Use data not models – Lensing of '69

An example for data-driven inference

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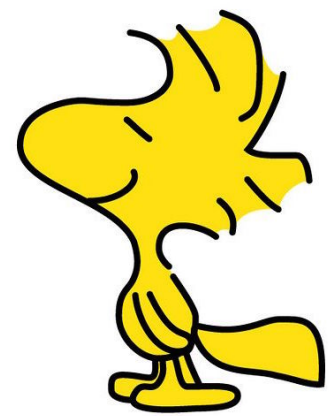
Debating the potential of machine learning
in astrophysical surveys



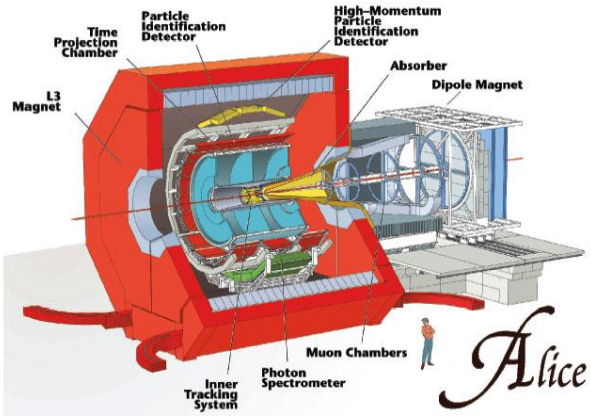
Artificial Intelligence and Artificial Stupidity

Artificial Intelligence requires human understanding of model building

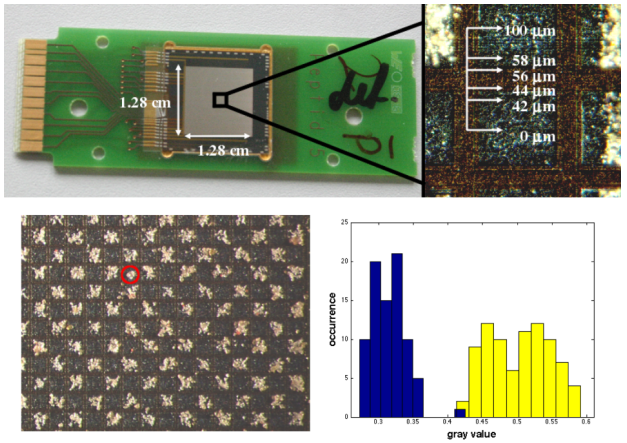
Image credits: China Daily; D. Heaven, Nature **574**, 163-166 (2019)

My learning process

1) Particle physics pattern recognition



2) Life science image processing



3) Cosmological singularity theory

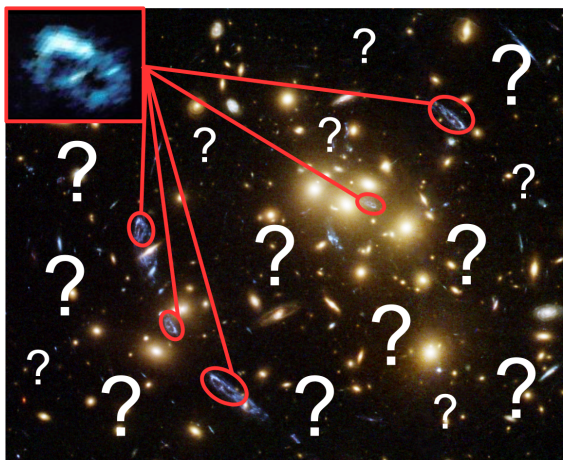
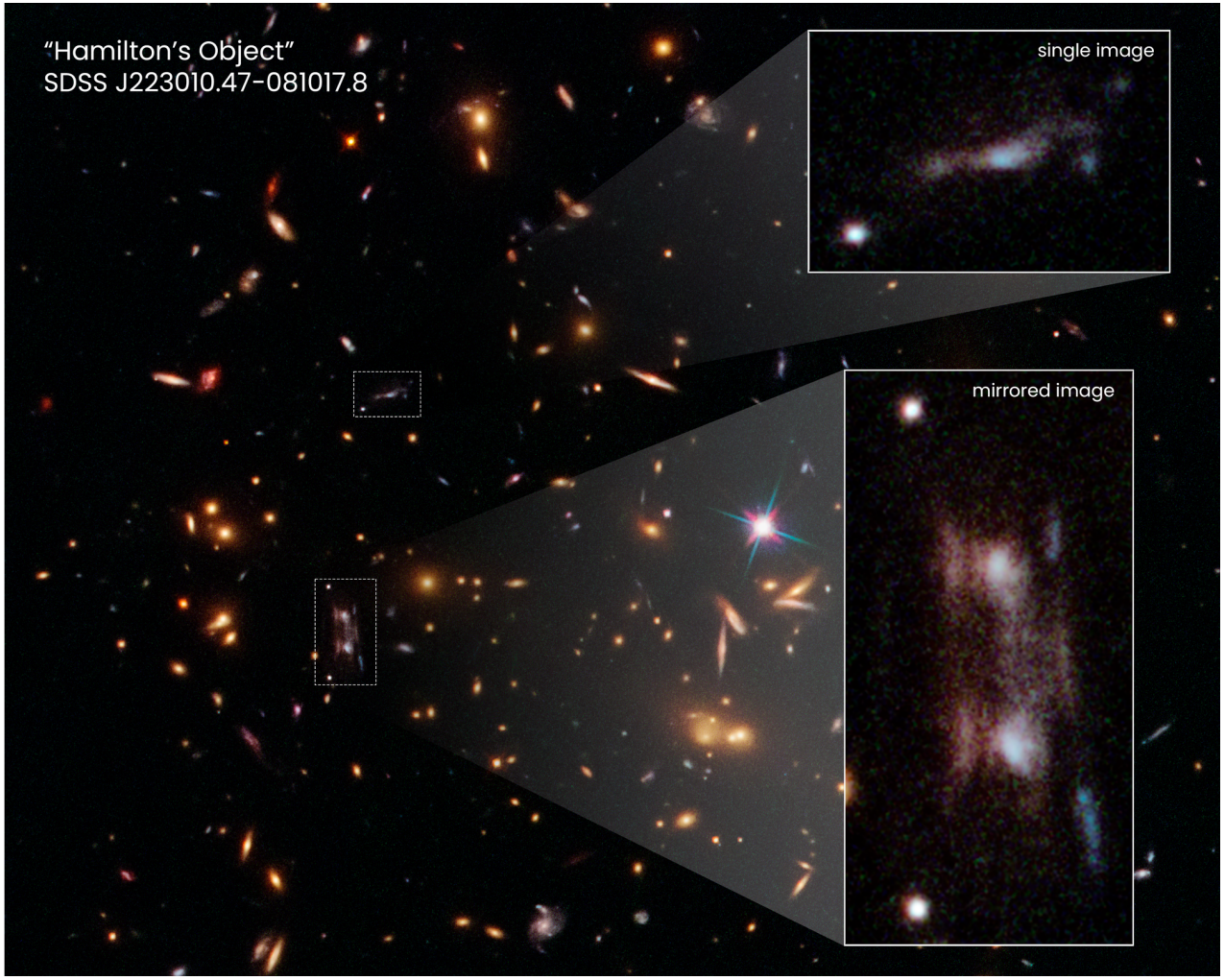


Image credits: CERN; NASA/Hubble

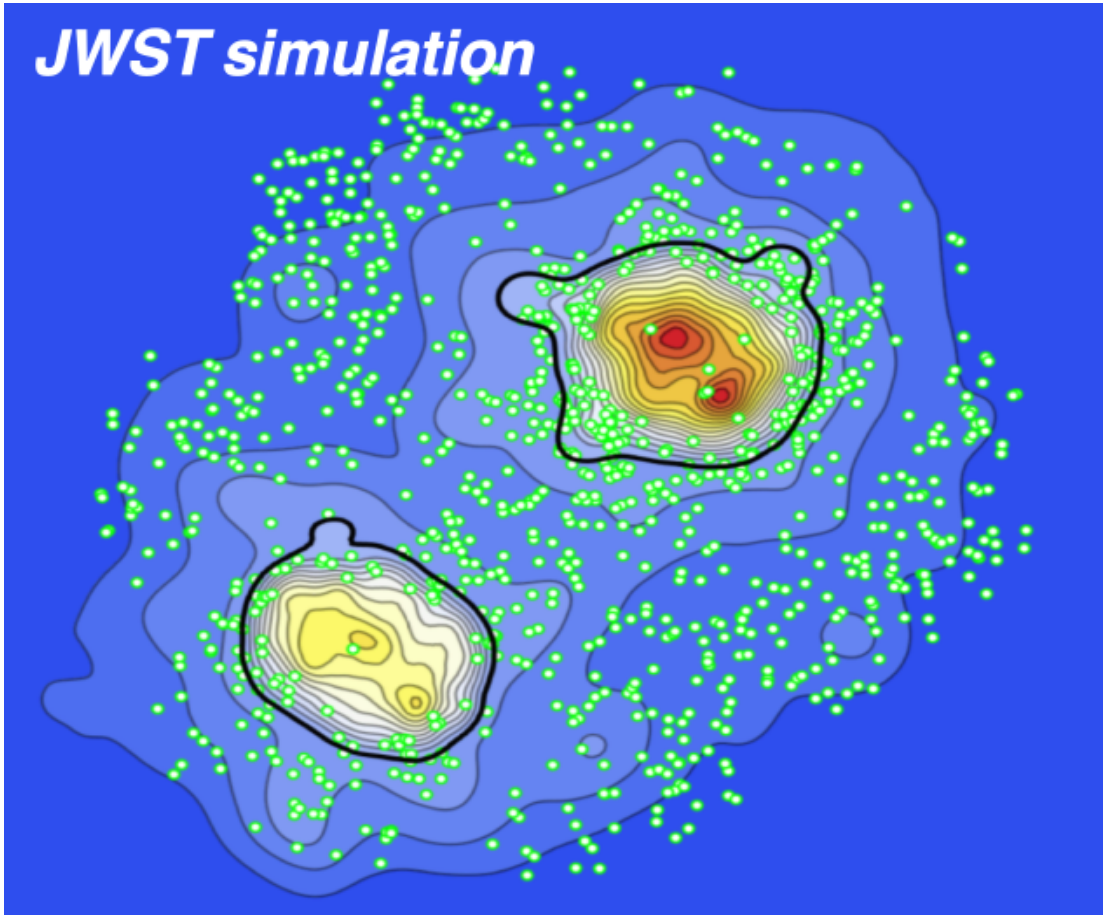
Why back to maths? Reason 1: Model fit not possible



Data too sparse to fit a model

Image credits: J. DePasquale STScI; R. Griffiths et al. MNRAS **506**(2), pp.1595-1608 (2021)

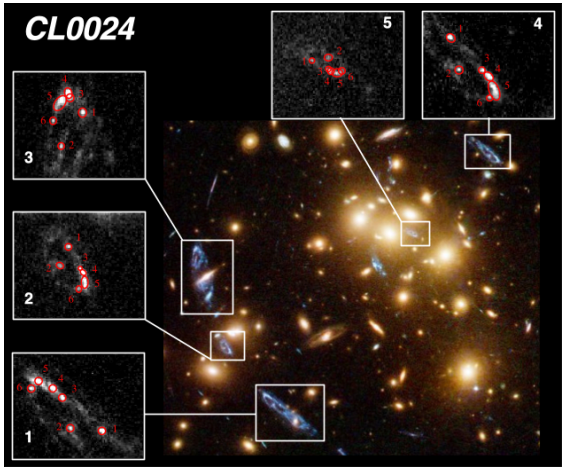
Why back to maths? Reason 2: Model fit not neccessary

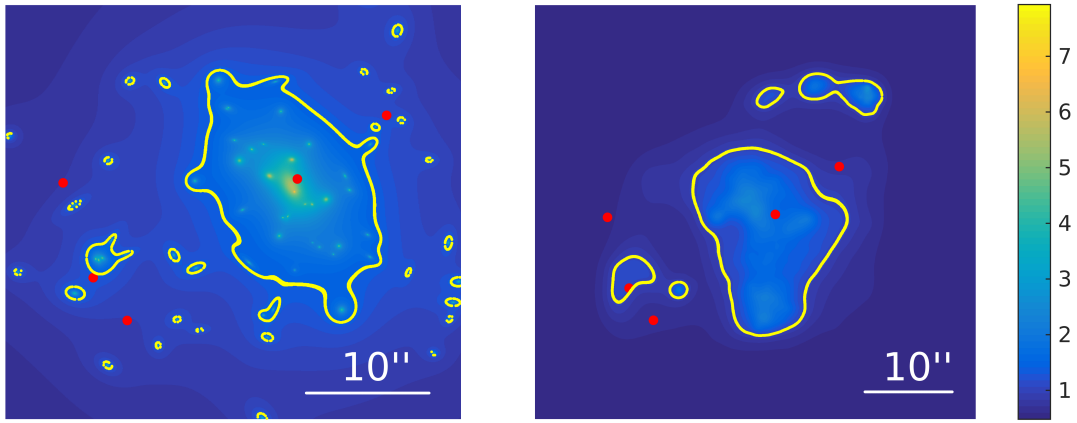


Data covers most of the area of interest

Image credits: A. Ghosh et al. MNRAS **494**(3), pp.3998-4014 (2020)

Why back to maths? Reason 3: Model fit not unique





Several models explain data equally well

Image credits: NASA/ESA M. J. Jee, H. Ford; J. Wagner, J. Liesenborgs, N. Tessore A&A **612**, A17 (2018)

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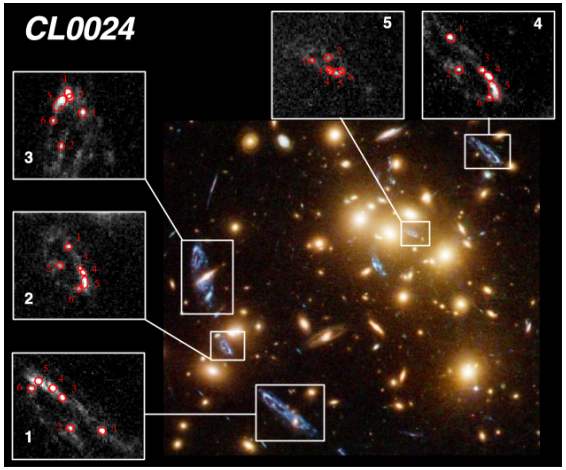
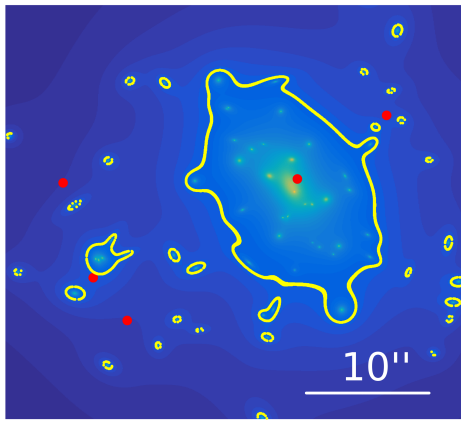
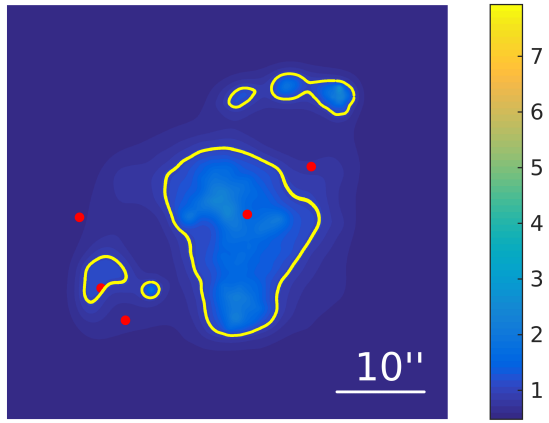






Several models explain data equally well

Observables constrain local properties

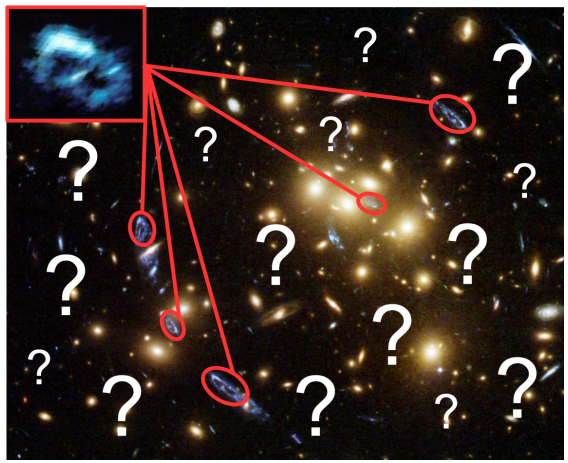
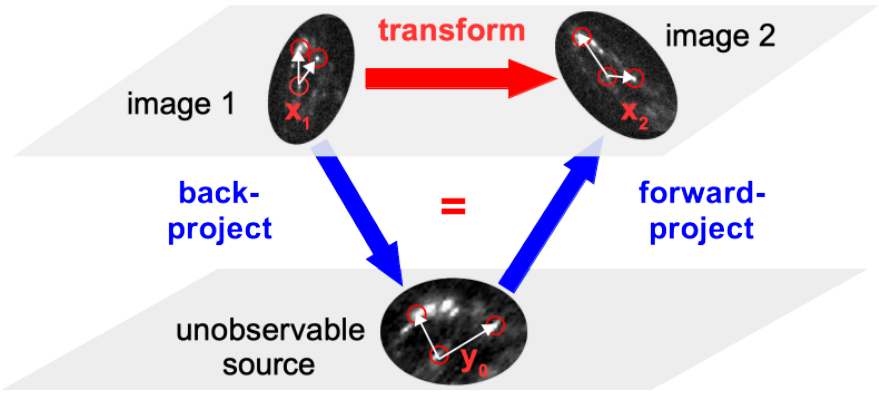


Image credits: NASA/ESA M. J. Jee, H. Ford; J. Wagner, J. Liesenborgs, N. Tessore A&A **612**, A17 (2018)

Use data not models – get back to the formalism



local distortions (amplitude & direction)

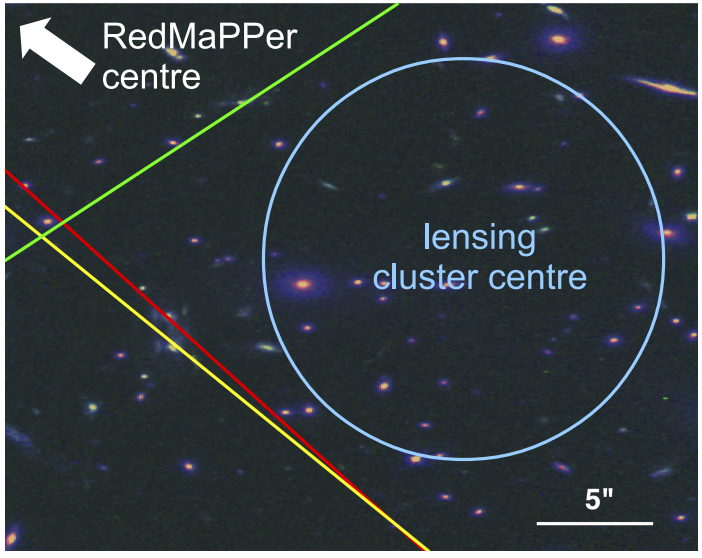
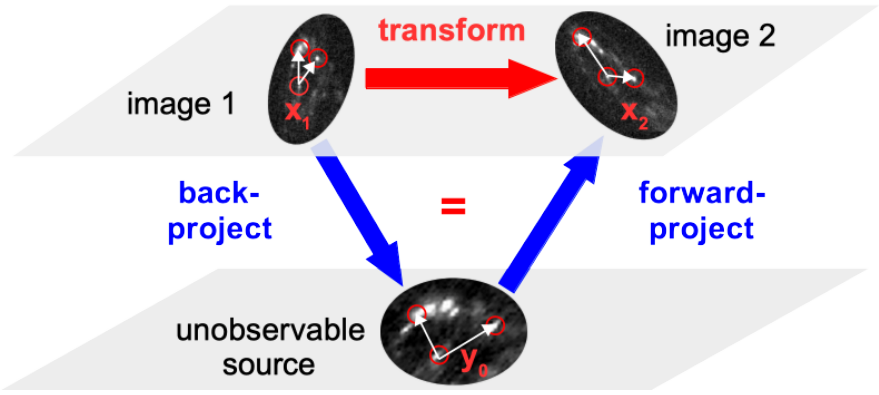


Image credits: Wagner, Universe **5**(7) (2019); R. Griffiths et al. MNRAS **506**(2) (2021)

Use data not models – get back to the formalism



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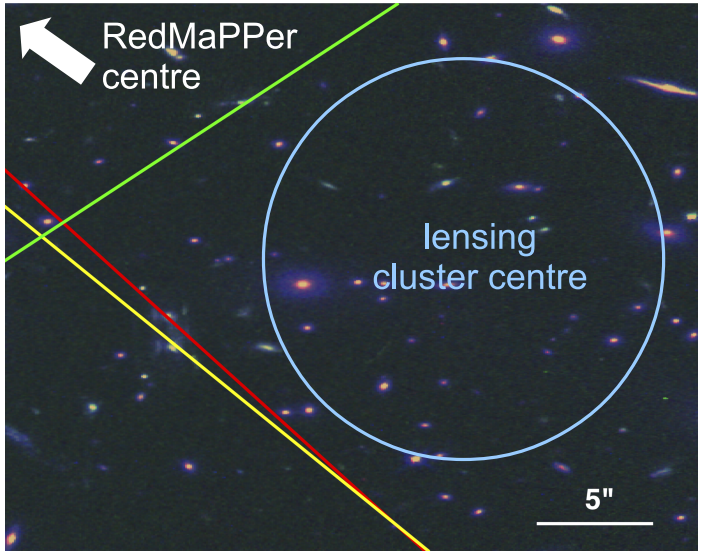
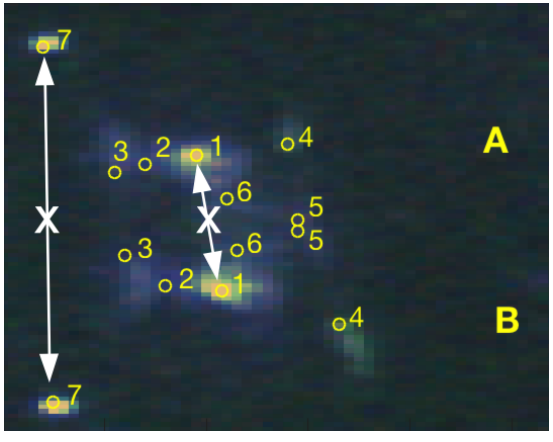




critical curve (linear approximation)

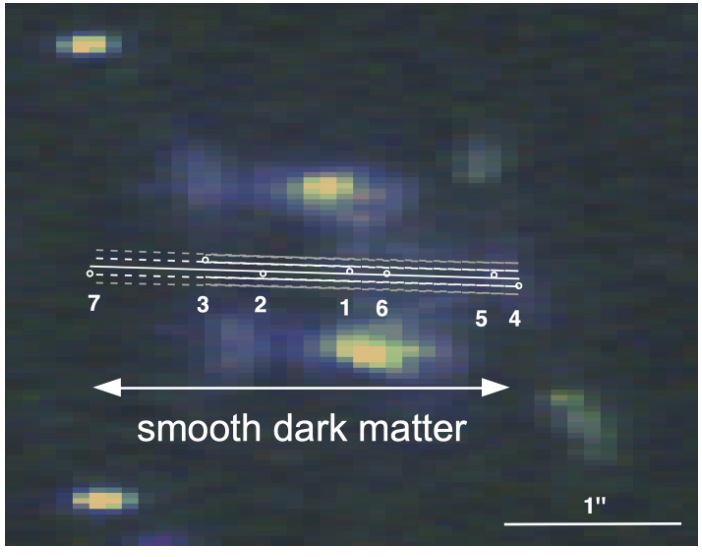
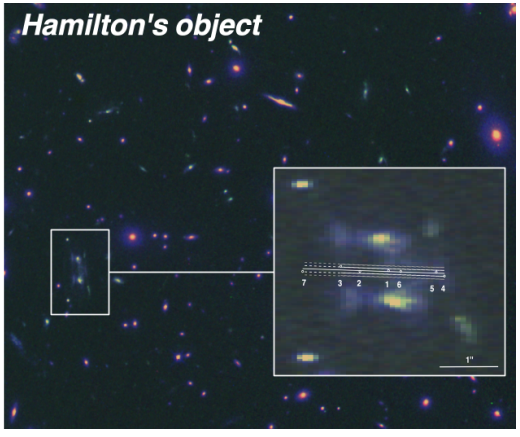


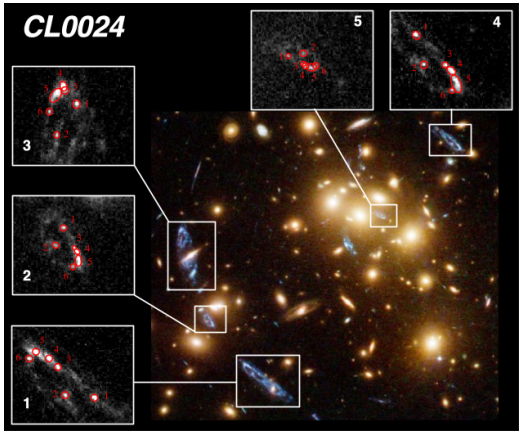
Image credits: Wagner, Universe **5**(7) (2019); R. Griffiths et al. MNRAS **506**(2) (2021)

Summary & Model extensions

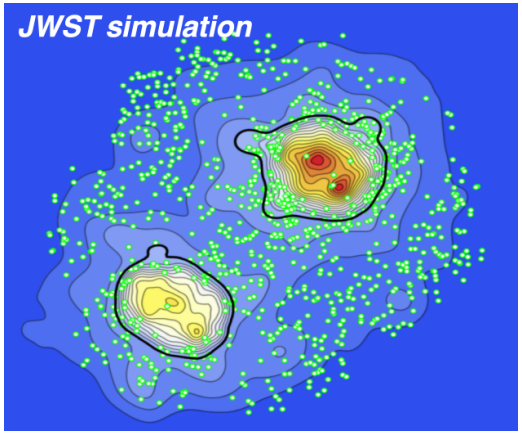
explore distortions in sparse data



verify assumptions by model comparison



reconstruct a lens by joining data



local approach for sparse and large data sets

extended by models into data-devoid regions

machine learning support for modelling and model selection