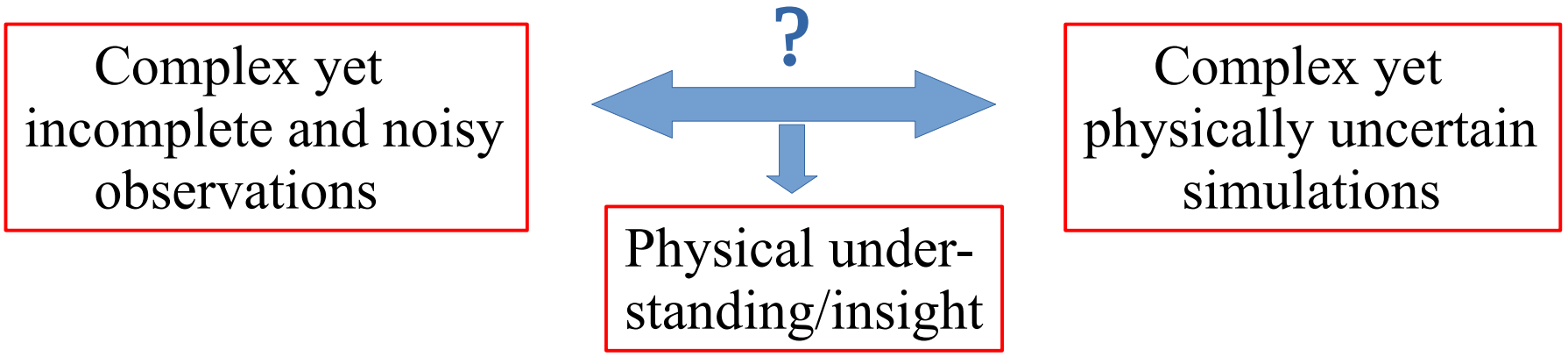
- Hubble-Sandage/de Vaucouleurs classification is no longer useful

- What is the goal of classification?
  - Separation into disjoint classes?
  - Pattern identification?
  - Measurement of quantitative indices?
  - linking to physical processes?
- How can ML help?
  - supervised? How do we train?
  - unsupervised? How do we interpret the result?

Galaxies are strongly coupled, highly nonlinear, multi-scale and multi-physics systems with timescales << the Hubble time



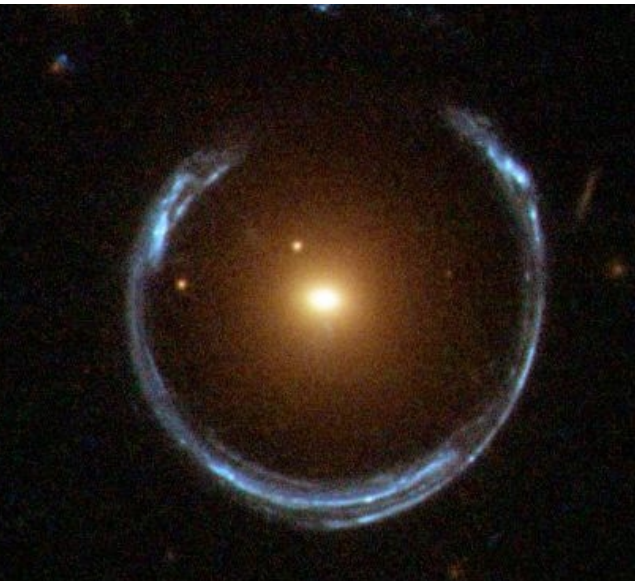
Traditional classification mixes:

– structure (B/T, bars…)
– star formation (HII regions)
– ISM physics (dust lanes...)
– dynamics (spirals, bars, companions)
– scale (M33 vs M101)

Classification suitable for ML?

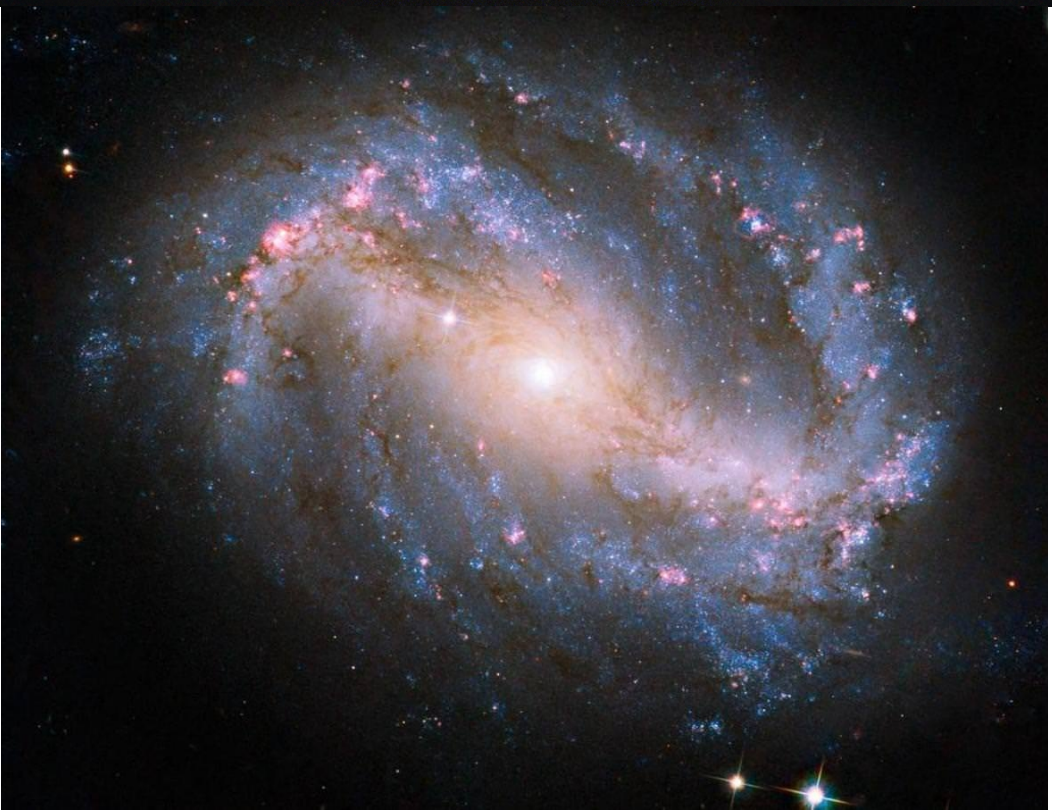
Star vs galaxy

Superposition vs interaction



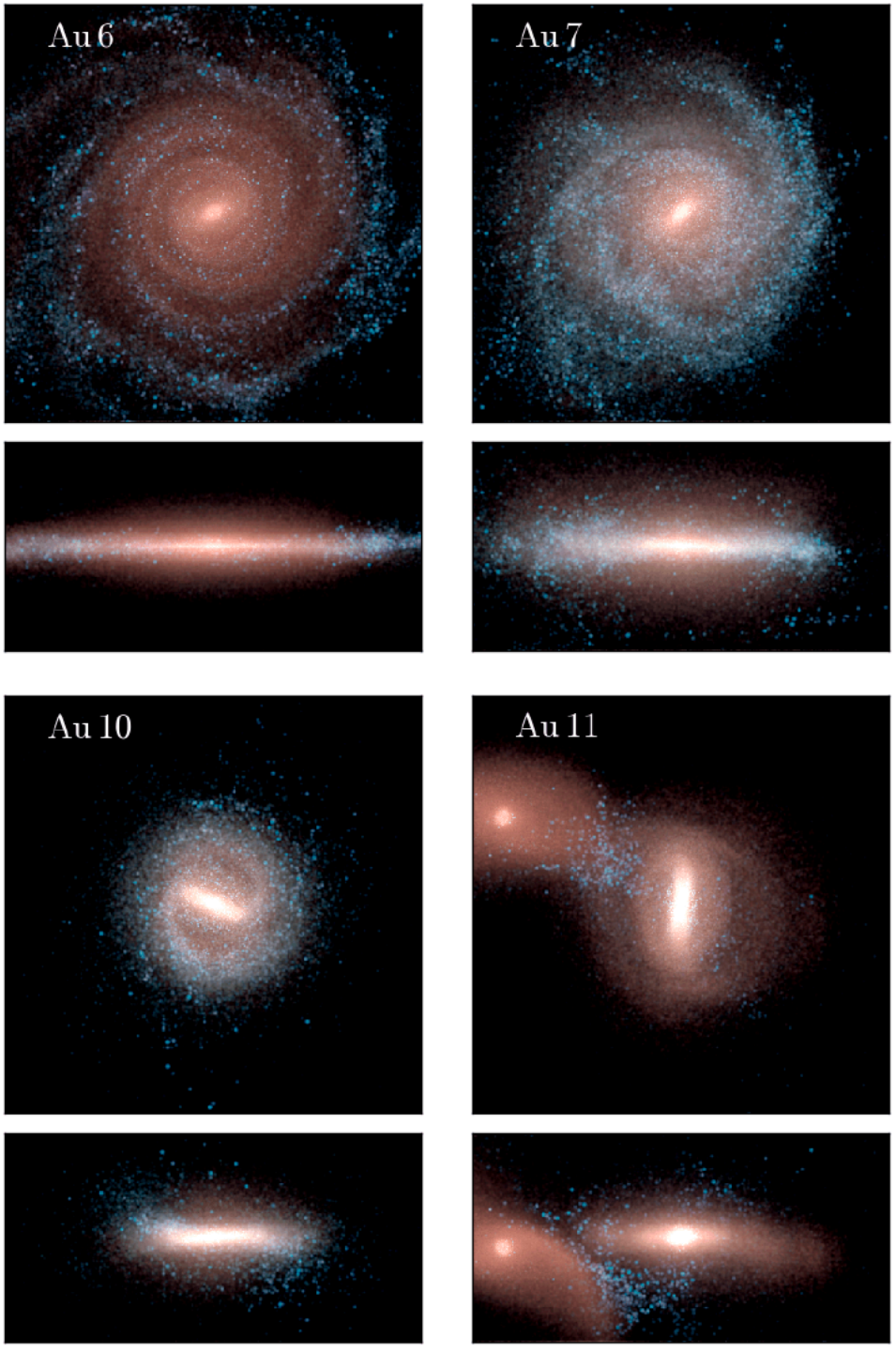
Lensed vs unlensed

AGN vs compact bulge



Can ML pattern recognition identify, locate and quantify spiral arms and bars?

Can this be done in a way which links to star formation physics by comparing continuum, emission lines and dust?



Simulations of galaxy formation include increasingly realistic astrophysics.

They are producing complex images with at least some resemblance to reality.

The structure and morphology of the results are very sensitive to the astrophysical implementations

Some processes known to be important are not included (B-fields, CR's, dust evol'n…)

Other processes are included in very crude approximations (ISM, SF, AGN, winds..)

How do we train a machine to compare to the "correct" aspects of simulations when analysing real galaxies?

Simulations are most useful when they FAIL to agree with observation – can ML help to identify/characterise failures?

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