Gravitational Lensing with (in) the Millennium Run Observatory

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lensing simulation

calculating deflection angle

analytic model or from particles:

tree code deflection solver
modified algorithm to handle halos efficiently

adaptive smoothing for Nbody/hydro particles

multiple lens planes:
3d along light paths

lens model

single analytic lens
multiple analytic halos
Nbody/SPH particles
point masses (stars)
pixelized mass map

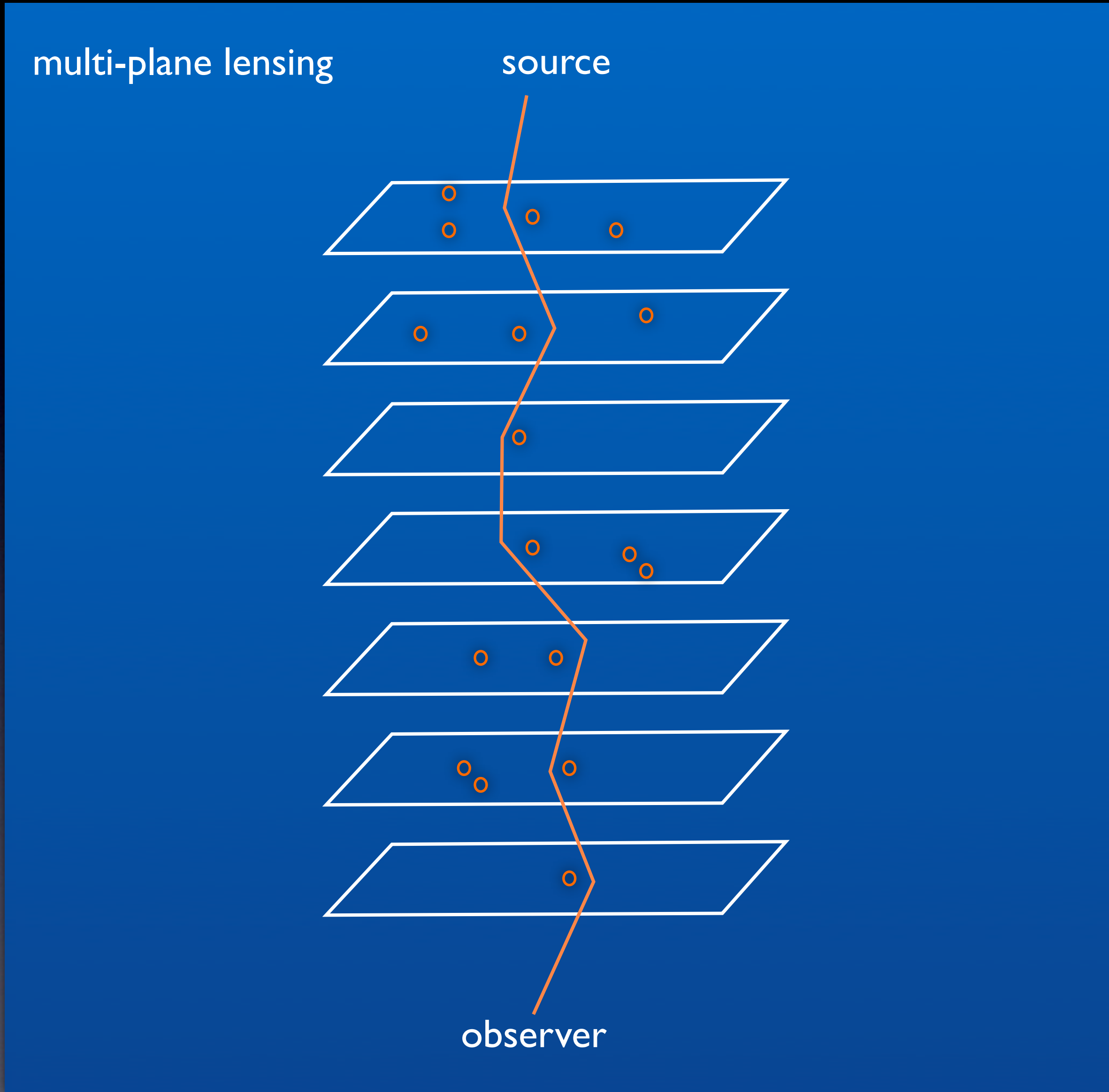
the grid of rays

adaptive grid refinement

full image reconstruction or just shear and convergence

source model

analytic model for surface brightness
and
direct pixelized images


multi-plane lensing
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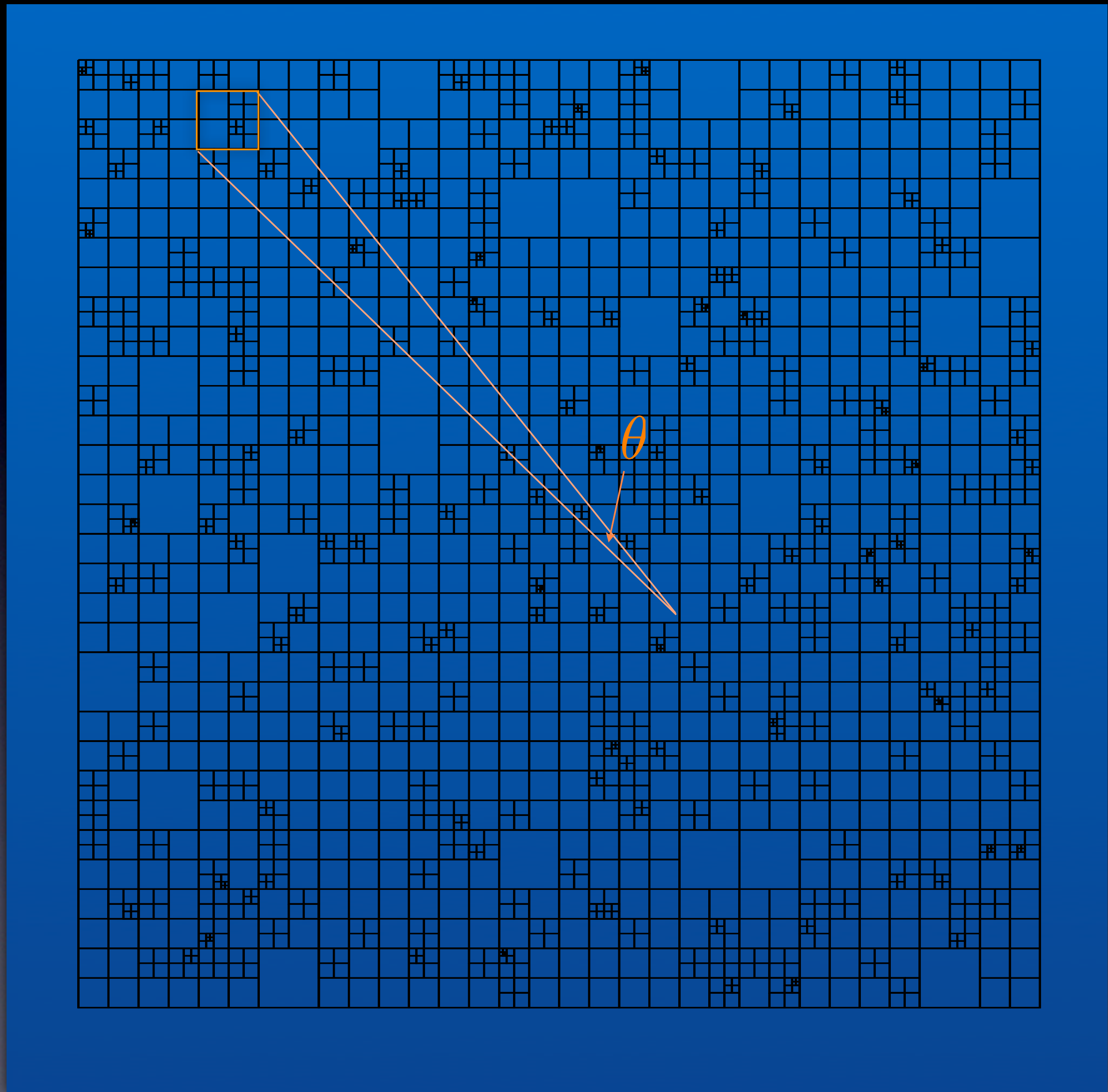
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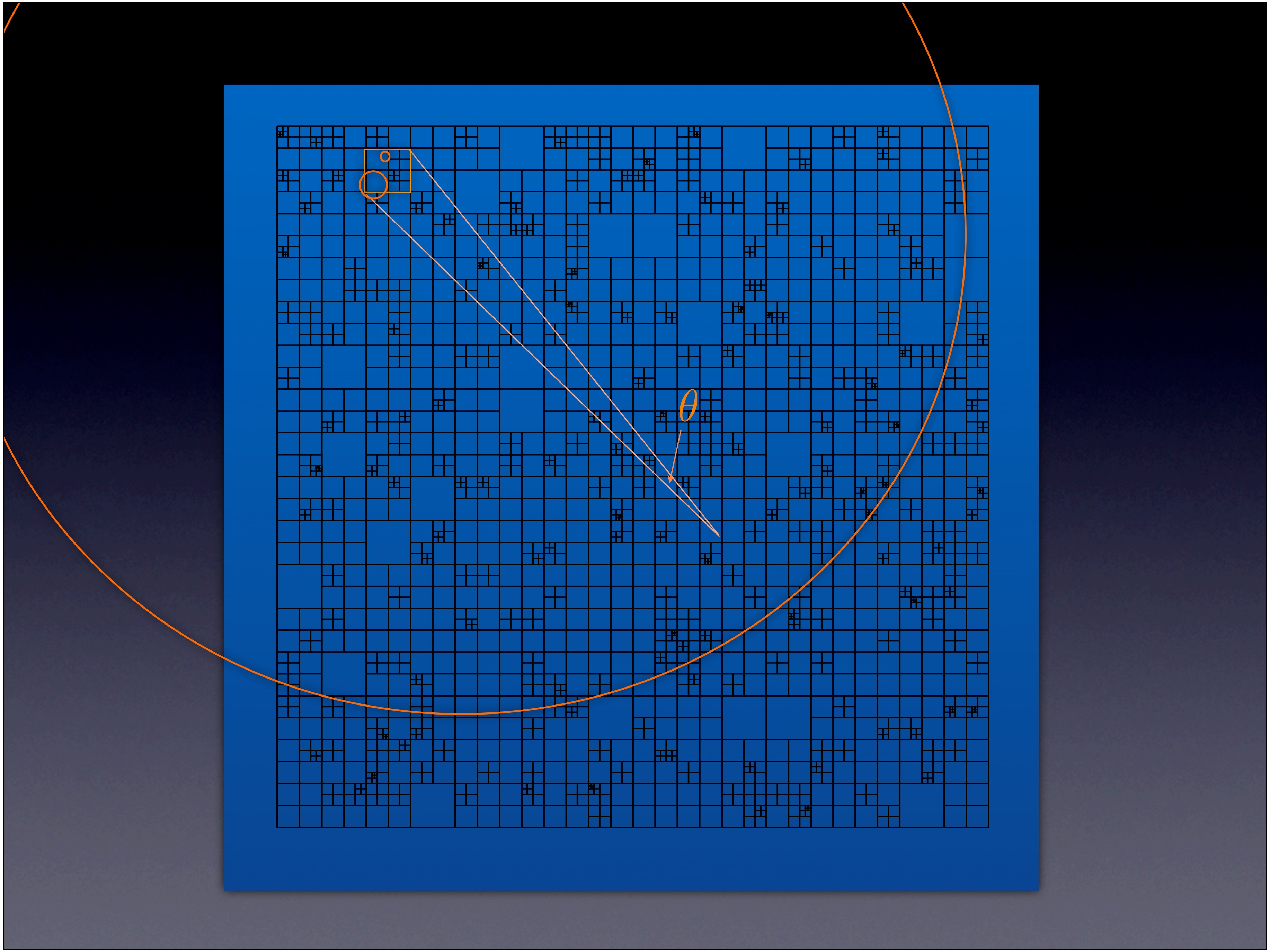
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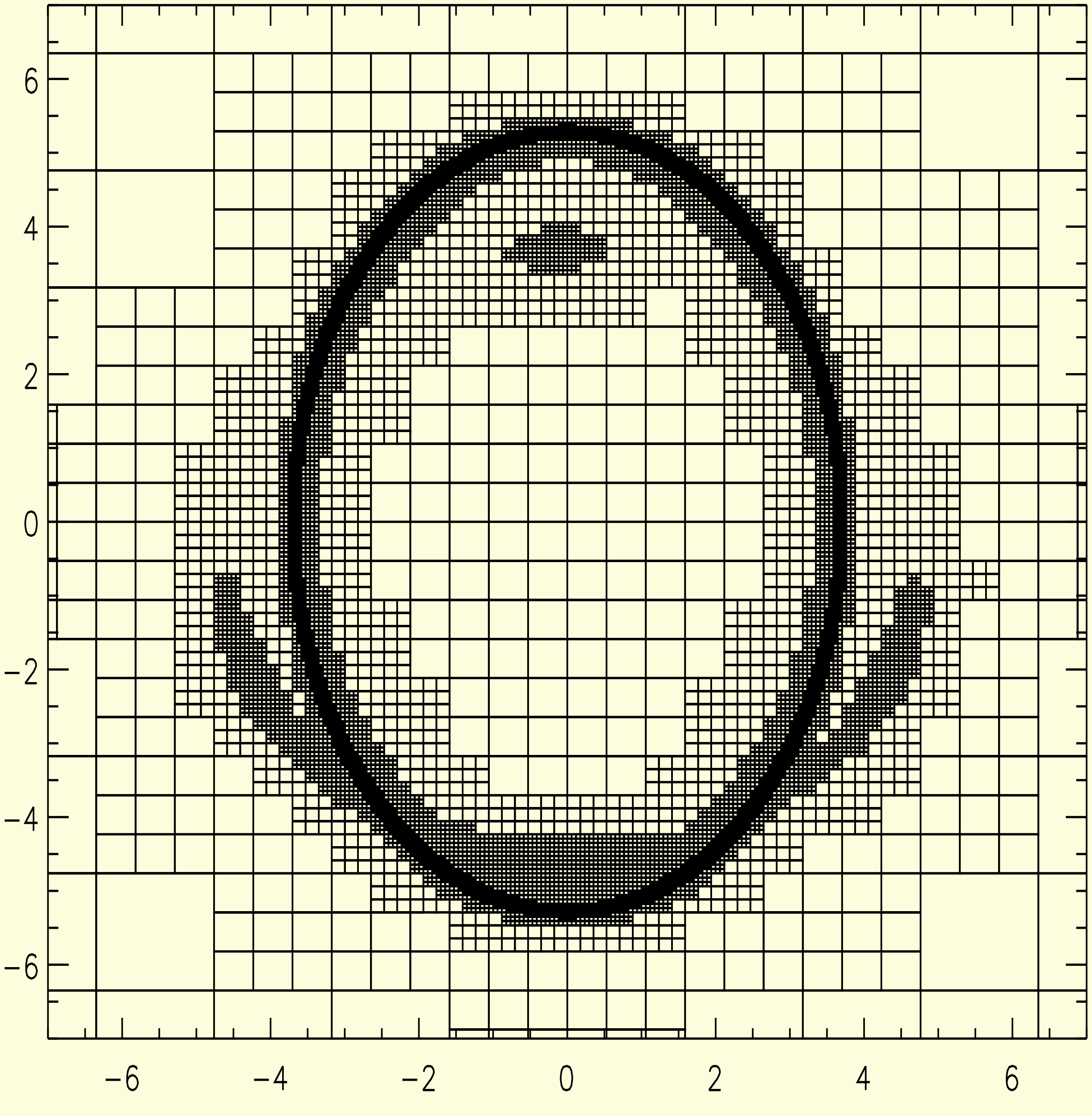

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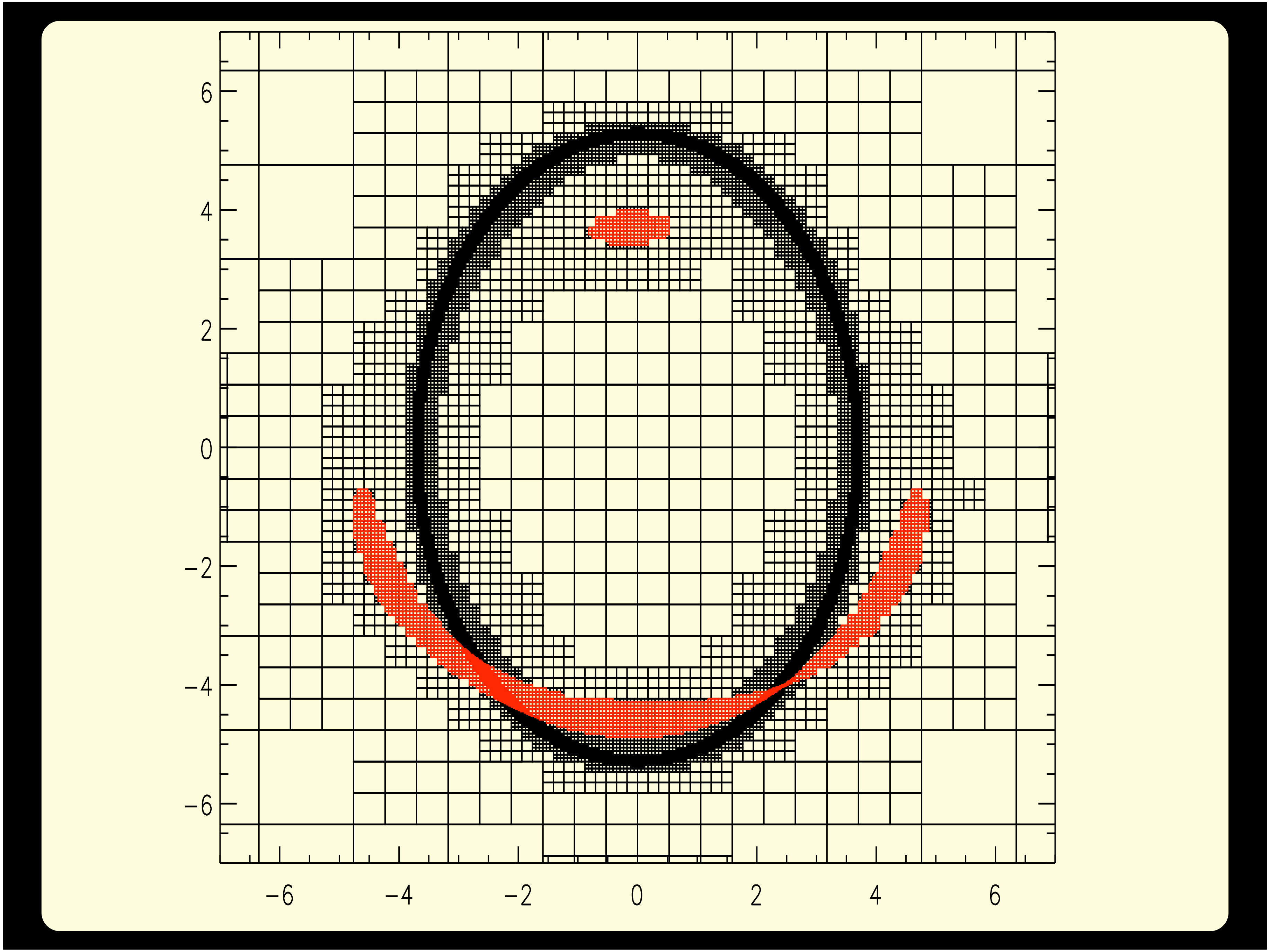
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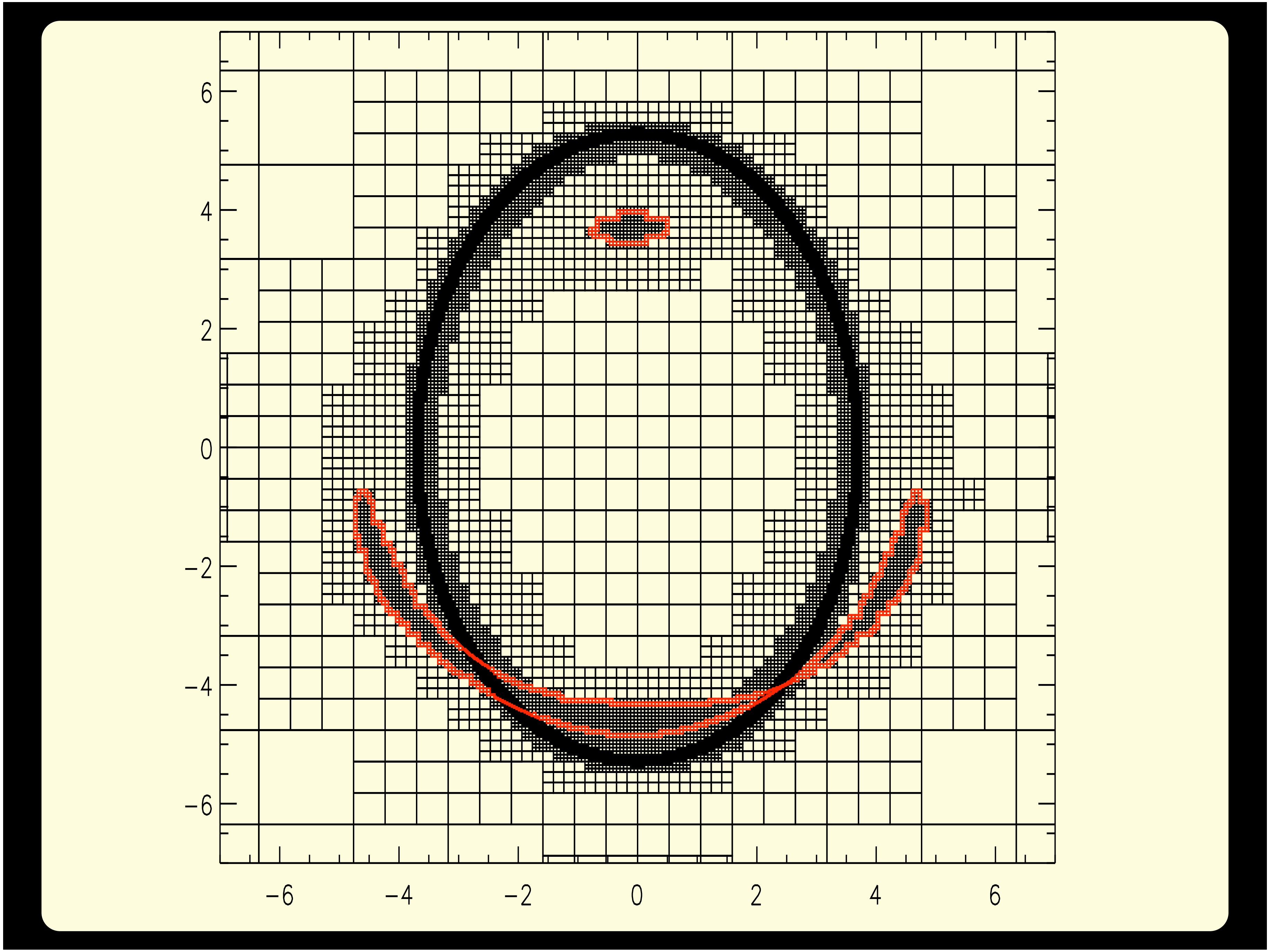

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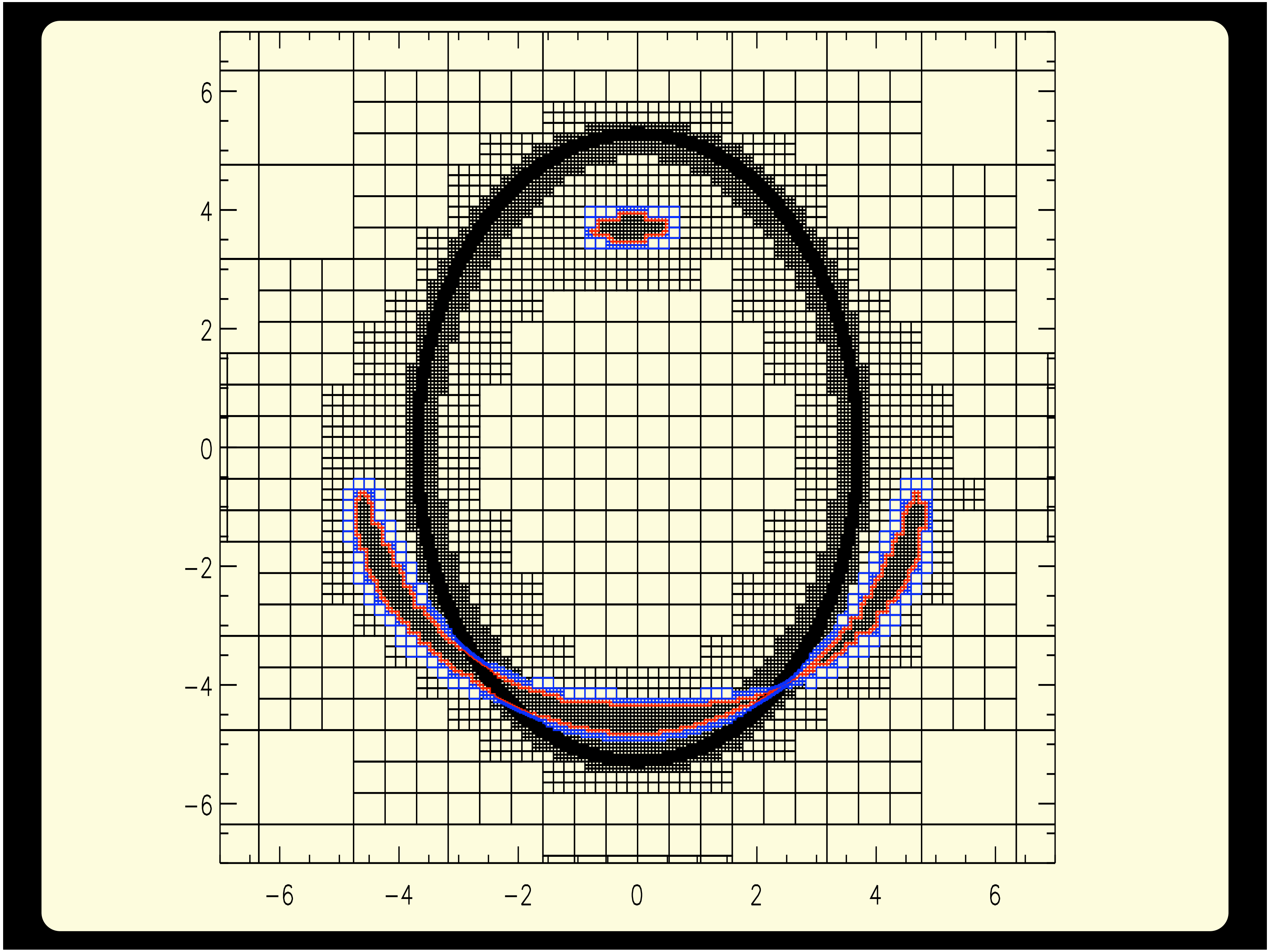

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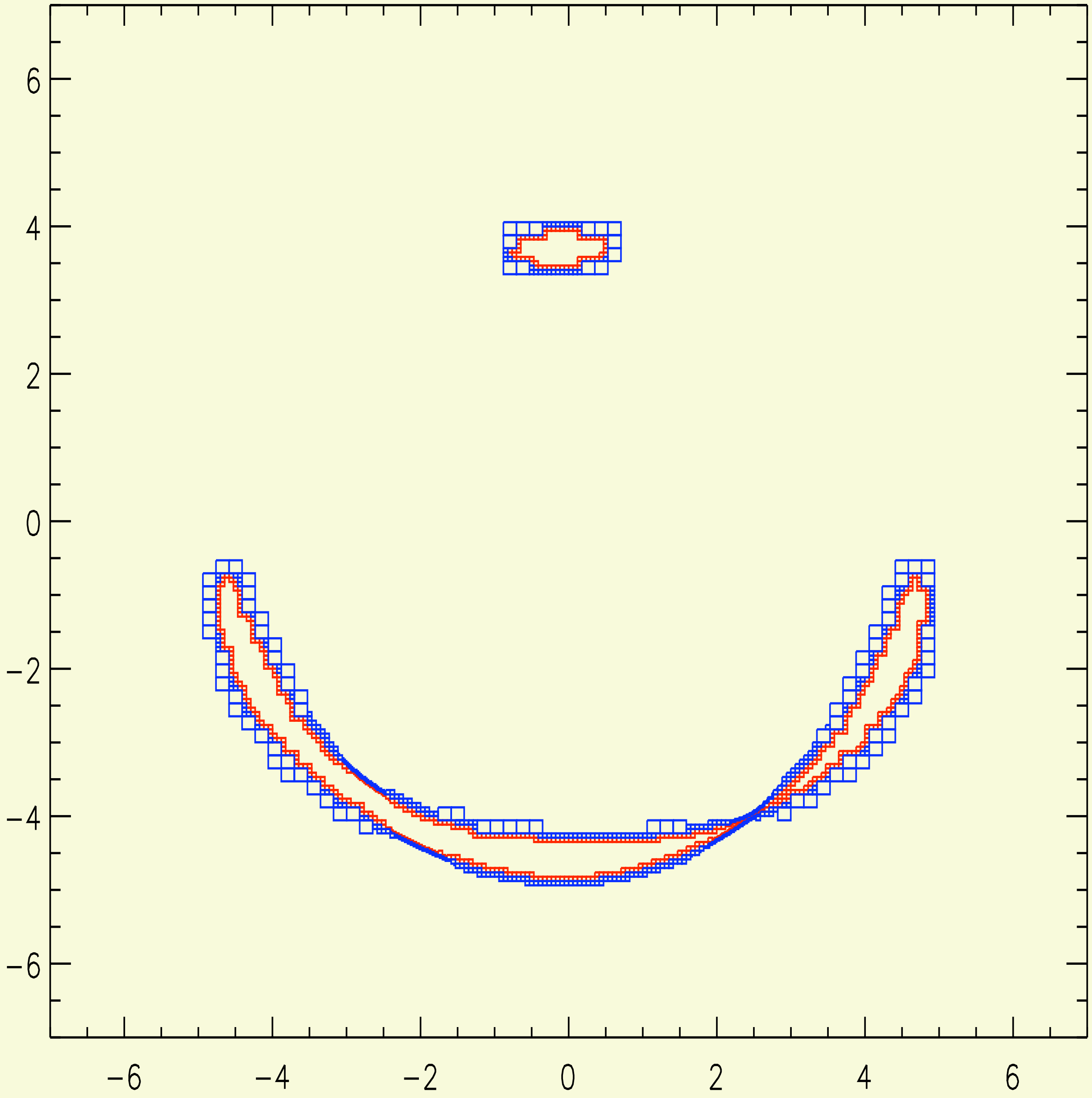
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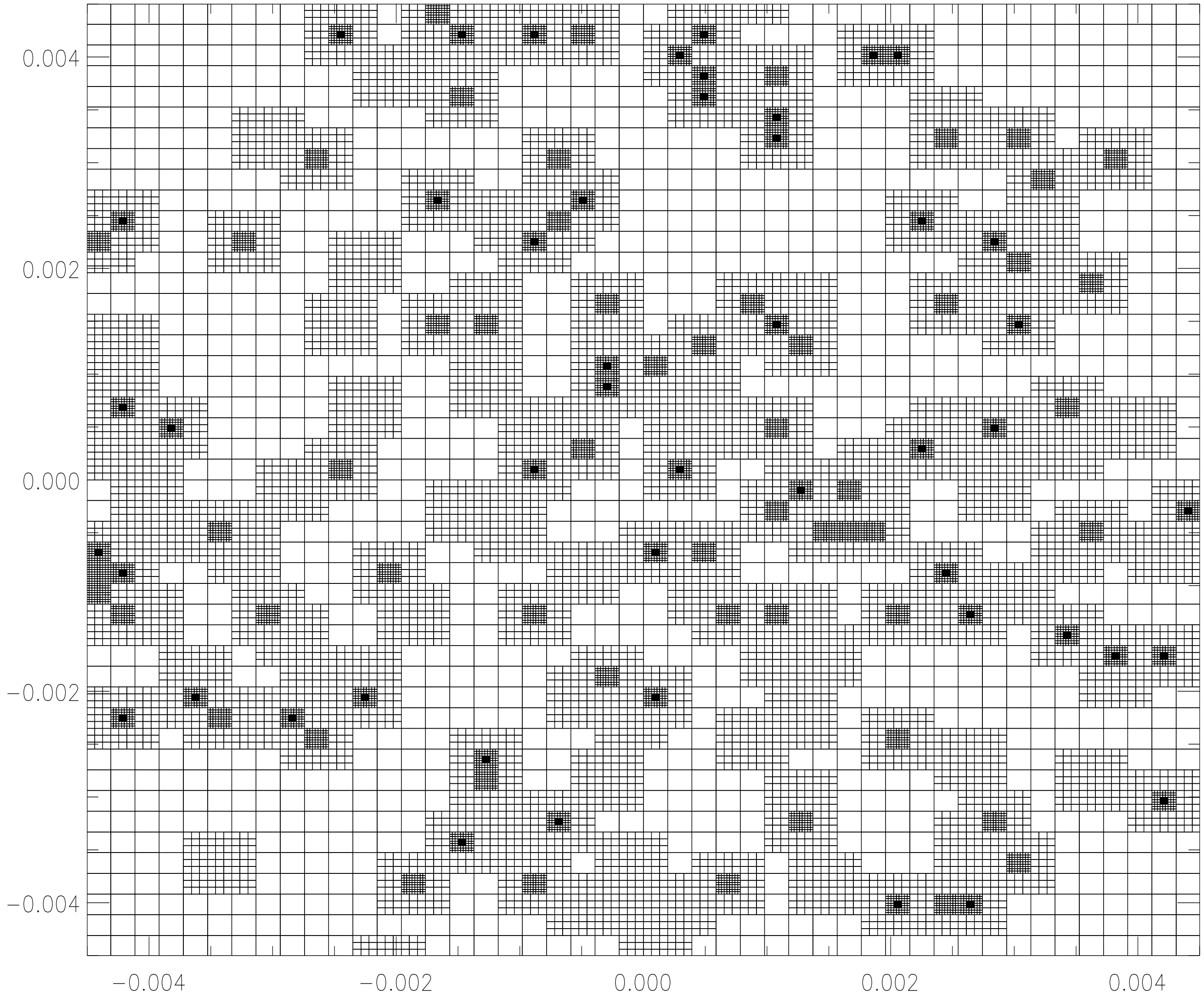
Adaptive Grid Refinement



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Halo Lens Model

Advantages to using halos

- Much less memory required
- Much faster
- Baryonds need to be put in by hand anyway

Disadvantage

- Not all the mass is in the halos.
- Each halo is different

Halo Lens Model

Halo is represented as a NFW profile fit to the mass, half mass radius and peak circular velocity of the Millennium halo.

Halos mass to stellar mass ratio taken from abundance matching results or held fixed.

The "Galaxy" is represented by a NSIE (non singular isothermal sphere) the follows the Faber-Jackson relation, $\sigma \propto M_{\rm stars}^{1/4}$

Random ellipticity and orientation

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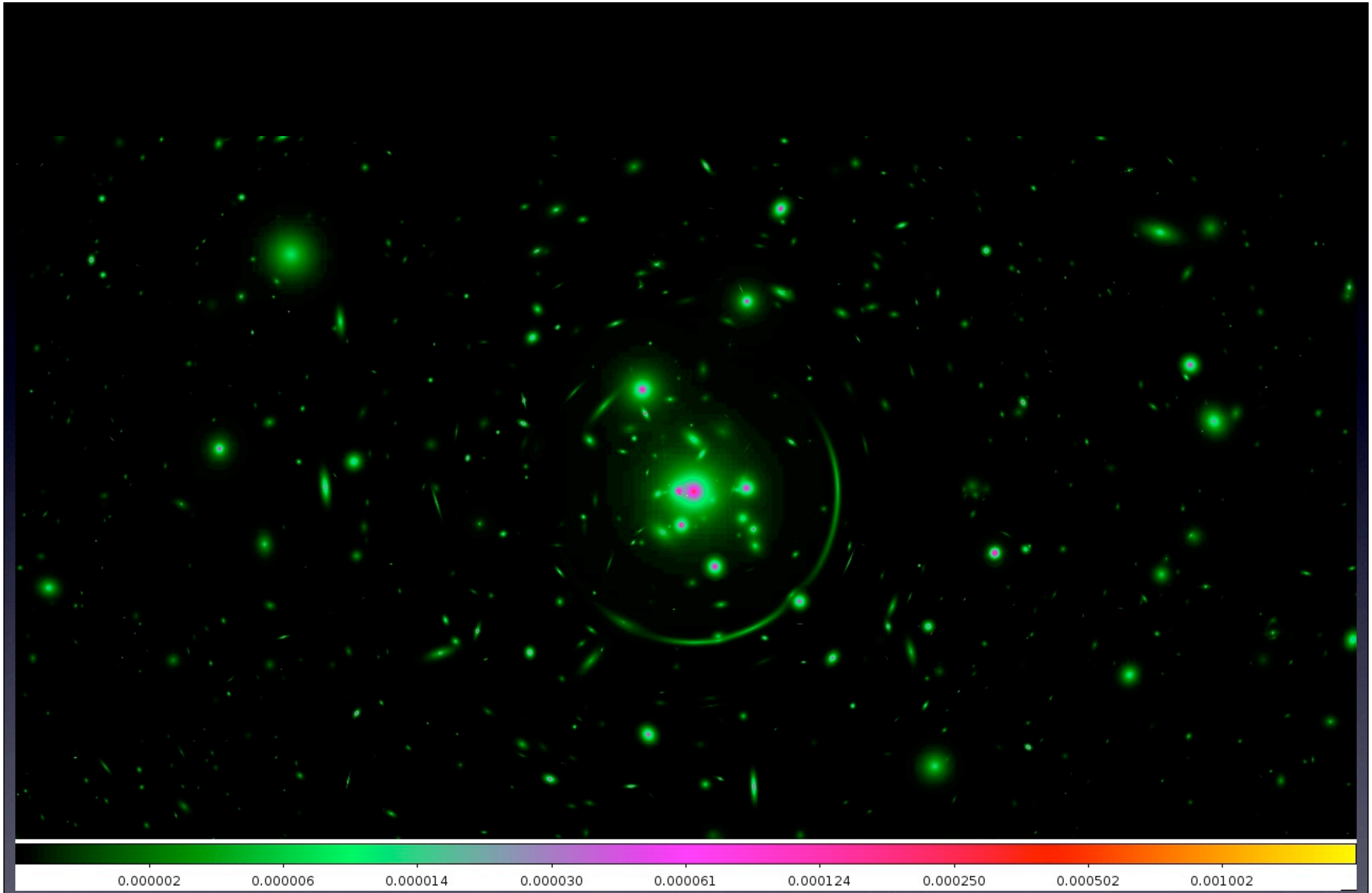
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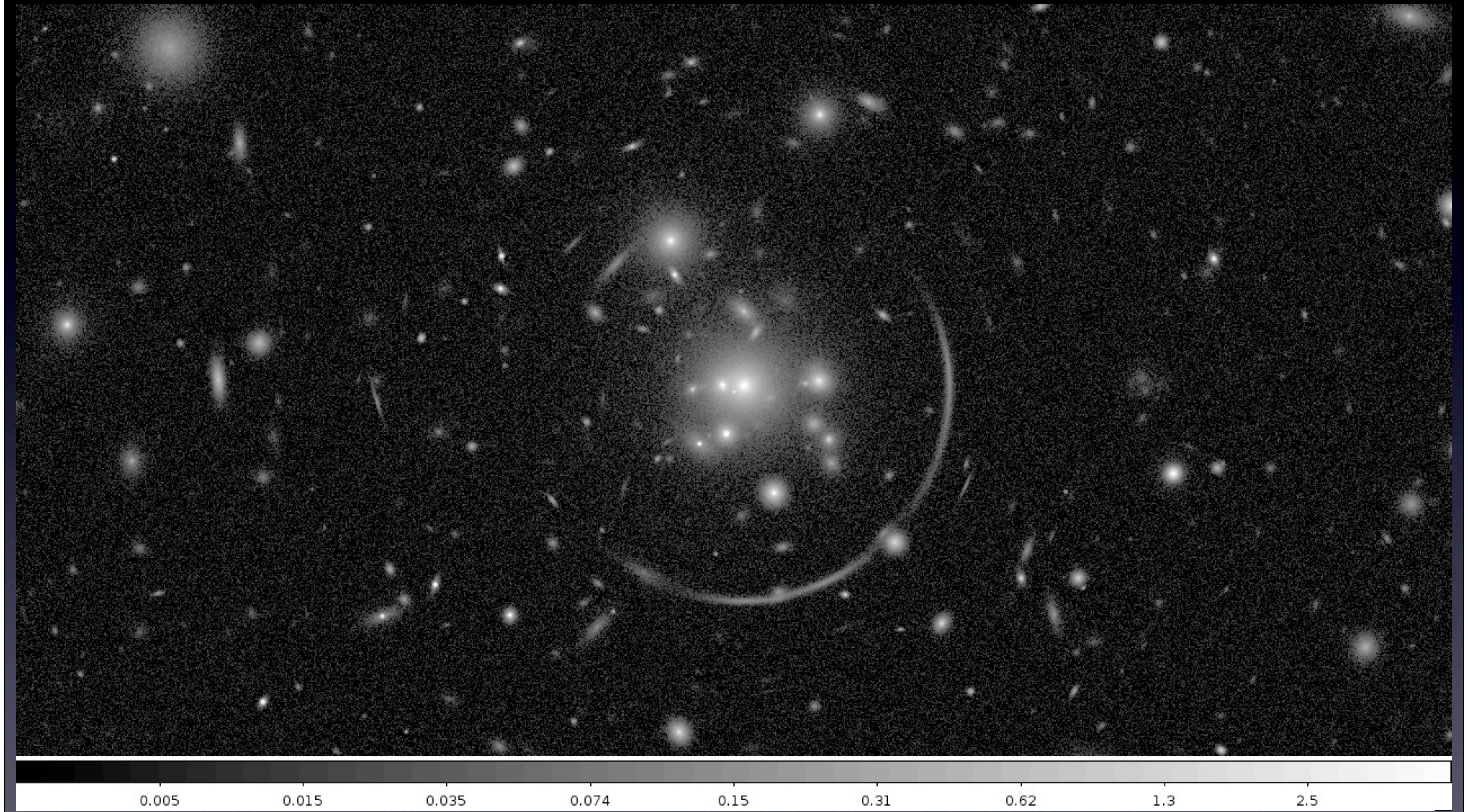
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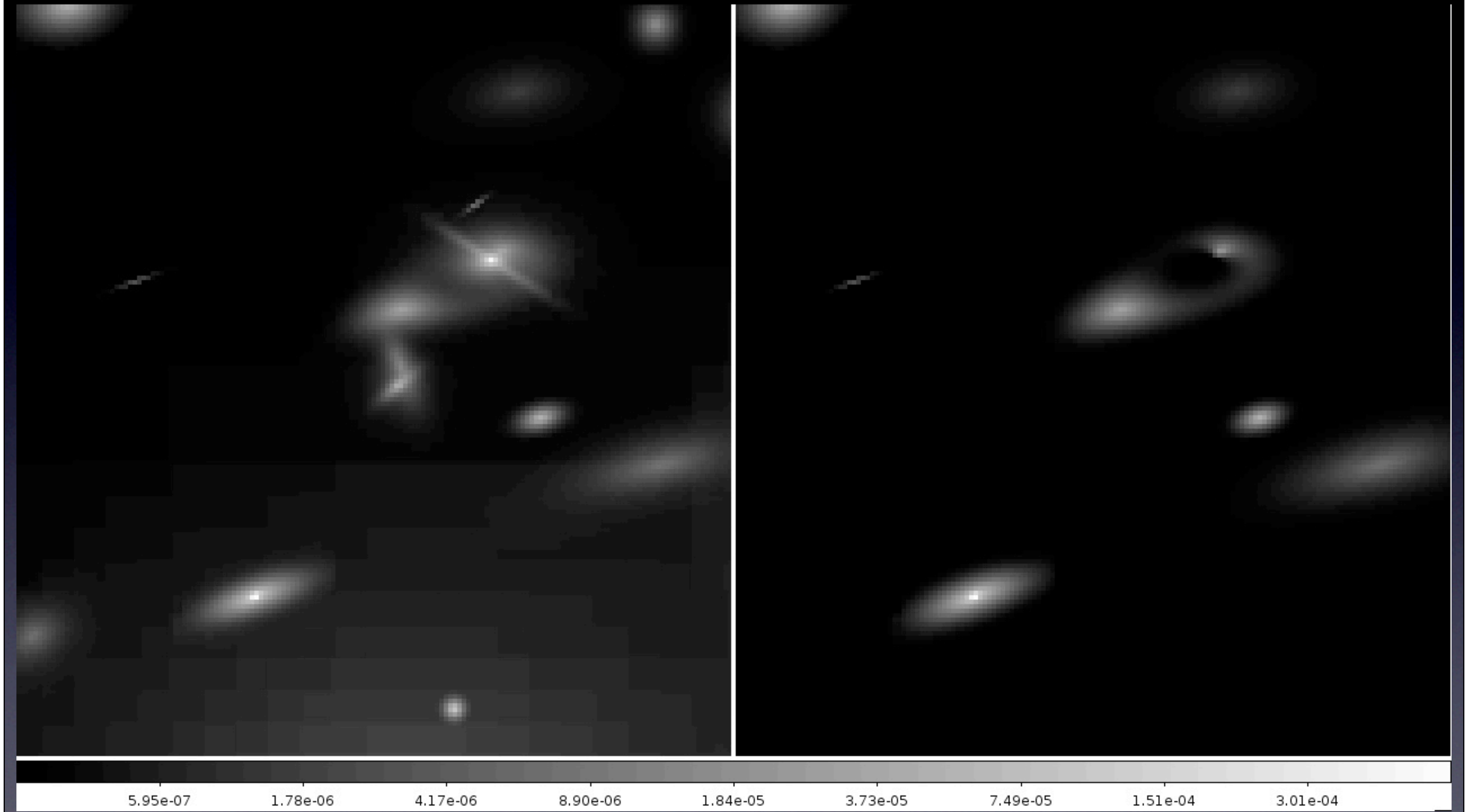
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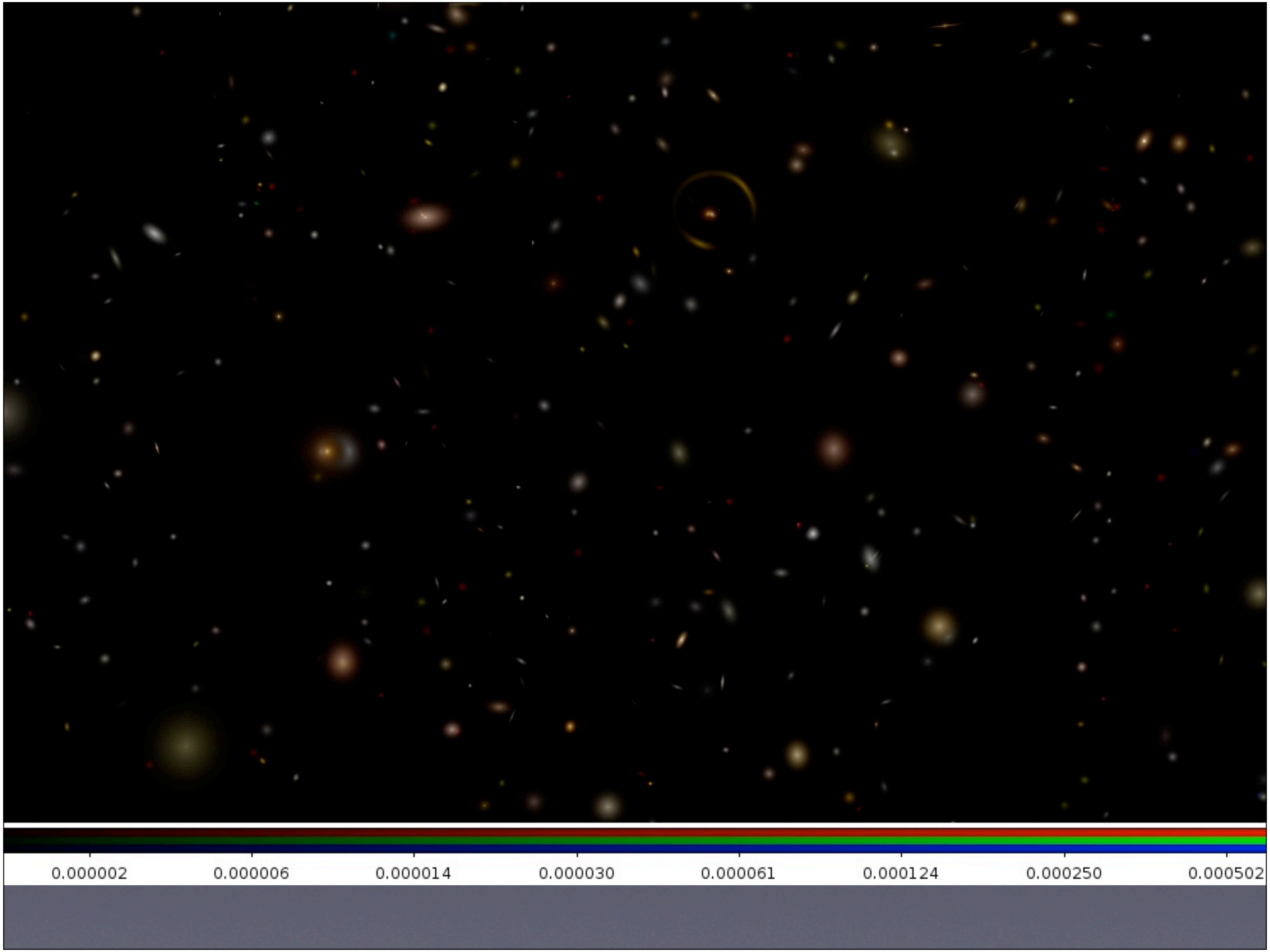
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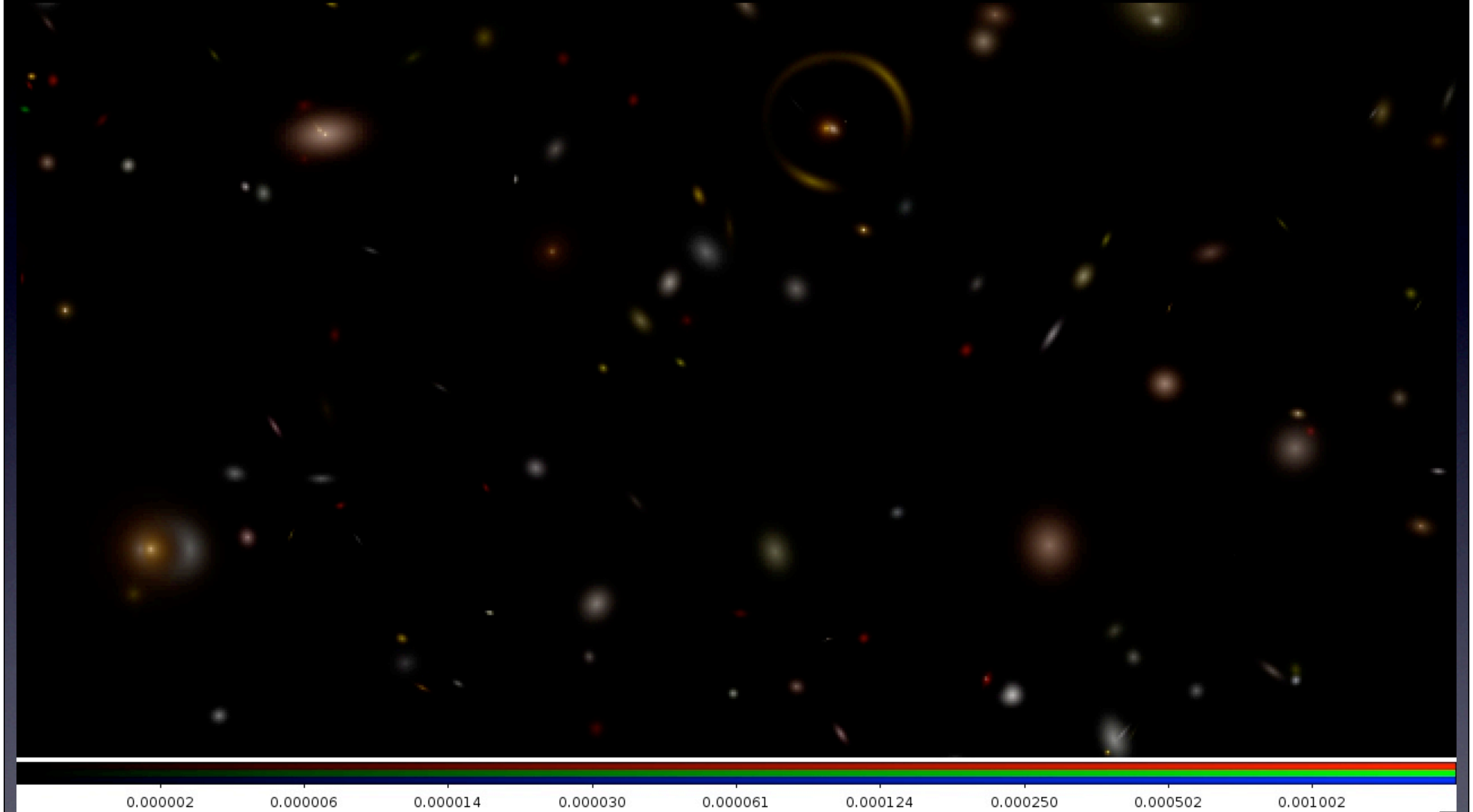
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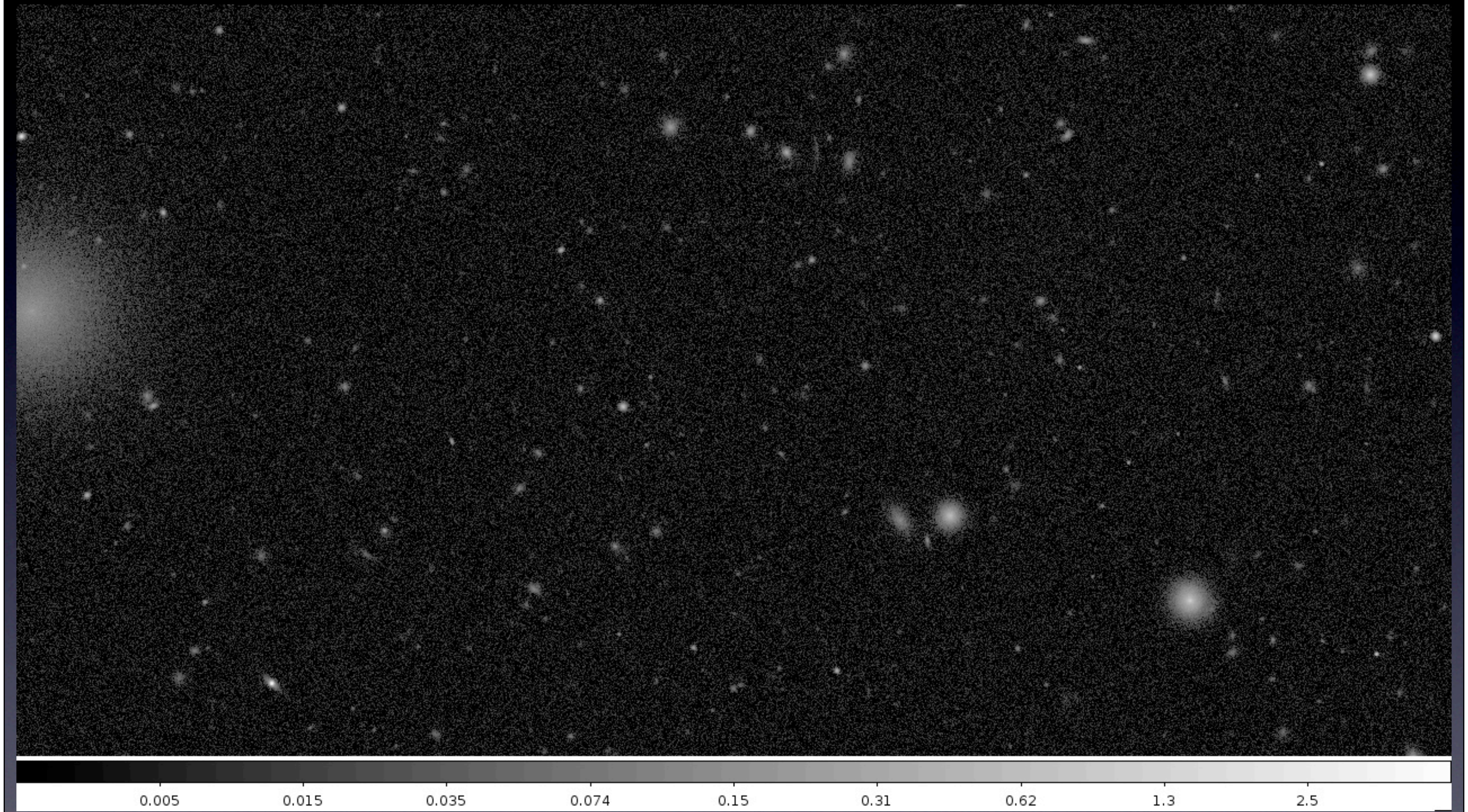
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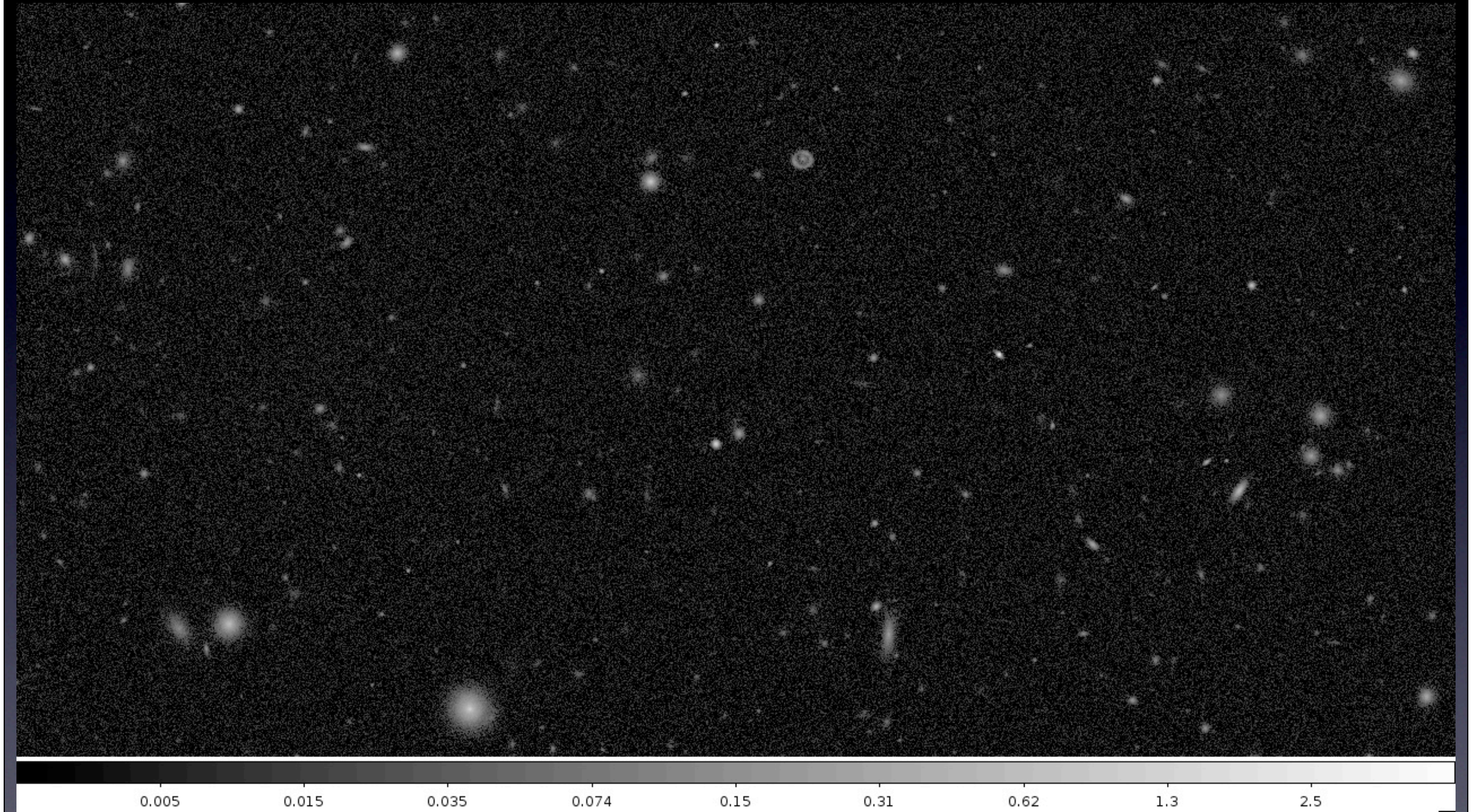
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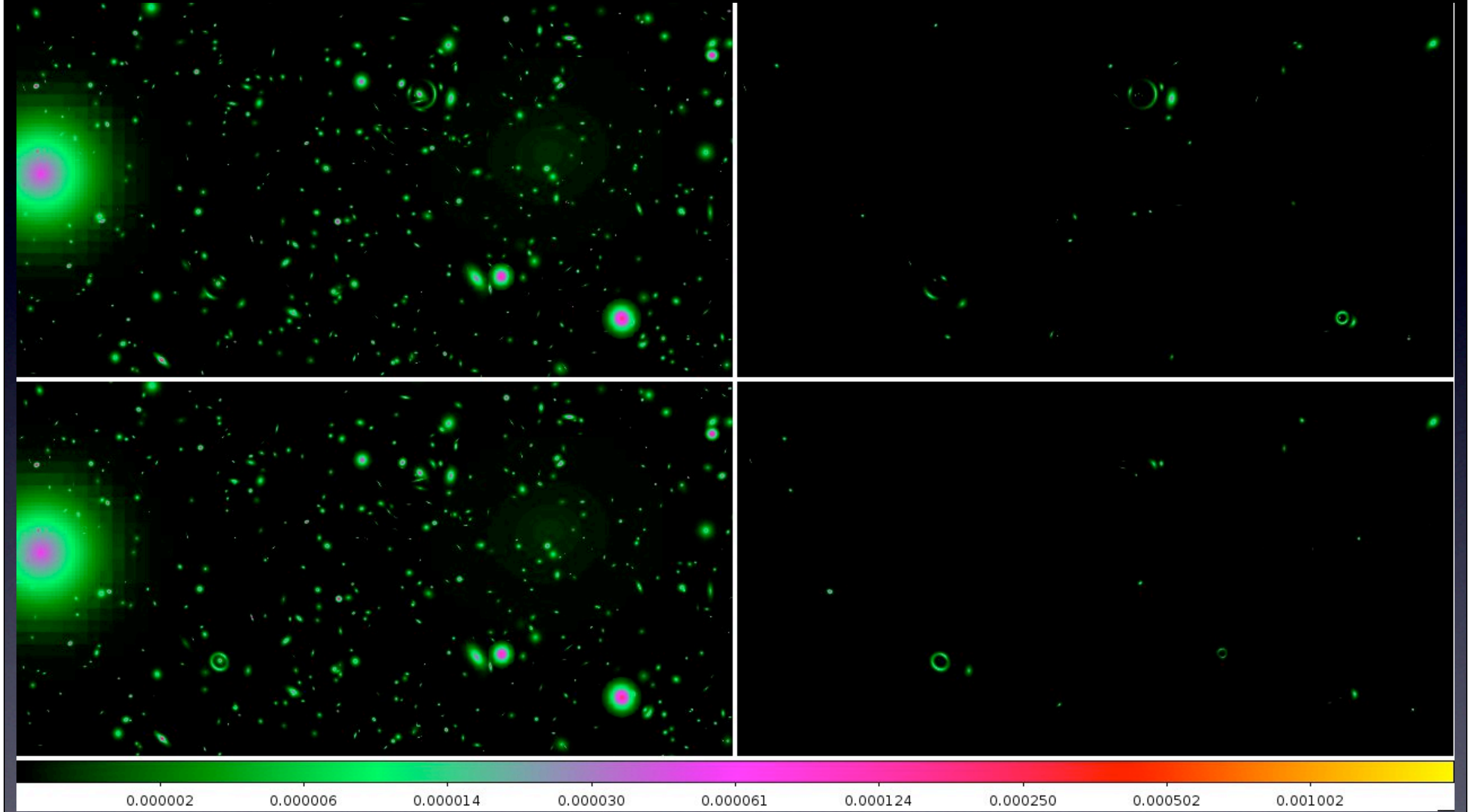
Putting the Baryons In the Halos



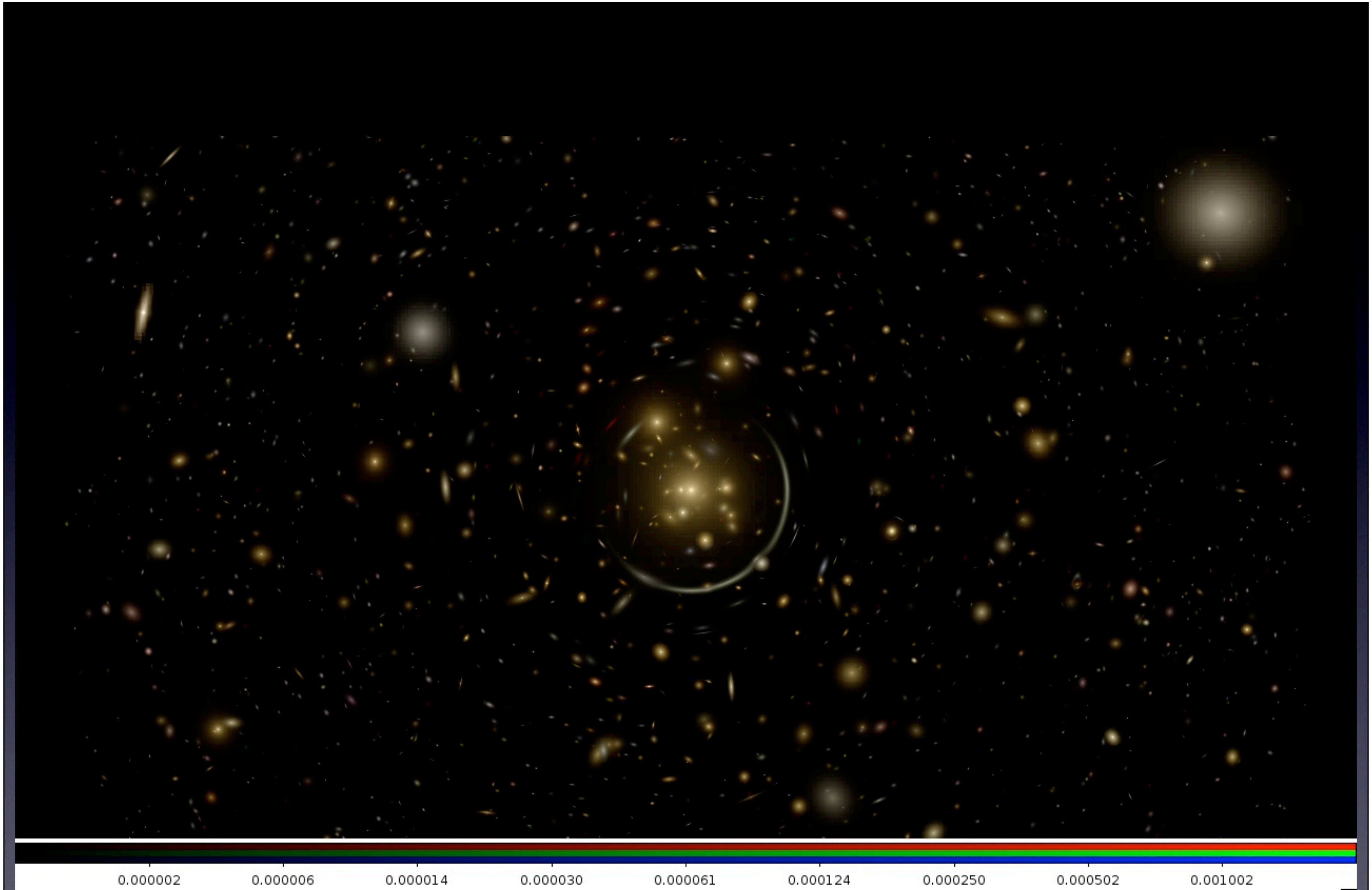
Future Development

Improve speed so that the lensing can be done on the fly or close to it.

Improve realism of mass distribution in galaxies and halos.
Need shapes of halos in data base!

Improve realism of sources.

Dust extinction in lens galaxies?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