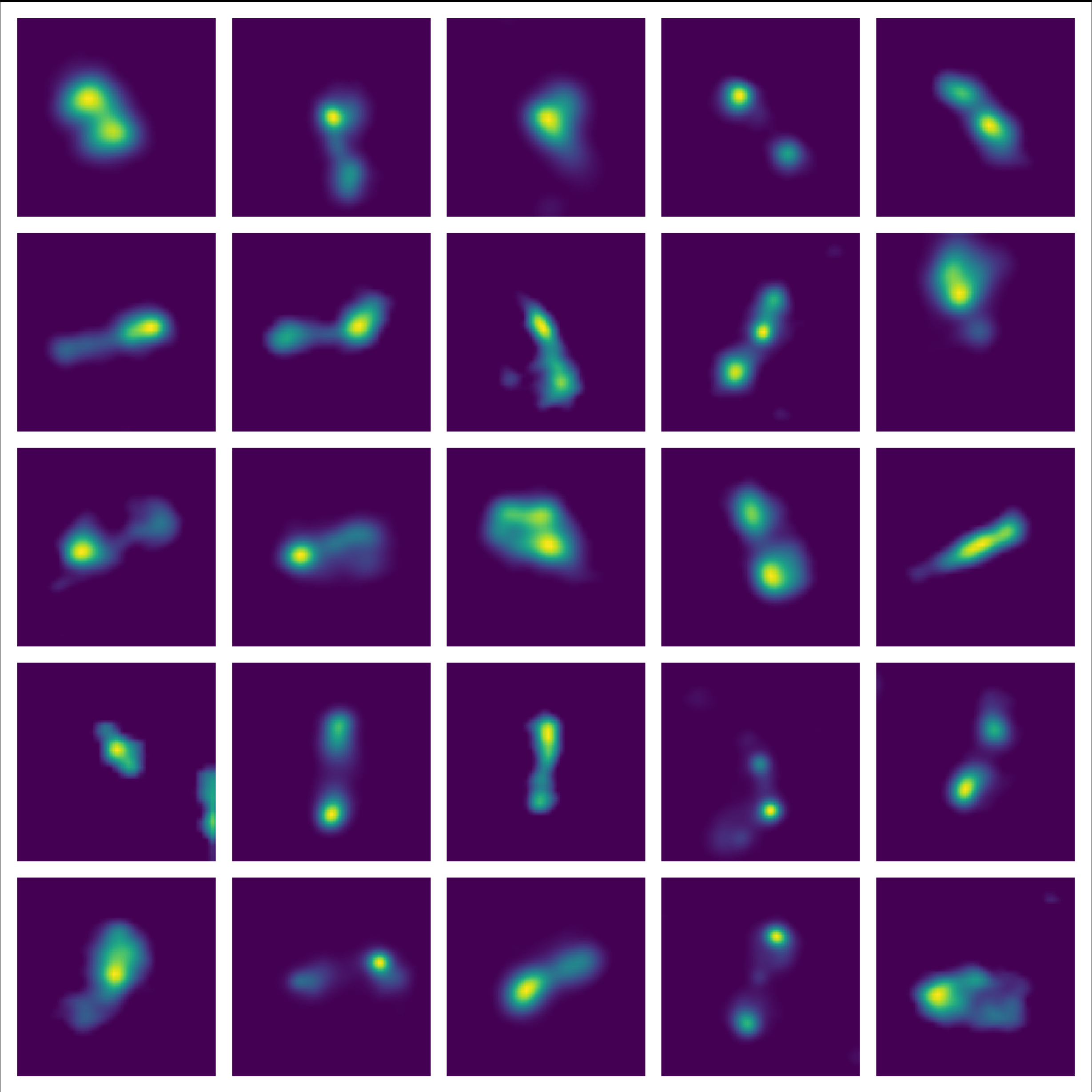**arXiv:2503.19111**

Introduction

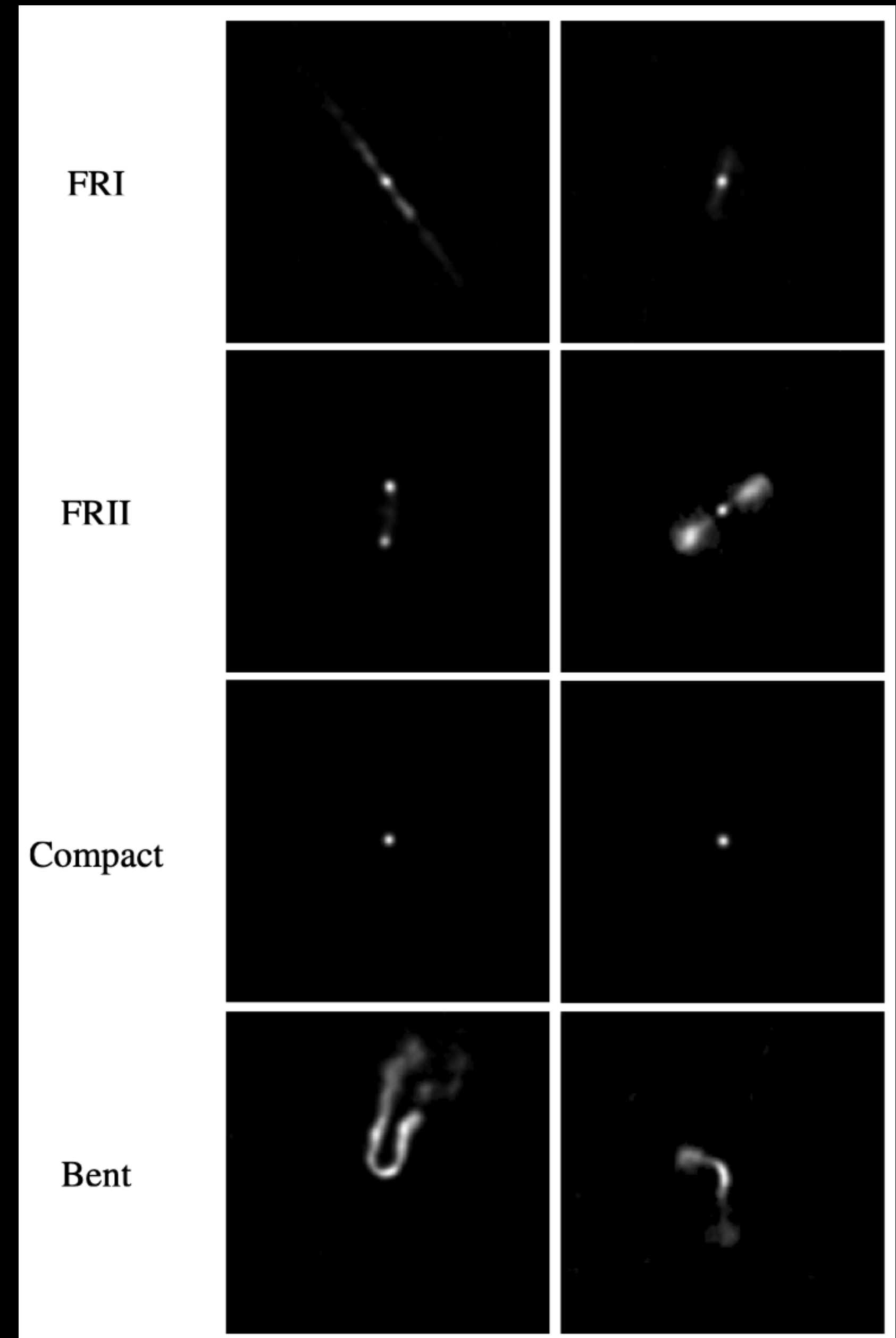# Radio Galaxies

Radio Galaxies

arXiv:2003.06137

LoTSS DR2 Sources

# Motivation

Can we classify radio sources without labels?

- Lack of theoretical models or simulations

- Differing and possibly inadequate classification schemes

- Possible discovery of new morphologies

FRI

FRII

Compact

Bent

arXiv:2212.08504
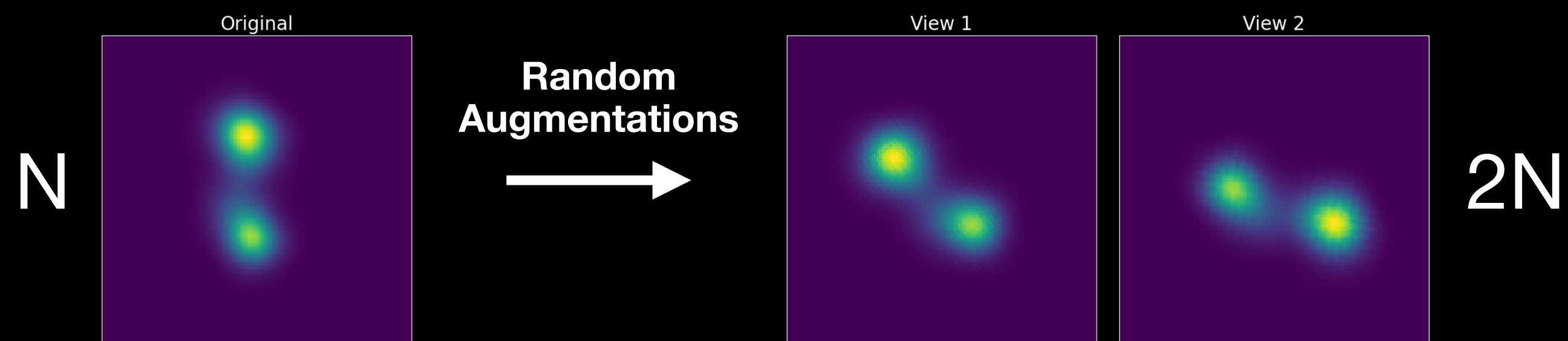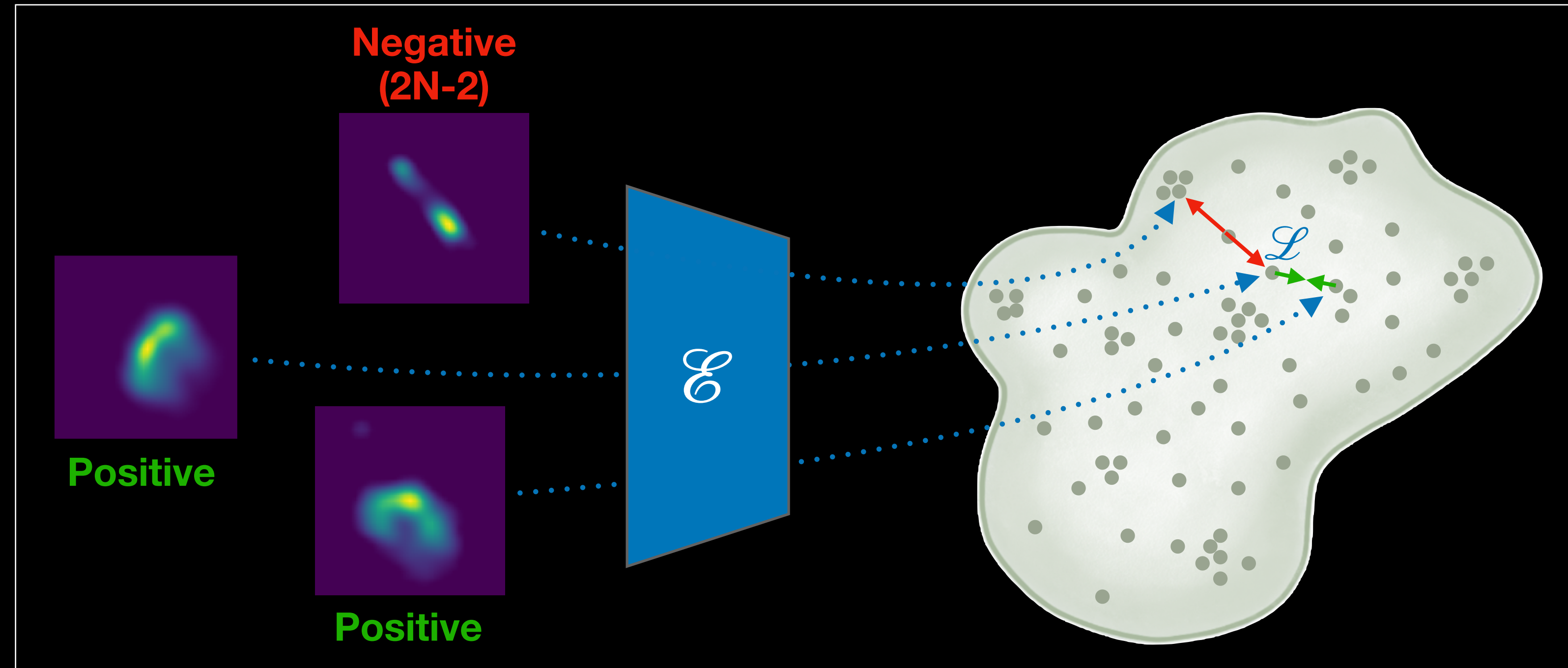
Method

SSL Approach

1. Learn a representation space that encodes image similarity

2. Create a small labelled subsample that describes the morphological variety

3. Provide class probabilities for the dataset
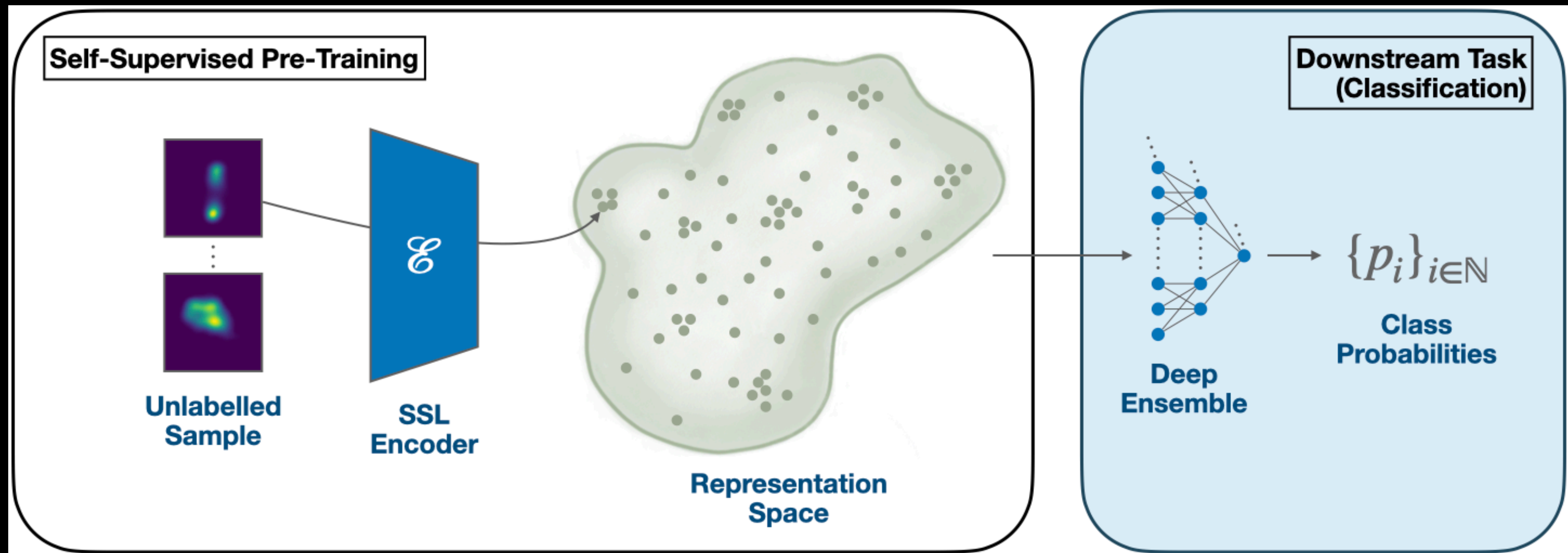
1. Representation Space
Contrastive Learning

- Dataset:

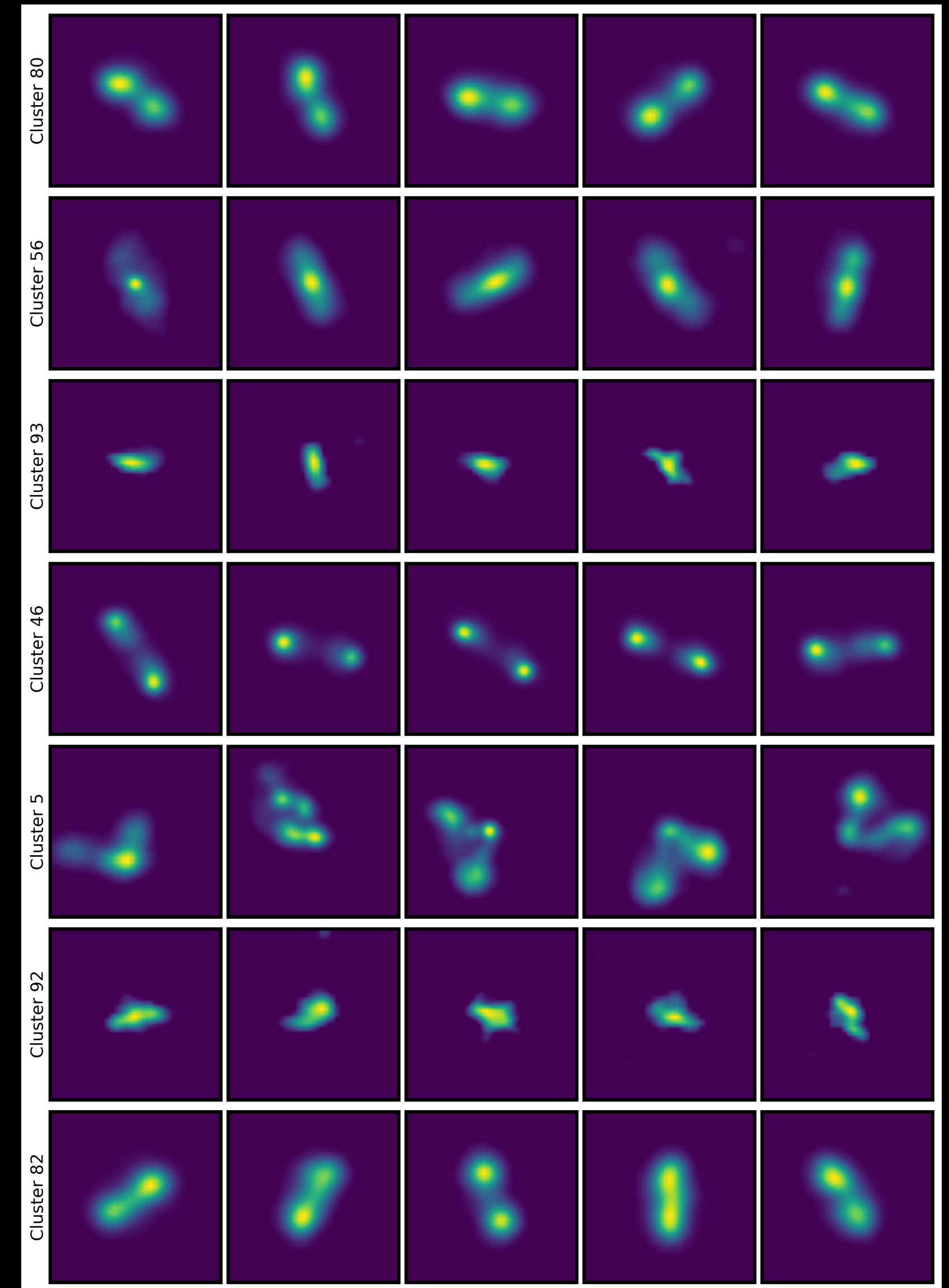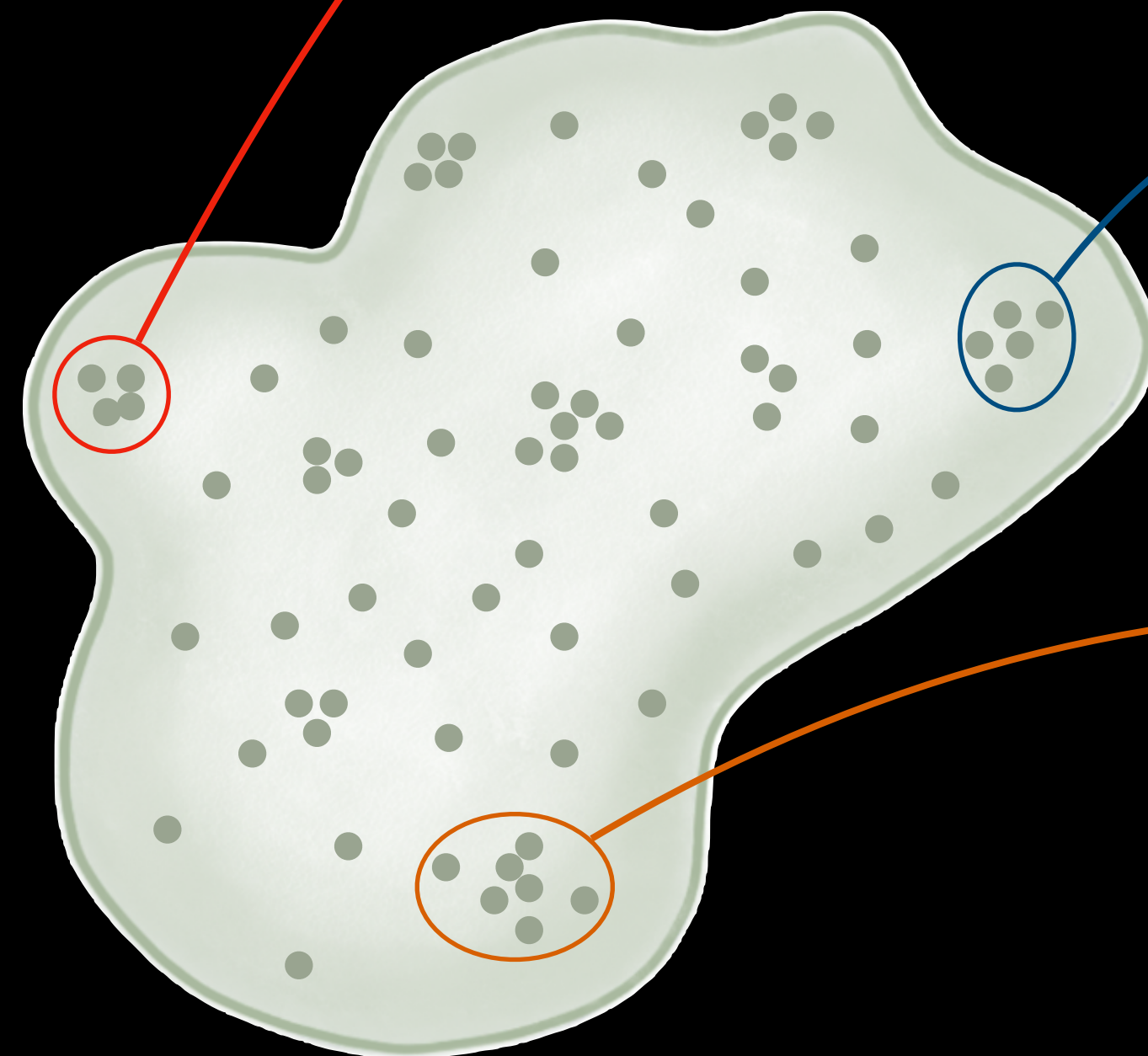   42 230 sources

*simplified diagram
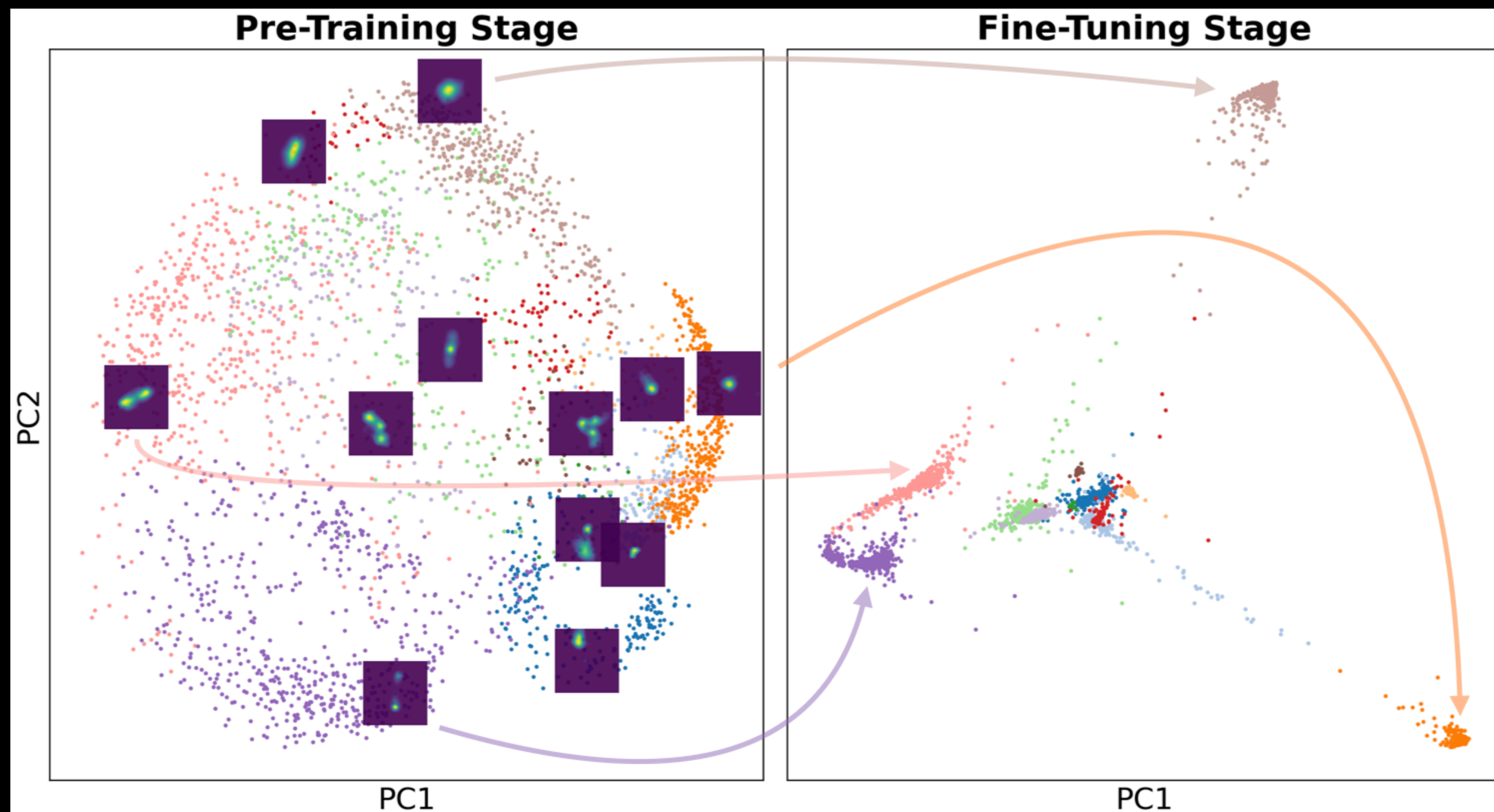
2. Subsample labelling
Clustering

- Labelled subsample:

  - 12 classes

  - 2920 sources

3. Fine-Tuning
Supervised Classification

Pre-Training Stage

Fine-Tuning Stage

PC1

PC2
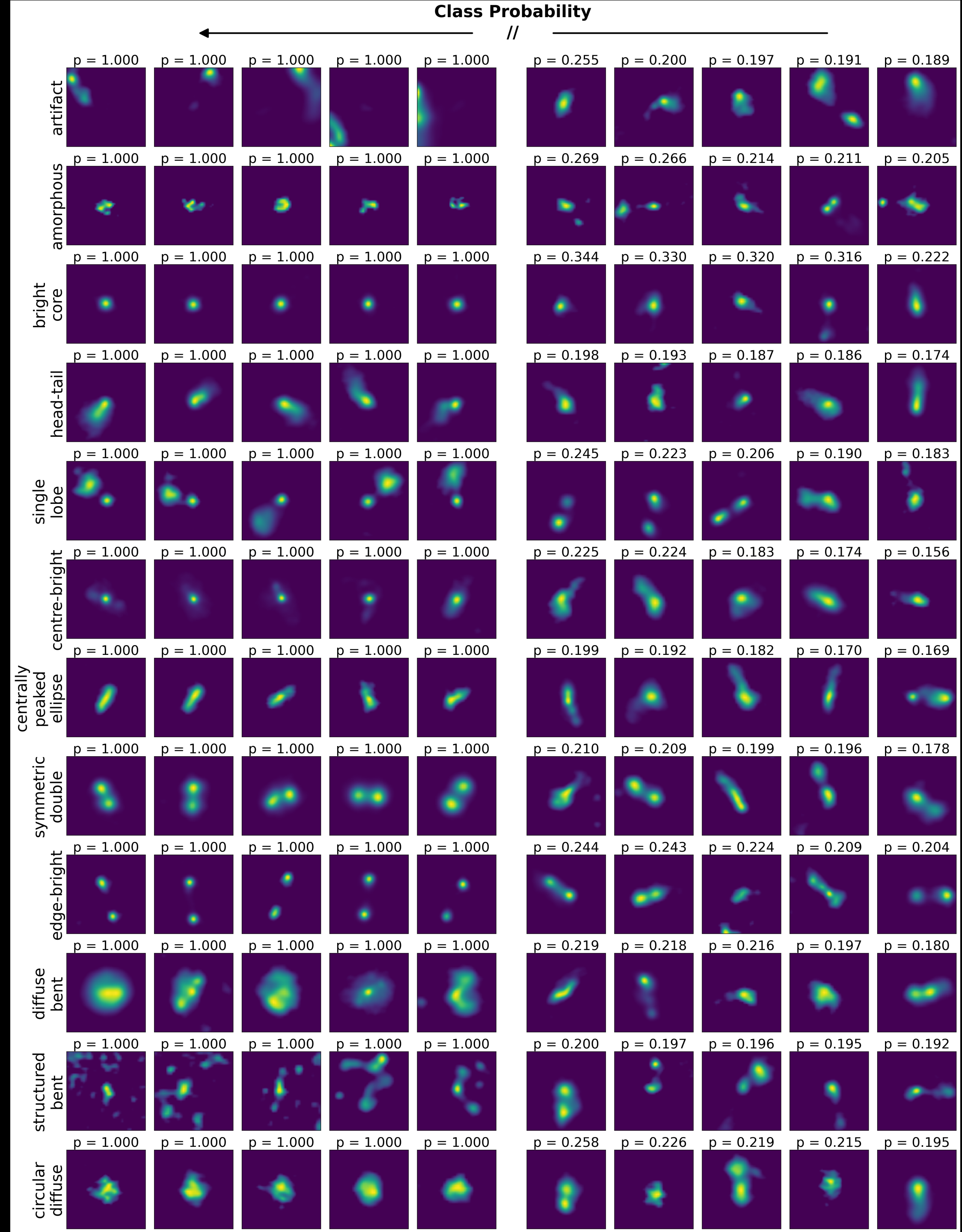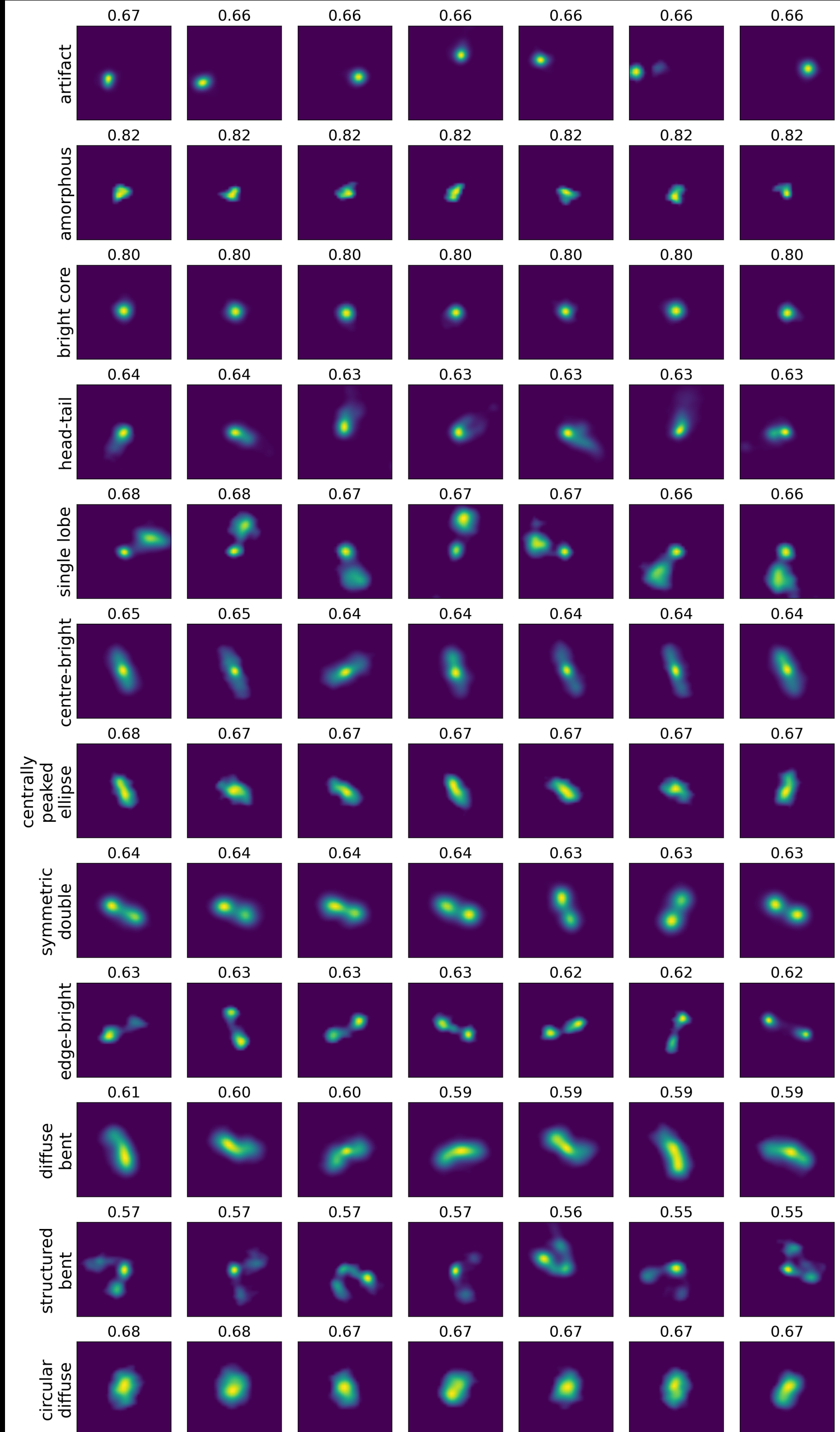
PC1

Results

Results
Classification

Conclusions

✅

- The morphological similarity was successfully encoded in the representation space

- The required effort for survey classification was significantly reduced

- A new classification scheme based on the geometric appearance was proposed

🛠️

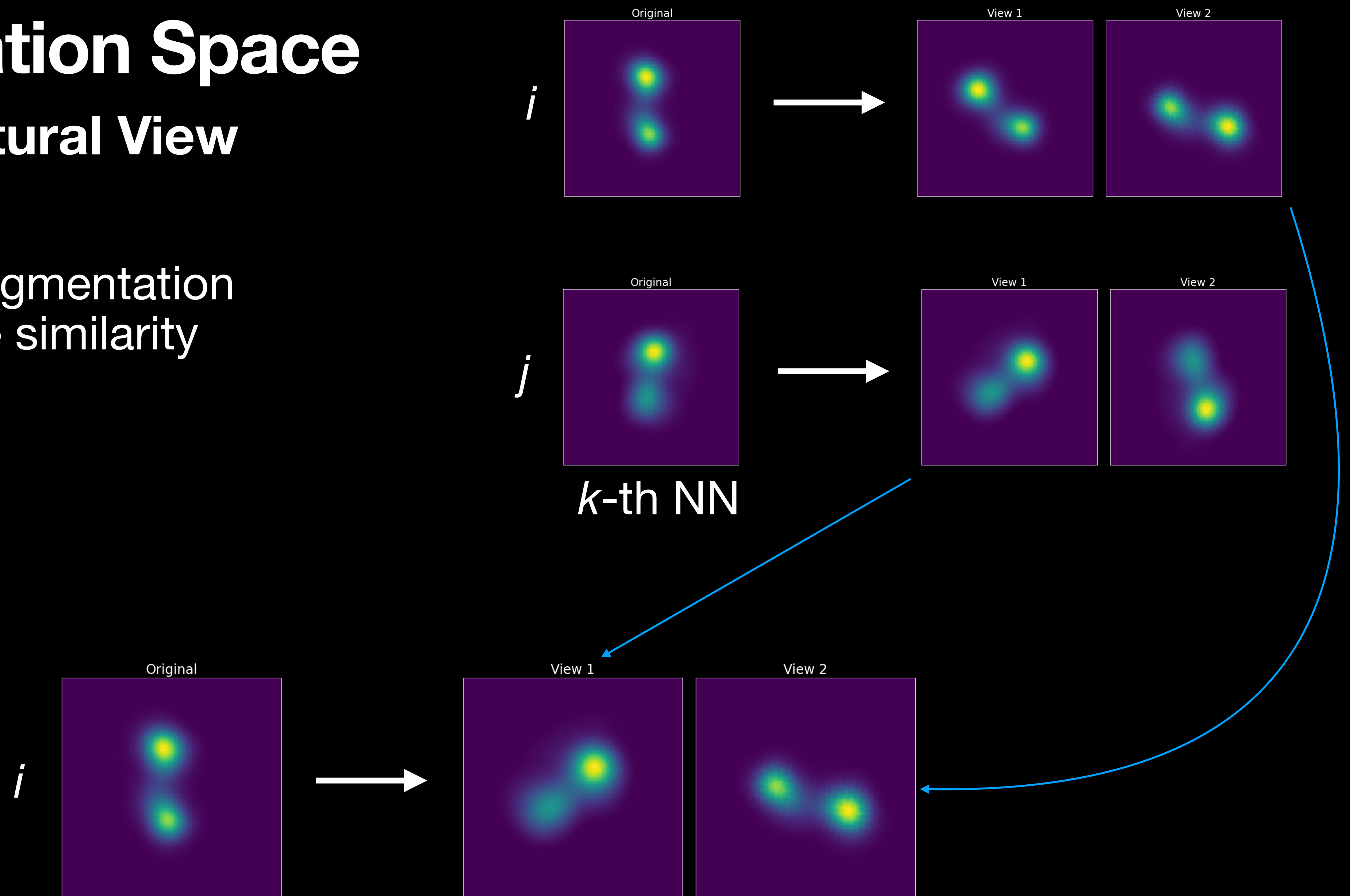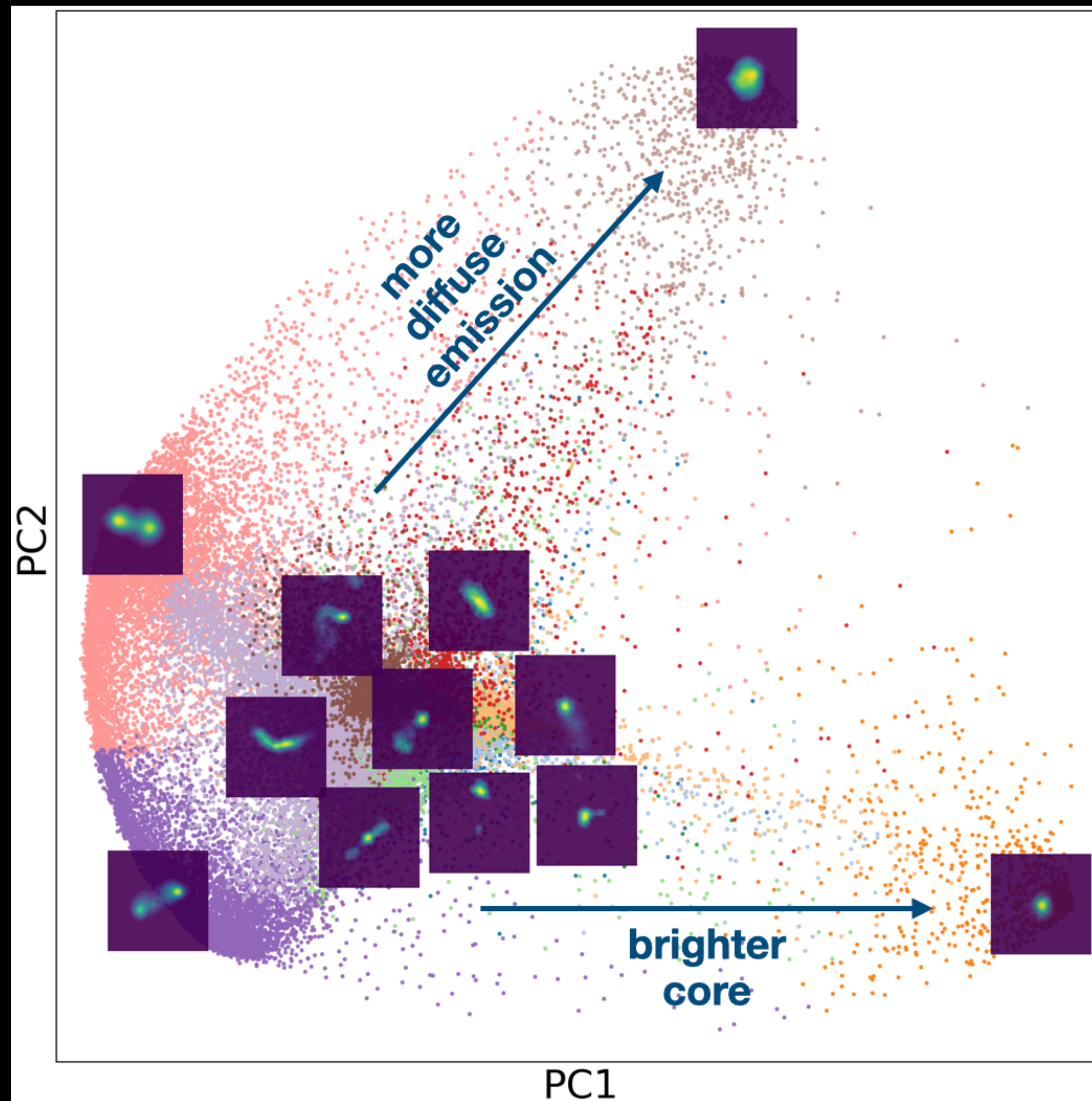- The method still requires human intervention

Thank you!

Representation Space
Random Structural View

- New random augmentation based on image similarity

Representation Space

Evaluation
Visual Classification

Evaluation
Visual Classification

- F1 score

Class	p ≤ 85%	Entire sub-set	p ≥ 99%
artifact	0.22	0.59	0.77
amorphous	0.31	0.67	0.92
bright core	0.00	0.63	0.85
head-tail	0.17	0.36	0.59
single lobe	0.22	0.48	0.83
centre-bright	0.40	0.73	0.91
c. p. ellipse	0.33	0.42	0.70
symmetric double	0.41	0.64	0.87
edge-bright	0.54	0.65	0.81
diffuse bent	0.40	0.47	0.59
structured bent	0.26	0.51	0.67
circular diffuse	0.53	0.66	0.80
Macro average	**0.37**	**0.60**	**0.80**