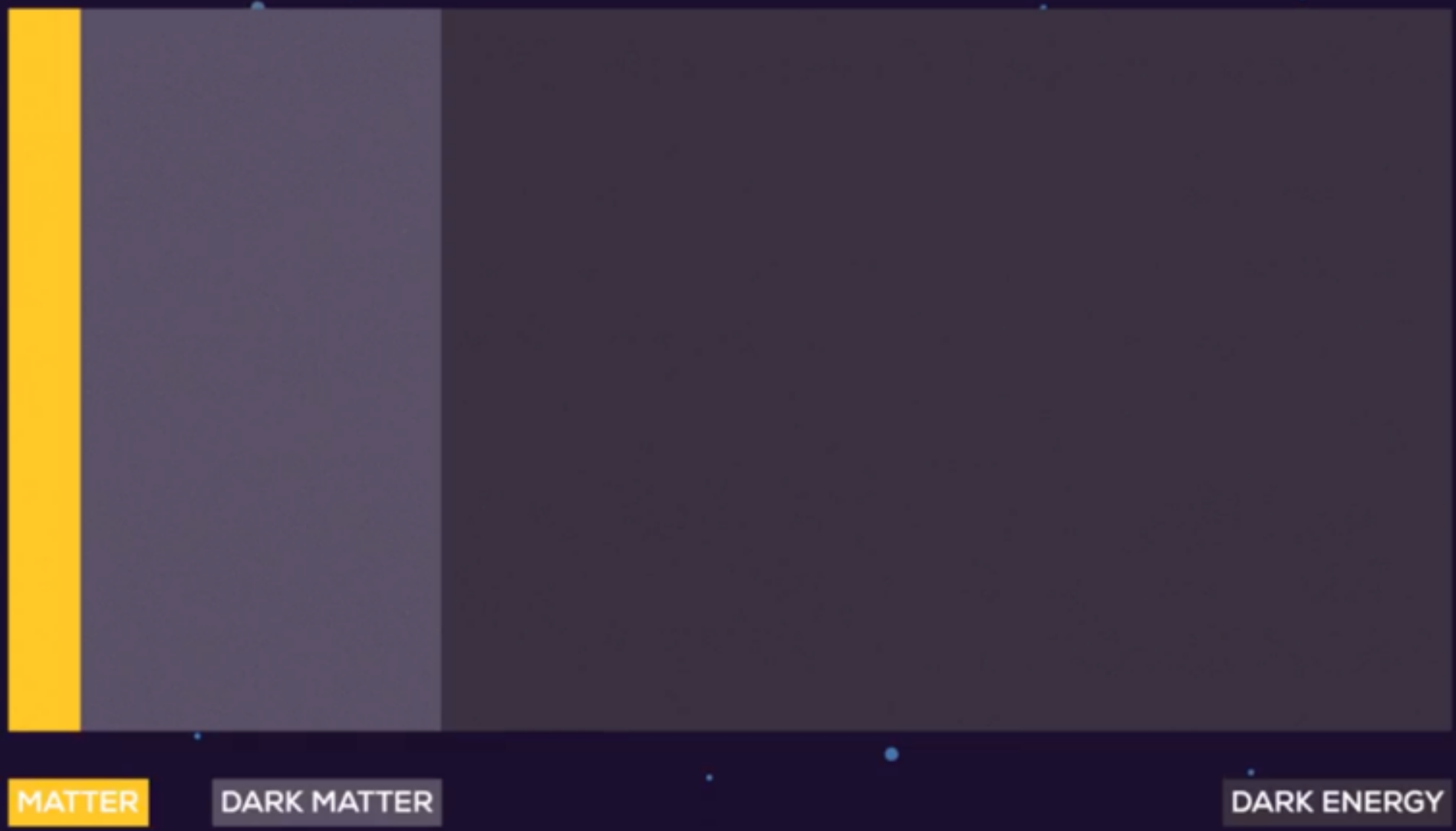
Mass estimates of Galaxy Clusters via Strong Gravitational Lensing

Umberto Rescigno

Supervisors:
Prof. Claudio Grillo
Prof. Marco Lombardi

Physics Department,
University of Milan, Italy
Workshop 2017

Universe composition



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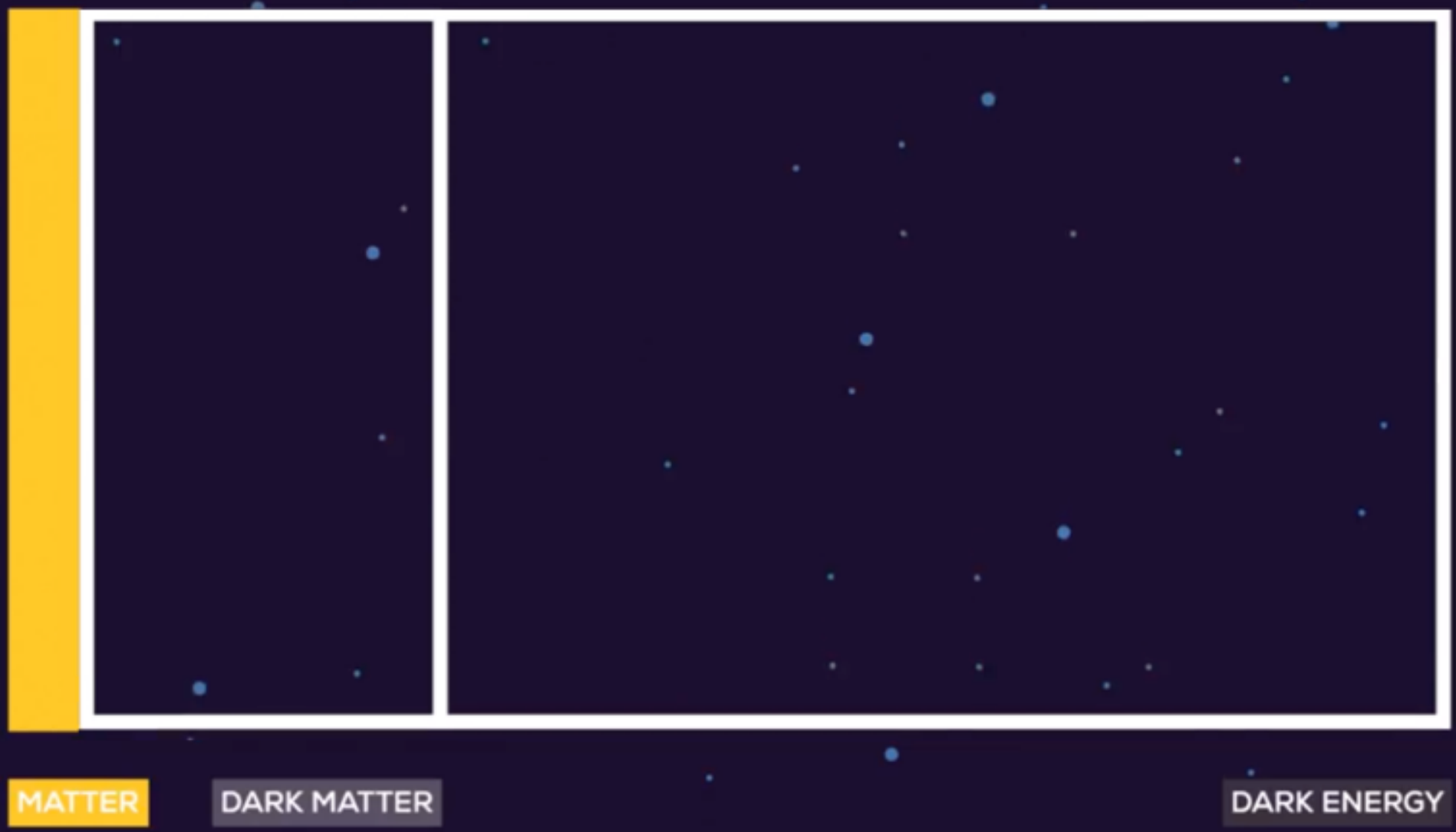

Standard cosmology and Gravitational Lensing

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  Dark Matter characterization

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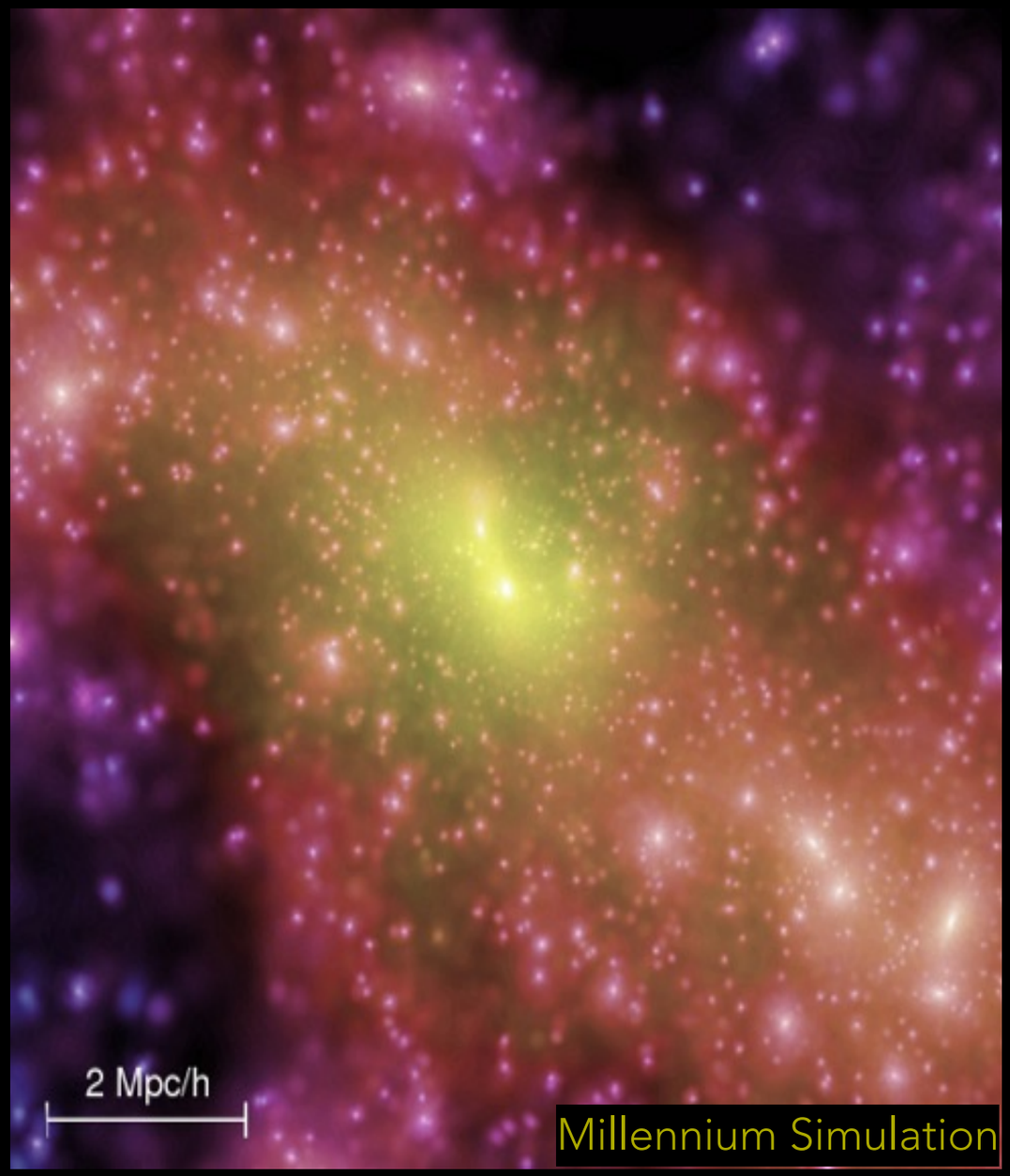

Galaxy Clusters

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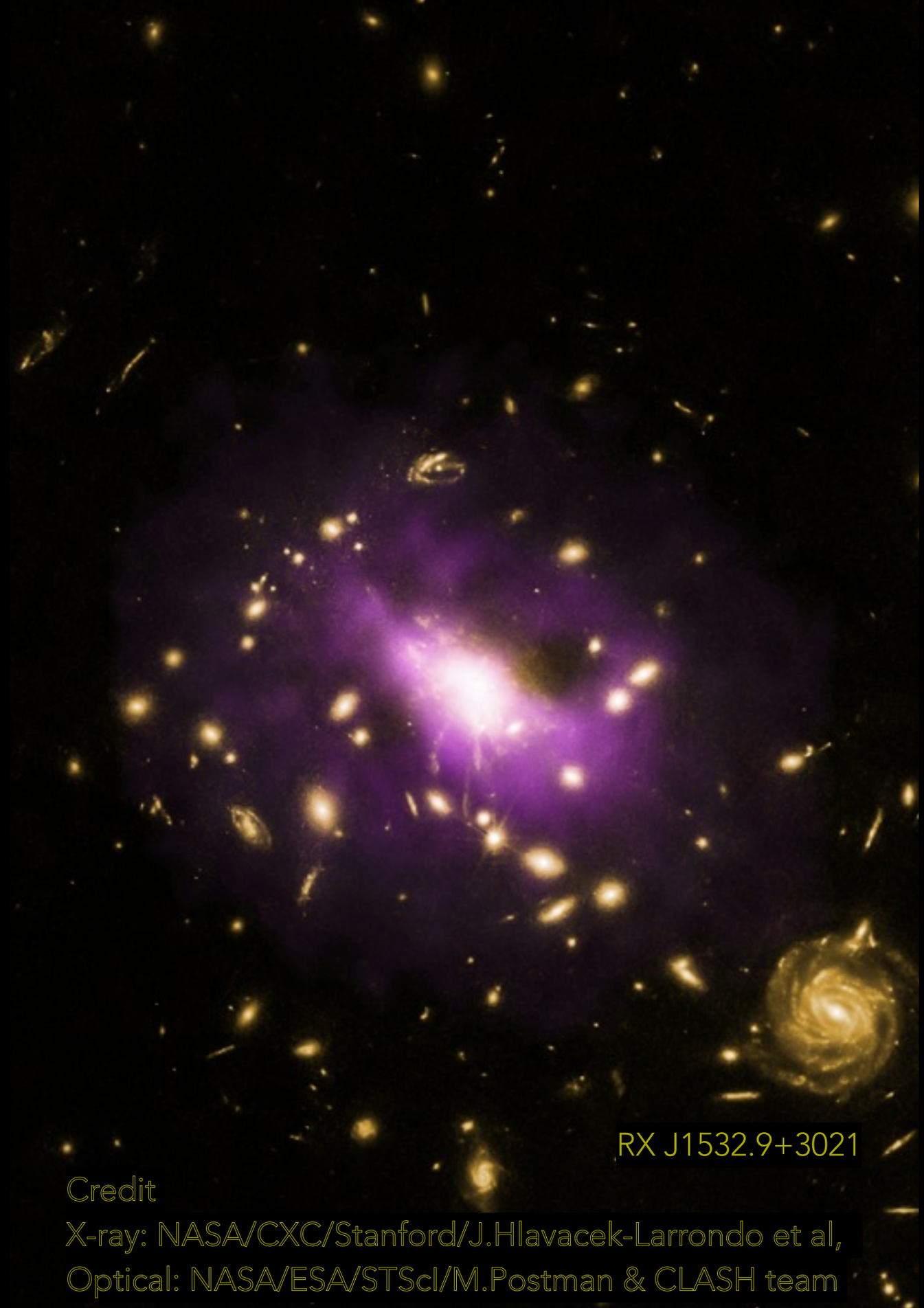

RX J1532.9+3021

Credit
X-ray: NASA/CXC/Stanford/J.Hlavacek-Larrondo et al,
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- Galaxies
  N ≃ 50-1000
  1% Mass

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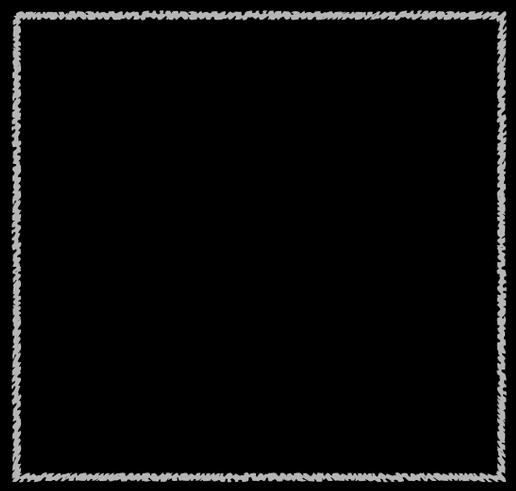

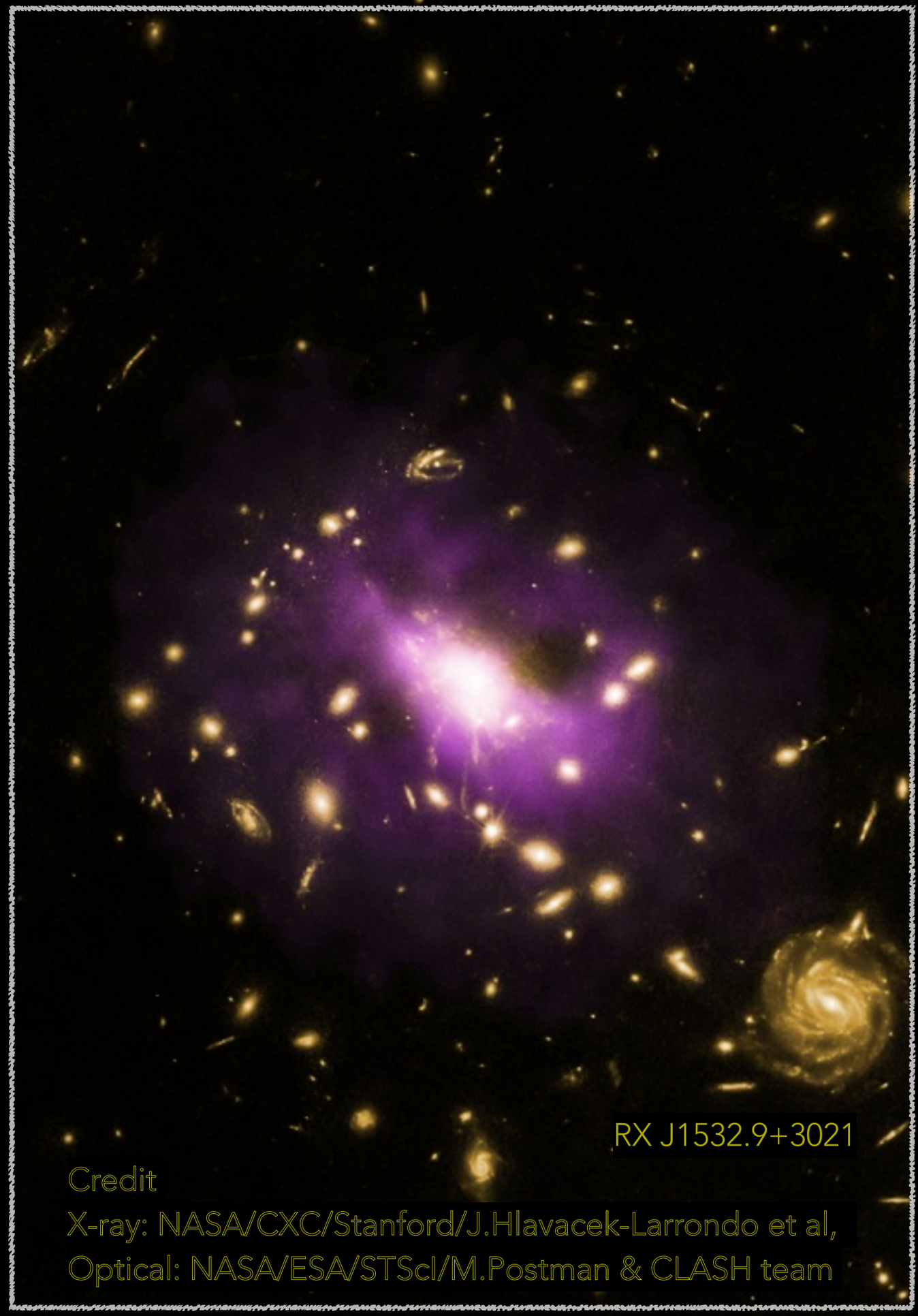

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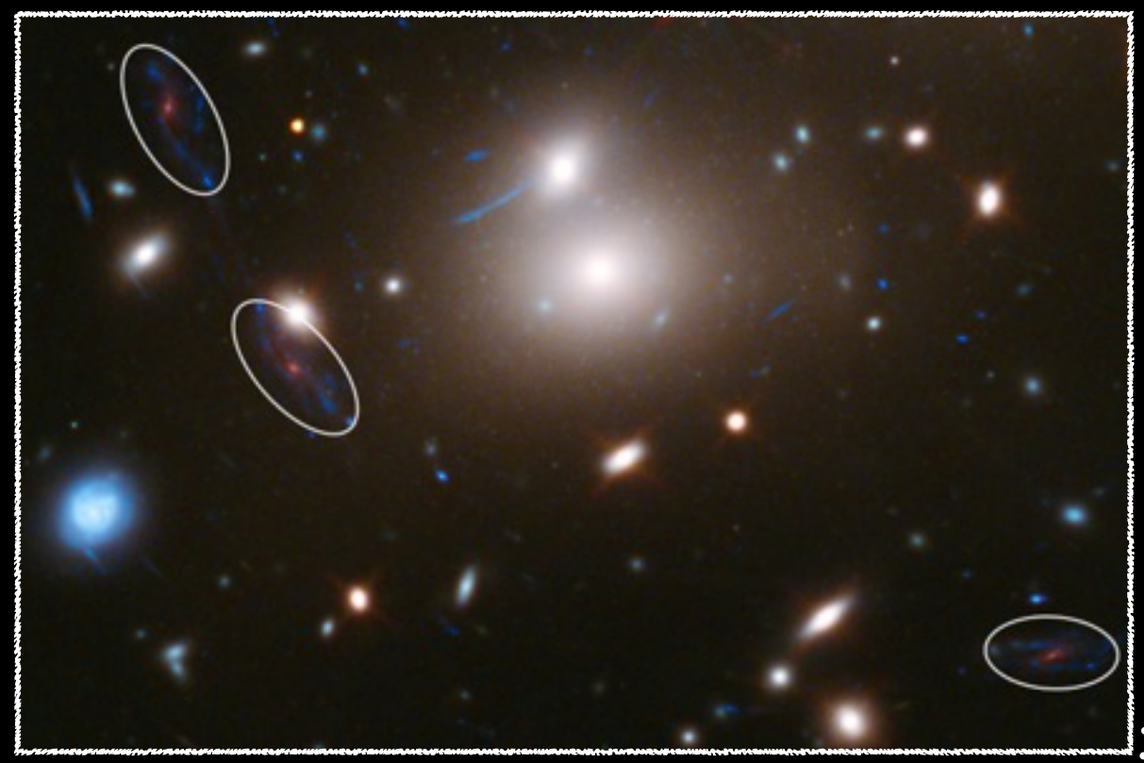
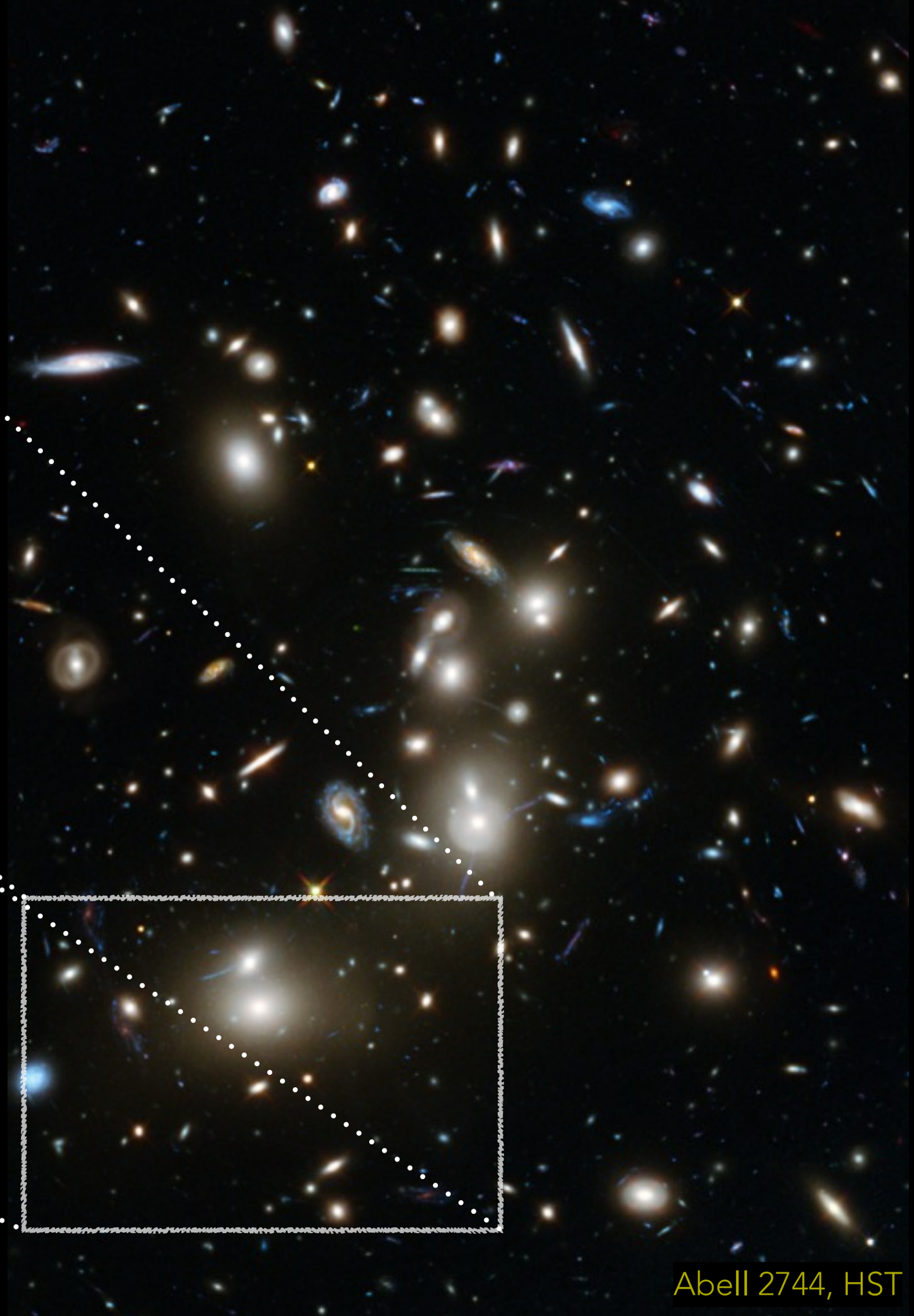
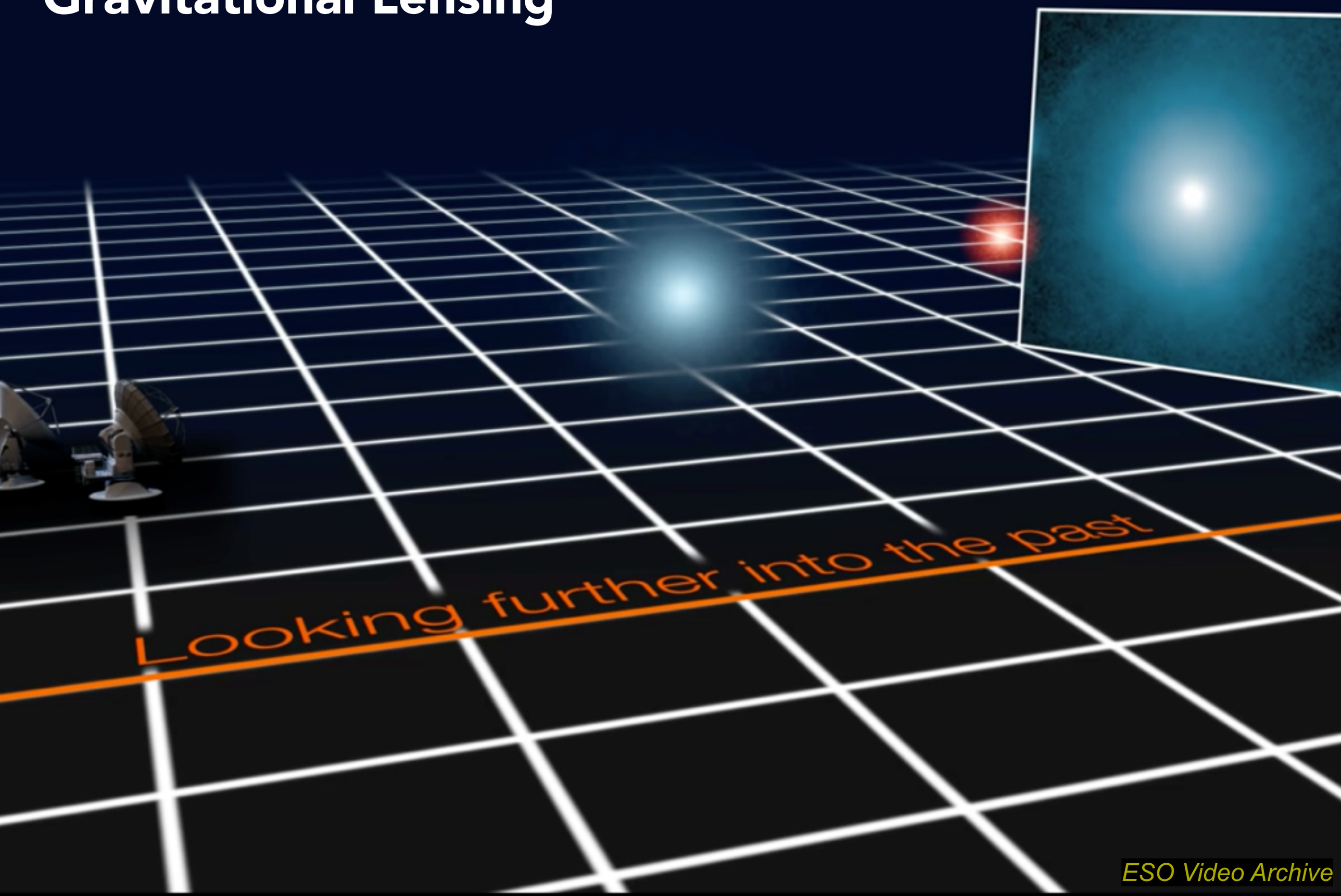




Abell 2744, HST

Gravitational Lensing



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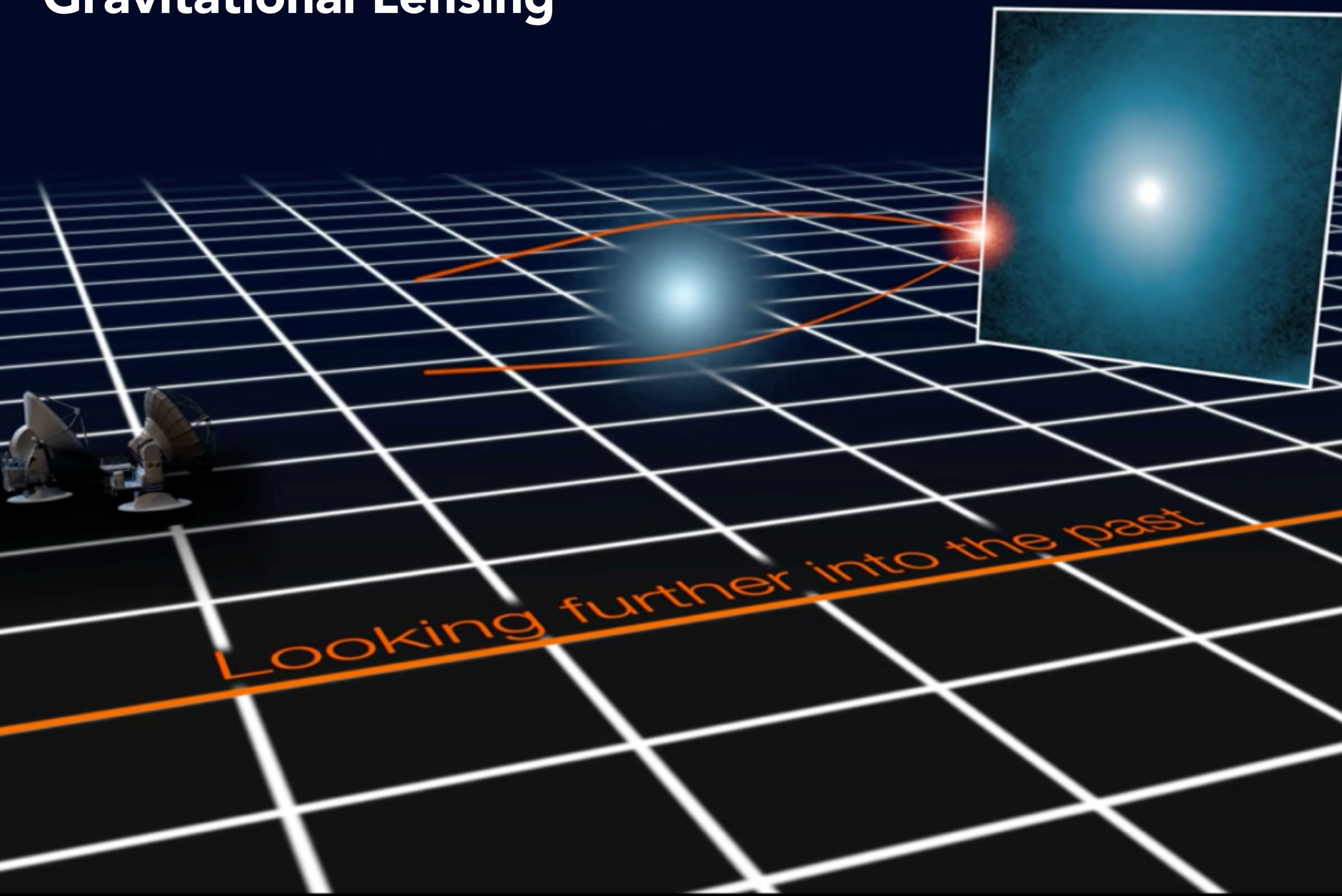

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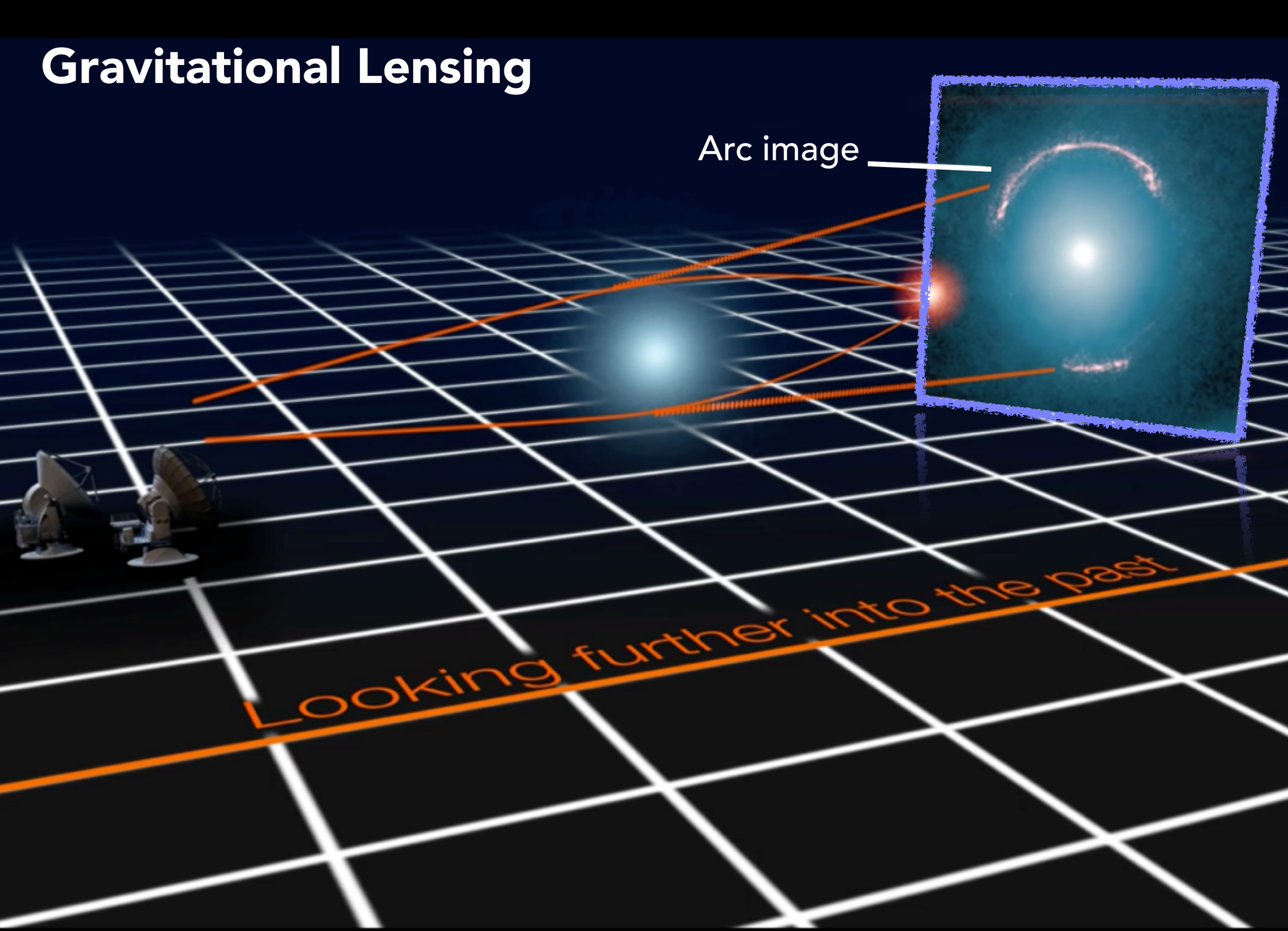

Configuration

Observation

Dr. R. Livermore (University of Texas)
Dr. F. Summers (Space Telescope Science Institute)

Configuration

Observation

Weak regime (outer cluster region)

- single image

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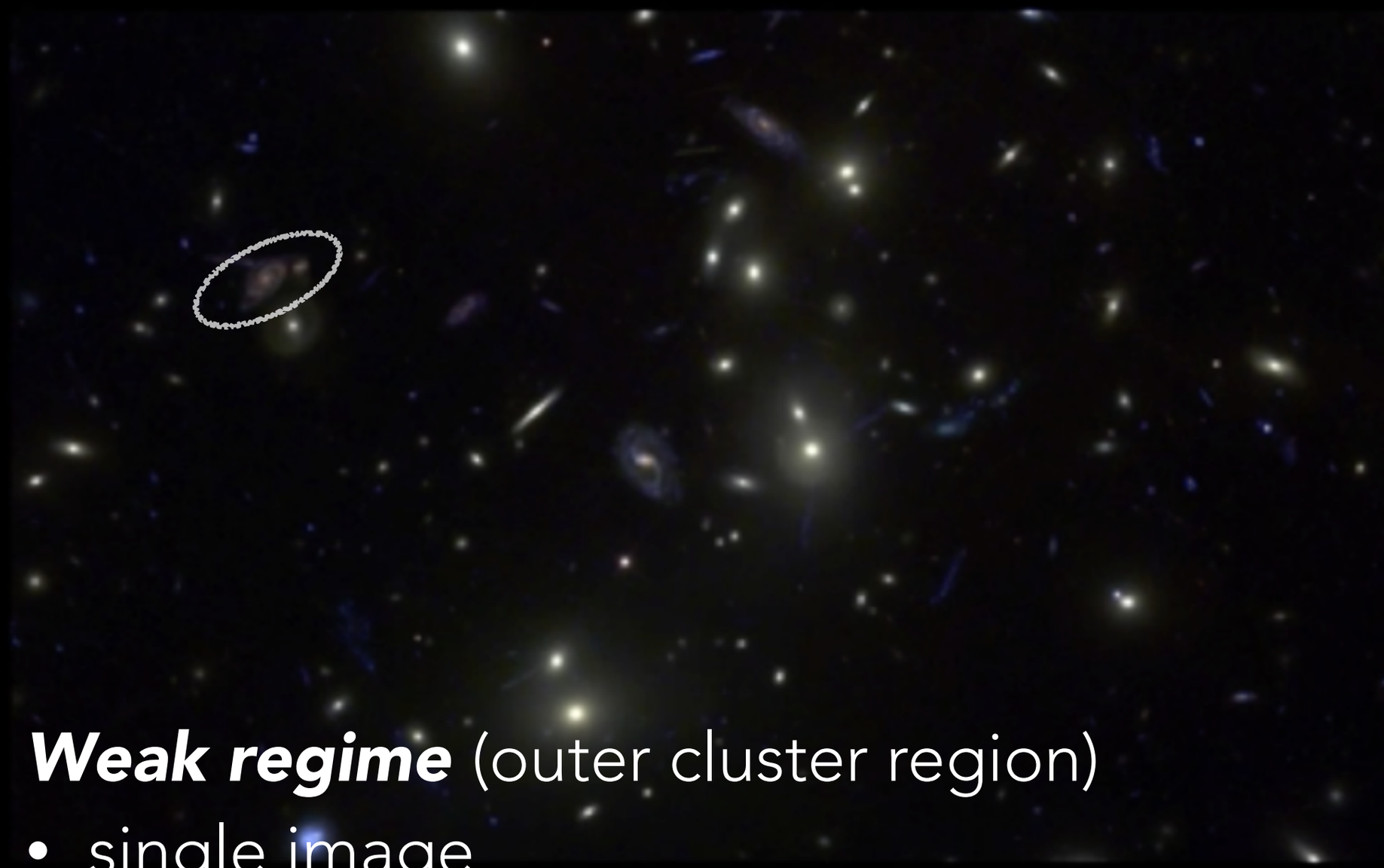

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Strong regime (inner cluster region)

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Strong Lensing

Rings around galaxies

Strong Lensing

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Ring in the core of galaxy groups (*Cheshire cat*)

Our cluster

Discovery: 2012

Members: ~1000

$M = 9 \times 10^{14}\ M_{\odot}$

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Generality

MACS 0416

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Merging phase:

- Two sub-clusters
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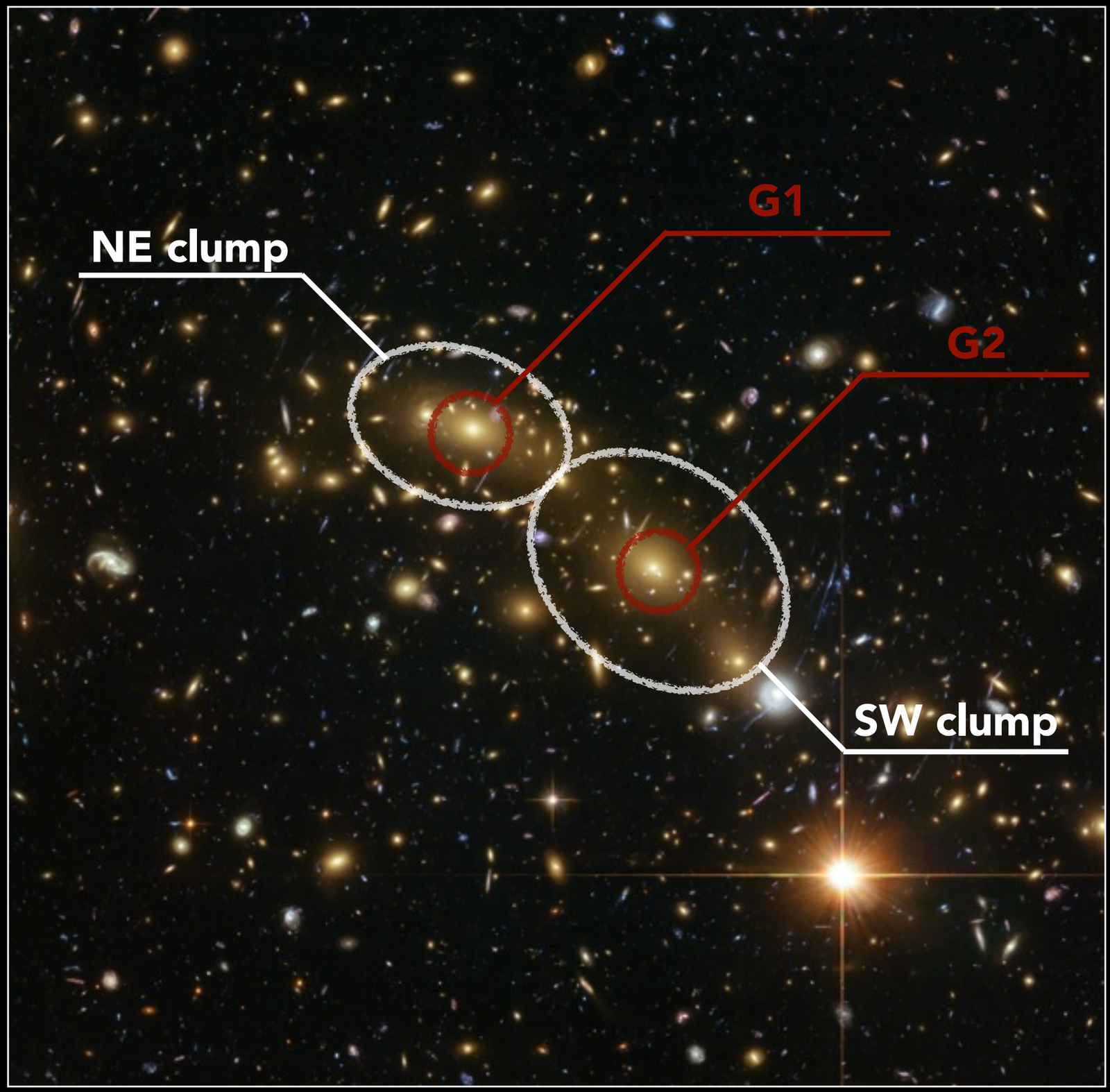
Cluster core



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Imaging: Hubble Space Telescope

Cameras: ACS, WFC3
Filters: 16 from UV to NIR

Spectroscopy: Multi Unit Spectroscopic Explorer

Spectral resolution: 2.4 Å
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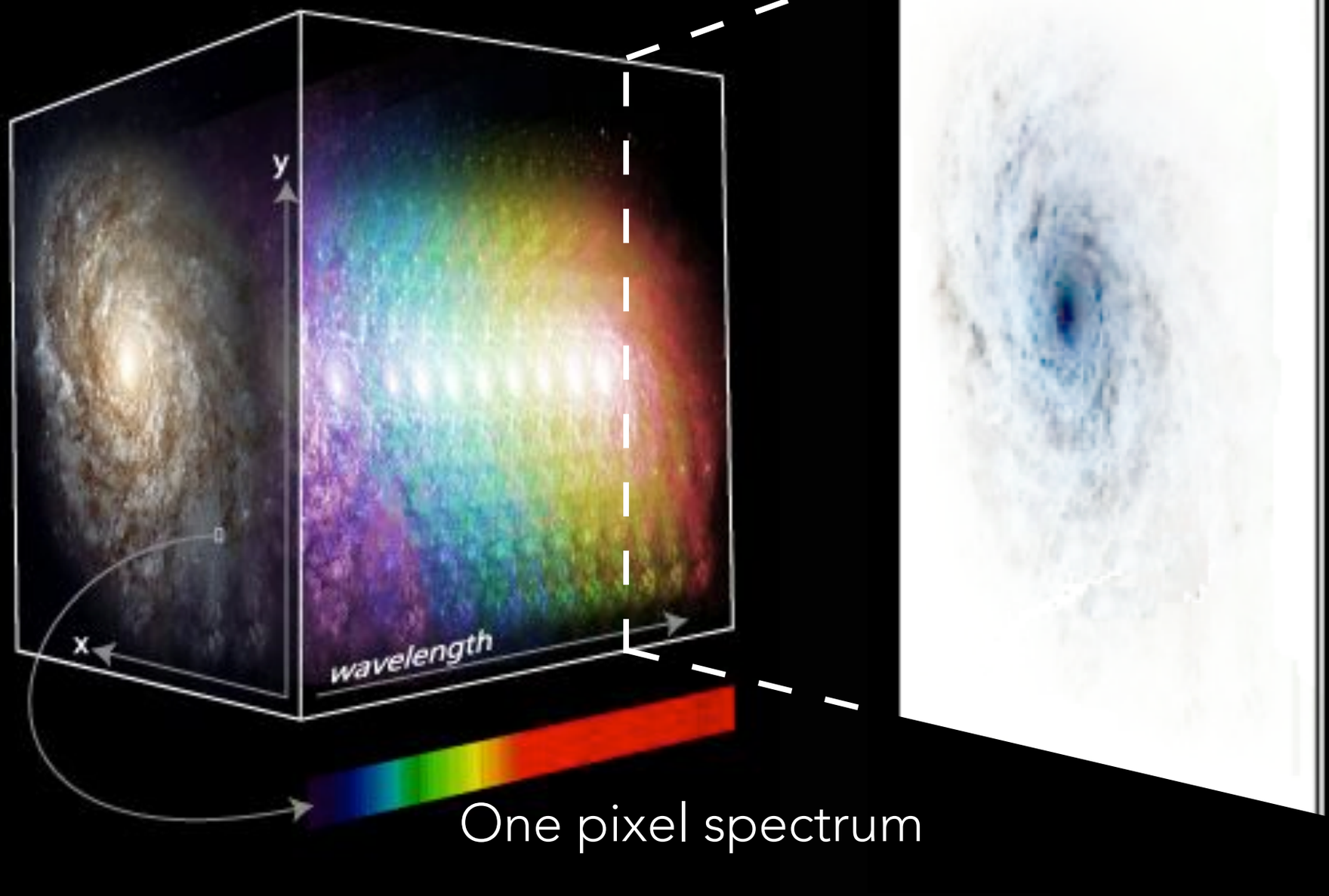
MUSE Data-Cube

Image at *all* wavelengths



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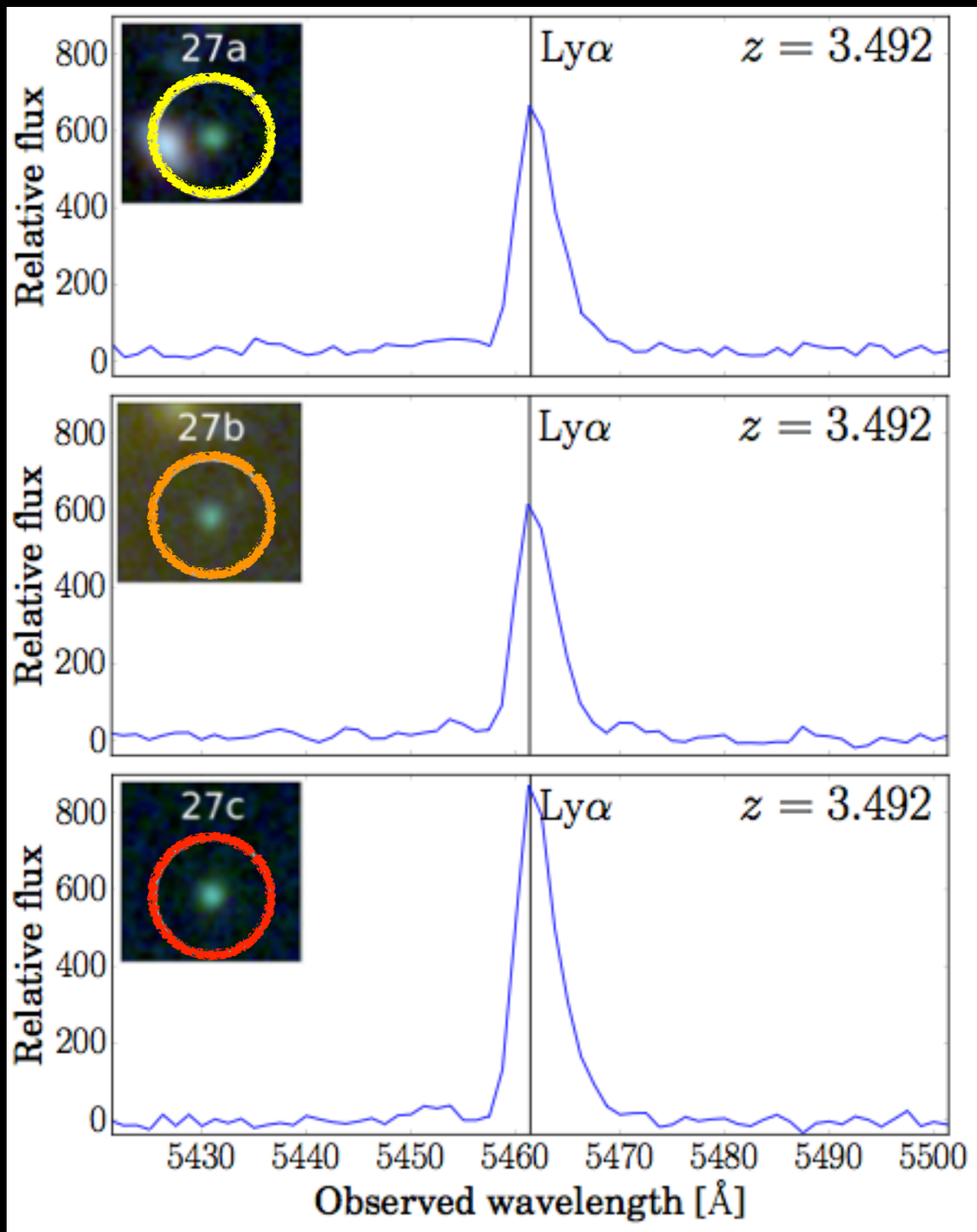
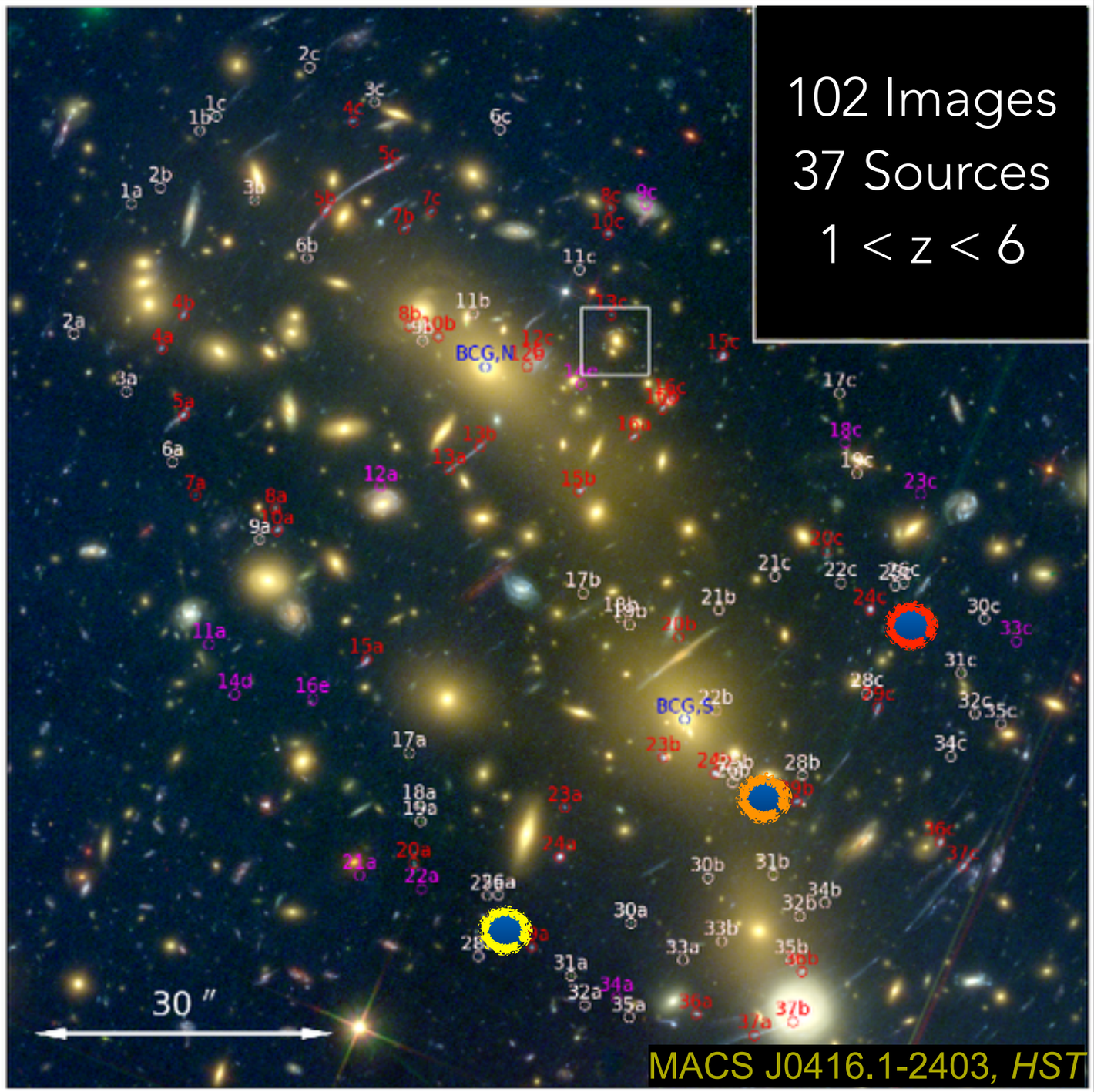
Grouped in 37 Families (of 2-3)





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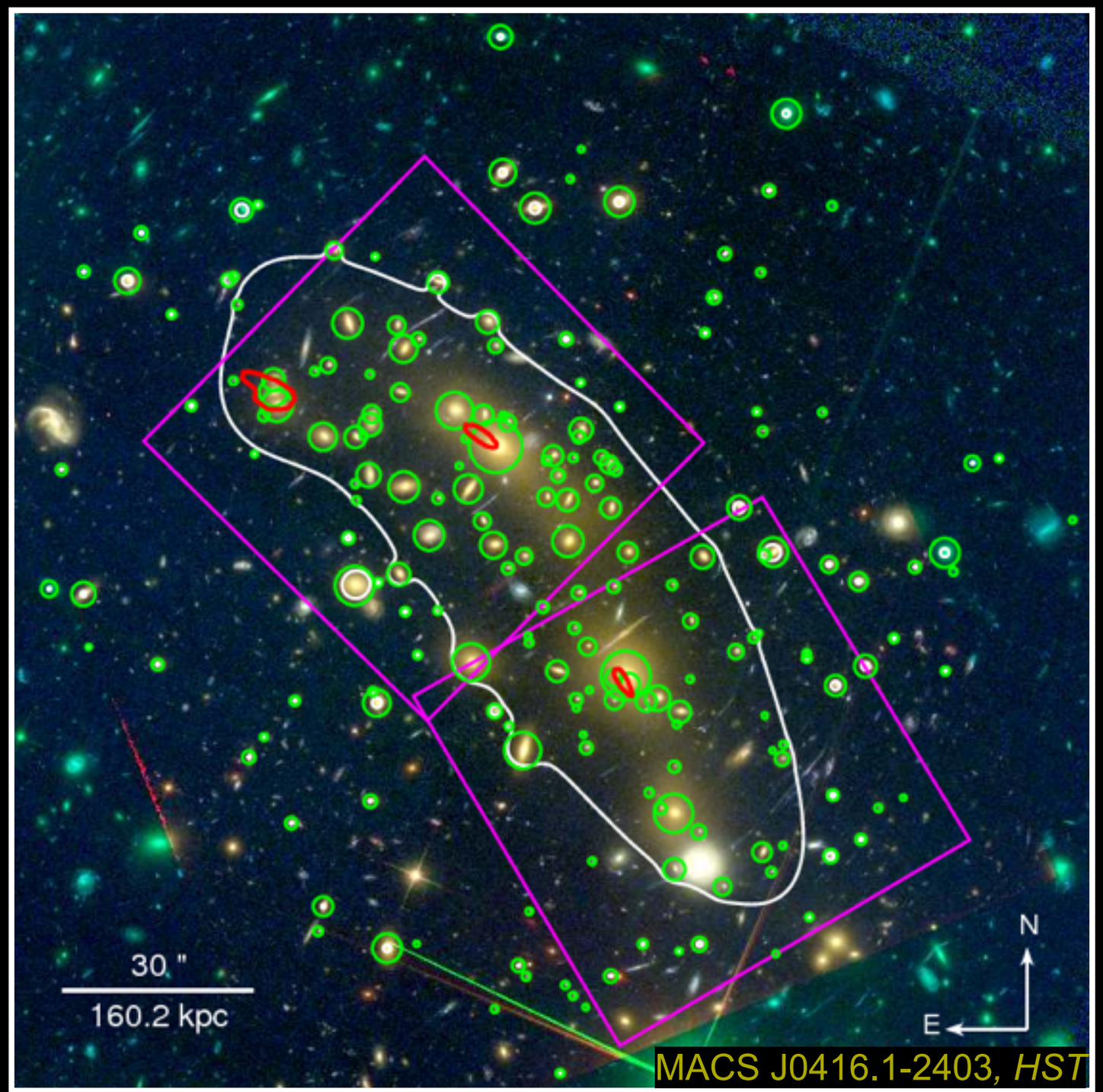

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Experiment(s)

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Catalogue of multiple images galaxy members

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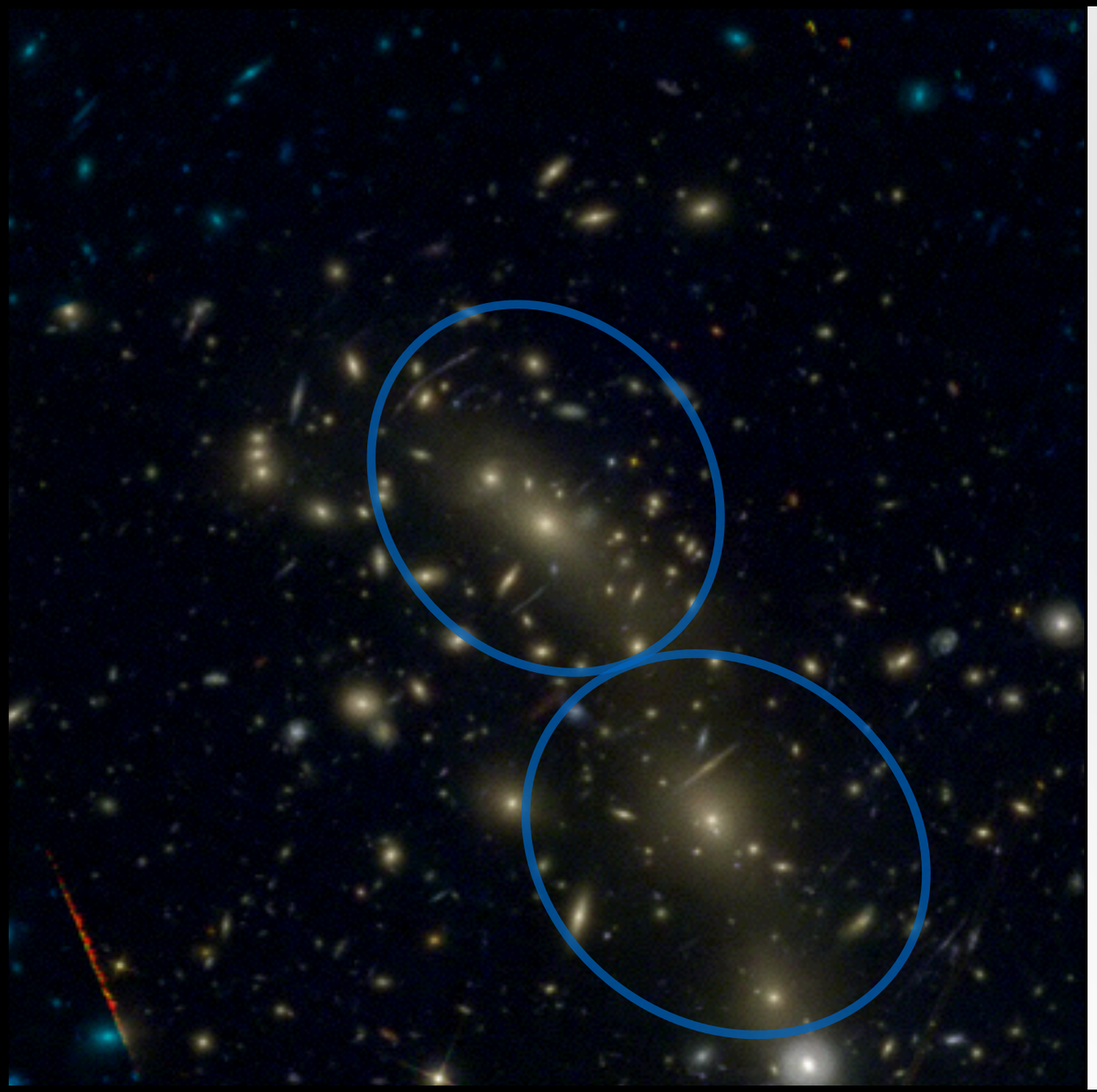
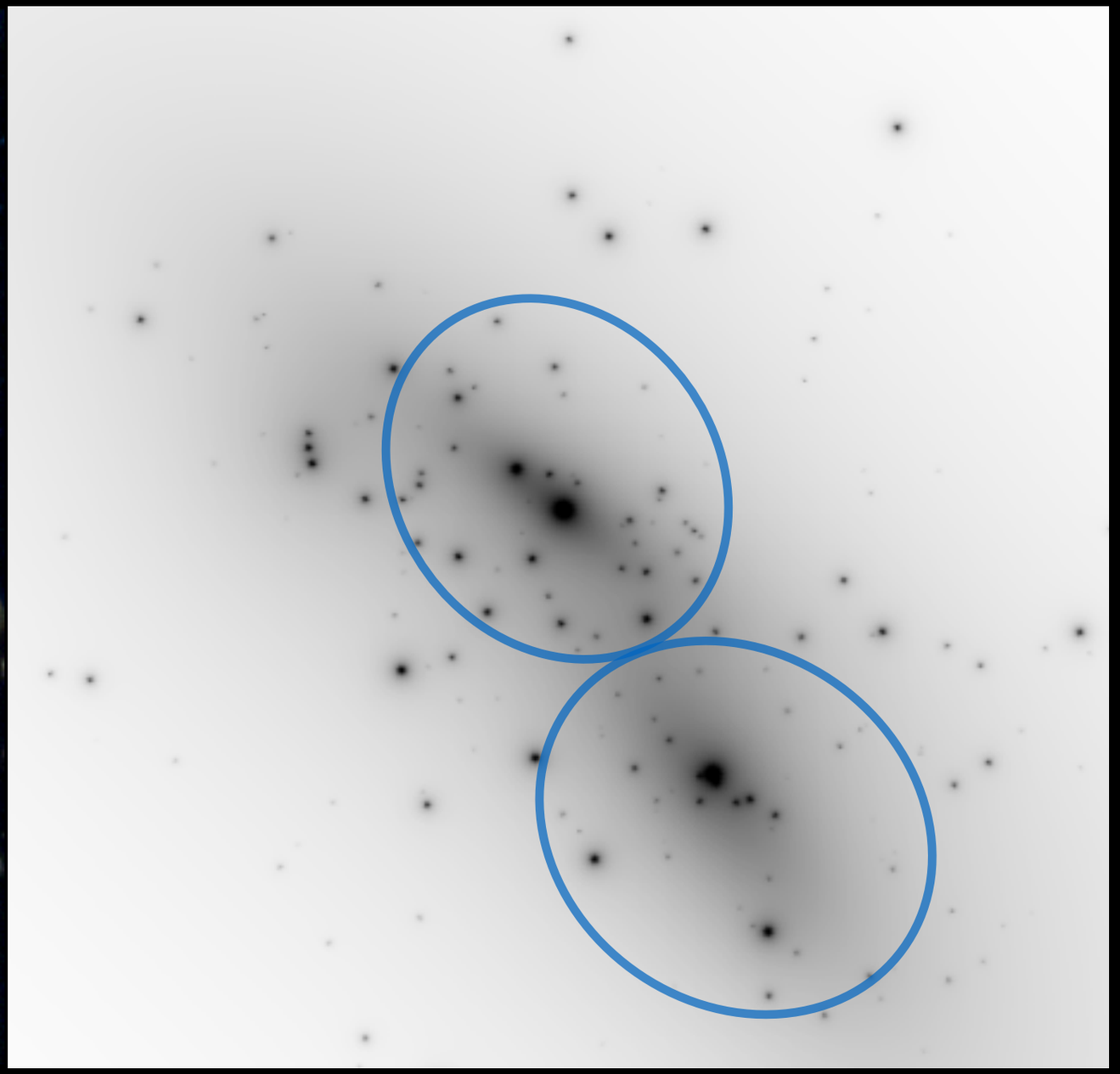
Our (principal) results

Diffuse halos: two (elongated) nearly around the brightest galaxies





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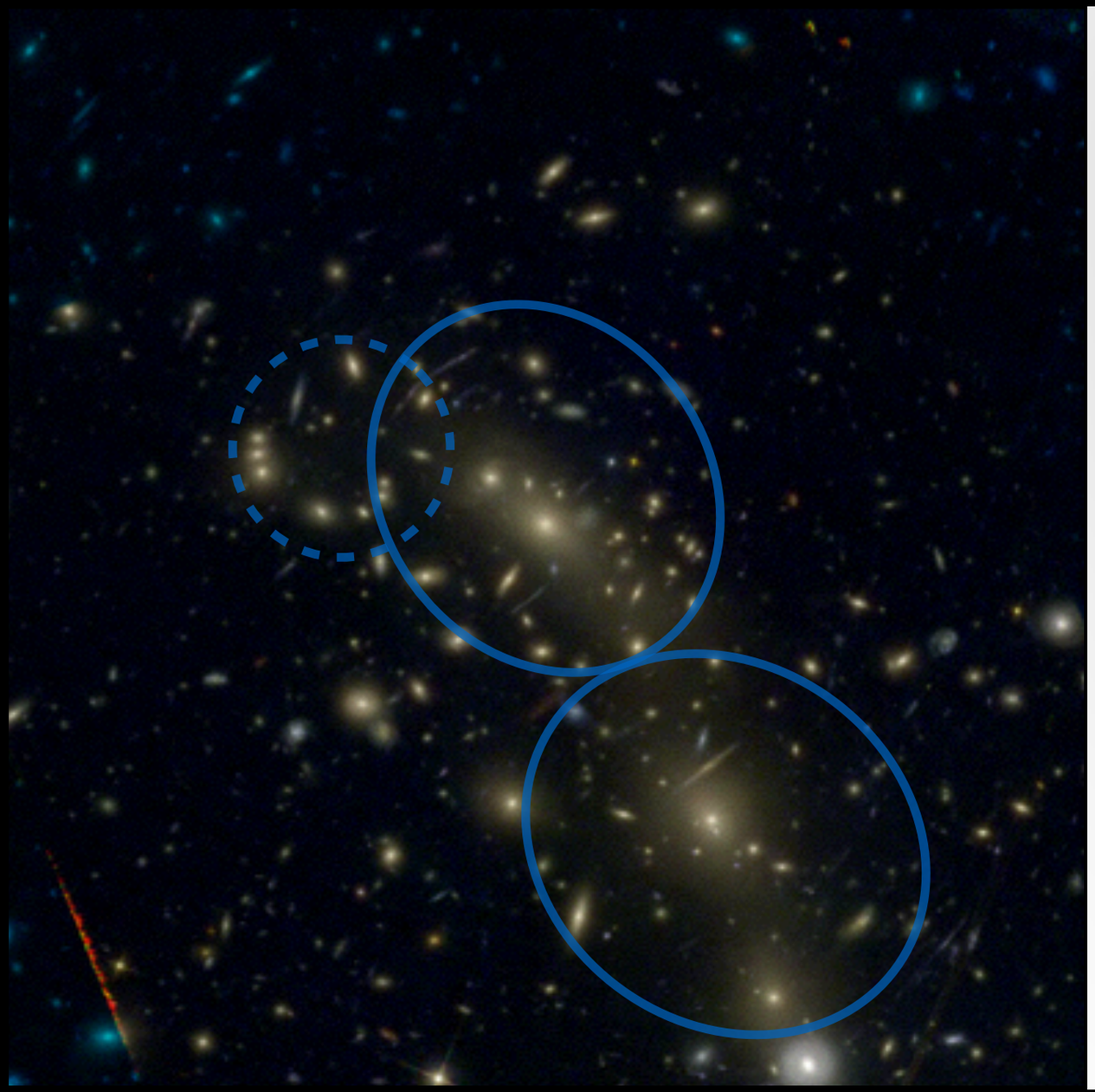

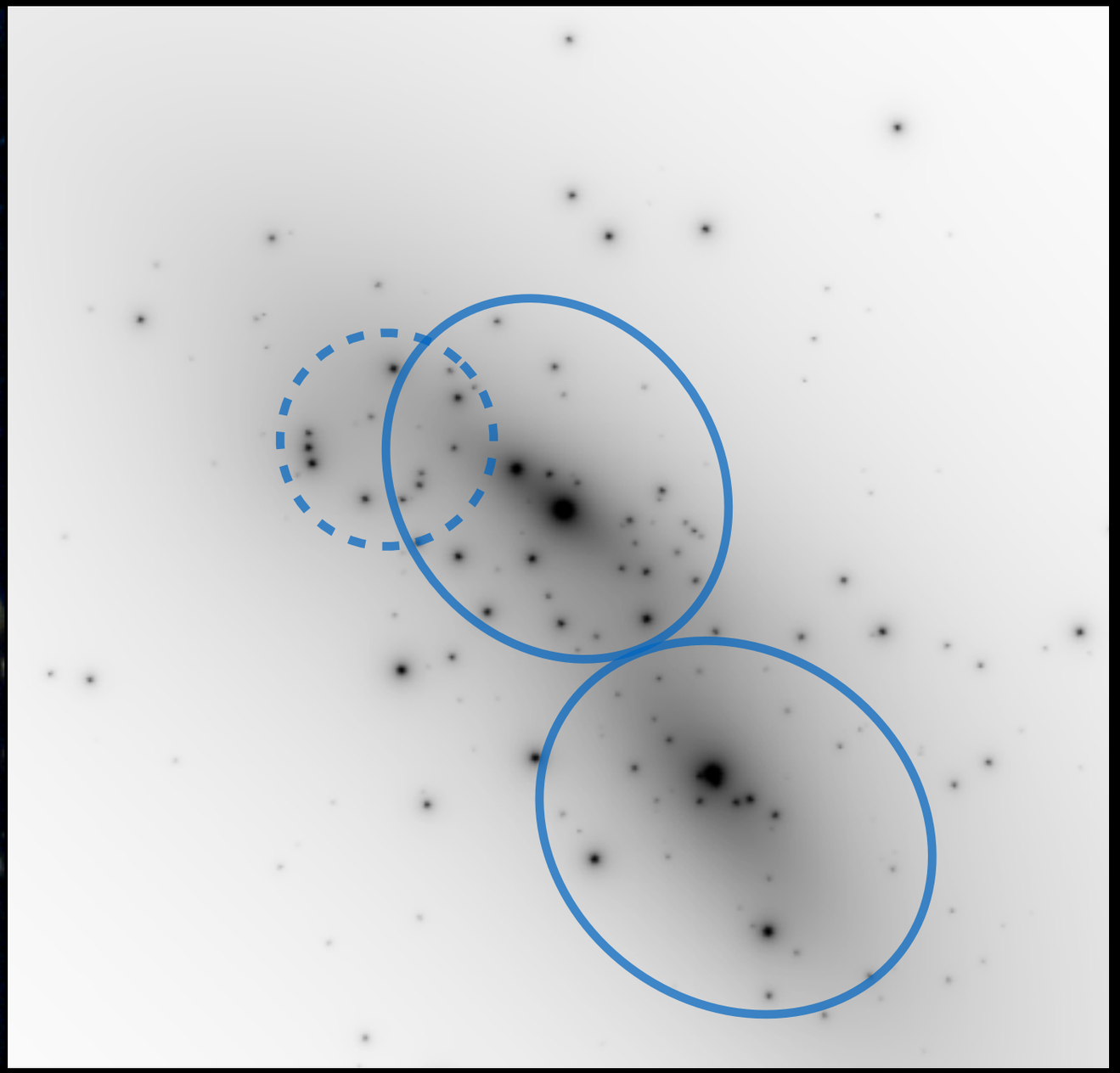

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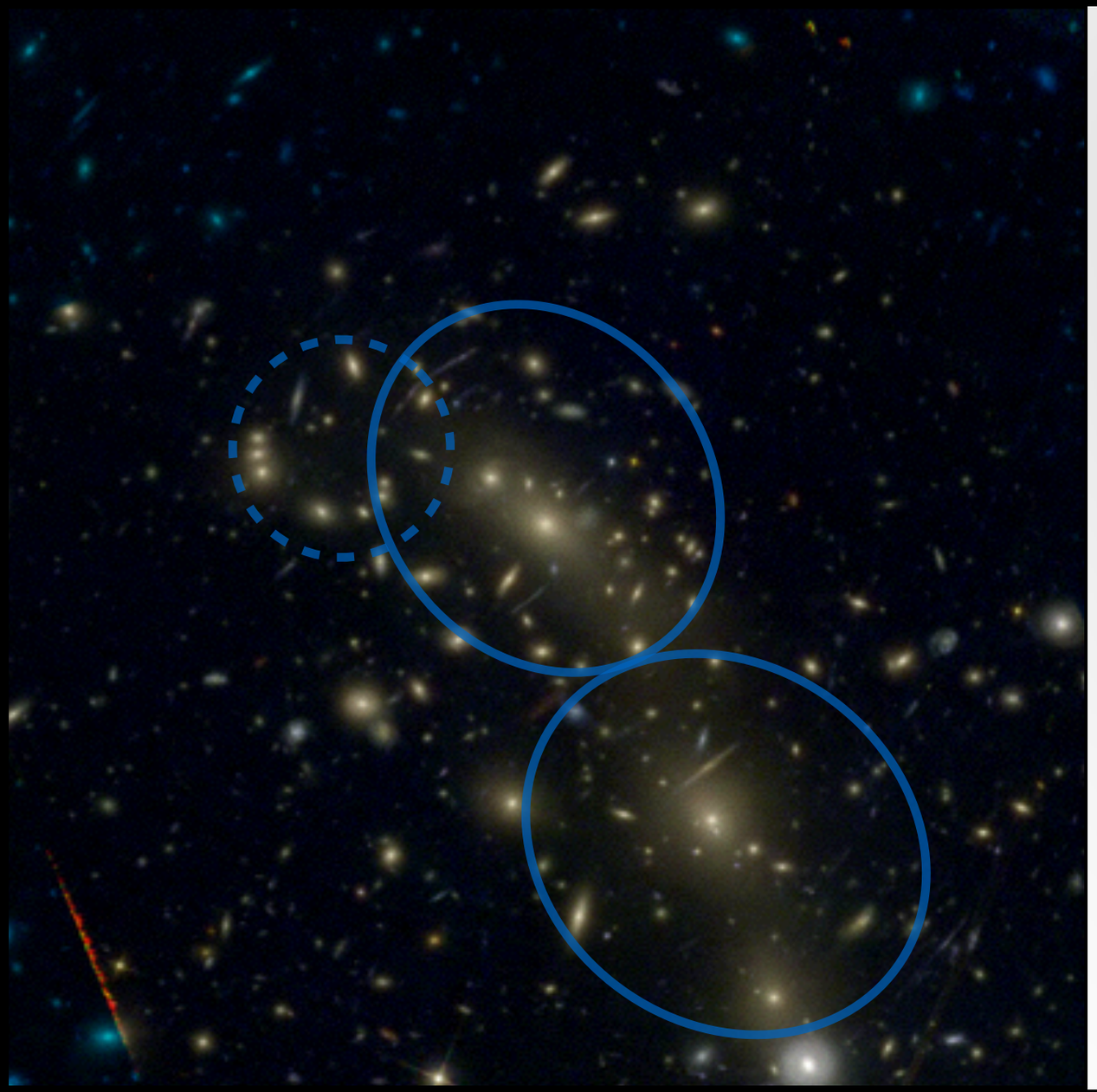

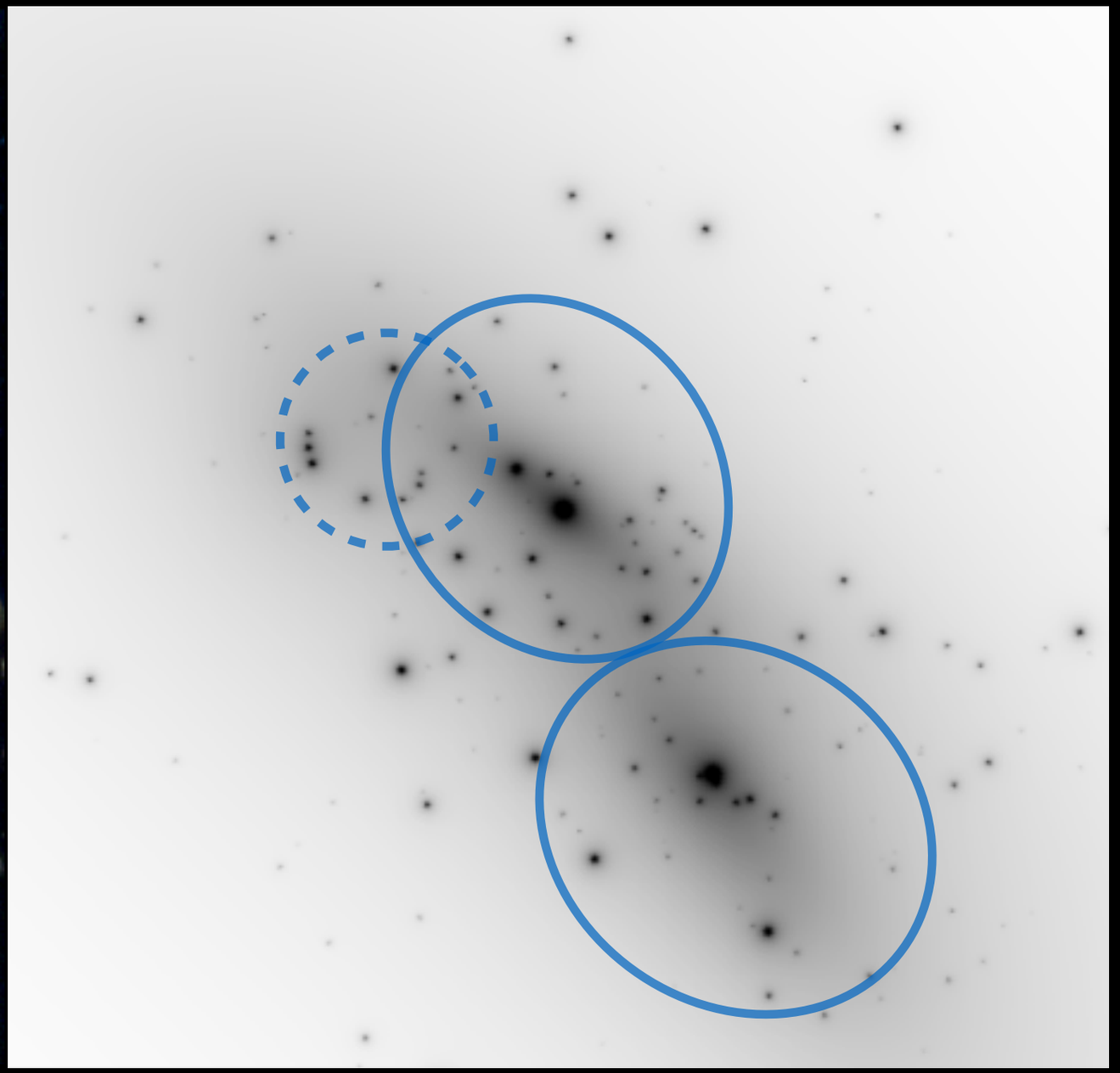

Motivations and Perspective

- **Why I decided to study gravitational lensing:**
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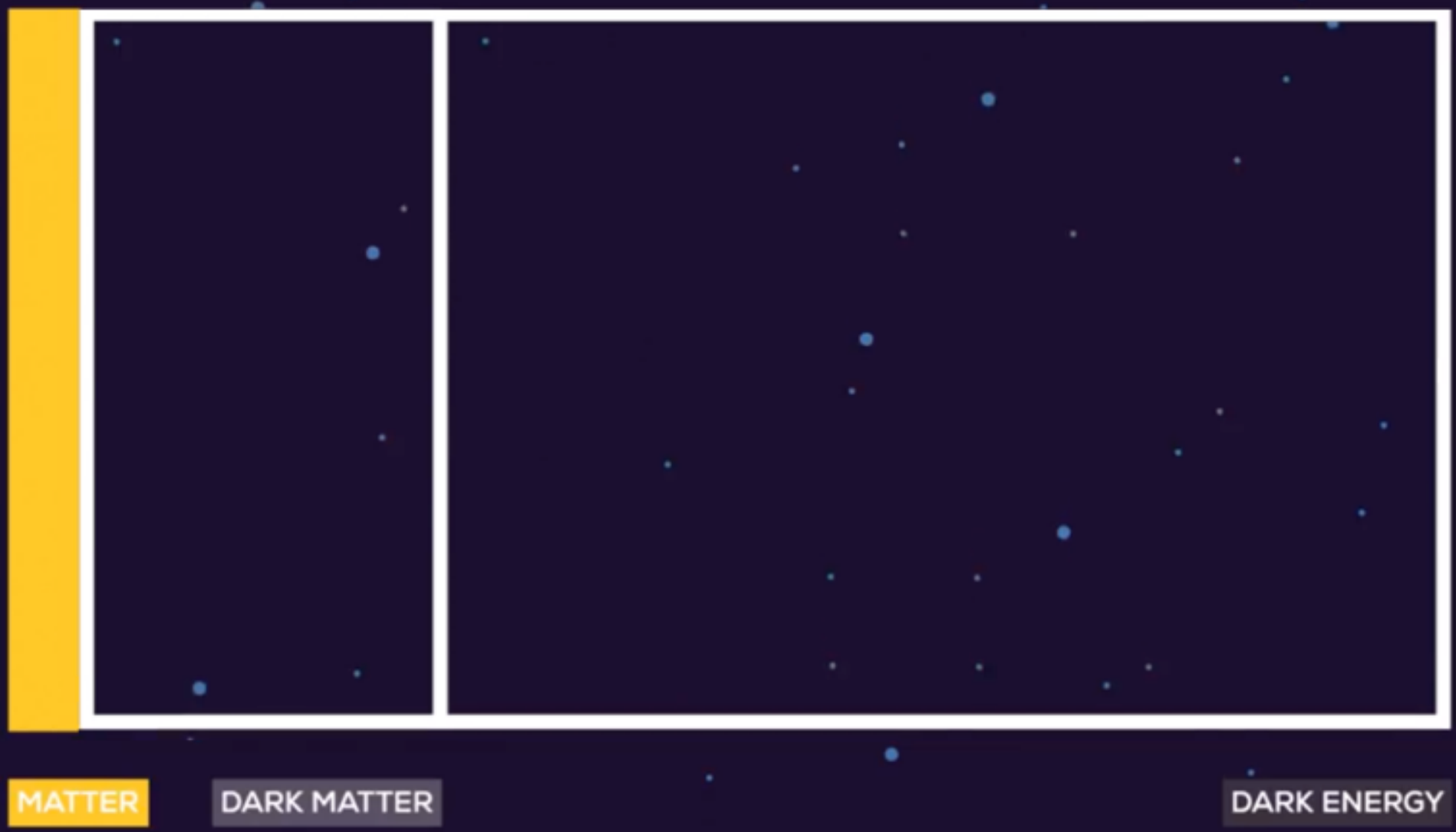

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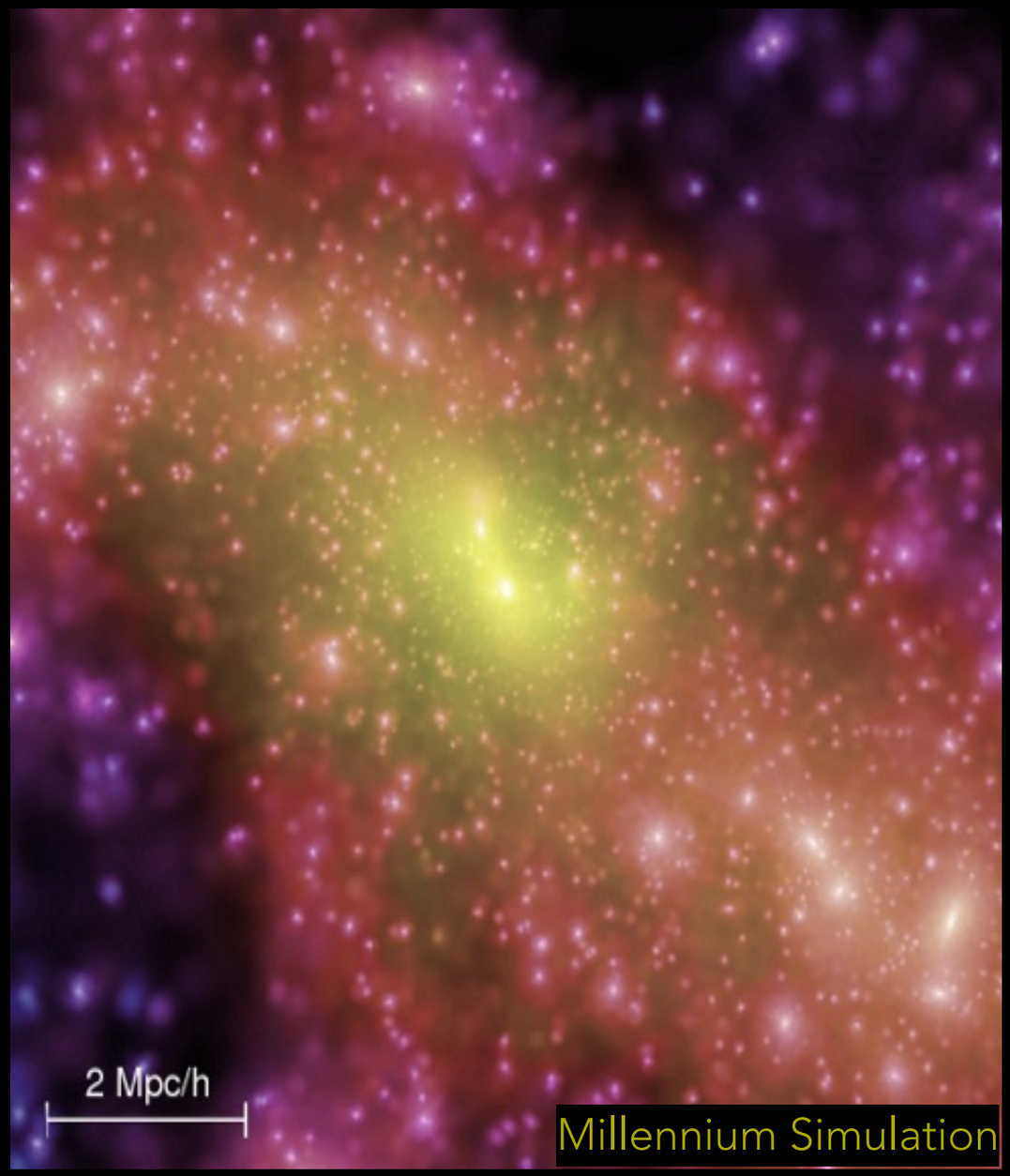

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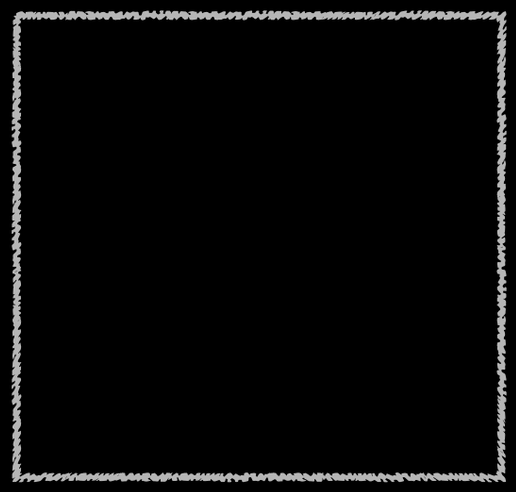

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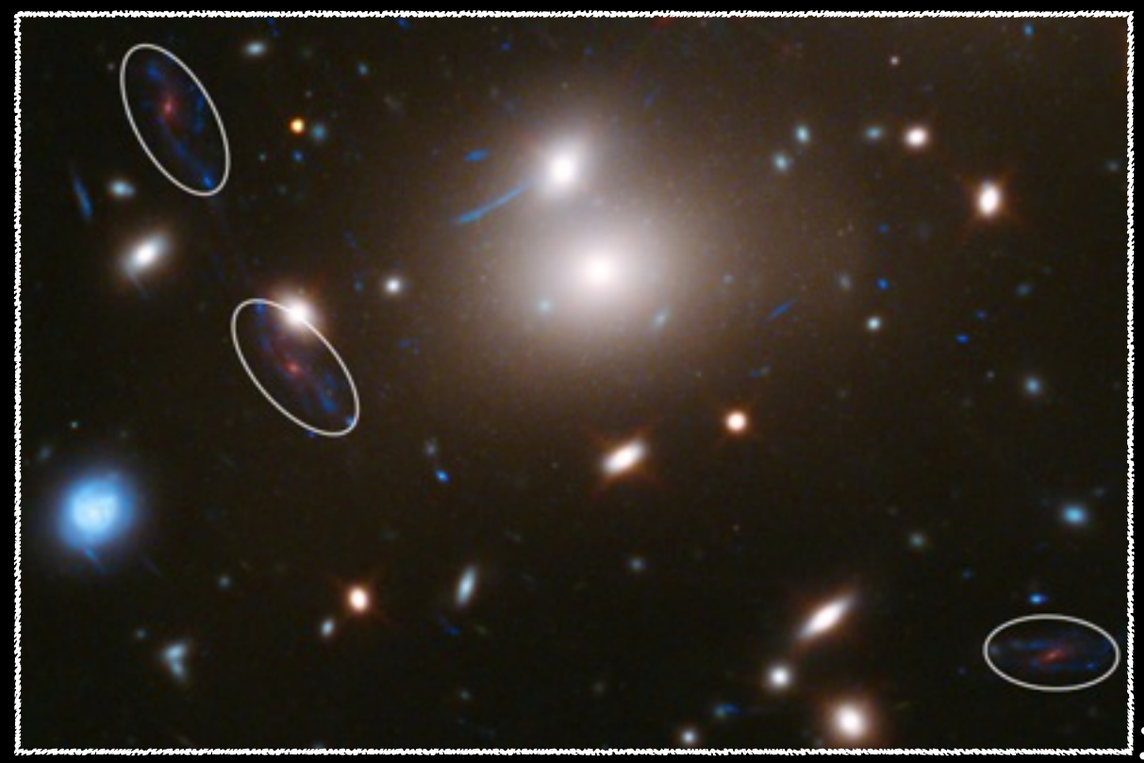

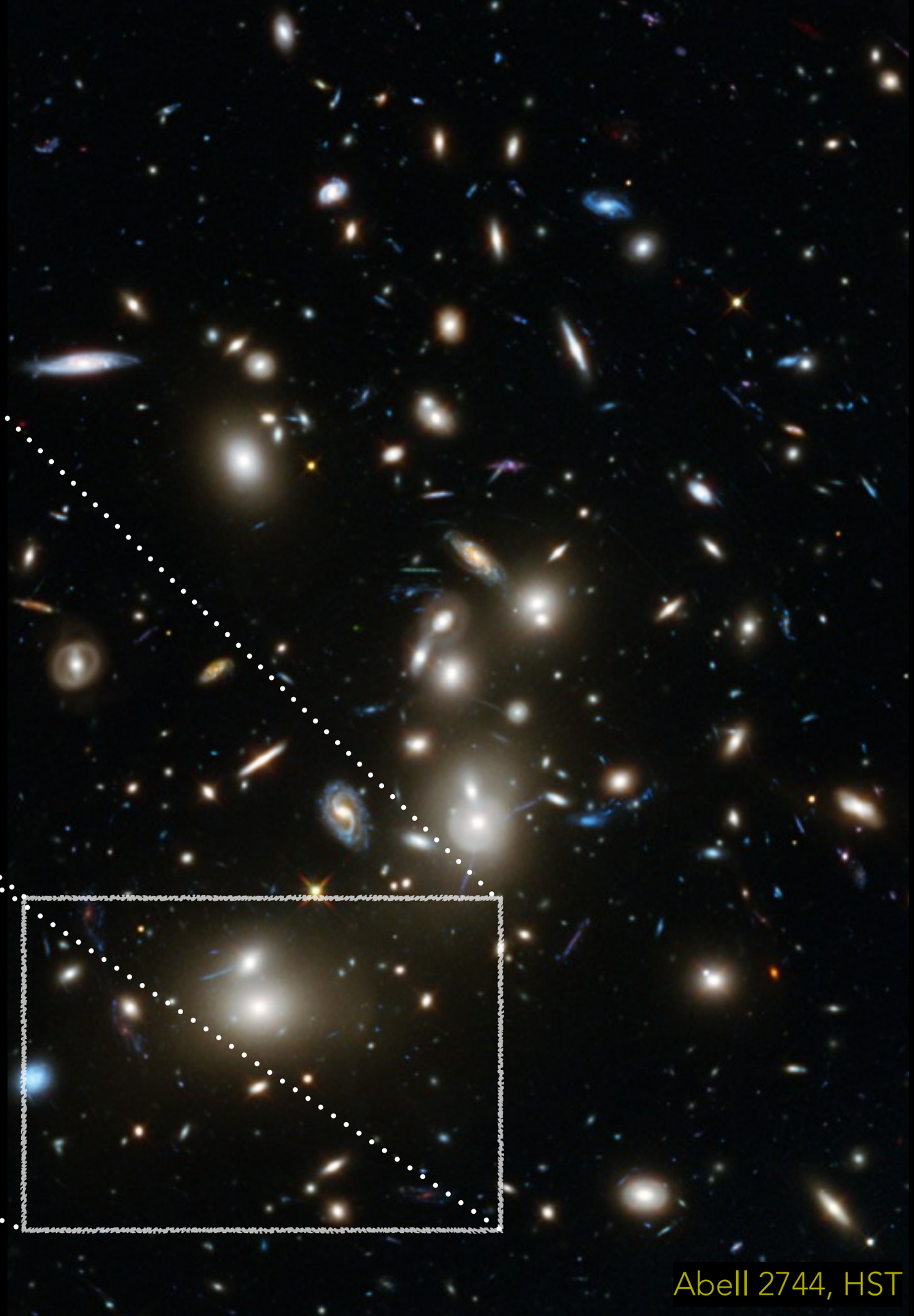

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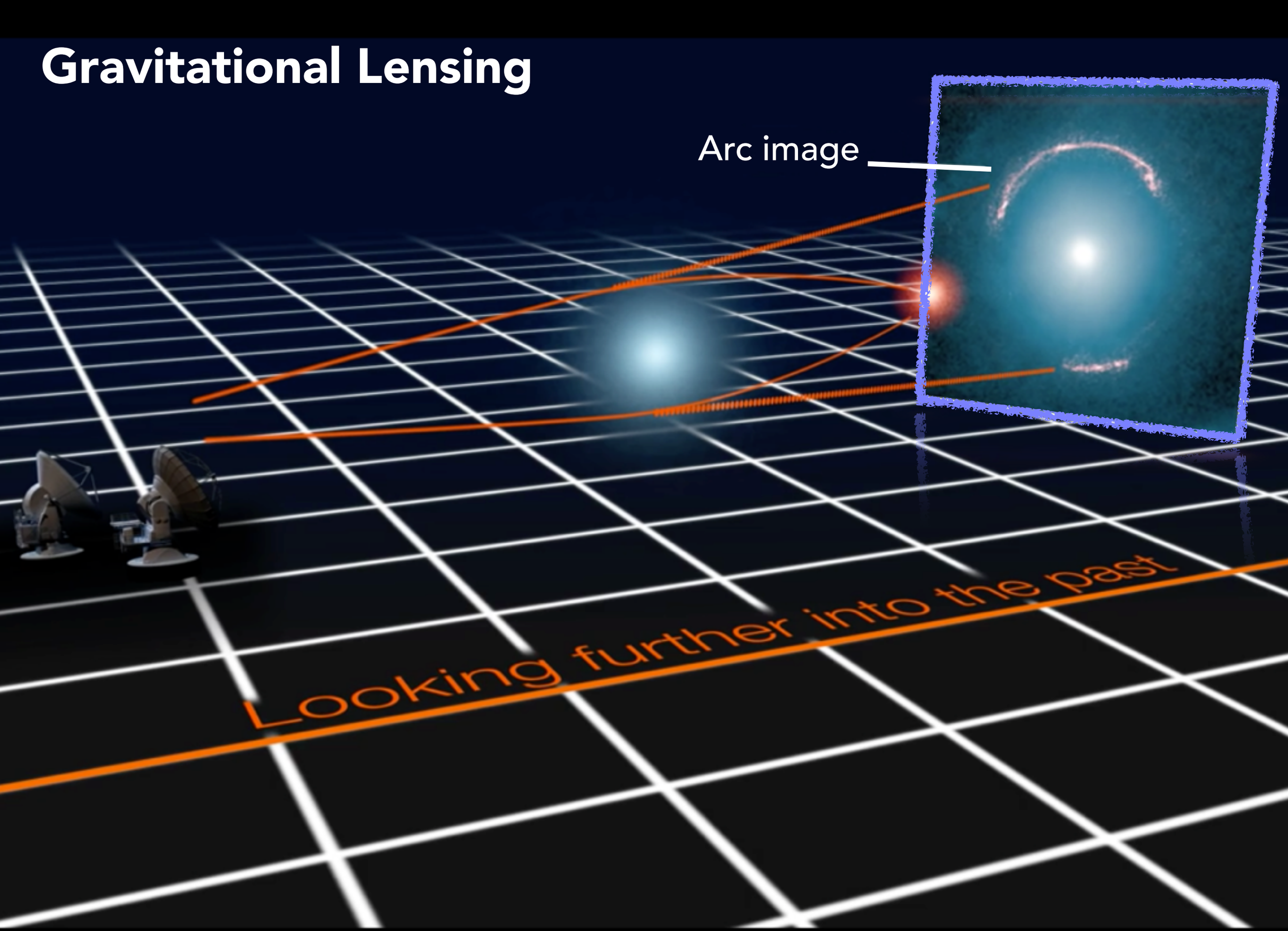

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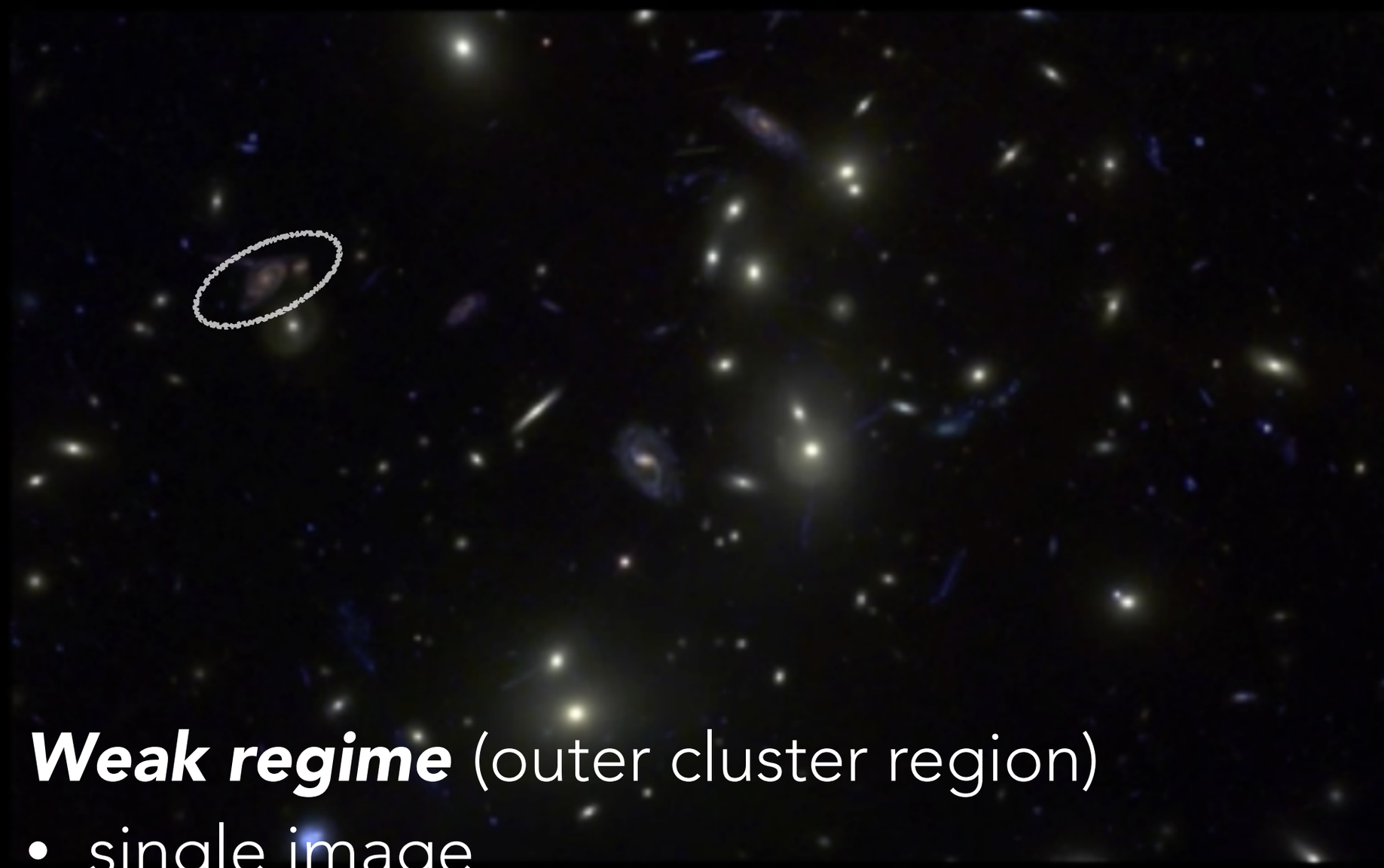

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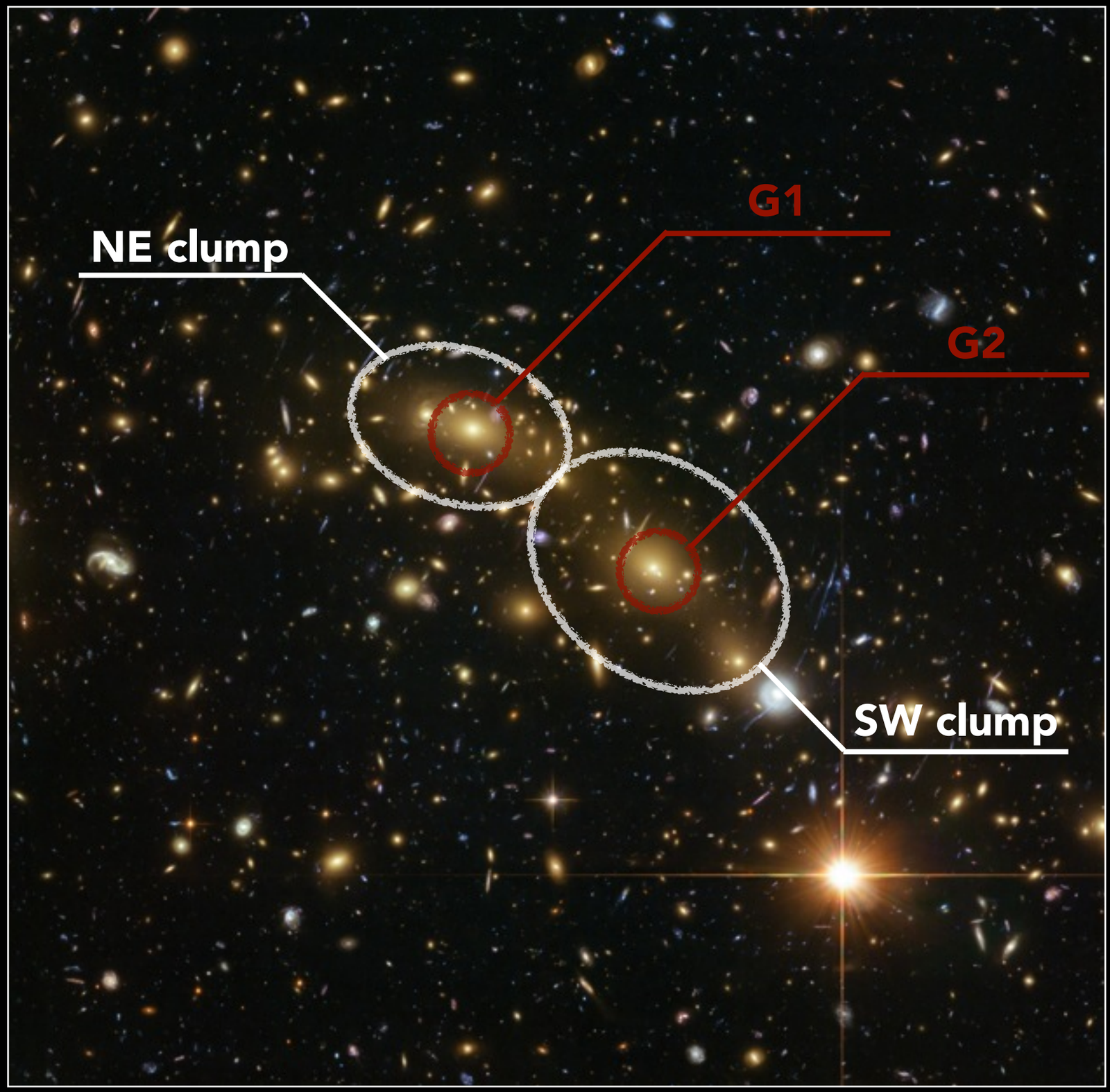

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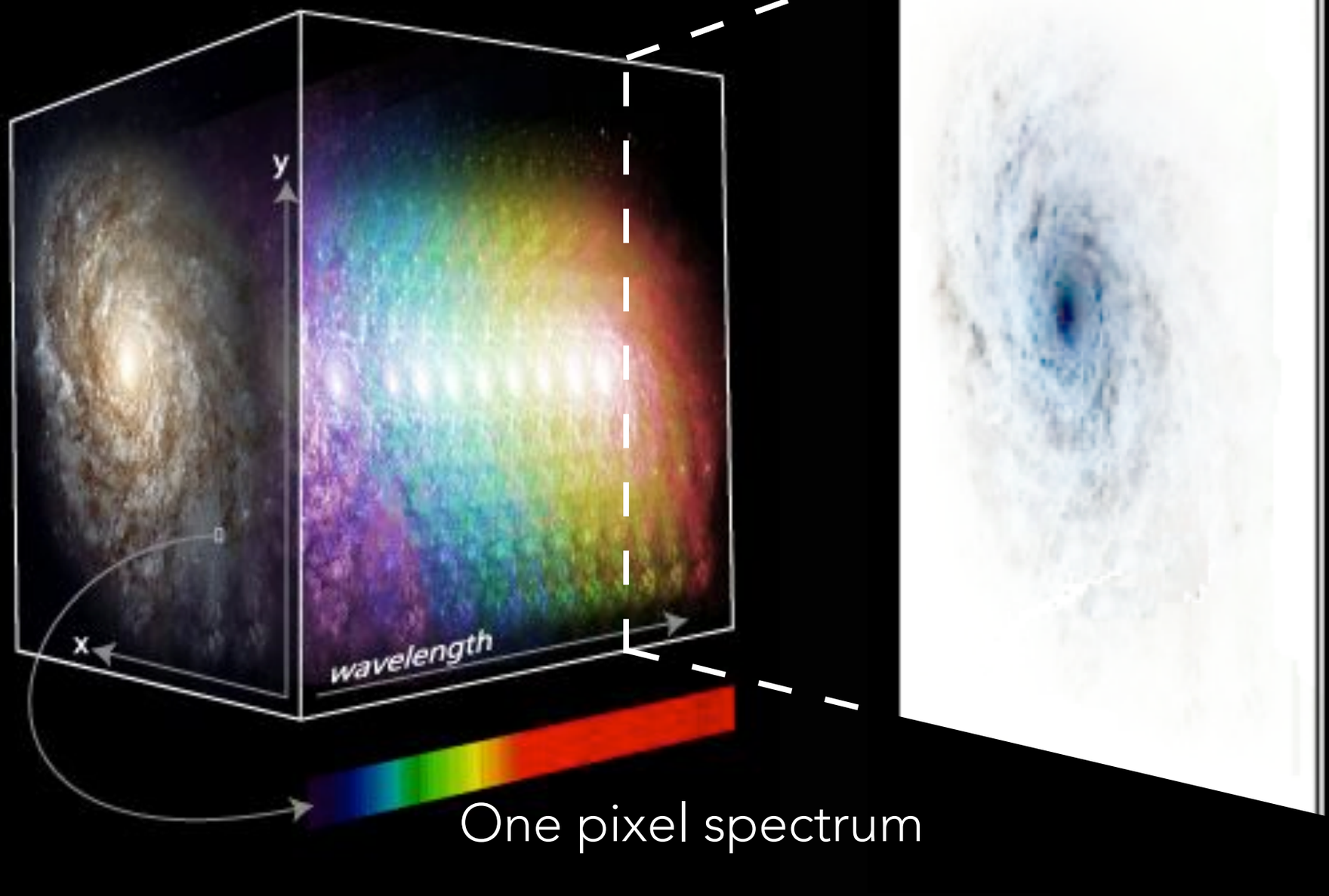

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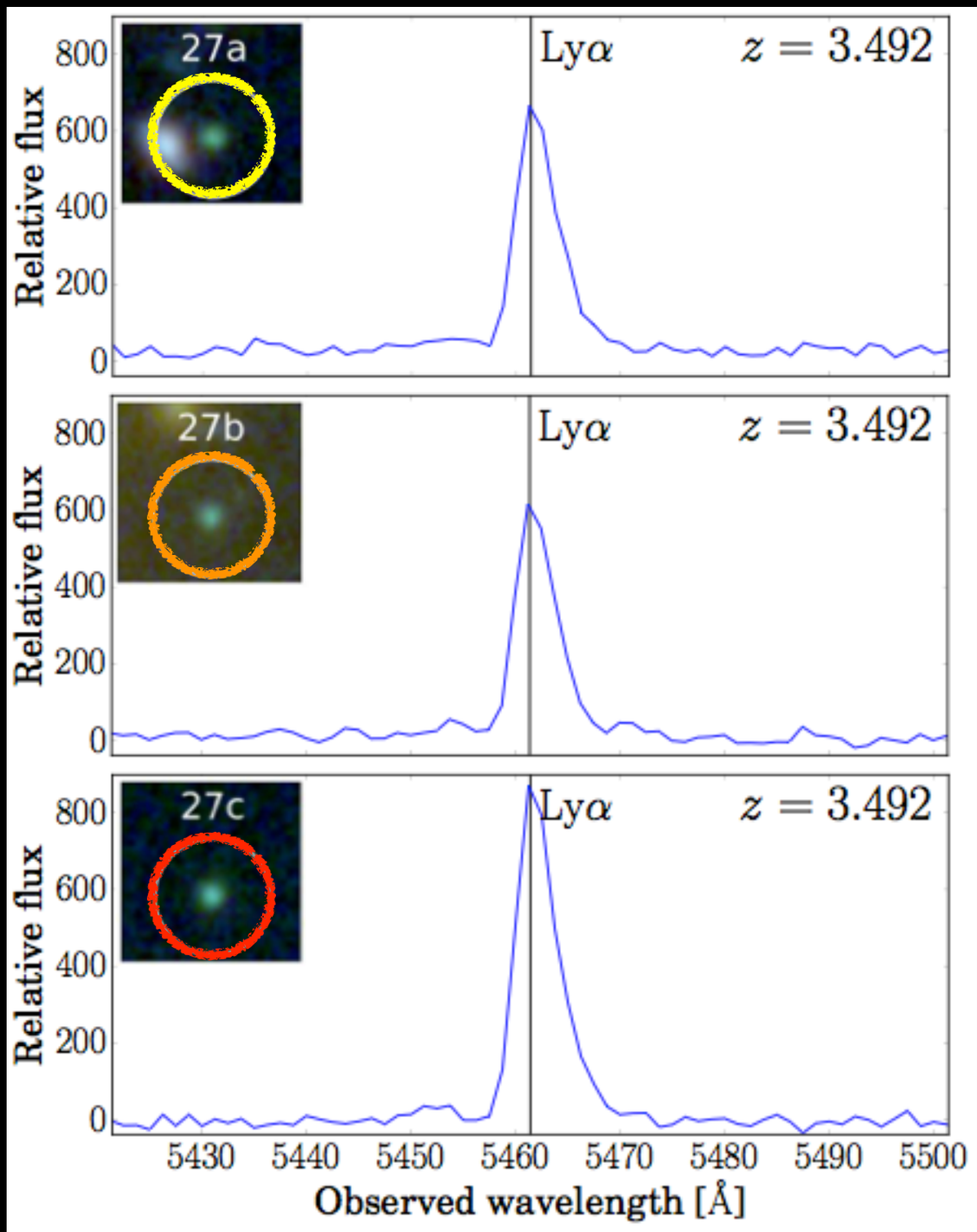

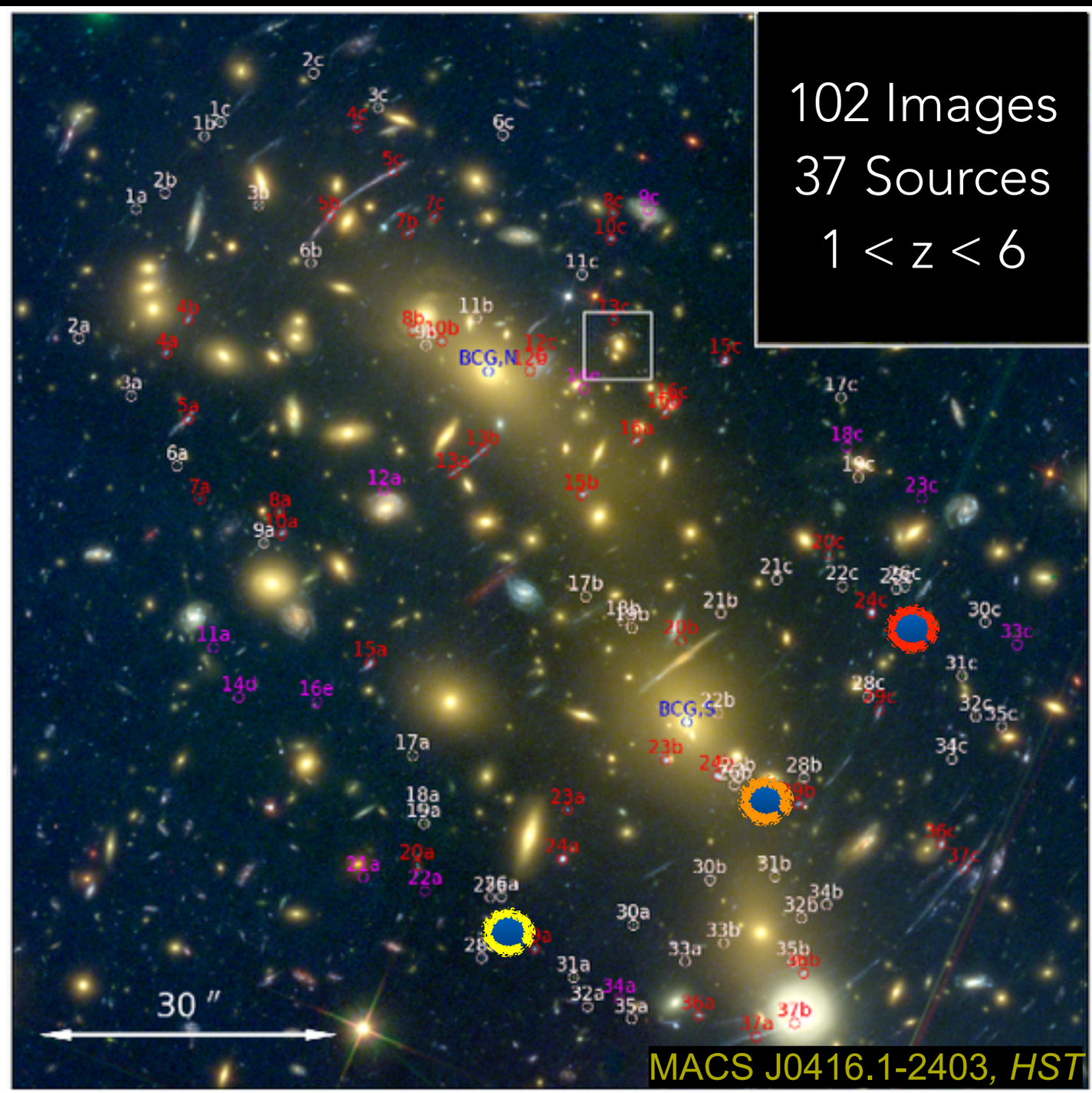

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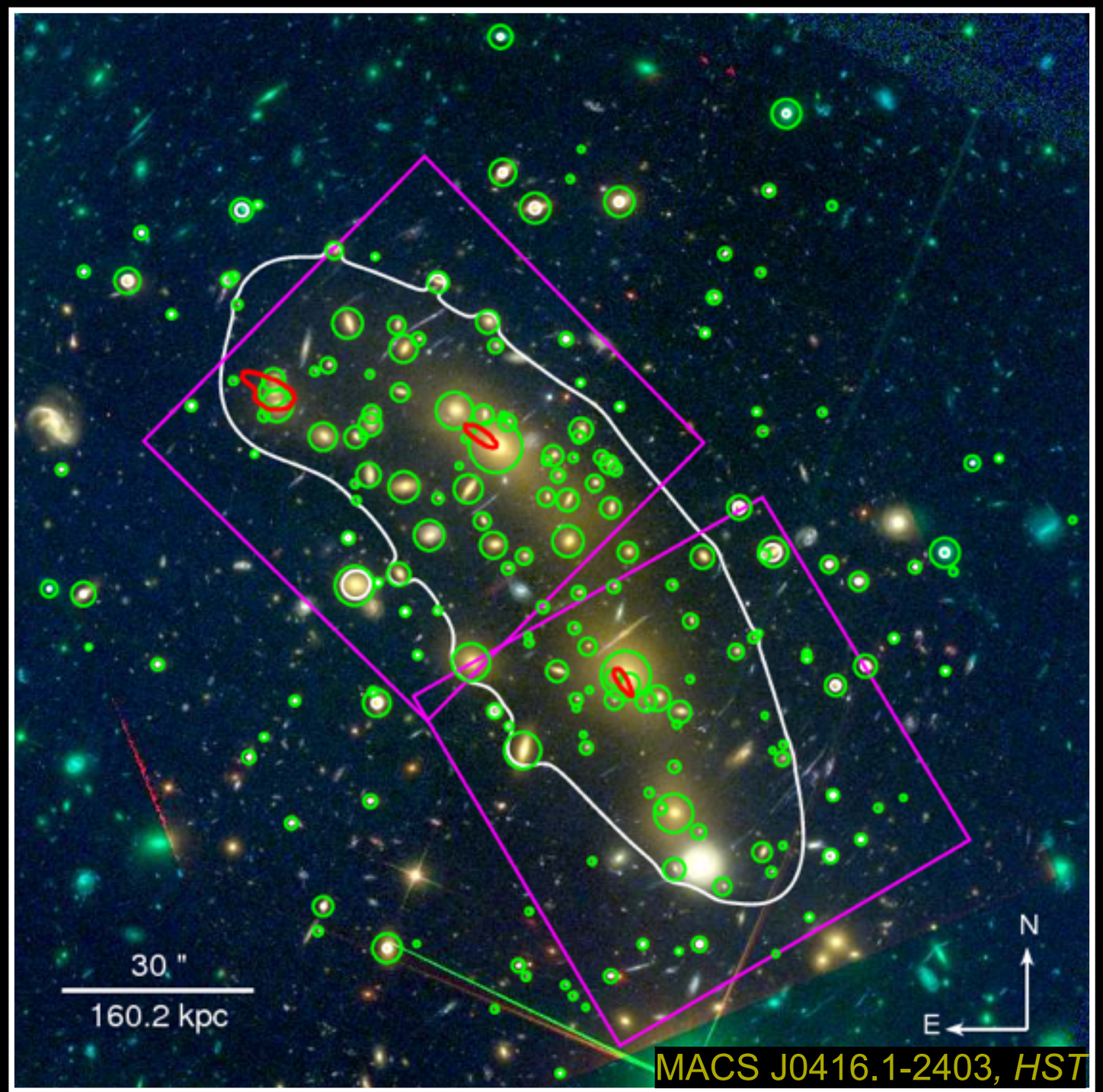

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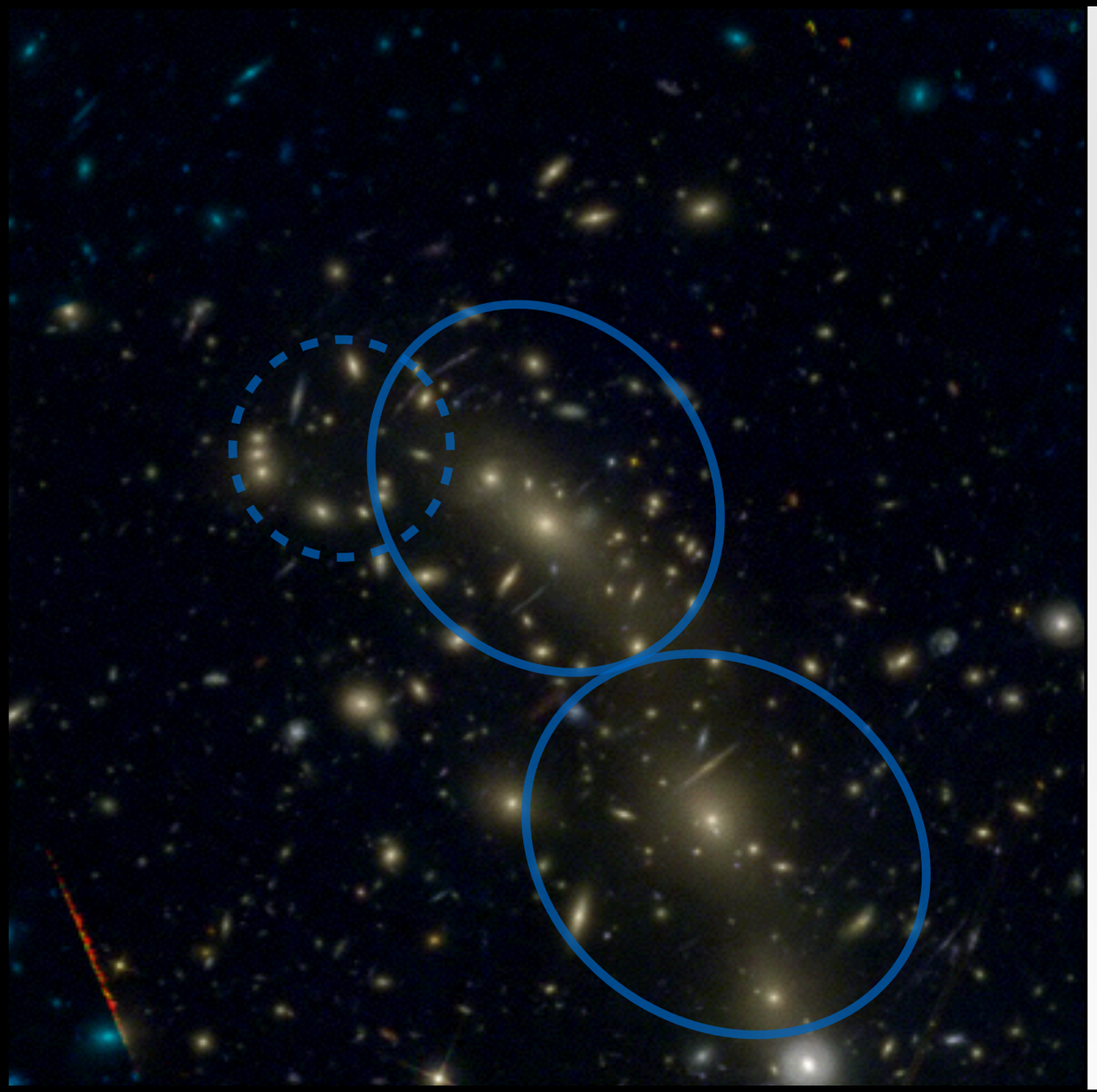

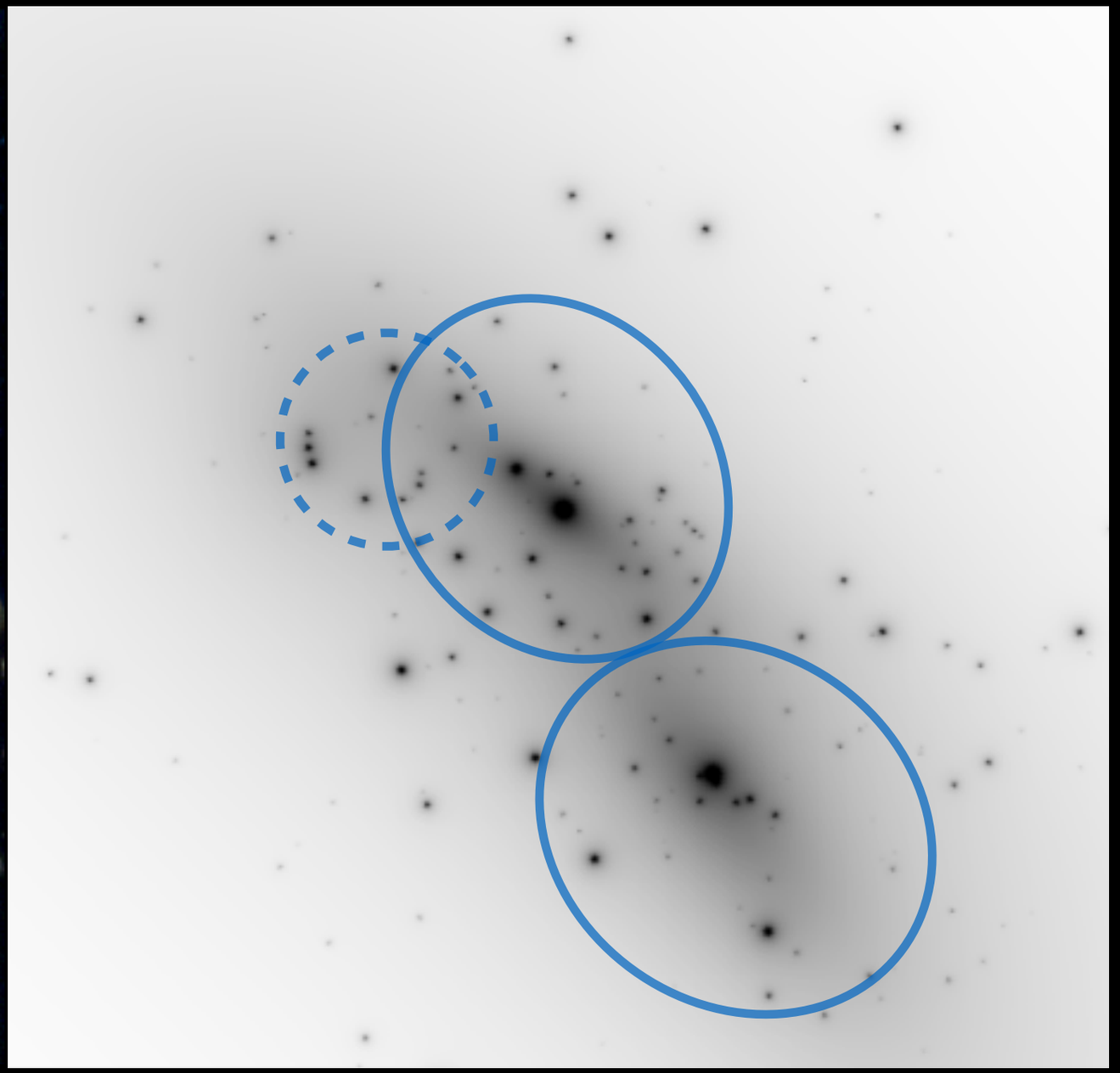

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Our cluster: a composite image

X-band (Chandra):

hot gas

blue diffuse emission

Visible (HST):

galaxies

color bands

Radio (NSF's Jansky VLA):

sonic shock waves

pink diffuse emission

Observation bands

MACS 0416