Visibility Modelling of a Star-Forming Ring in NGC 3351

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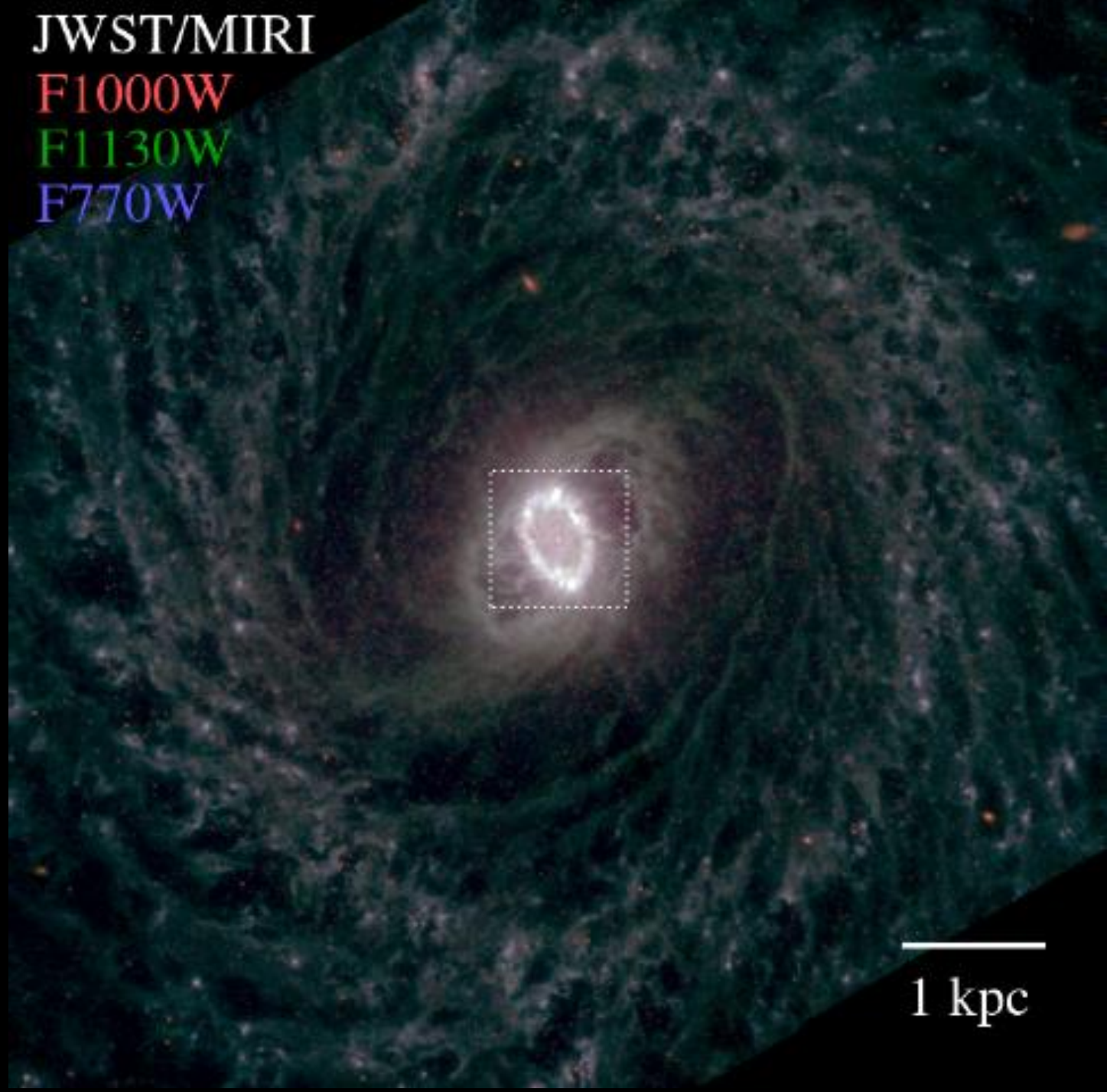
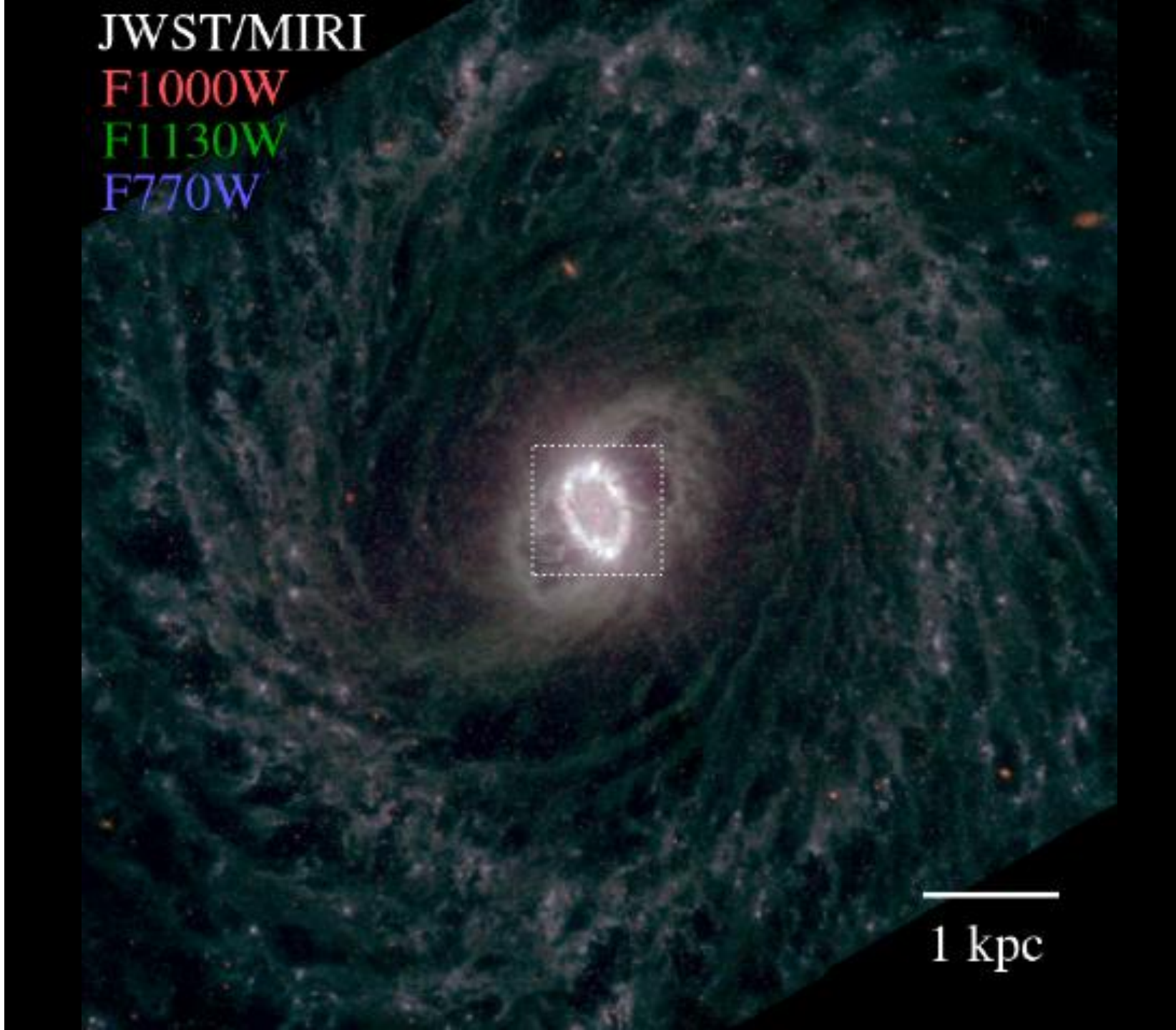


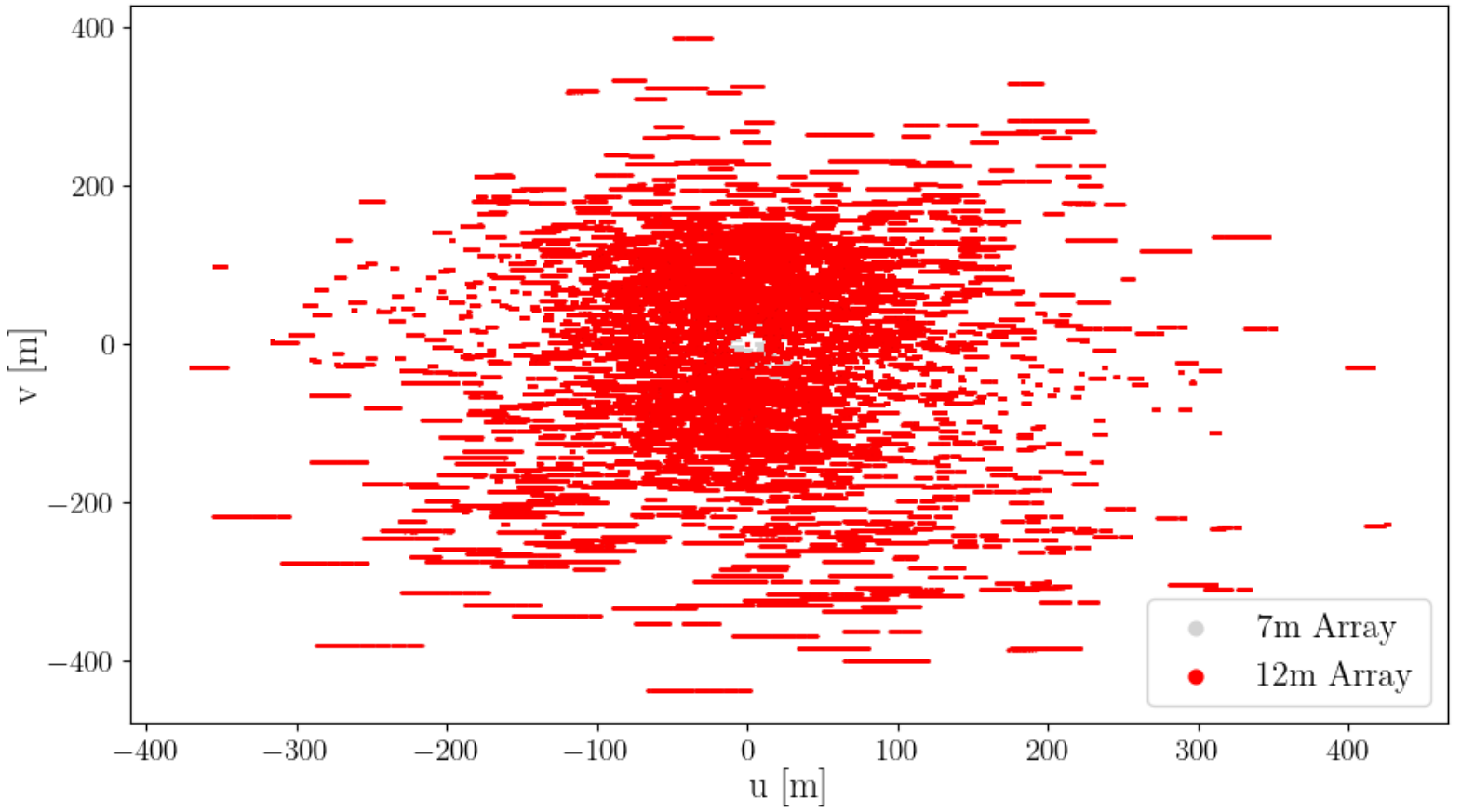
What is the nature of star-forming regions in nearby galaxies?

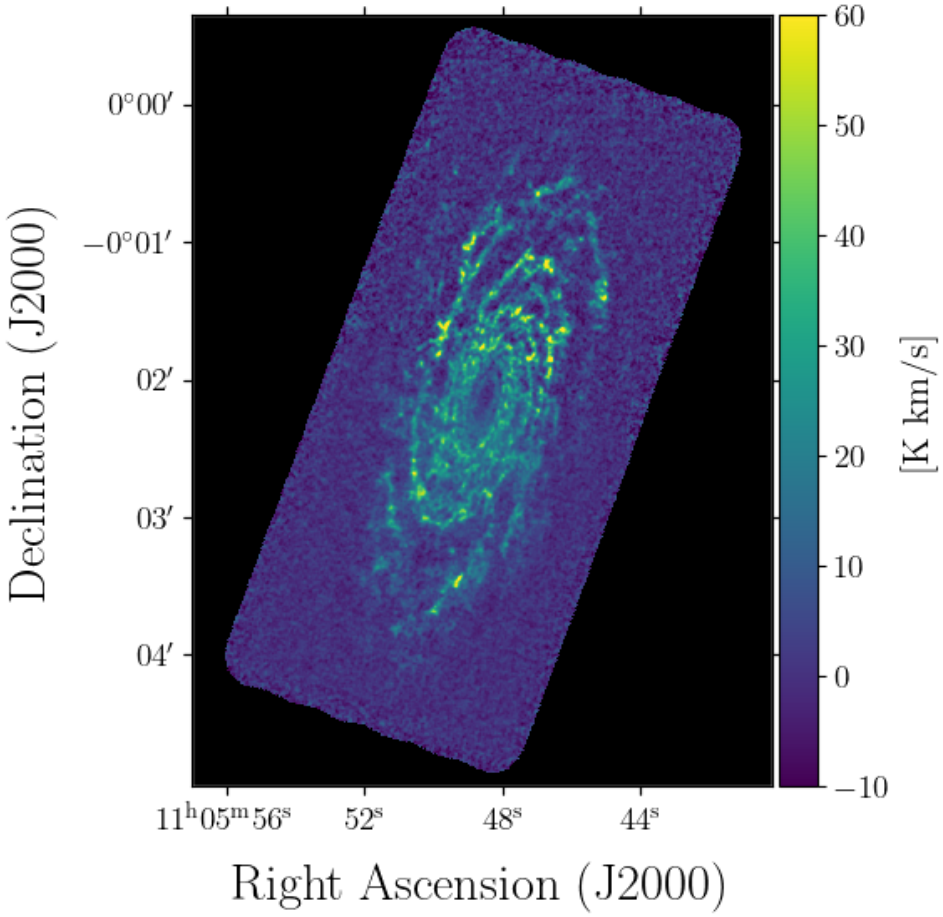


The Atacama Large (Sub-)Millimetre Array (ALMA) is the world's most advanced ground-based interferometer

Visibilities are produced by interferometers

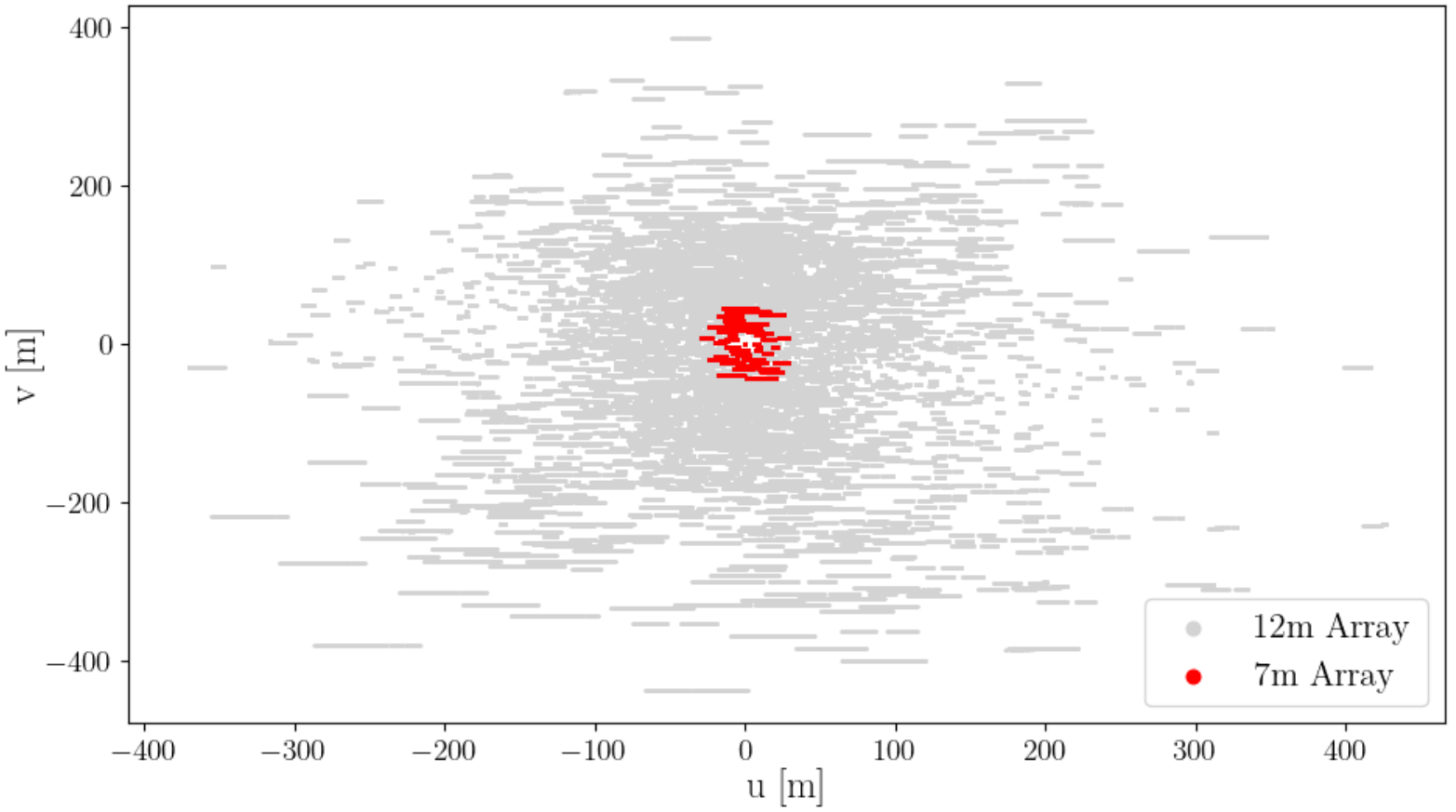
Long baselines = high angular resolution

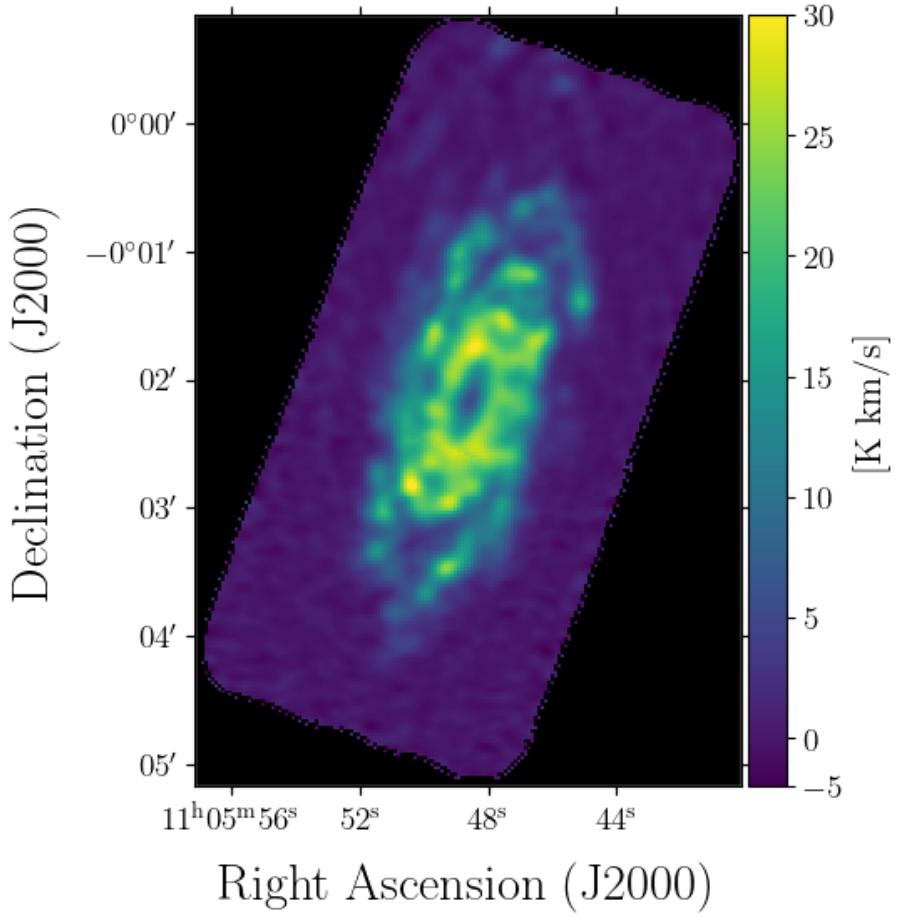




Visibilities are produced by interferometers

Short baselines = low angular resolution





The imaging process has several parameters that introduce biases and artifacts:

- Weighting
  - Robust parameter, uvtaper
- Gridding
- Deconvolver
  - Scales, scale bias
- Masking
- Major/minor cycle length
- Gain

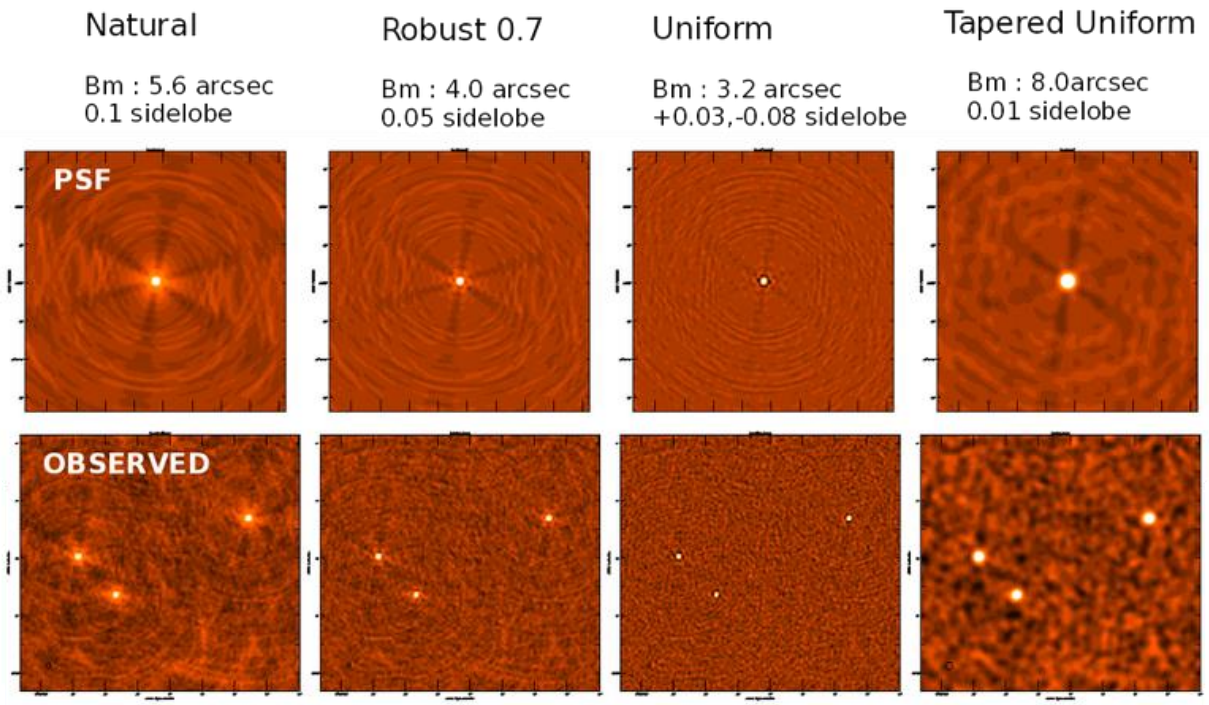
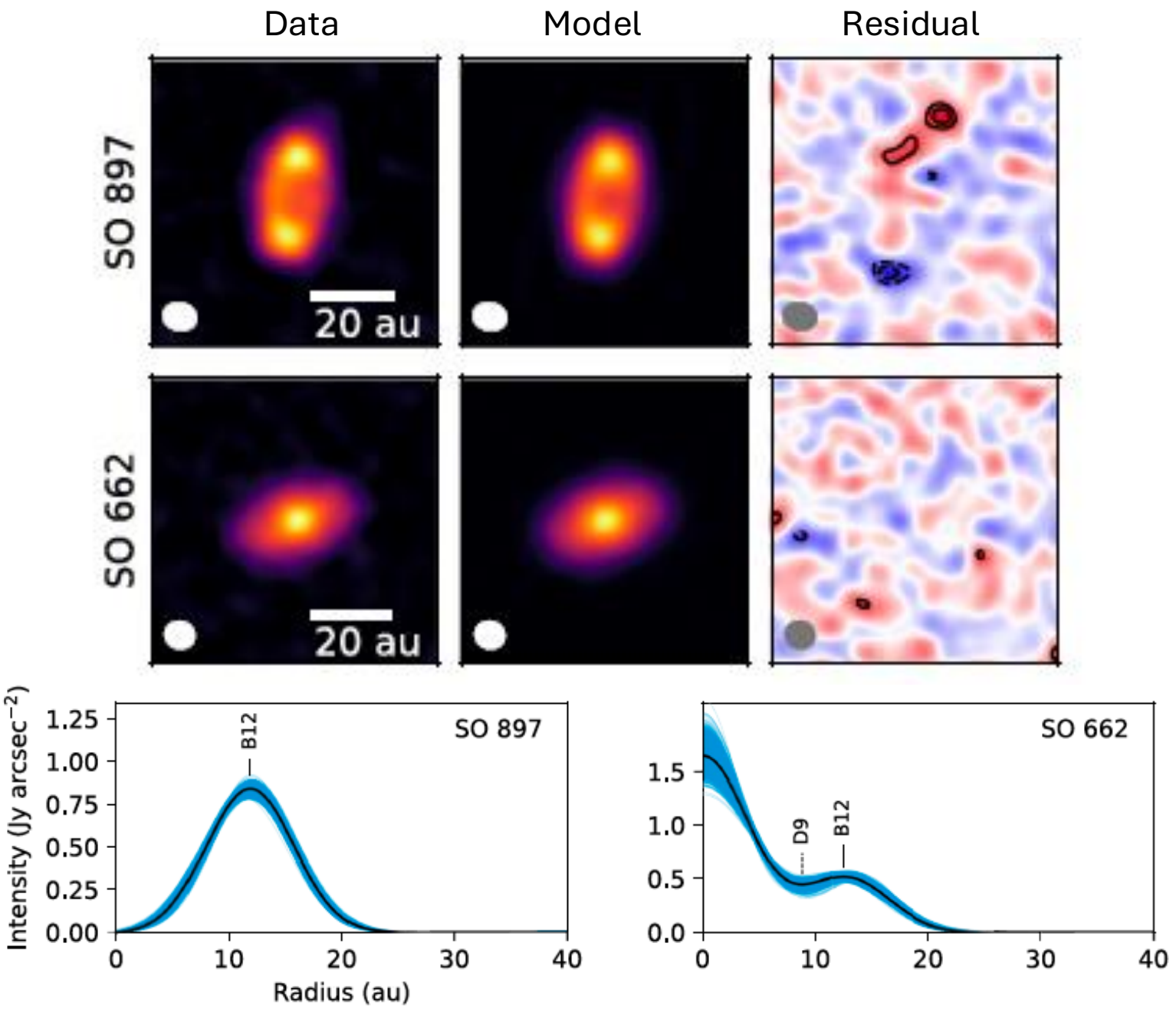


Figure from *Synthesis Imaging,* CASAdocs

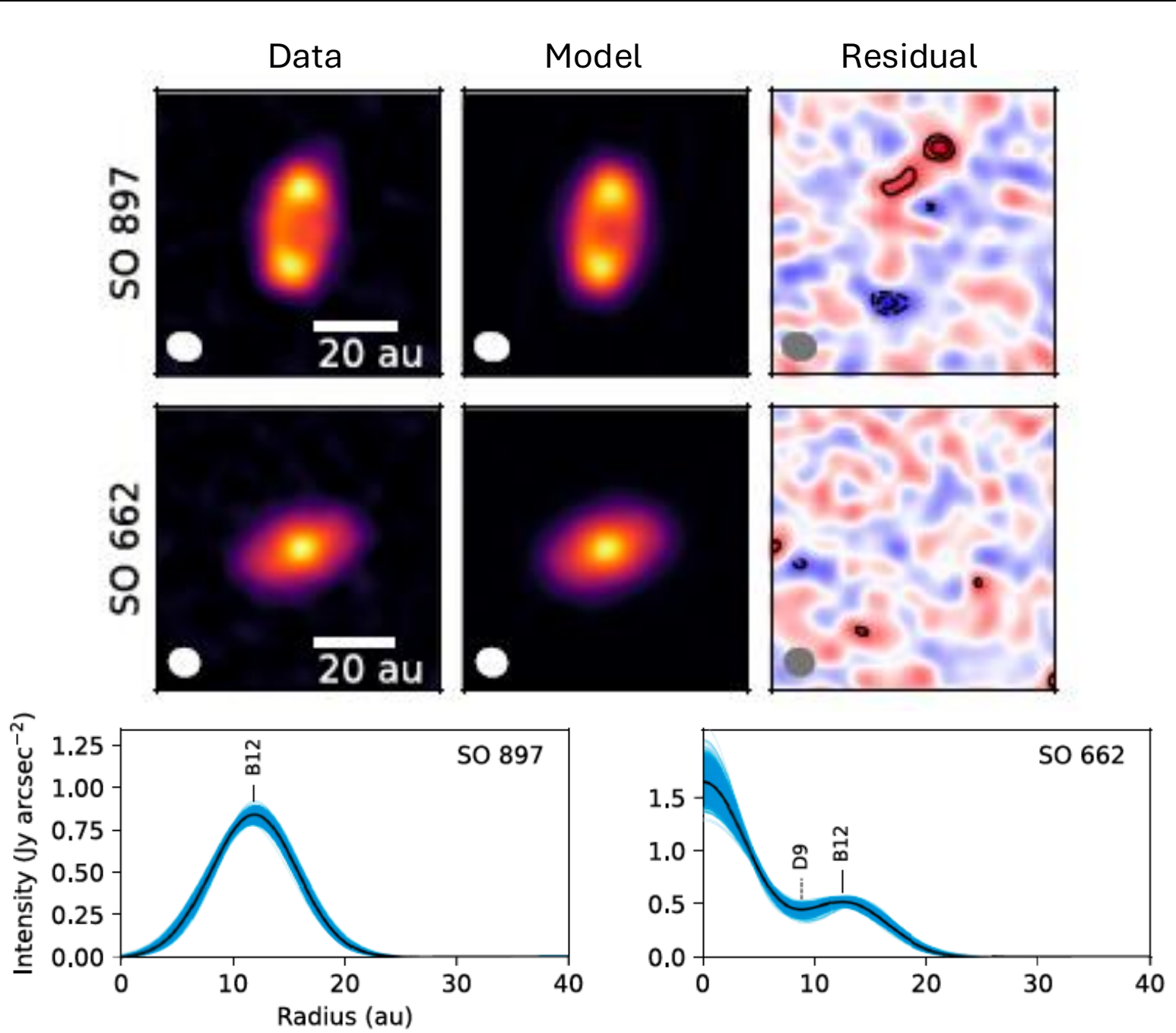
Model visibilities can be fit directly to observed data



Figures adapted from Huang et al., 2024, *ApJ,* **976,** 132

Visibility modelling can:

1) reveal sub-beam features
2) isolate asymmetries in the residual

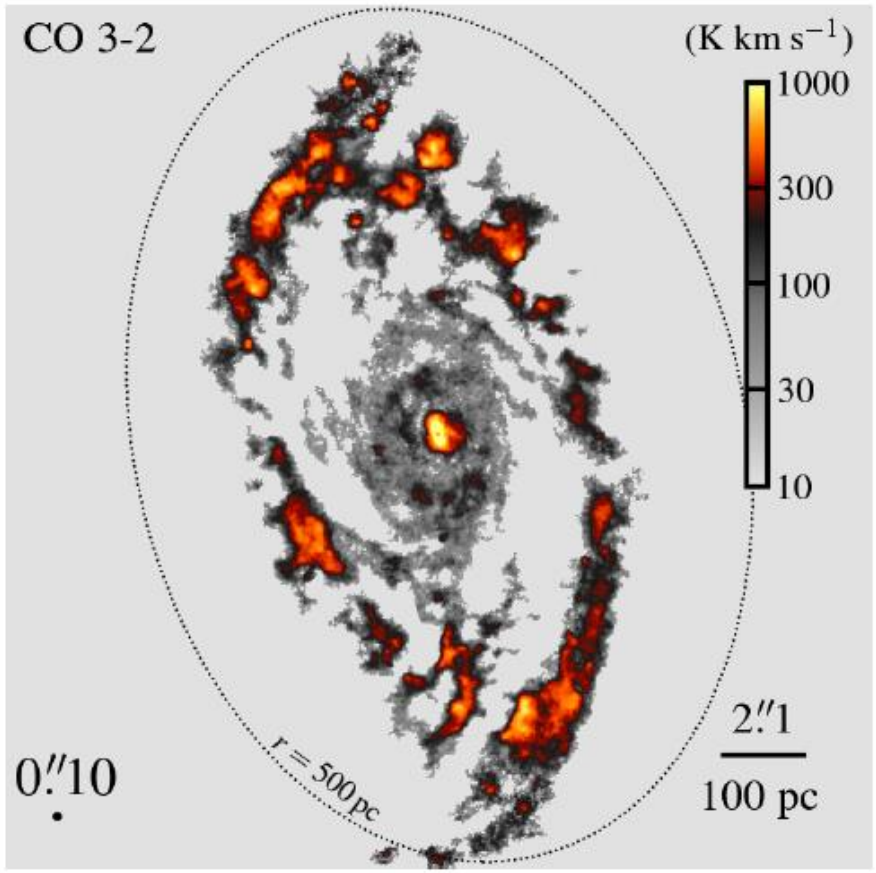


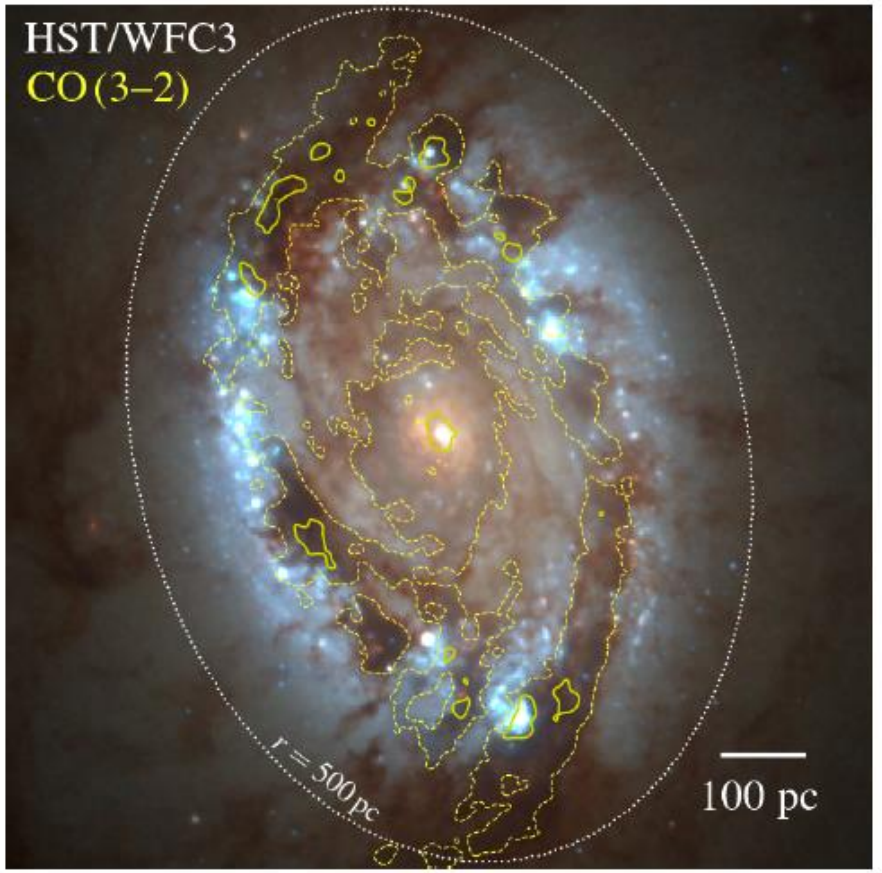
Figures adapted from Huang et al., 2024, *ApJ,* **976,** 132

Star-forming gas ring

Star formation is obscured by dust

93 GHz star formation not affected by dust



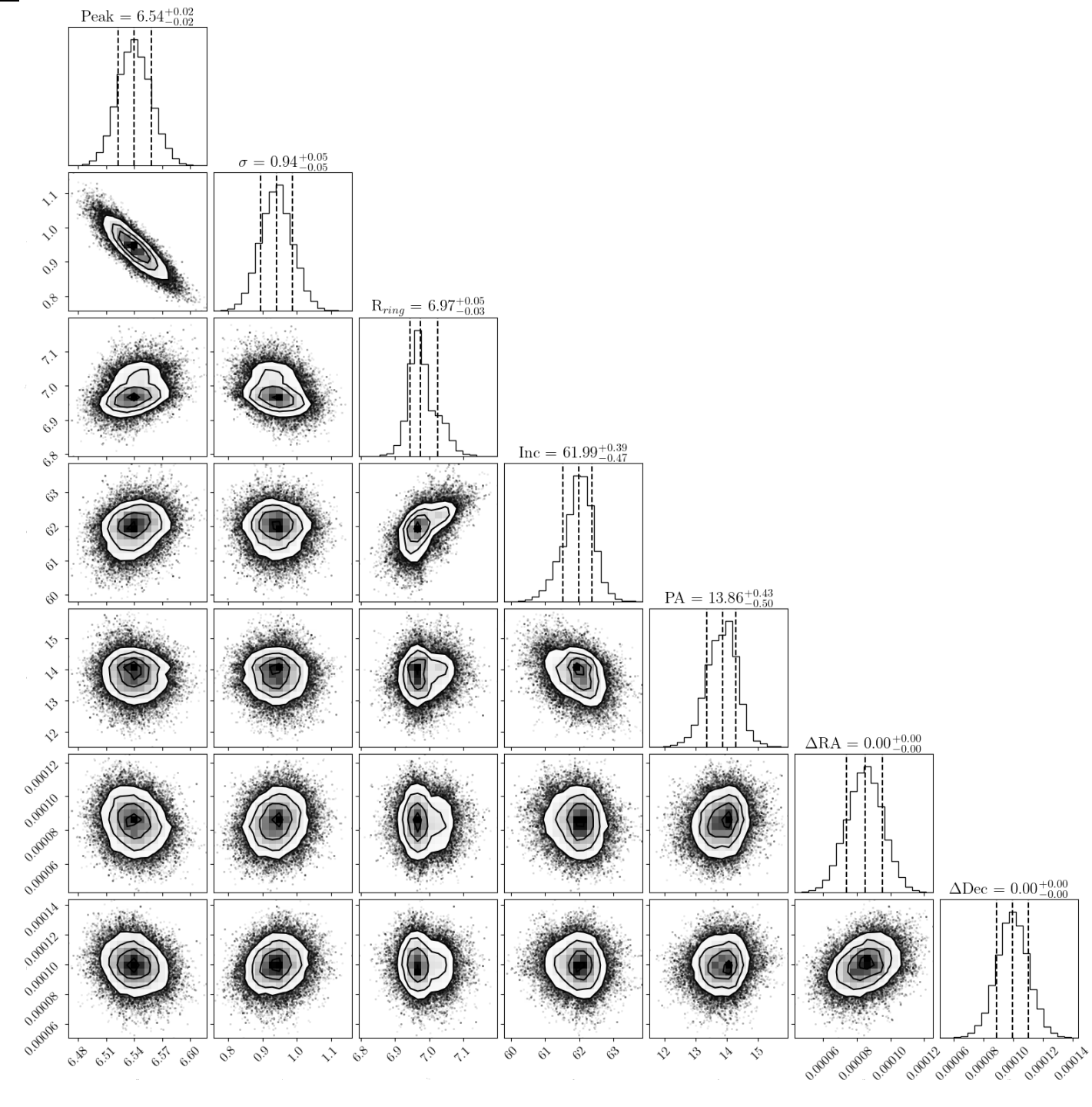


Figures adapted from Sun et al., 2024, *ApJ*, **967,** 133

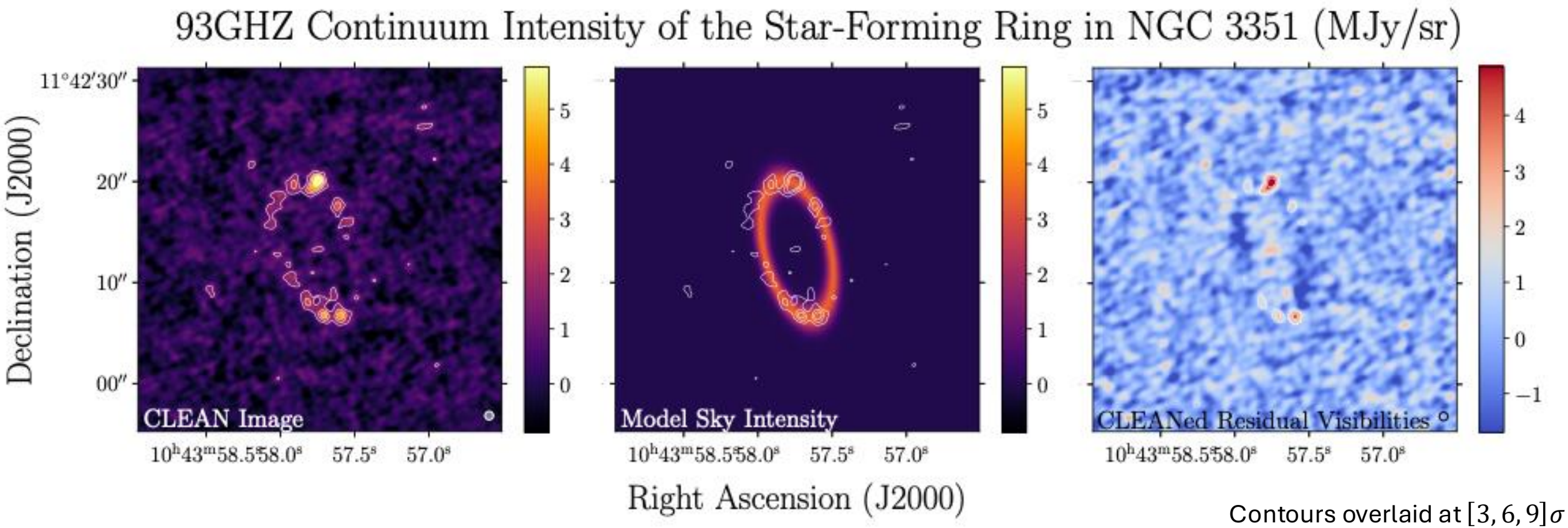
Visibility Fitting Method

emcee was used to implement an MCMC sampler for model fitting

- 100 walkers
- 150 step burn-in phase
- 3000 step fitting phase



Best Fit Ring Model



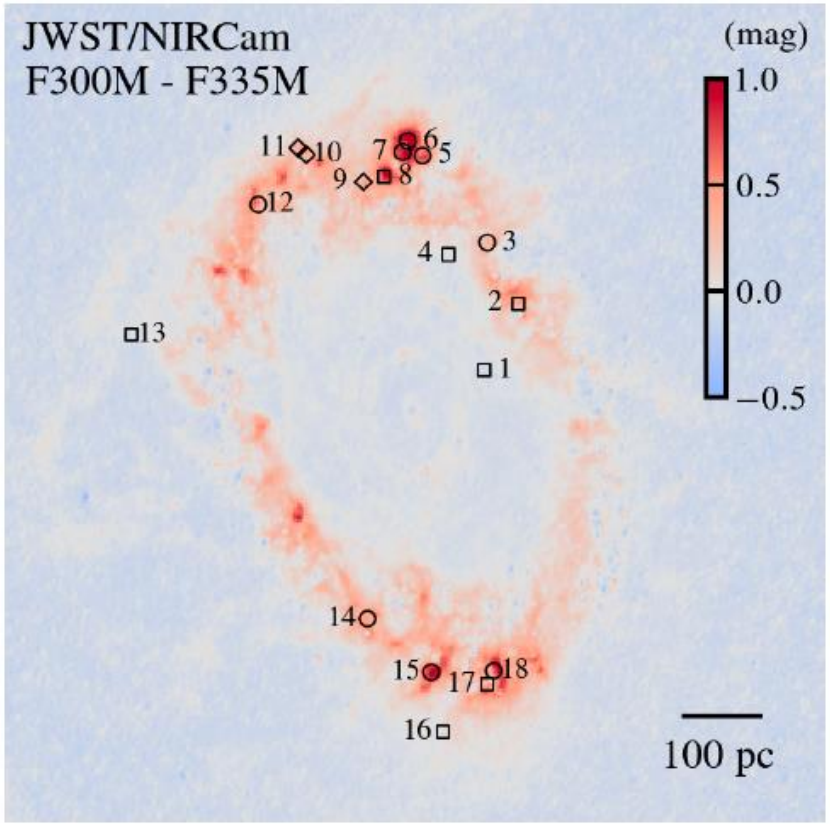
Contours overlaid at $[3, 6, 9]\sigma$

Overall ring structure reproduced in the best fit model

- Significant residuals remain for the point sources along the ring

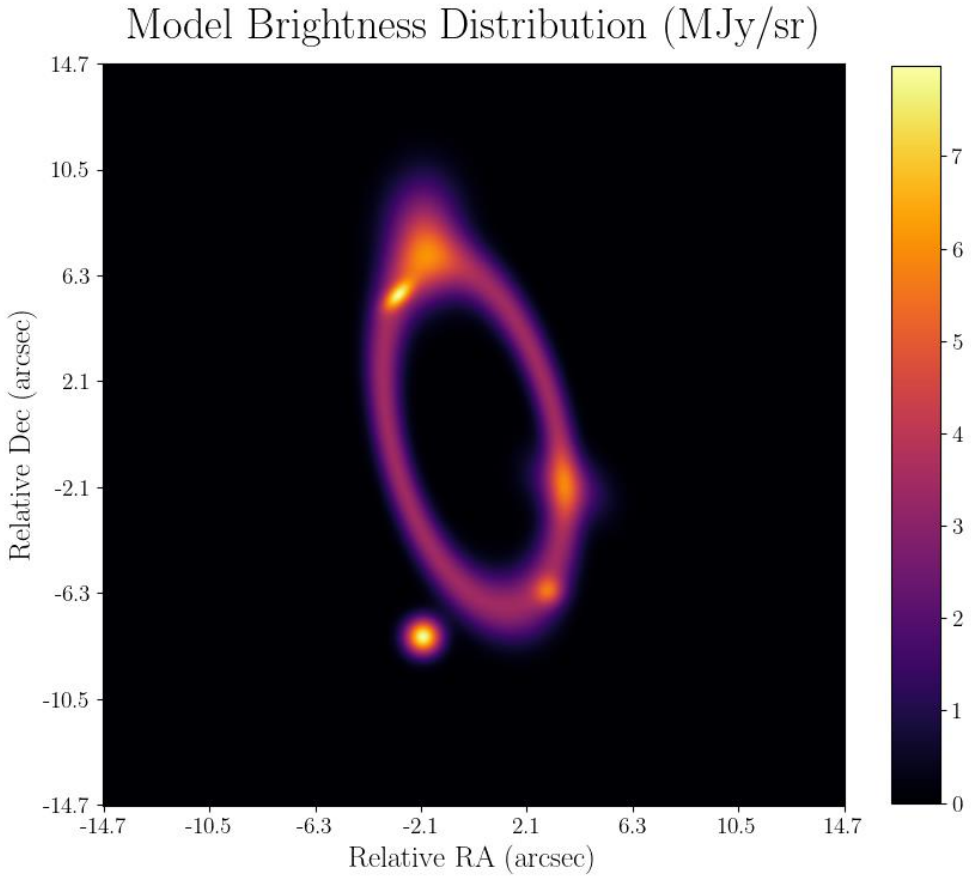
Future Directions

Multi-component models will allow more complex and accurate measurements of galaxy morphology.



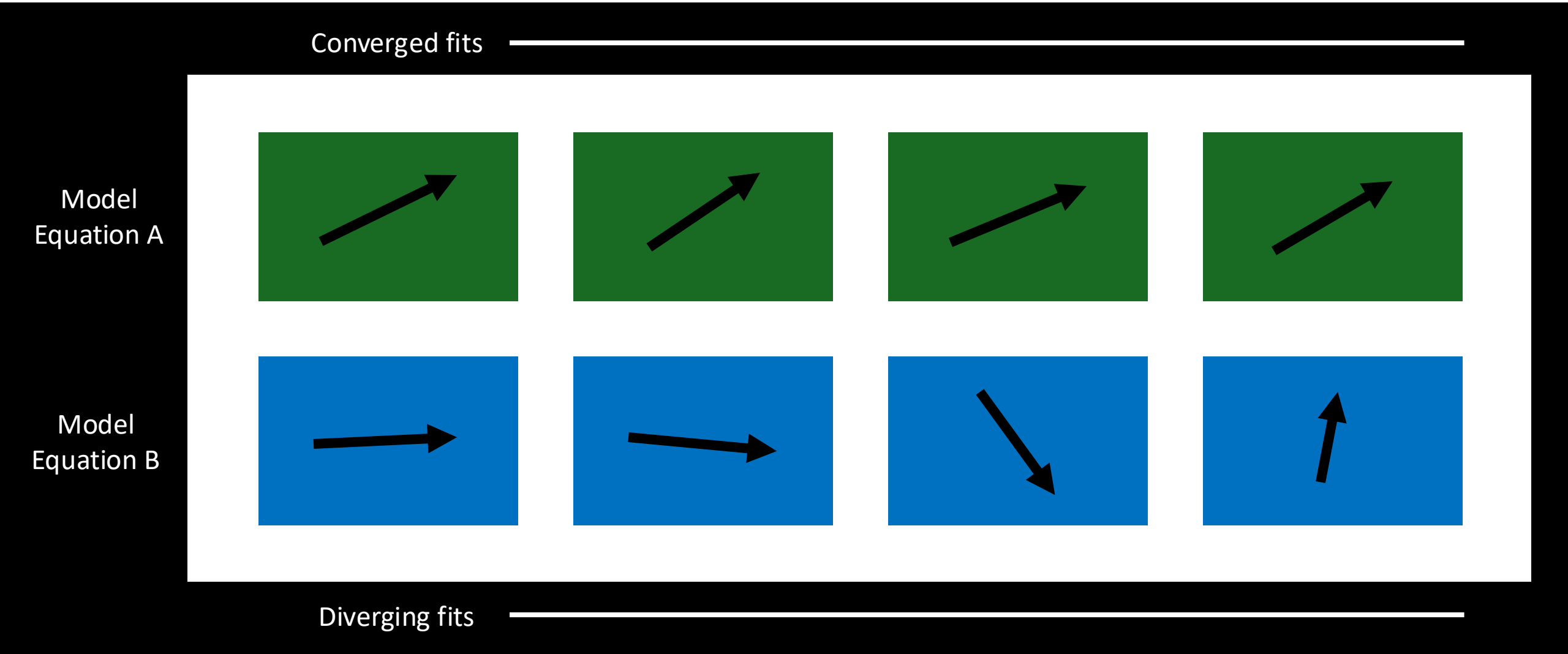
Left: NIRCam image of the inner ring in NGC 3351

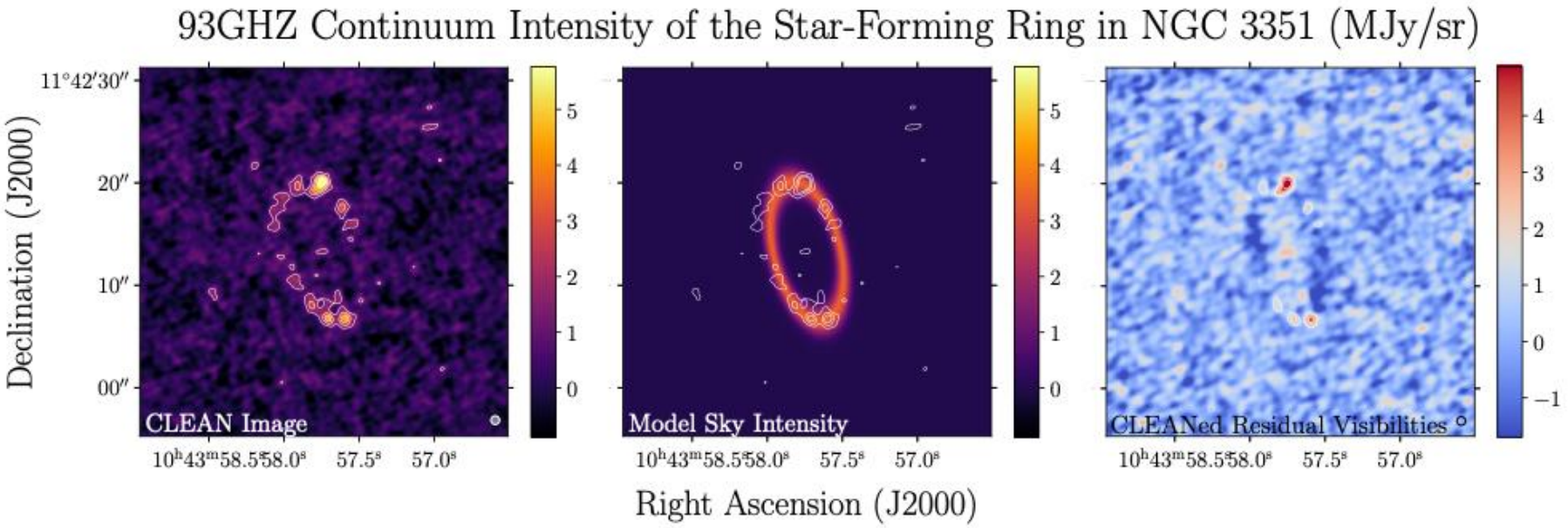
Right: Arbitrary example of a fitting model with a ring and 5 gaussian components



How strongly do the initial parameter guesses affect the fit achieved?

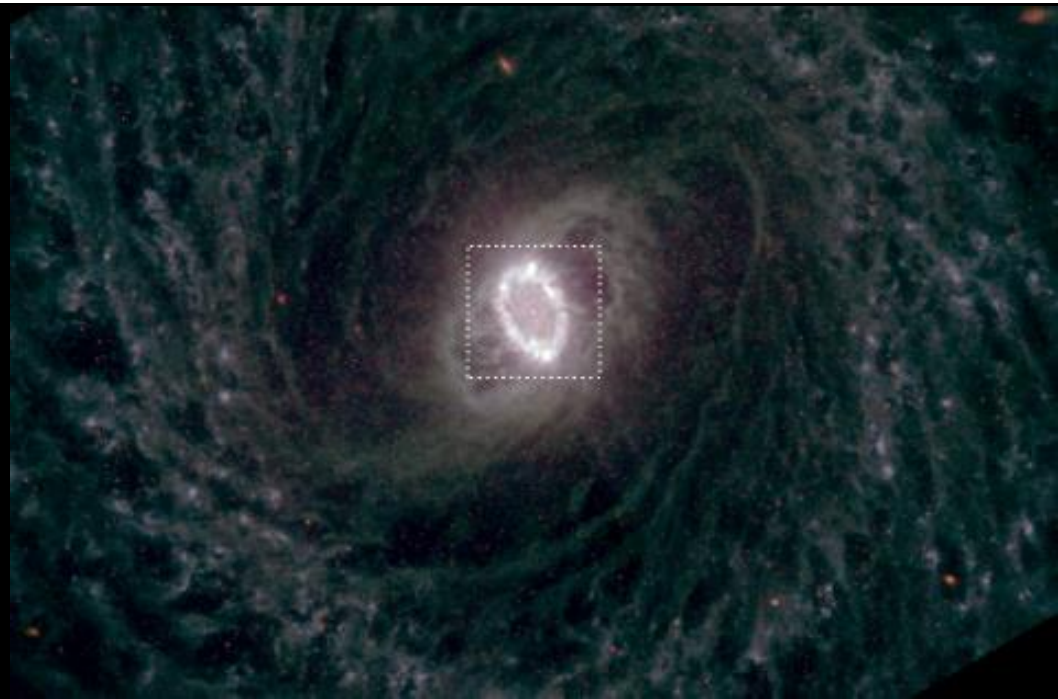
Is this fit the only solution? The best solution?





Visibility modelling is an effective technique for studying the morphology and brightness of star-forming regions in galaxies

Future work is necessary to make a more comprehensive tool



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Thank you to Helen Kirk, Samuel Fielder and Jess Speedie for their help in understanding imaging with ALMA.