National Aeronautics and Space Administration

Postdoc Research

Weak Lensing Calibration for the *Euclid* Mission

Authors: Diana Scognamiglio & Andre Vitorelli
JPL Postdoctoral fellows (3268)
Collaborator: Eric Huff (3268)

Background

Mission: Launched successfully on July 1 2023, aboard a SpaceX Falcon 9 from Cape Canaveral to Earth-Sun Lagrange point 2 (L2), *Euclid*, an ESA/NASA Medium-Class Mission, will observe a 15,000 deg^2 area over its 6-year duration. It will map the spatial distribution of matter in the Universe, influenced by the Universe's expansion and dark matter properties, primarily employing two methods: **weak gravitational lensing** (WL) and **galaxy clustering.**

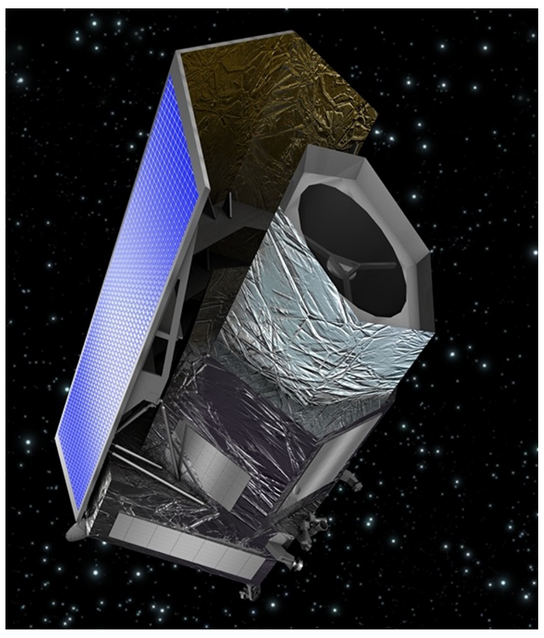

Figure 1: The Euclid telescope

Weak Gravitational Lensing: WL, a consequence of Einstein's General Relativity, distorts distant galaxy shapes by about 1% as their light passes through foreground mass structures (cosmic shear, as we referred to). This effect, caused by gravitational deflection, serves as a robust probe of matter distribution, independent of the foreground mass' nature and state.

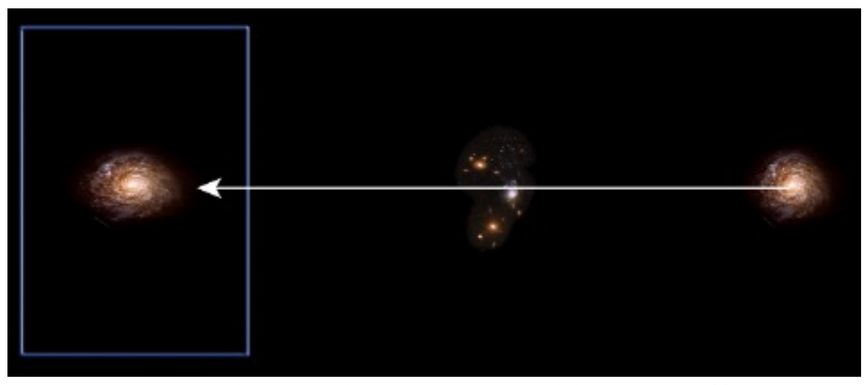

Figure 2: The weak gravitational lensing effect

Challenges: When we observe a galaxy, systematic errors due to many effects can arise, biasing the shear measurements, Fig. 3.

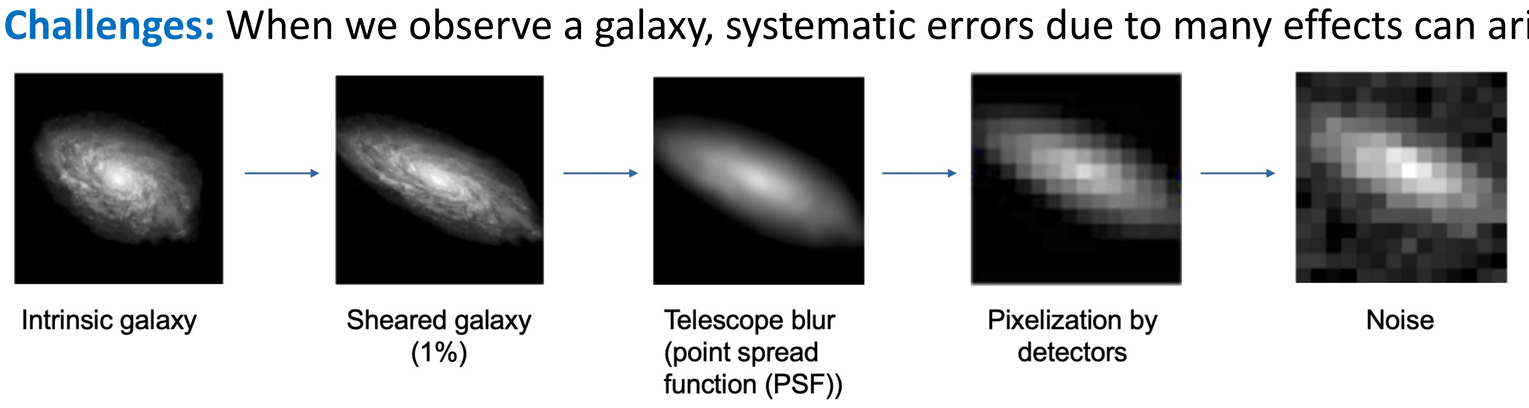

Figure 3: Intrinsic galaxy shape to observed image

Solution: Metacalibration is designed to address these systematics. It corrects shear measurements by simulating how shear affects galaxies with known properties (e.g. shear), enabling more accurate and unbiased results without prior assumptions. It involves five image manipulations, one for zero shear and four for different shear values, Fig. 4.

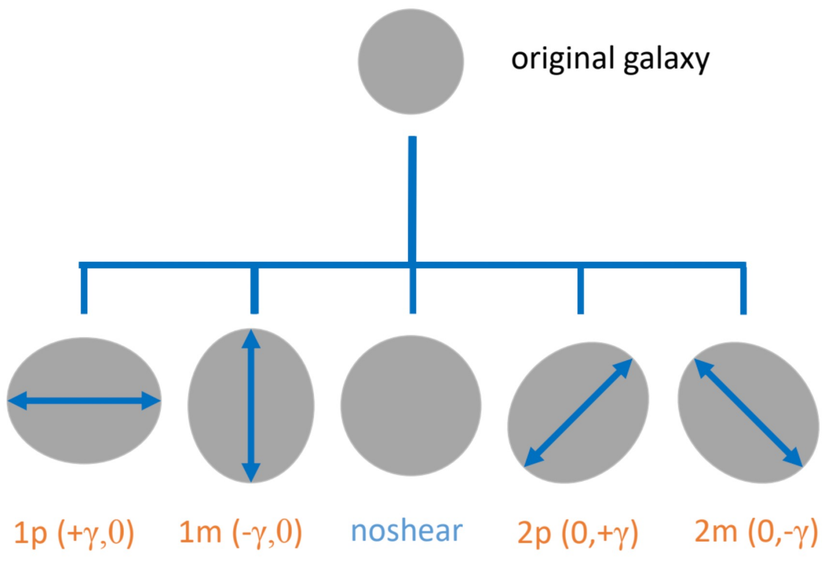

Figure 4: Image manipulation by Metacalibration

Approach and Results

We are building a cutting-edge pipeline to simulate galaxies with realistic morphologies and artifacts and employ Metacalibration to precisely measure their shapes, while also calibrate the systematic errors, Fig. 5.

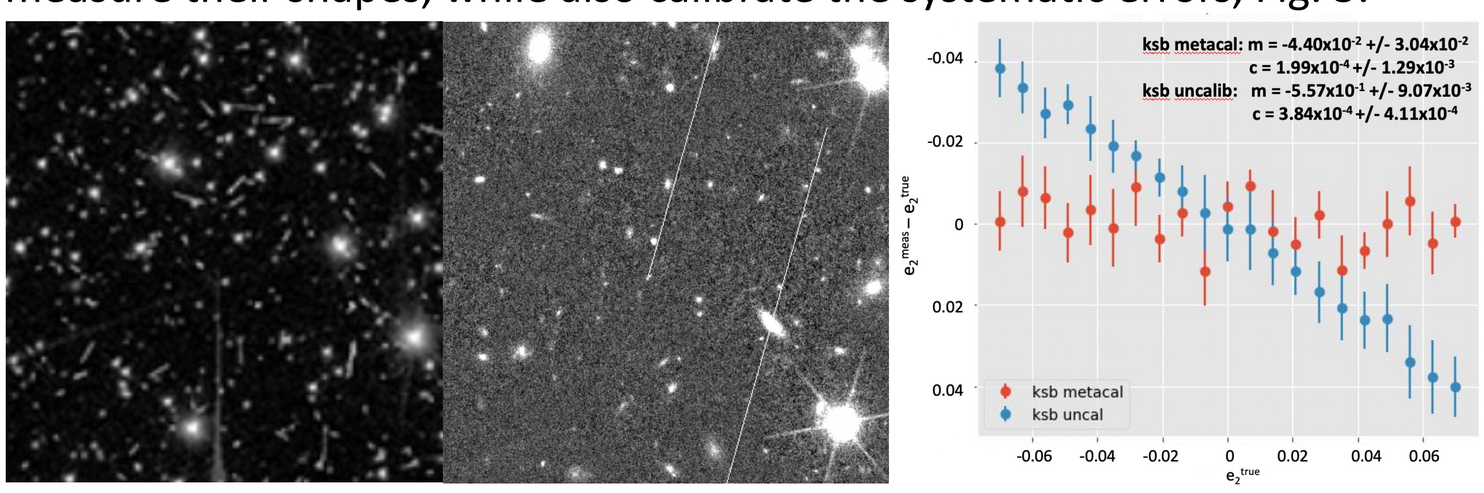

Figure 5: Euclid VIS First Light image; Simulated field with real and parametric morphology galaxies, stars, and cosmic rays; calibrated and uncalibrated shear measurements

Significance of Results/Benefits to NASA/JPL

This calibration method is a cornerstone for precise galaxy shape measurements, essential for mapping the Universe's matter distribution. Its adaptability supports *Euclid* and other NASA missions like JWST and Roman, establishing its central role in advancing scientific goals at both NASA and JPL.

Future Work

The pipeline will be integrated in the official *Euclid* pipeline and it will be executed on real *Euclid* data. The results will be shared through publications and presented at the upcoming *Euclid* Consortium Meeting.

National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

www.nasa.gov

Clearance Number: CL#00-0000

Poster Number: PRD-A-006

Publications and Acknowledgements:
Scognamiglio D., Vitorelli A., Huff E. et al., in preparation

Authors Contact Information:
D. Scognamiglio: 626-491-1272, dianas@jpl.nasa.gov
A. Vitorelli: 626-318-7965, andre.vitorelli@jpl.nasa.gov