Title: Generative AI for Image Reconstruction: A First Attempt

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Collection/Series: Future Prospects of Intensity Interferometry

Subject: Cosmology

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Abstract:

In modern astronomy, artificial intelligence (AI) is increasingly utilized to analyze large volumes of data, significantly reducing the need for human computational resources and time. Machine learning (ML) techniques are at the forefront of revealing astronomical mysteries by analyzing observed data. Here, we will introduce the application of machine learning to Intensity Interferometry (II) data for high-resolution optical astronomy, aiming to overcome the limitations of traditional image reconstruction methods. In this presentation, we demonstrate successful image reconstruction of a fast-rotating star using conditional Generative Adversarial Networks (cGANs), a supervised machine learning approach. Simulations of II are based on an assembly of four telescopes similar to existing arrays. However, the sensitivity of the signal and high resolution are expected to improve with additional baselines. It makes the current and future Cherenkov Telescope Array Observatory (CTAO) an ideal candidate for II applications. Our approach is highly relevant and innovative, addressing key challenges in phase reconstruction and proposing novel solutions that could revolutionize high-resolution imaging in astronomy.

Generative AI for Image Reconstruction: a First Attempt

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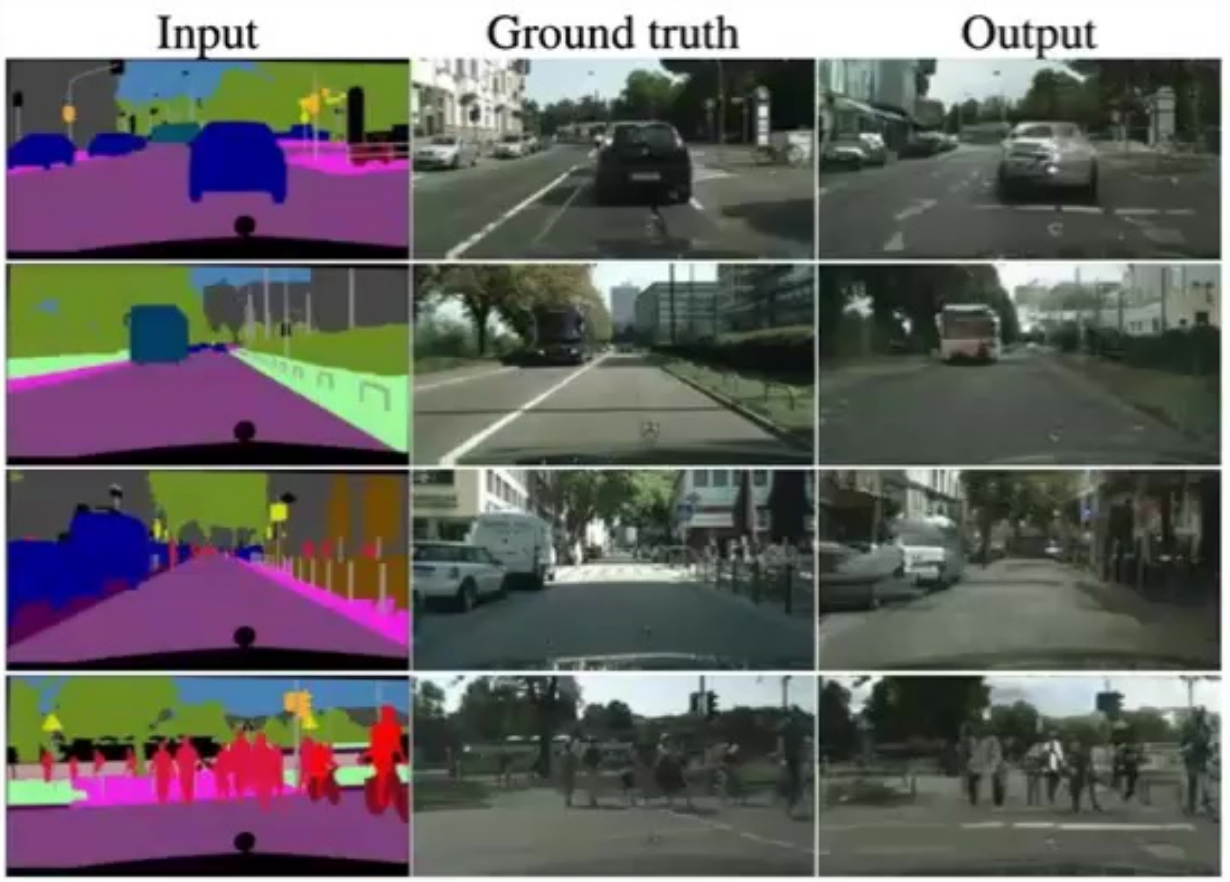
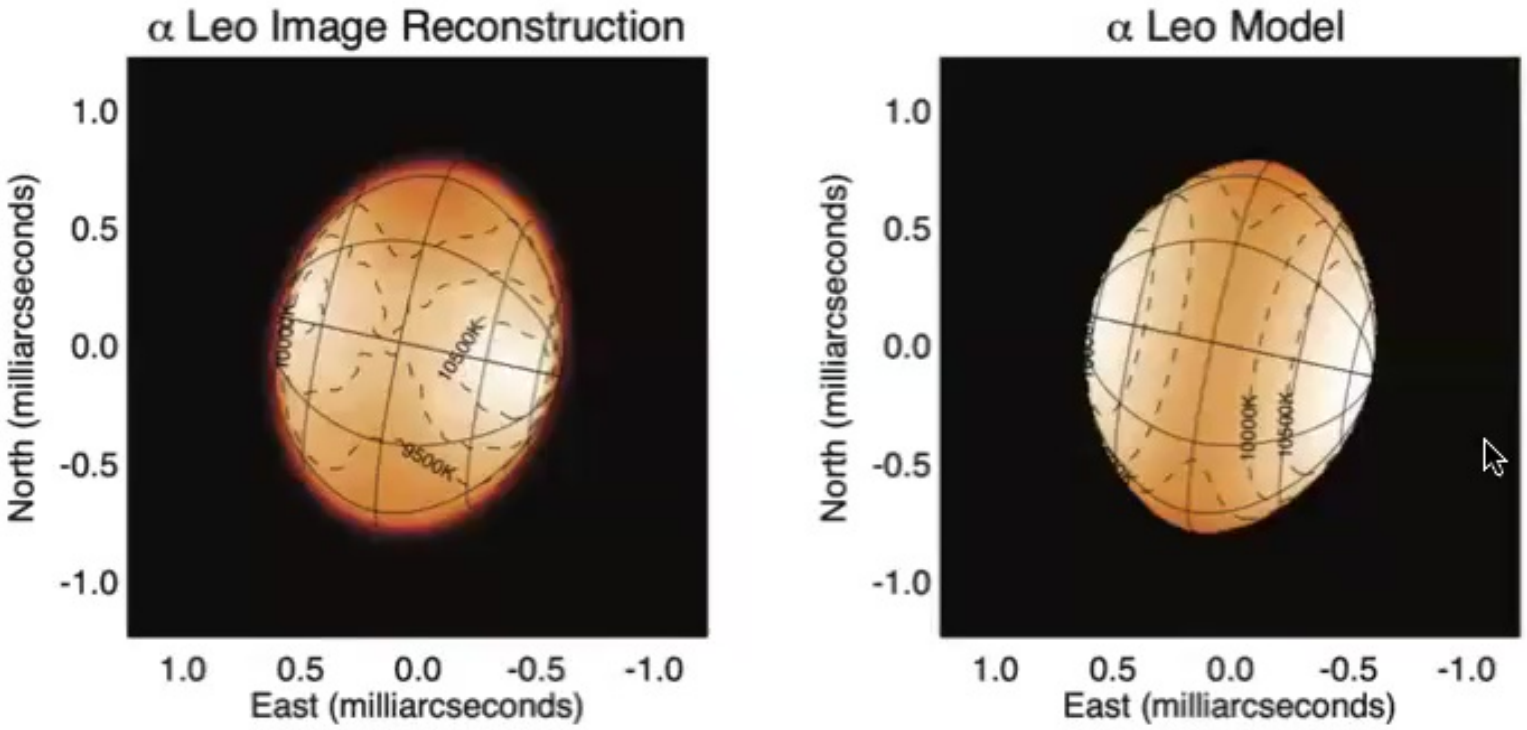
Can we adapt this?



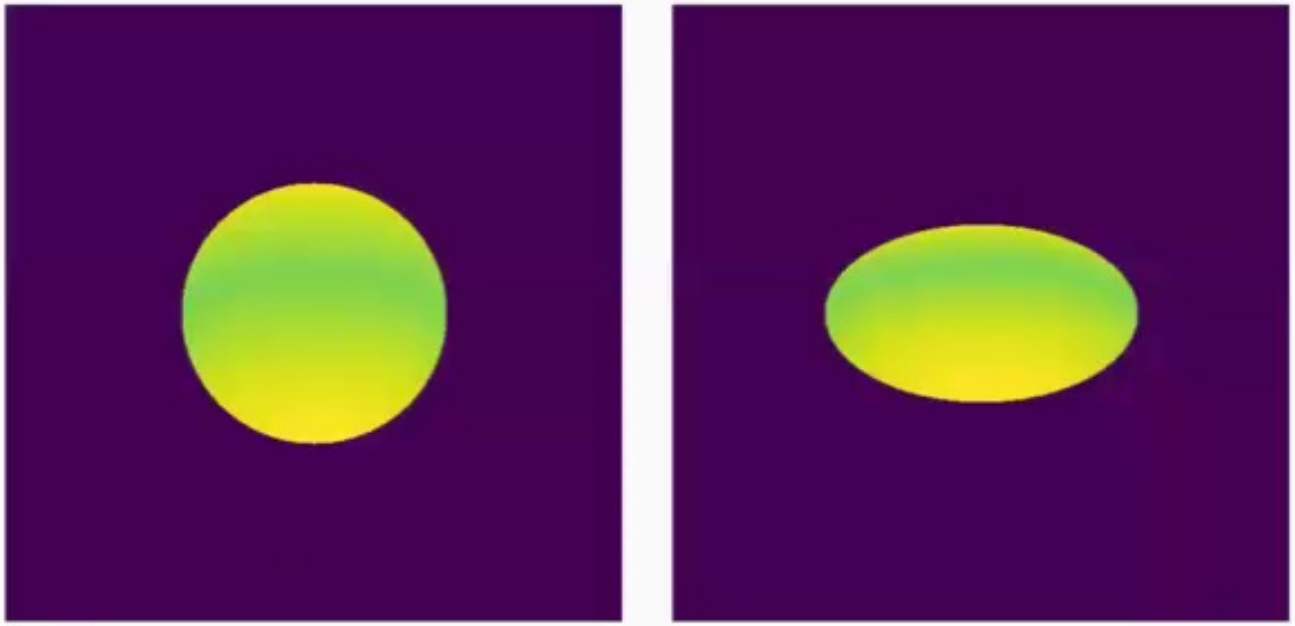
https://phillipi.github.io/pix2pix/

Gravity Darkening

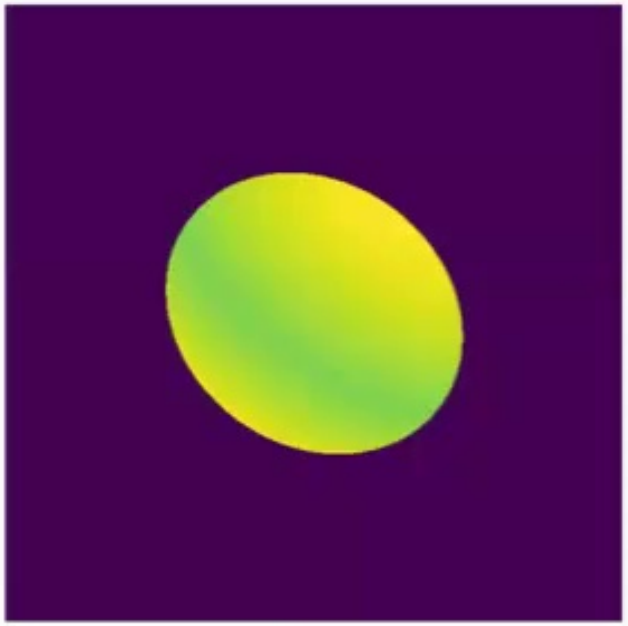


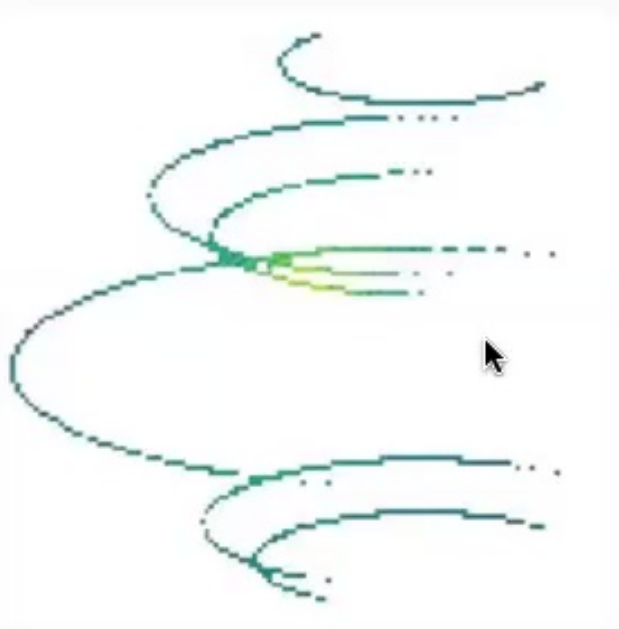
Che et al (2009) using CHARA

Make a training set



Make a training set

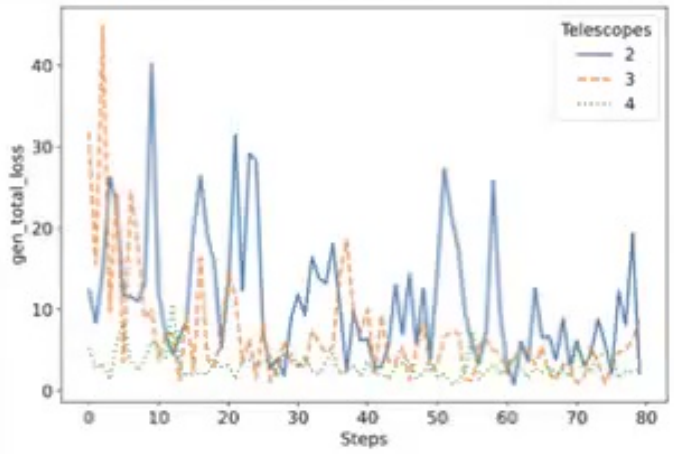


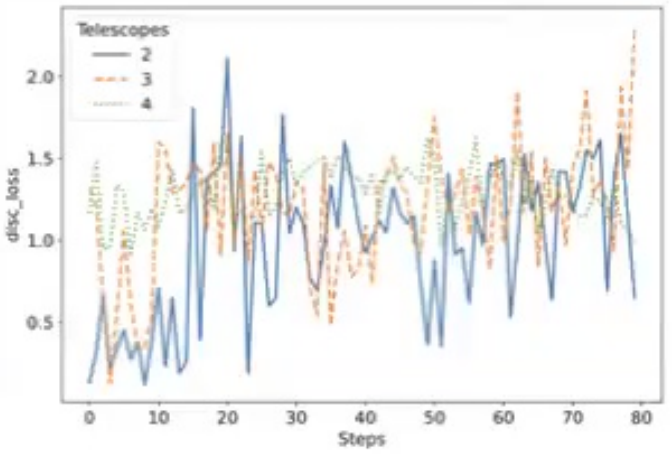


The training set has 60 000 of these.

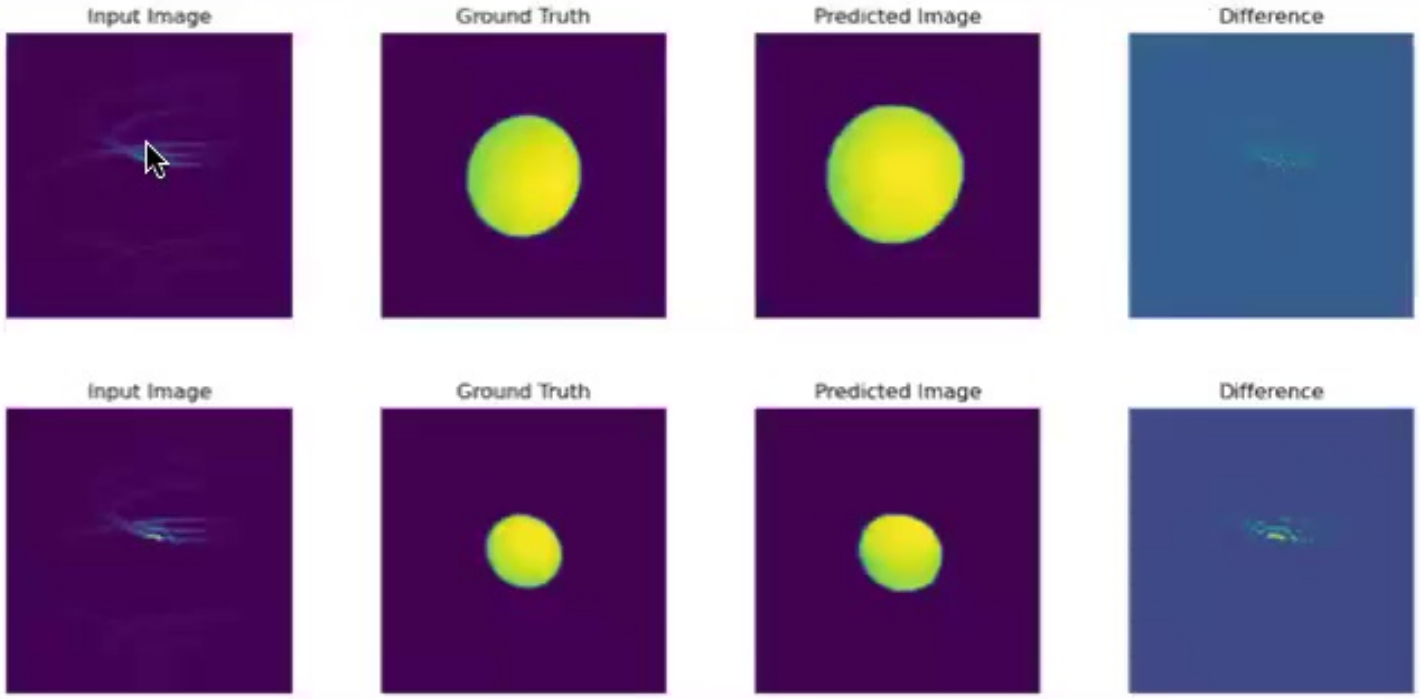
A cGAN

- One network (the generator) produces images from sparse II data.
- A second network (the discriminator) separates good and bad images.
- These are trained alternately.

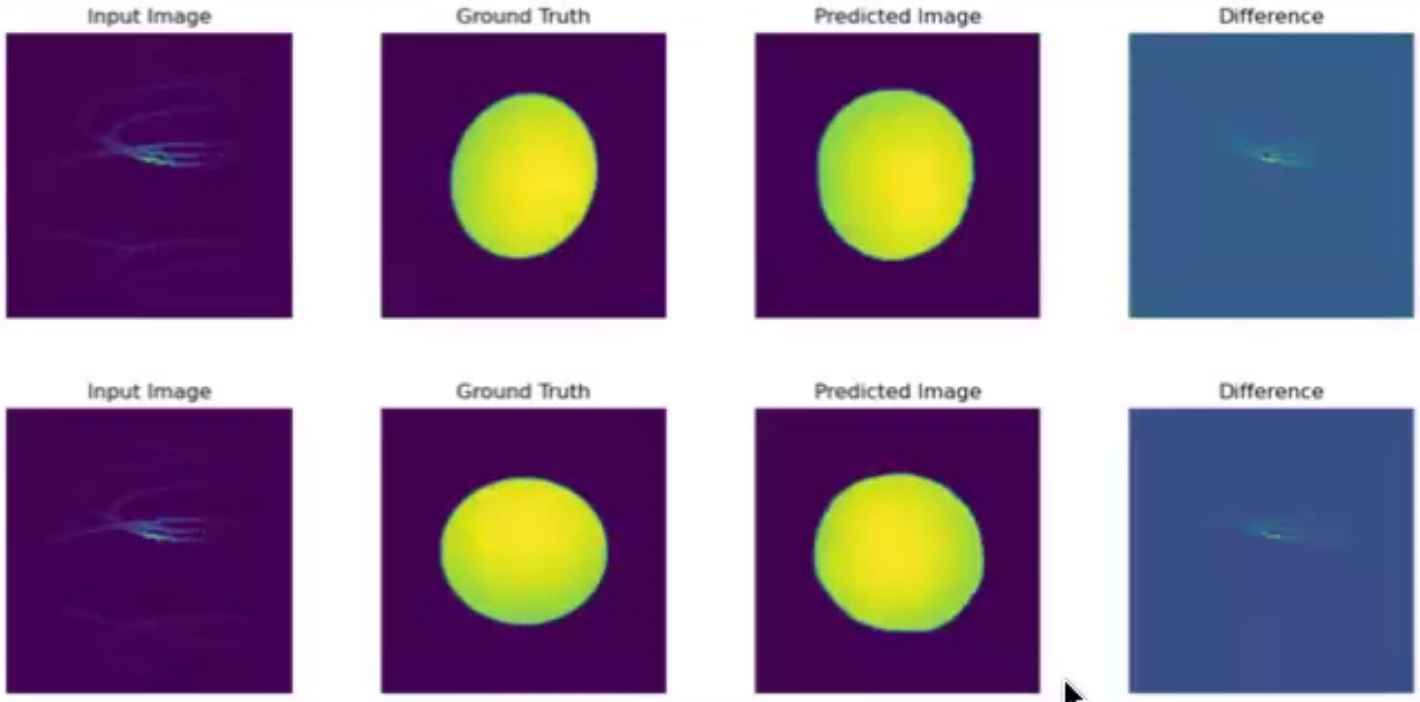




Results


Input Image
Ground Truth
Predicted Image
Difference
Input Image
Ground Truth
Predicted Image
Difference

Results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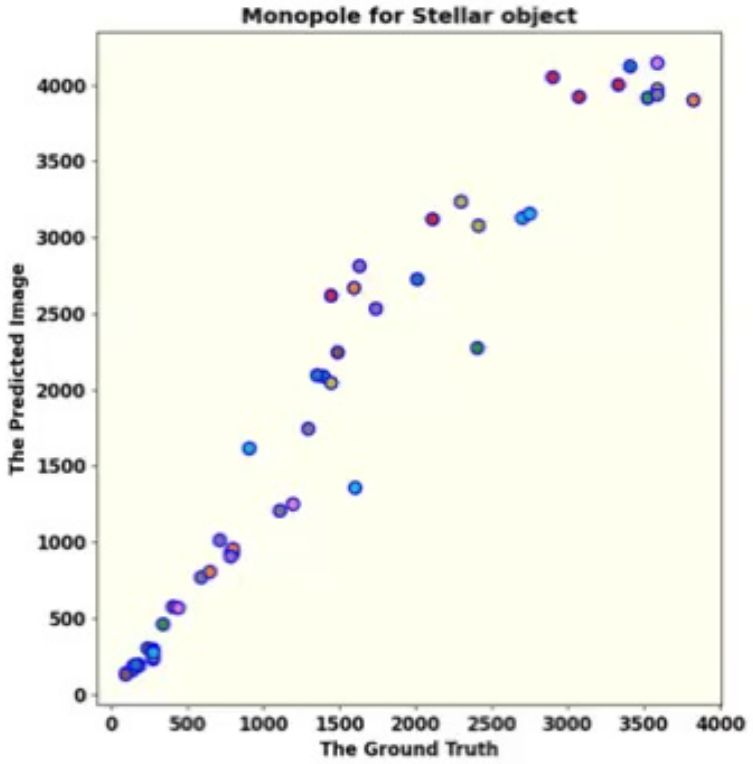
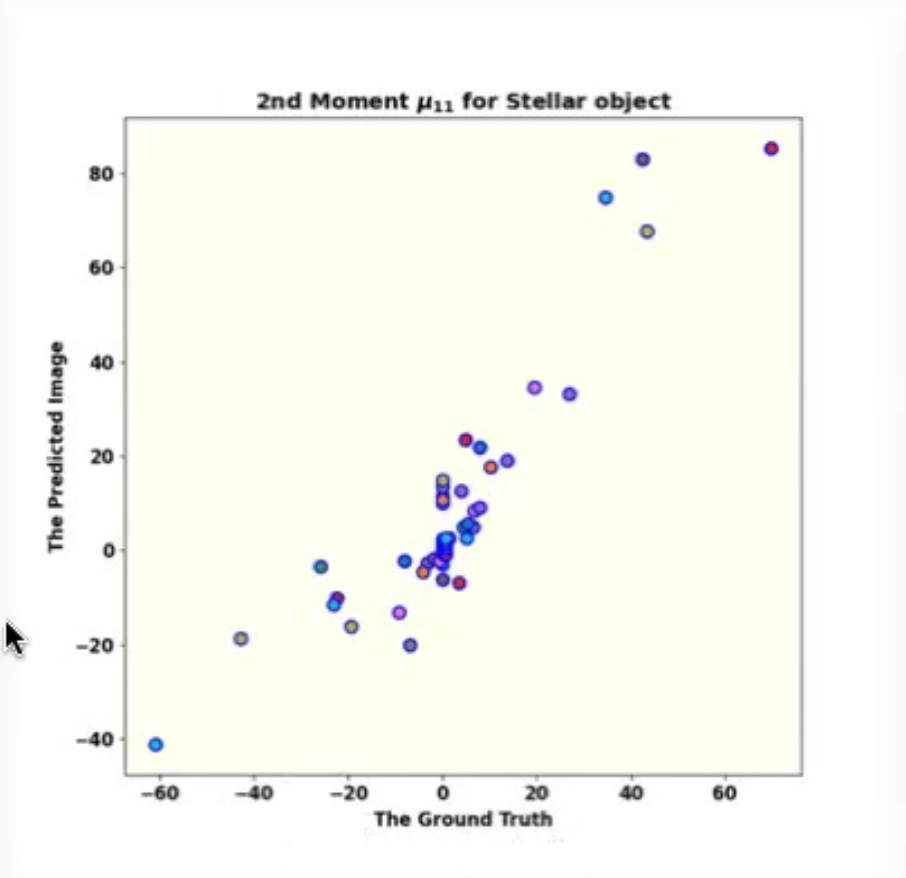
Difference

Recovery of Multipoles



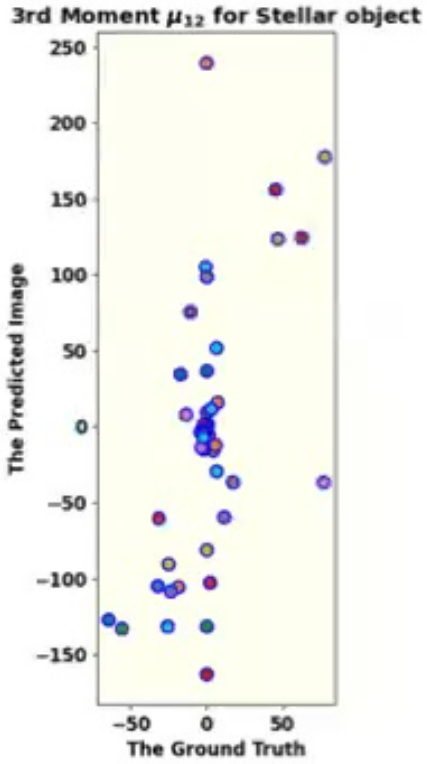
Monopole is well recovered.

Recovery of Multipoles



Second moment is also well recovered.

Recovery of Multipoles



Third moment is less good.

Summary

- Adapting an off-the-shelf code gives encouraging results for reconstructing gravity-darkening using ${}^4C_2$ baselines.
- Interpretion of loss functions desirable.
- Next step: simulations of interacting binaries as training set?