National Aeronautics and Space Administration

FY23 Innovative Spontaneous Concepts Research and Technology Development (ISC)

Kinematic Lensing Analysis with Palomar Telescope Data

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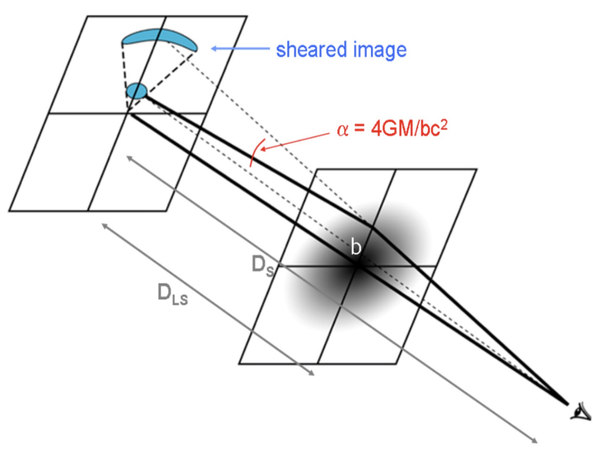
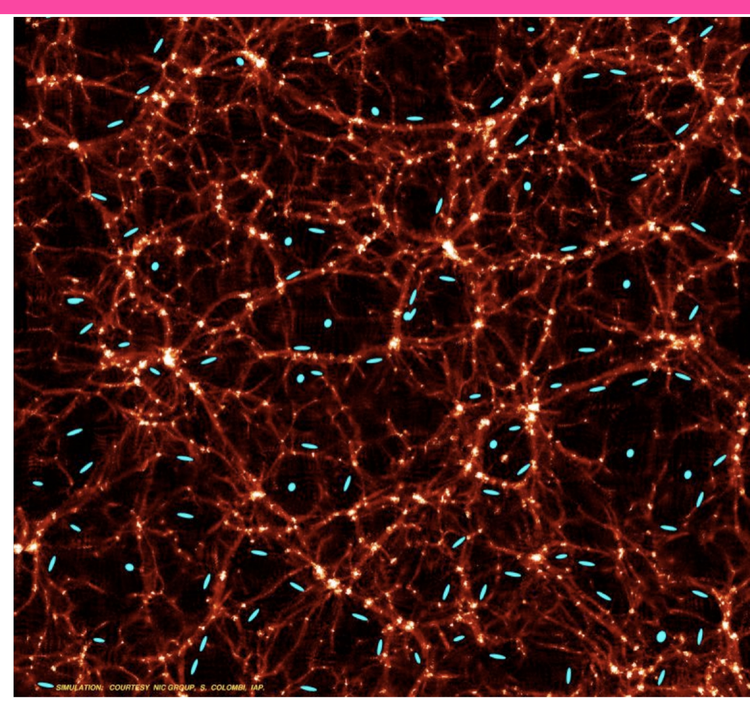
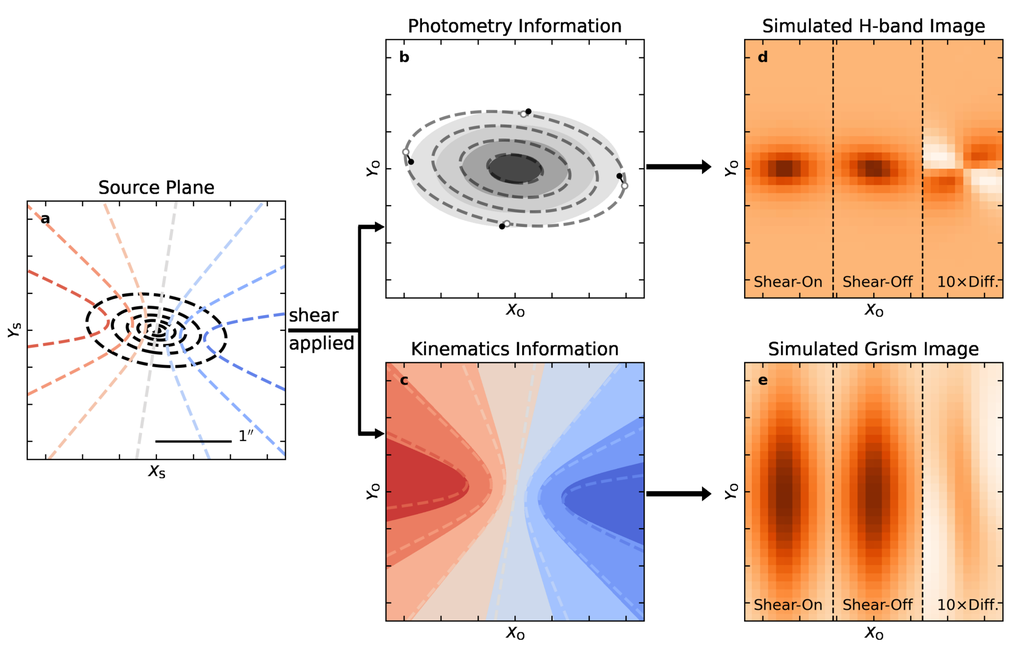
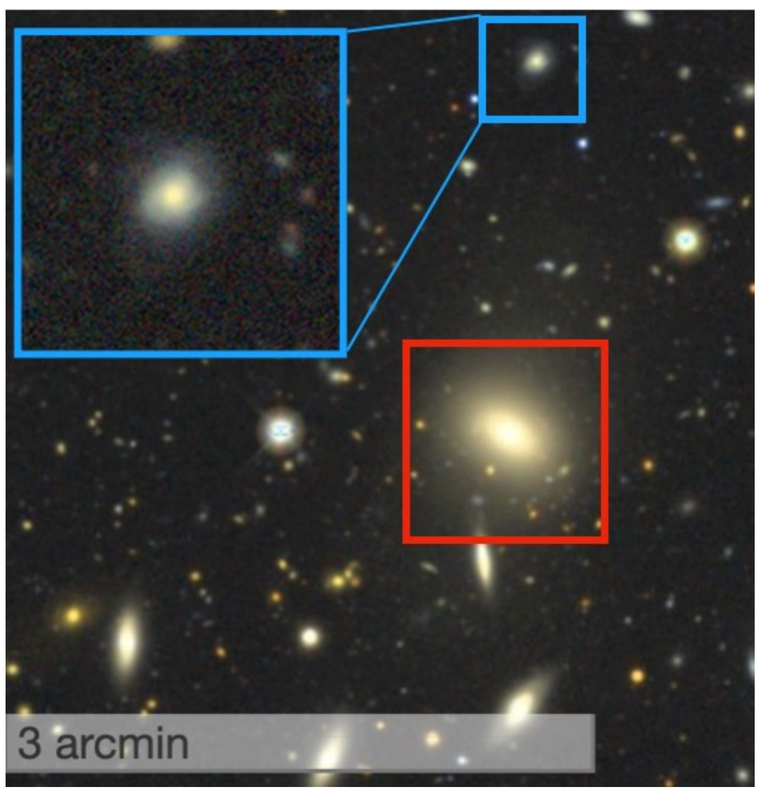
Objectives: We have invented a new method for measuring gravitational lensing that exploits spectroscopic measurements of the internal motions of galaxies. This method appears to reduce the noise in lensing measurements, a key cosmological probe, by **an order of magnitude.**
The goal of this effort was to obtain the data necessary to perform a demonstration measurement on real data.







Background: Gravitational lensing by cosmic structures (see above) distorts the observed ellipticities of galaxies. Normally, this effect is indistinguishable from small changes in the real 3D orientation of galaxies.
However, measurements of galaxy rotation made with spectroscopy (see left) can distinguish *intrinsic orientation* from the lensing distortion. In previous work, we simulated retrievals of the lensing distortion. Our results showed that kinematic measurements allow shear constraints from individual galaxies, and reduce the noise floor in lensing by a factor of roughly ten.

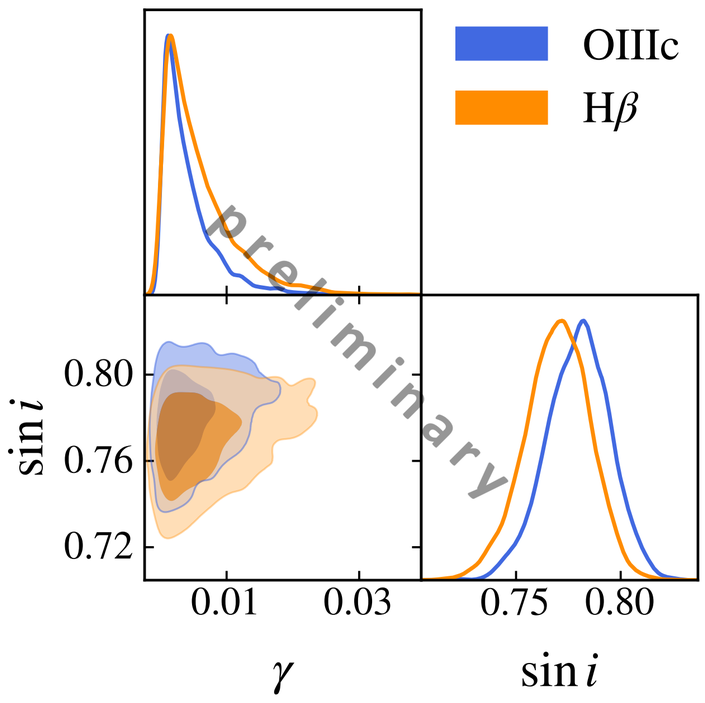


Approach and Results:
We used the Cosmic Web Imager on Palomar to obtain kinematic maps of disk galaxies located behind massive foreground galaxies, such as that at left.

While most of our time was lost to bad weather, we did succeed at measuring clear kinematics for one system. Changes to the available workforce disrupted this anlaysis.

We engaged a parallel effort with similar data, and succeeded in completing our measurement pipeline and performing a successful measurement on kinematic data from another instrument. Those results are shown at right.

The constraints on shear are consistent with our original forecasts. This result may represent the first detection of weak lensing from a single galaxy.



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Clearance Number: CL#00-0000
Poster Number: RPC-015

Significance to JPL:
Successful demonstration of this technique allows for an qualitative improvement in our ability to map dark matter, and opens up vast new areas of possible discovery space in future astrophysics investigations and missions.

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