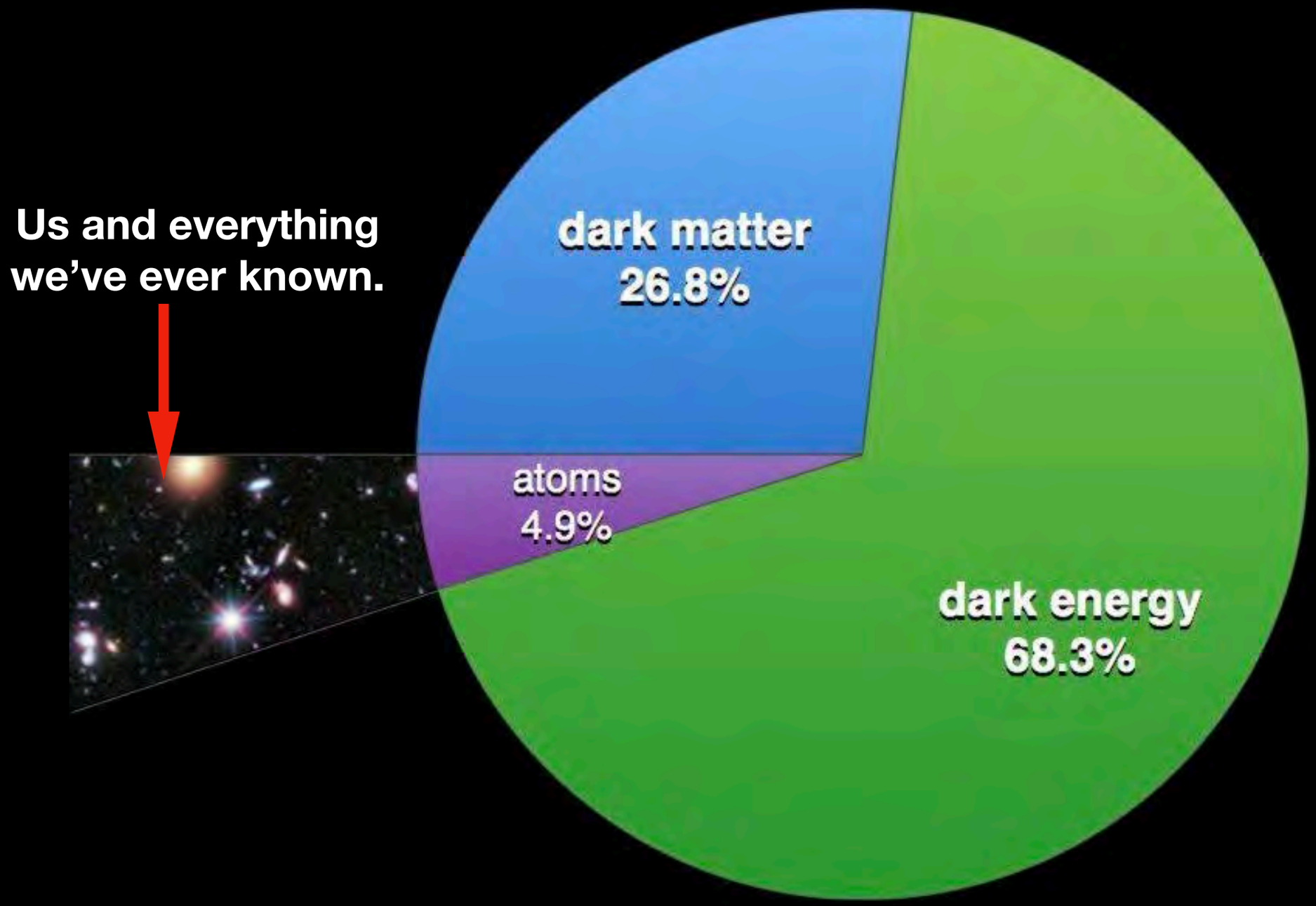
Warm dark matter chills out

Dark matter halos smaller than previously known

present:
Daniel Gilman (UCLA)
Anna Nierenberg (JPL)

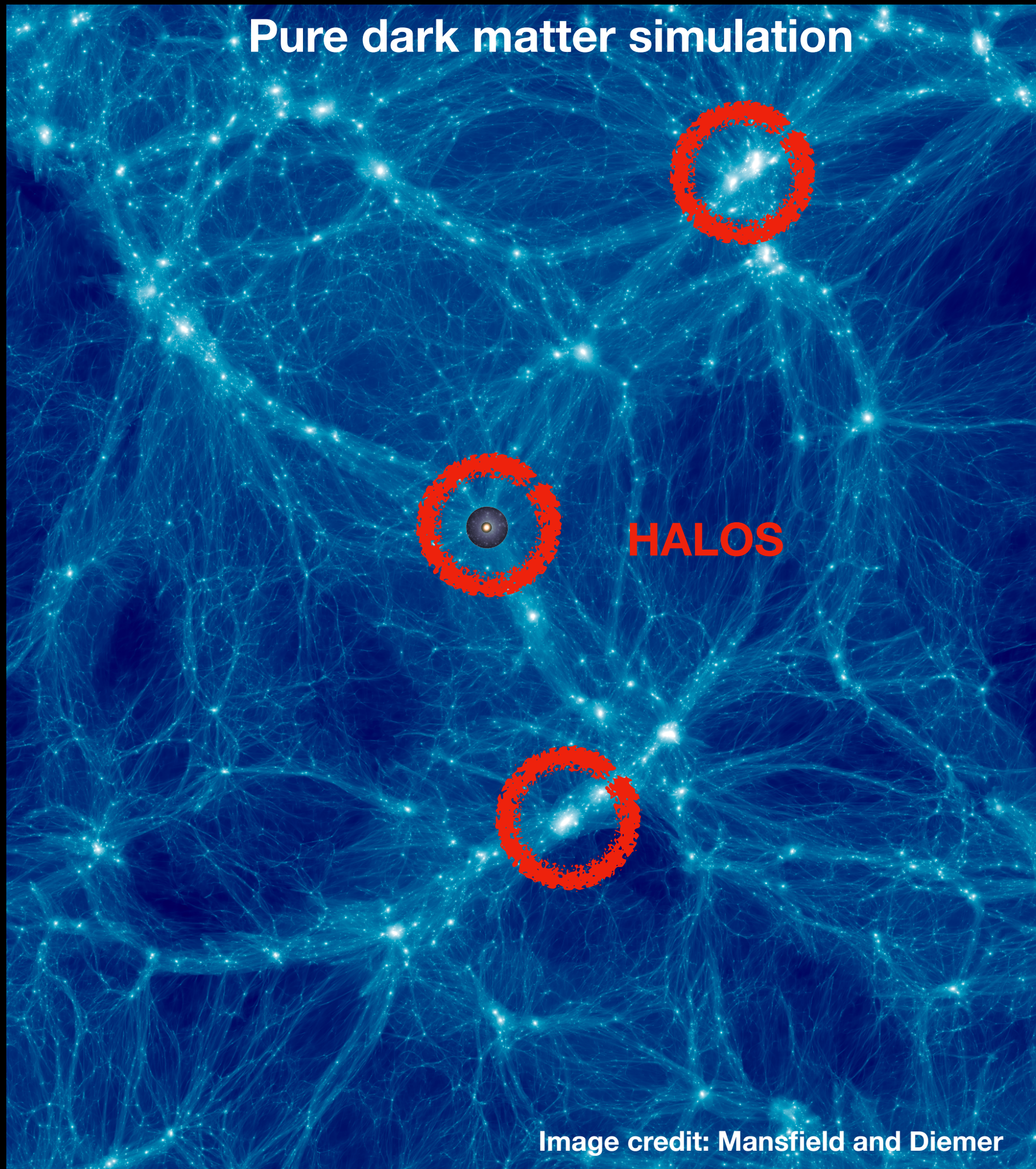


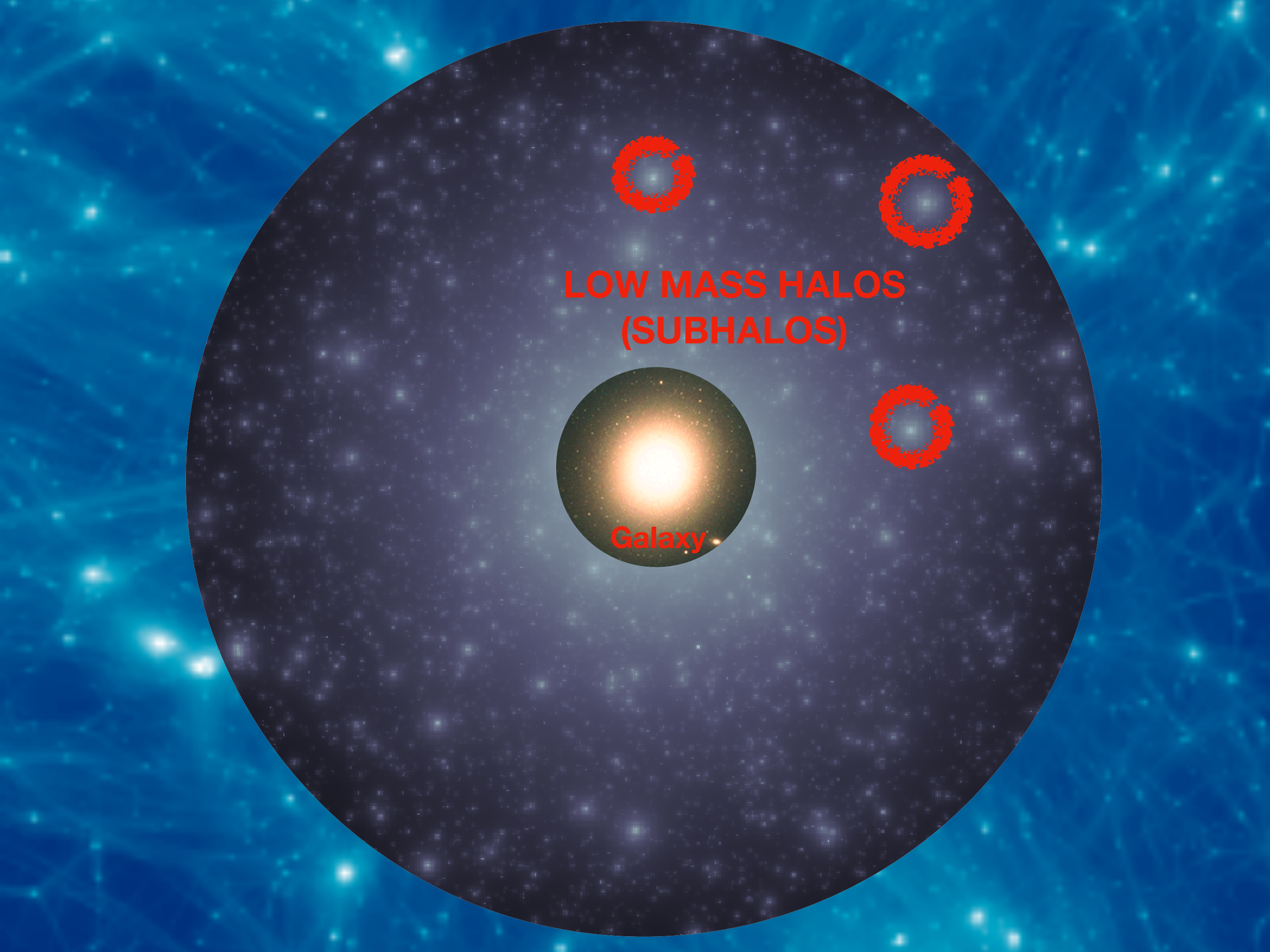
@AstroKatie/Planck13

We we know about dark matter:

1) Forms the invisible scaffolding on which visible structures like galaxies form

2) All galaxies live in ‘halos'




LOW MASS HALOS
(SUBHALOS)
Galaxy

Different dark matter theories make unique predictions for the number of subhalos

‘Cold’ dark matter predicts an abundance of substructure.

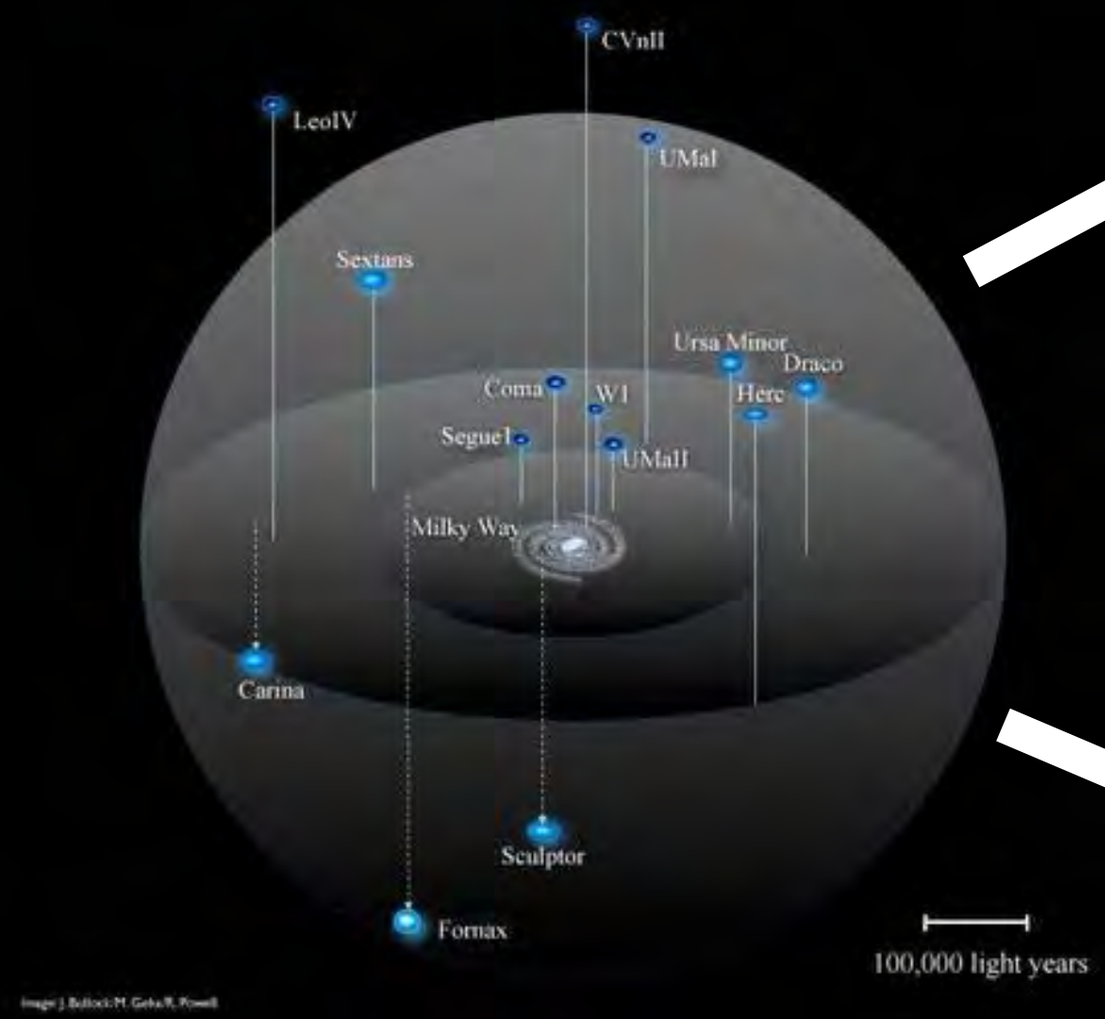
‘Cold’ refers to the particles’ speed: slow-moving particles clump together to form halos more easily.

In ‘warm’ dark matter, there is a dearth of structure below a certain scale.

‘Warm’ refers to the particles’ speed: fast-moving particles cannot form structure below a characteristic scale that depends on the dark matter particle mass.

EVERY GALAXY IS IN A DARK MATTER HALO, BUT NOT EVERY HALO NECESSARILY HOSTS A GALAXY.

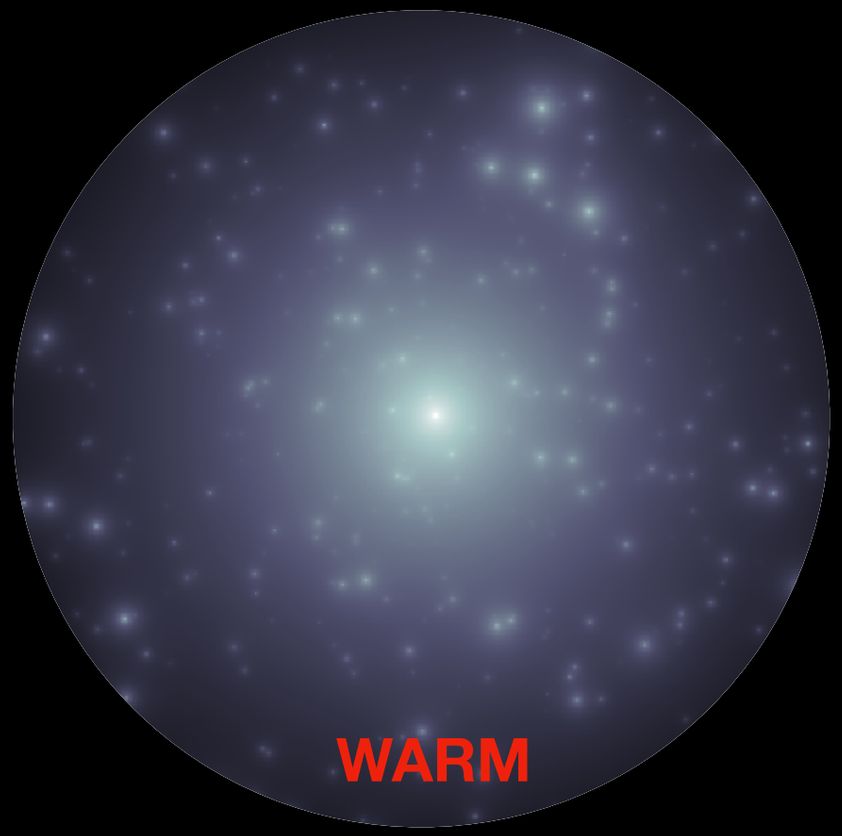
WHAT WE SEE



credit: Bullock, Geha, Powell

?

WHAT COULD BE THERE

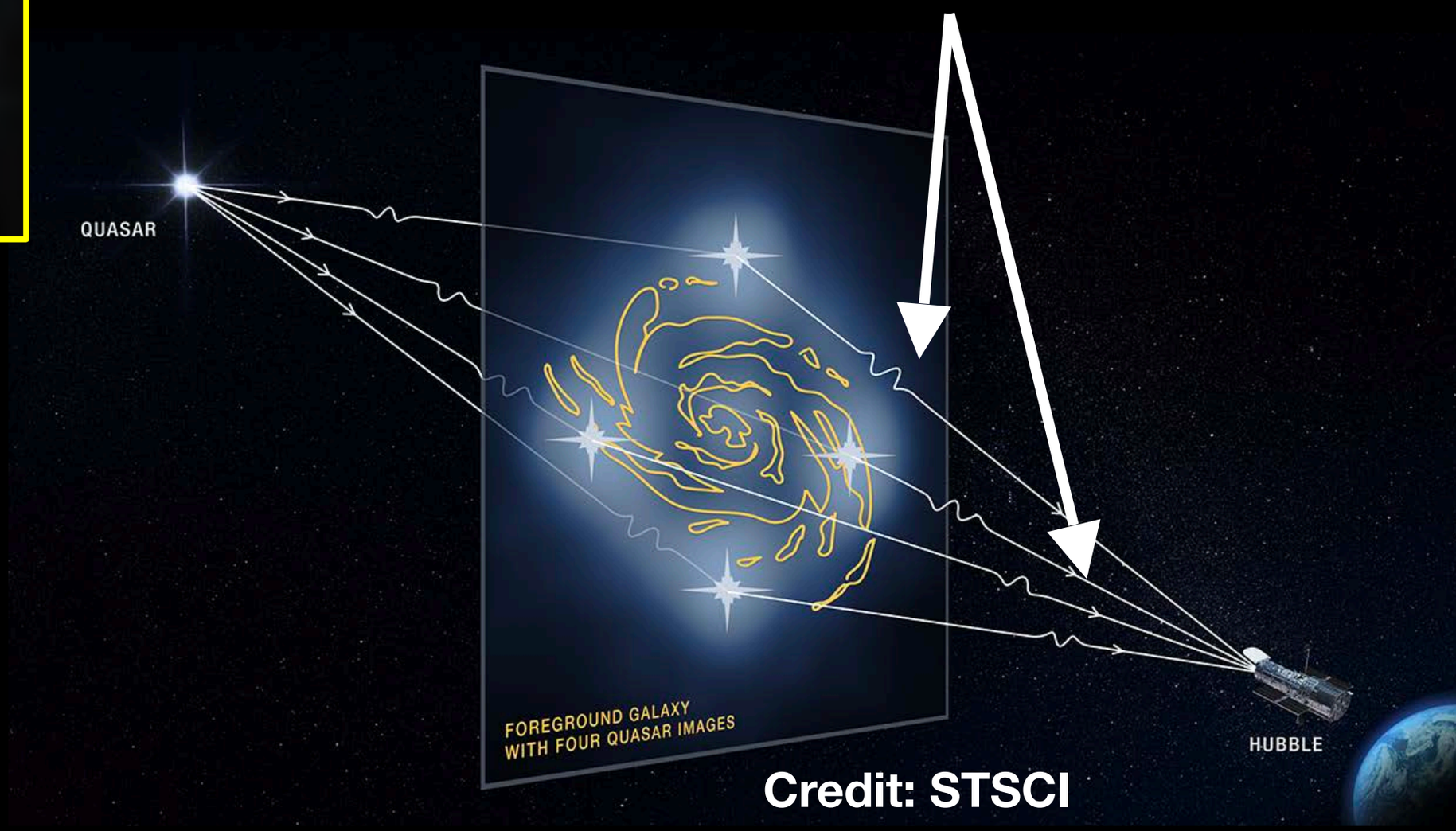


The problem:

The most pronounced differences between various dark matter theories lurk on scales where halos contain no stars, making them invisible.

Gravitational lensing lets you see invisible dark matter halos

Hubble Image
Credit: STSCI



Credit: STSCI

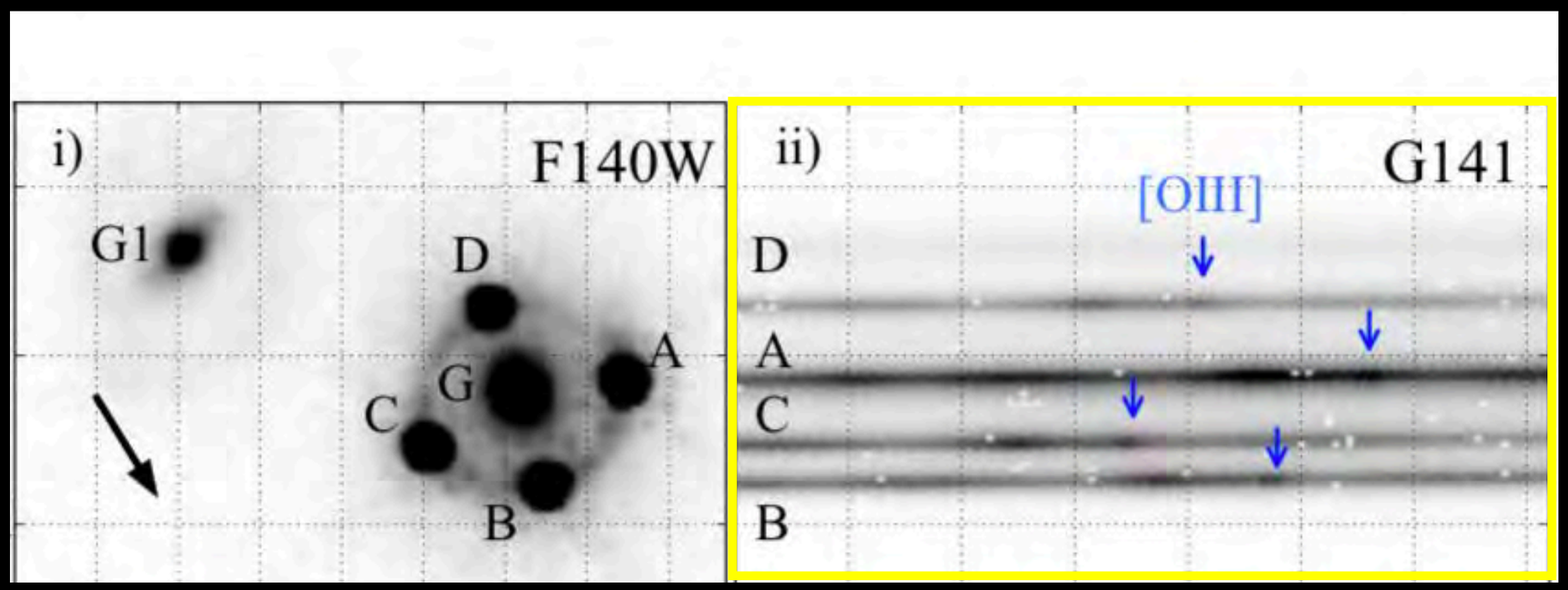
Anatomy of a strong gravitational lens

The relative brightness of the images is extremely sensitive to low-mass dark matter structure structure 10,000 times less massive than the main lensing galaxy.

strong lensing = gravity vision

We use HST spectroscopy to measure image brightness in one color, circumventing contamination at other wavelengths.

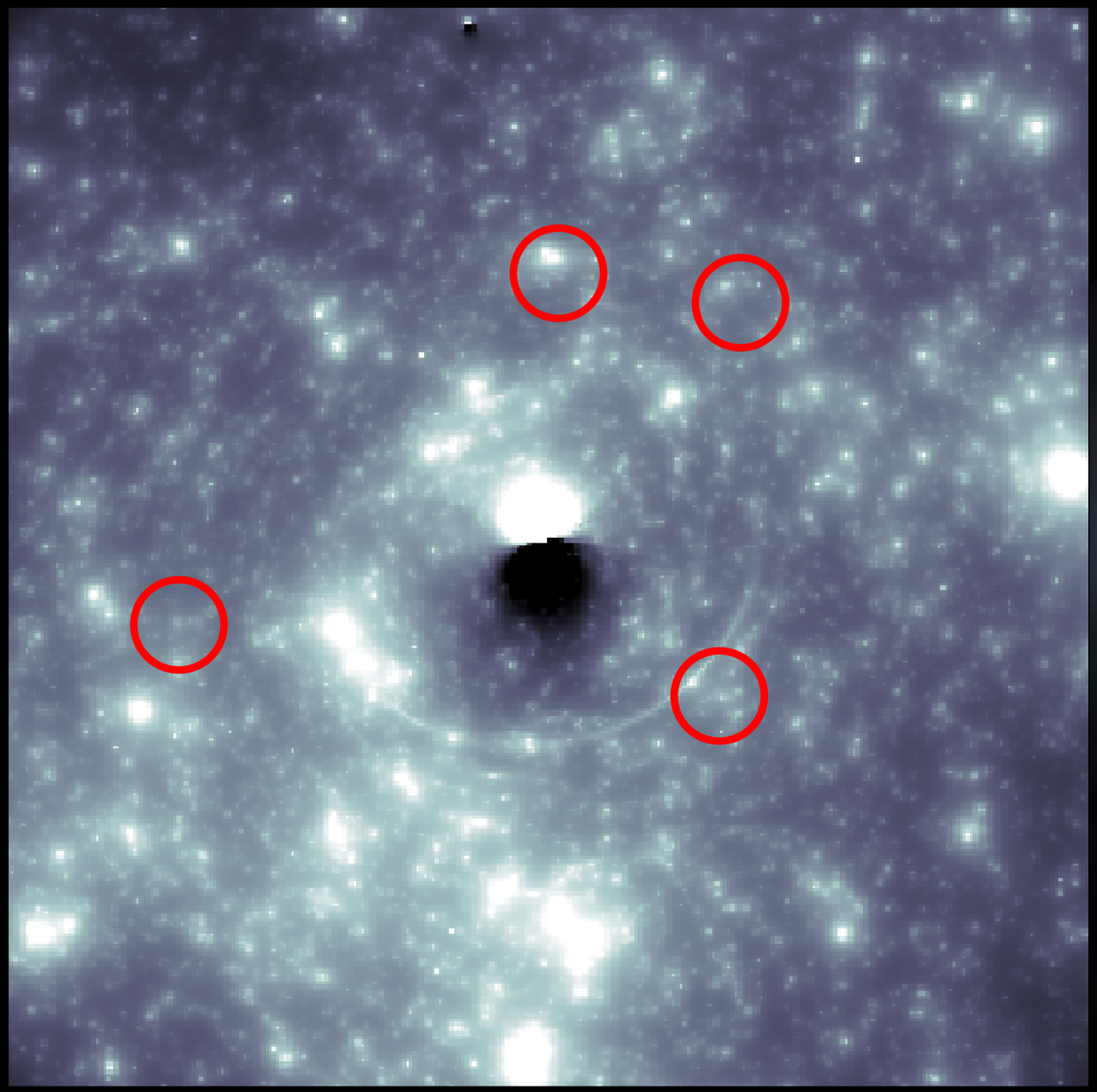
HST `direct' image** **HST `grism' image

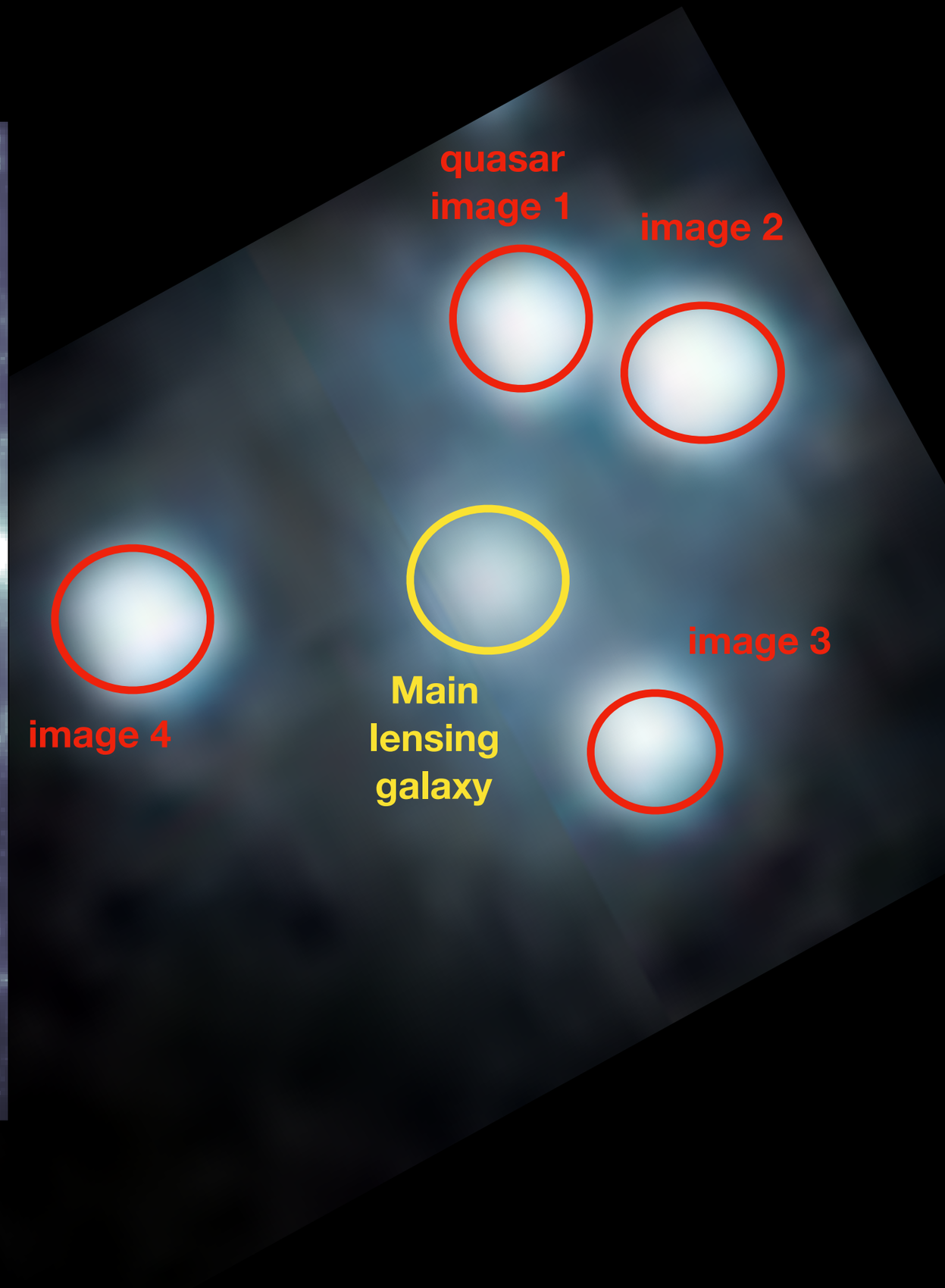


Nierenberg et al. 2017, 2020

HST GO 15177, 13732, PI Nierenberg

Simulated dark matter map



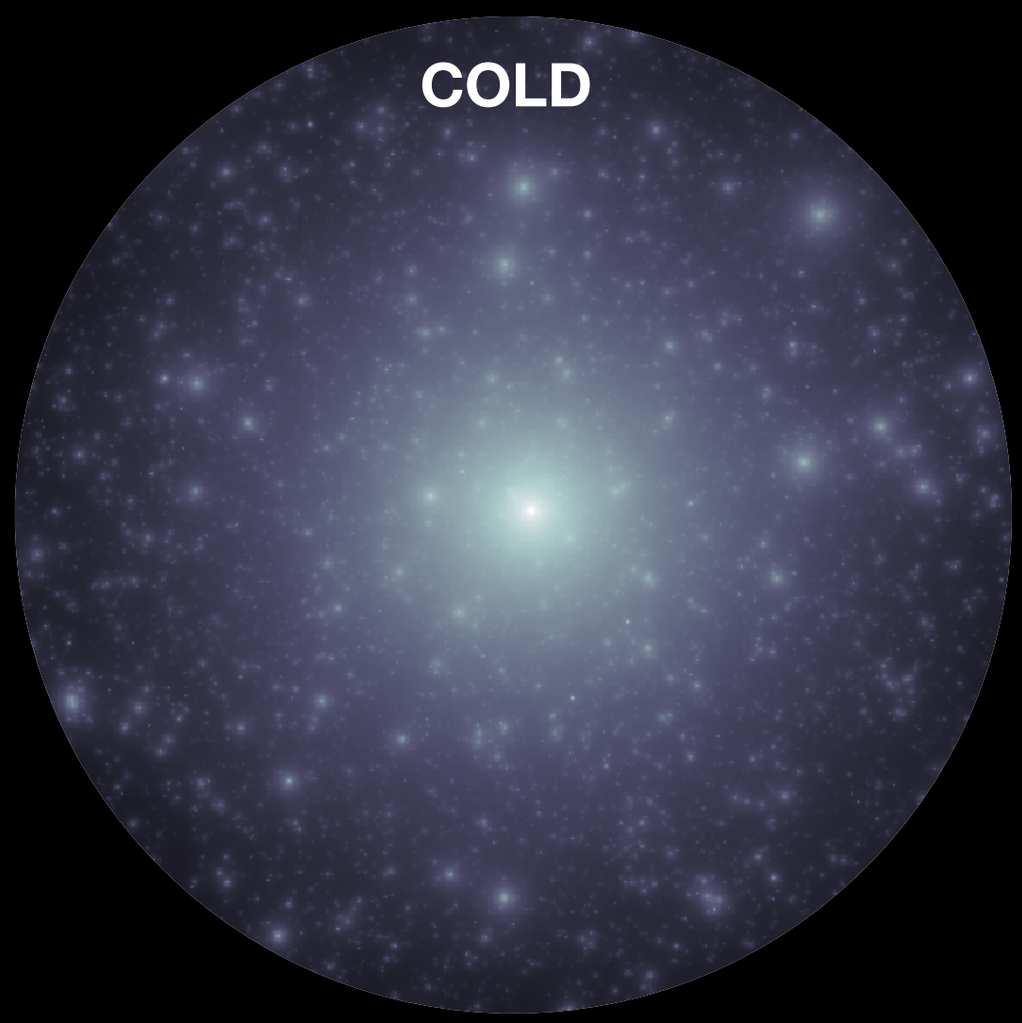


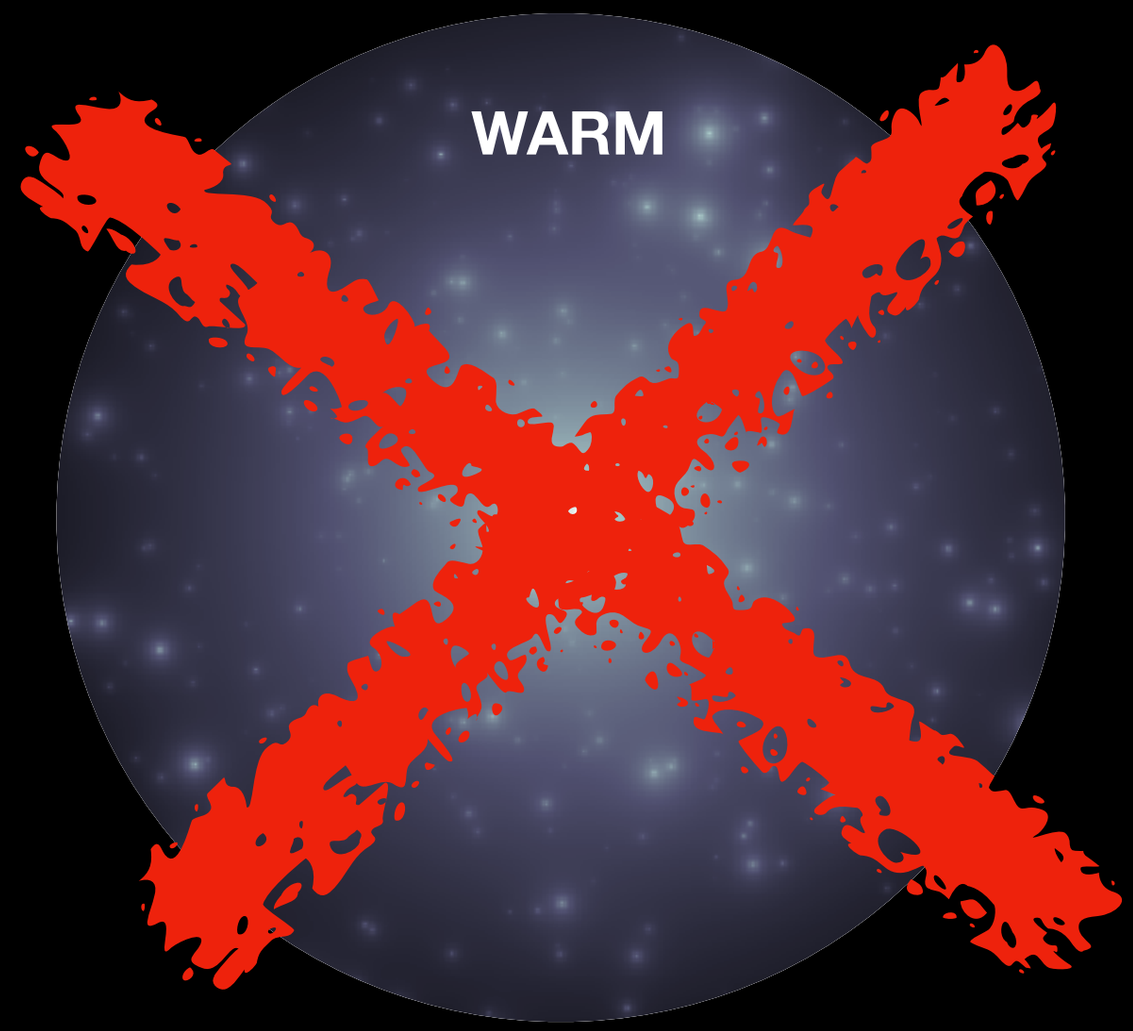
strong lensing = gravity vision

Our results

Using state of the art measurement and analysis methods, we were able to directly probe dark matter structures

at lower mass scales than ever before.





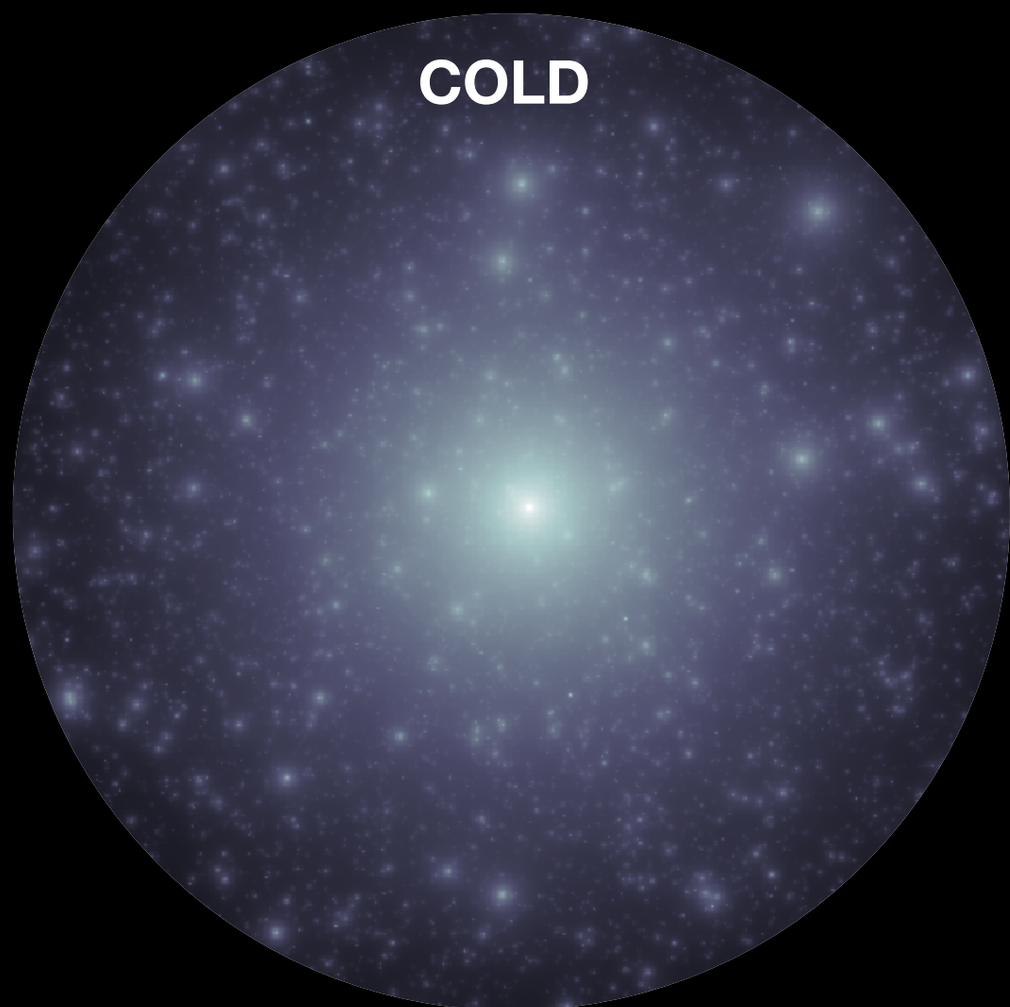
‘Warm’ dark matter has definitely ‘chilled out’

Our results

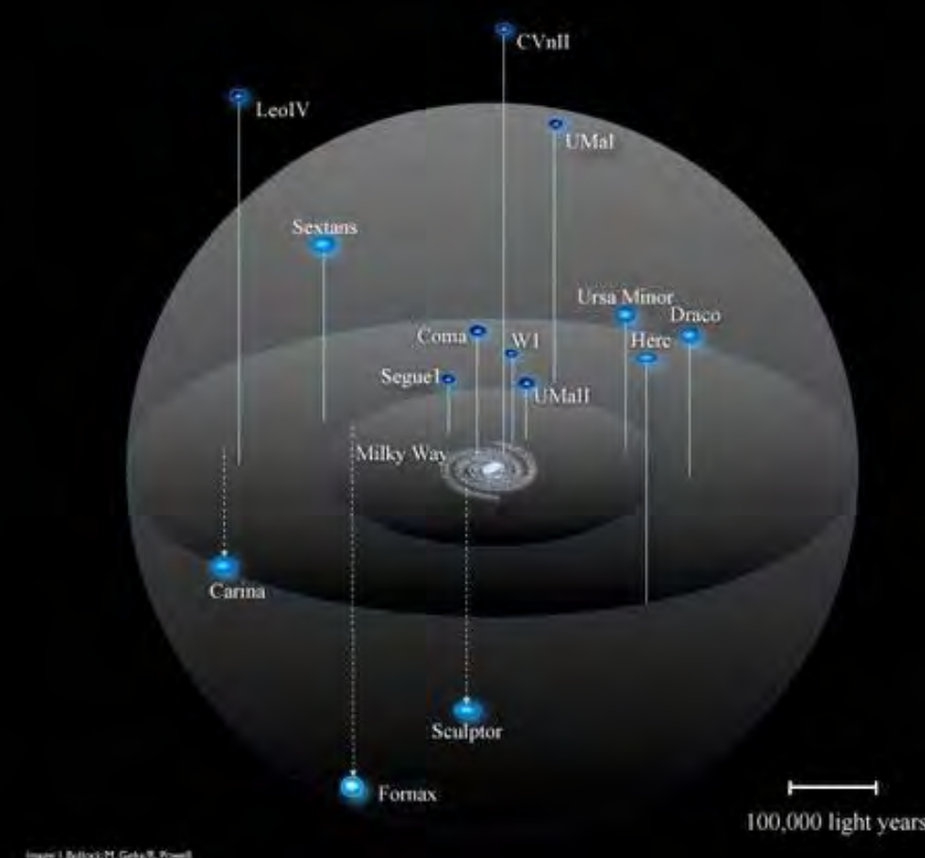
Using state of the art measurement and analysis methods, we were able to directly probe dark matter structures

at lower mass scales than ever before.

COLD



WHAT WE SEE



Future

- Thousands of these systems will be discovered by the Rubin telescope (formerly LSST) and WFIRST
- JWST, and next generation ground based observatories will enable rapid follow up and unprecedented constraints on the nature of dark mater