Finding Peas in the Early Universe with JWST

James E. Rhoads

NASA Goddard Space Flight Center

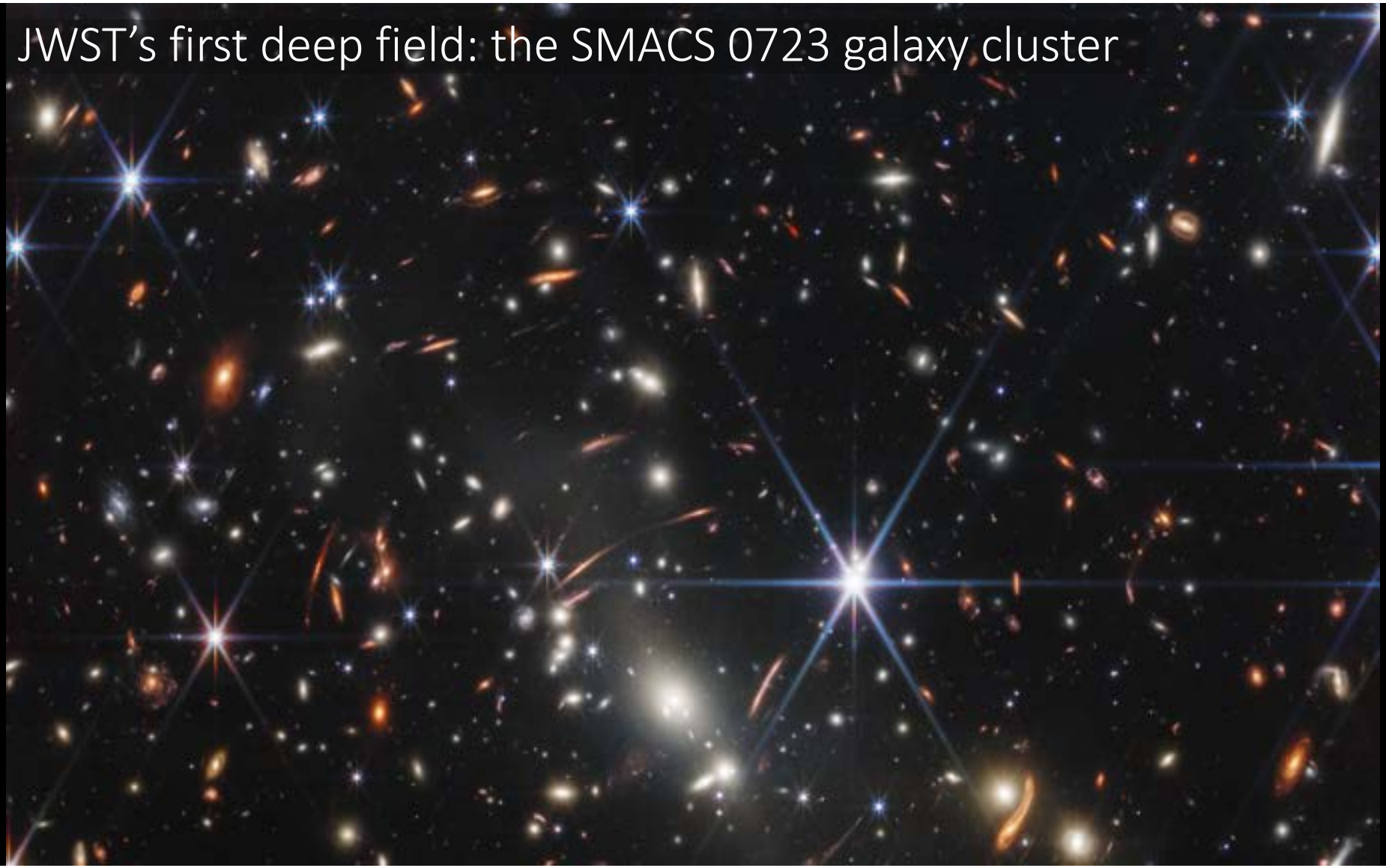
James.E.Rhoads@nasa.gov

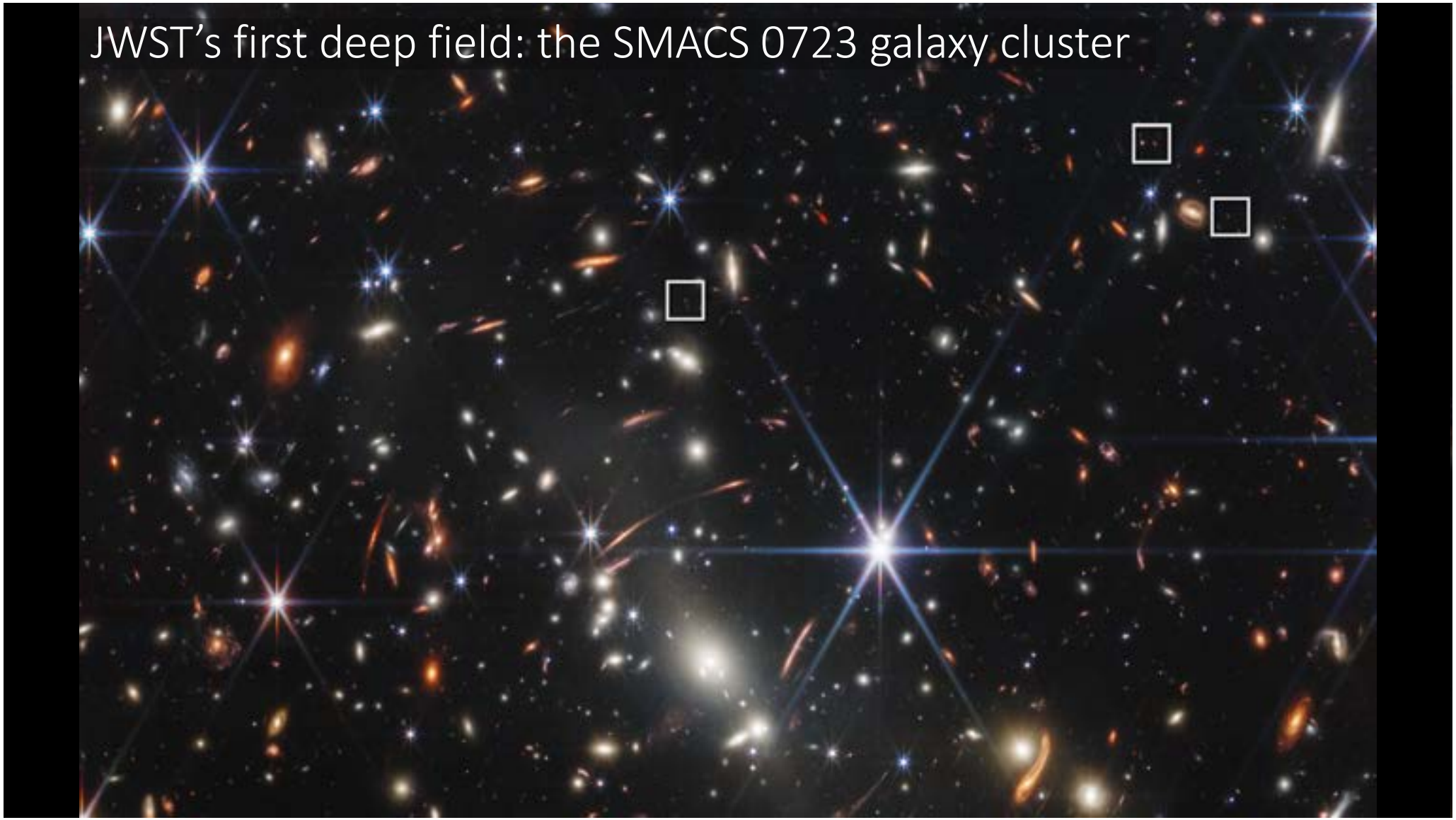
480-278-0192

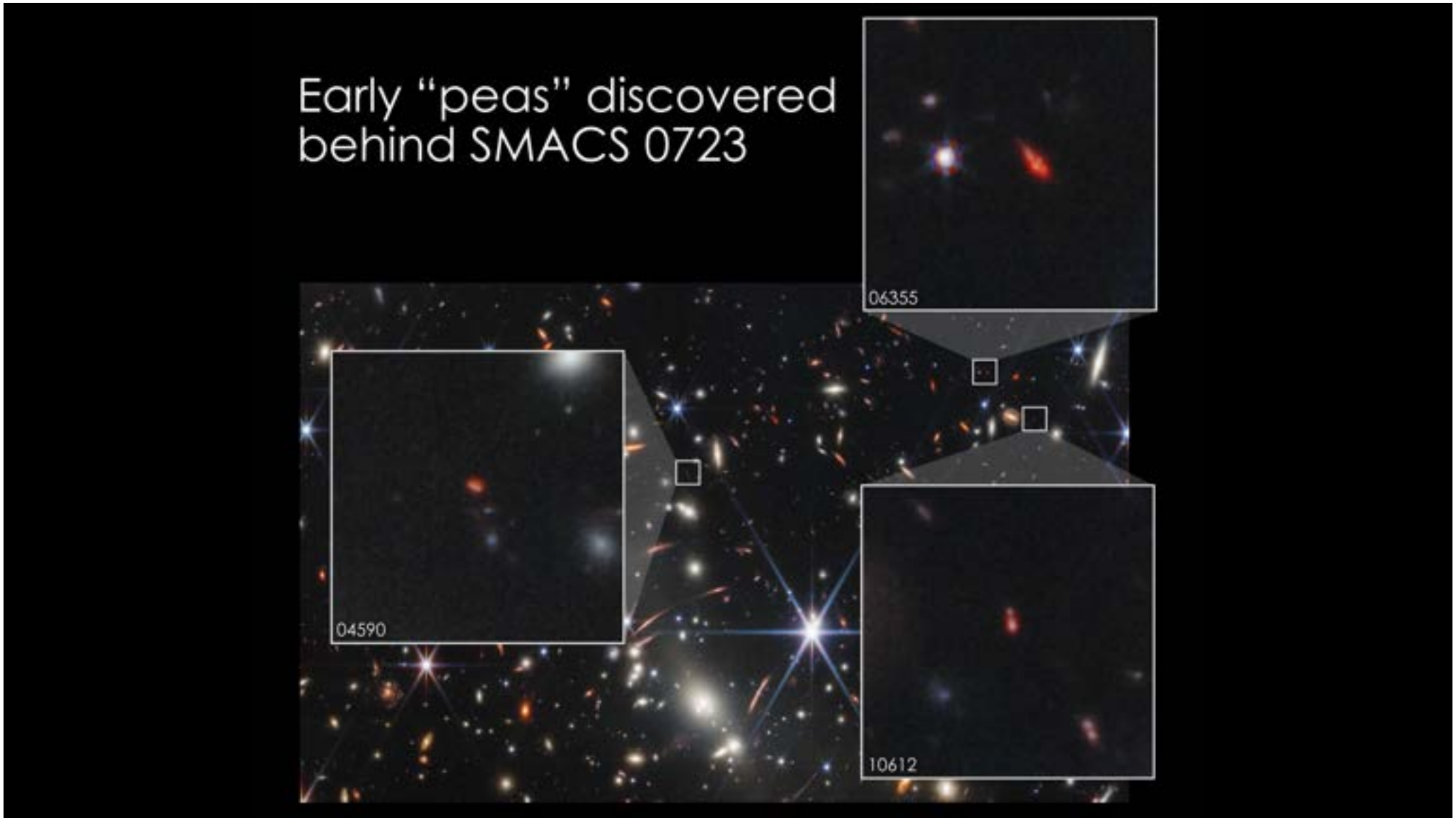
Based on work in collaboration with Isak G. B. Wold, Santosh Harish, Keunho J. Kim, John Pharo, Sangeeta Malhotra, Austen Gabrielpillai, Tianxing Jiang, and Huan Yang

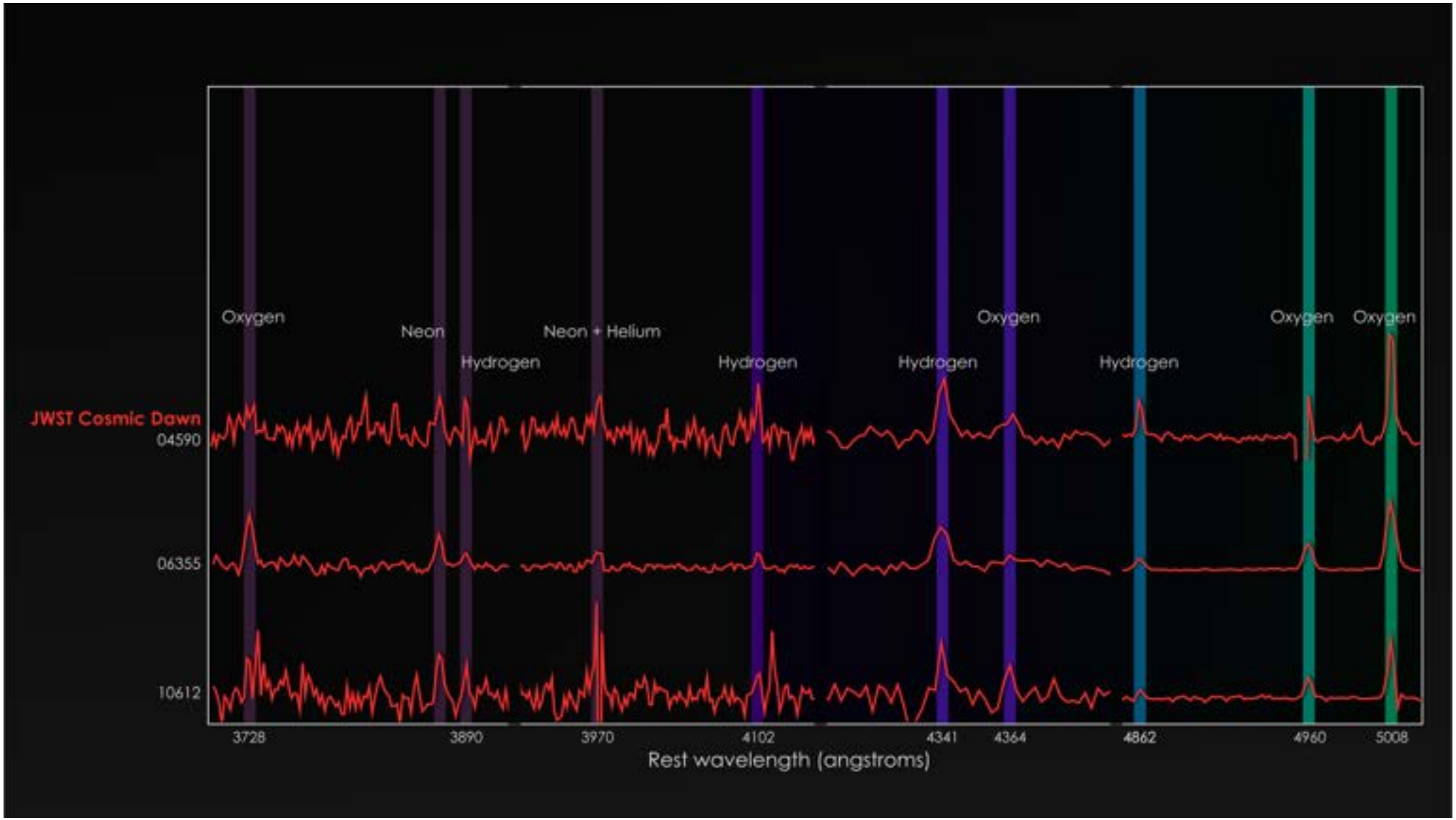
Rhoads et al, ApJ Letters 942, L14, 2023 January 3 - https://doi.org/10.3847/2041-8213/acaaaf

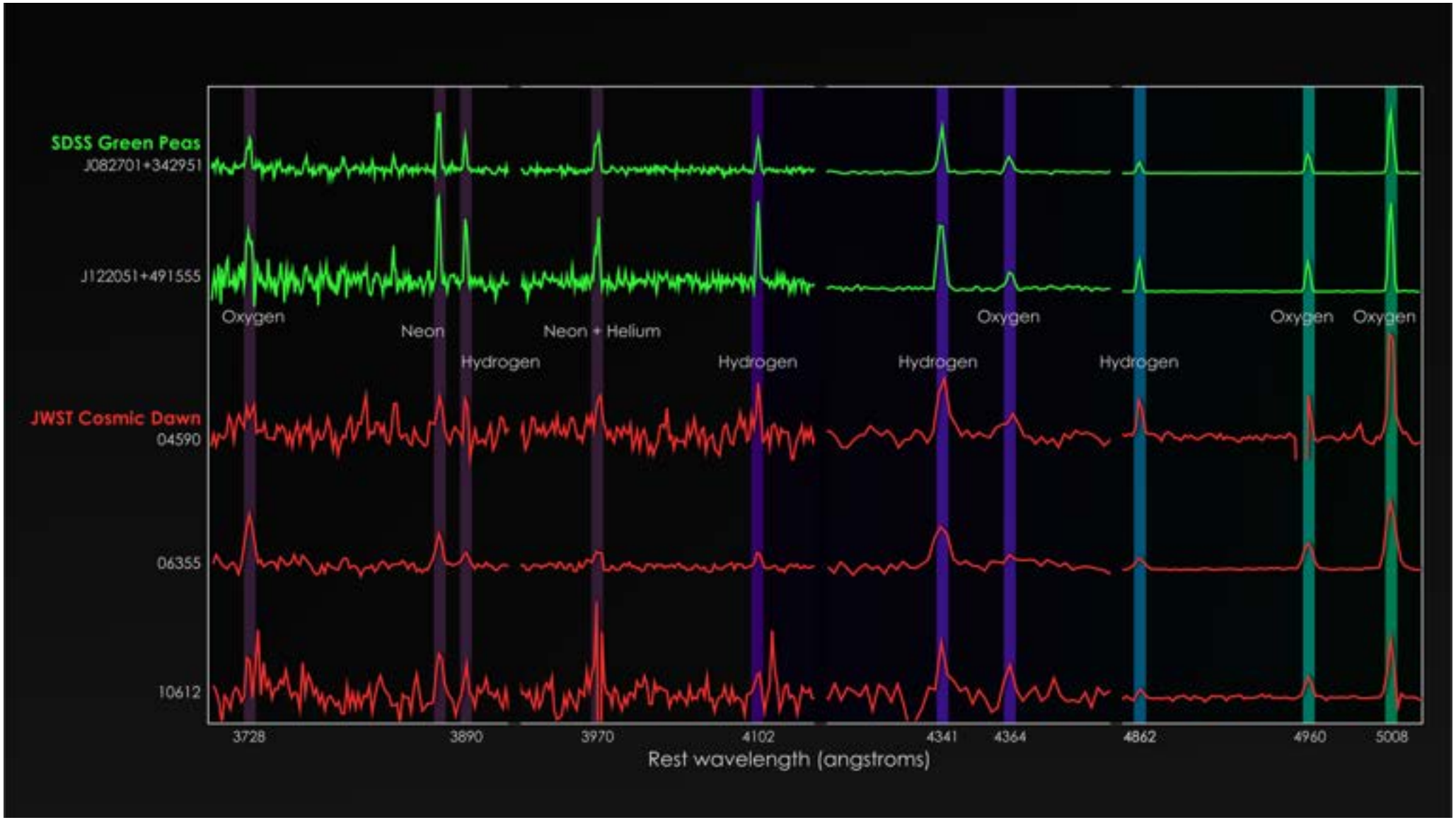
JWST’s first deep field: the SMACS 0723 galaxy cluster




JWST’s first deep field: the SMACS 0723 galaxy cluster


Early "peas" discovered behind SMACS 0723
06355
04590
10612


Oxygen
Neon
Hydrogen
Neon + Helium
Hydrogen
Hydrogen
Oxygen
Hydrogen
Oxygen
Oxygen
JWST Cosmic Dawn
04590
06355
10612
3728
3890
3970
4102
4341
4364
4862
4960
5008
Rest wavelength (angstroms)


SDSS Green Peas
J082701+342951
J122051+491555
JWST Cosmic Dawn
04590
06355
10612
Oxygen
Neon
Hydrogen
Neon + Helium
Hydrogen
Hydrogen
Oxygen
Hydrogen
Oxygen
Oxygen
3728
3890
3970
4102
4341
4364
4862
4960
5008
Rest wavelength (angstroms)

What are Green Pea Galaxies?

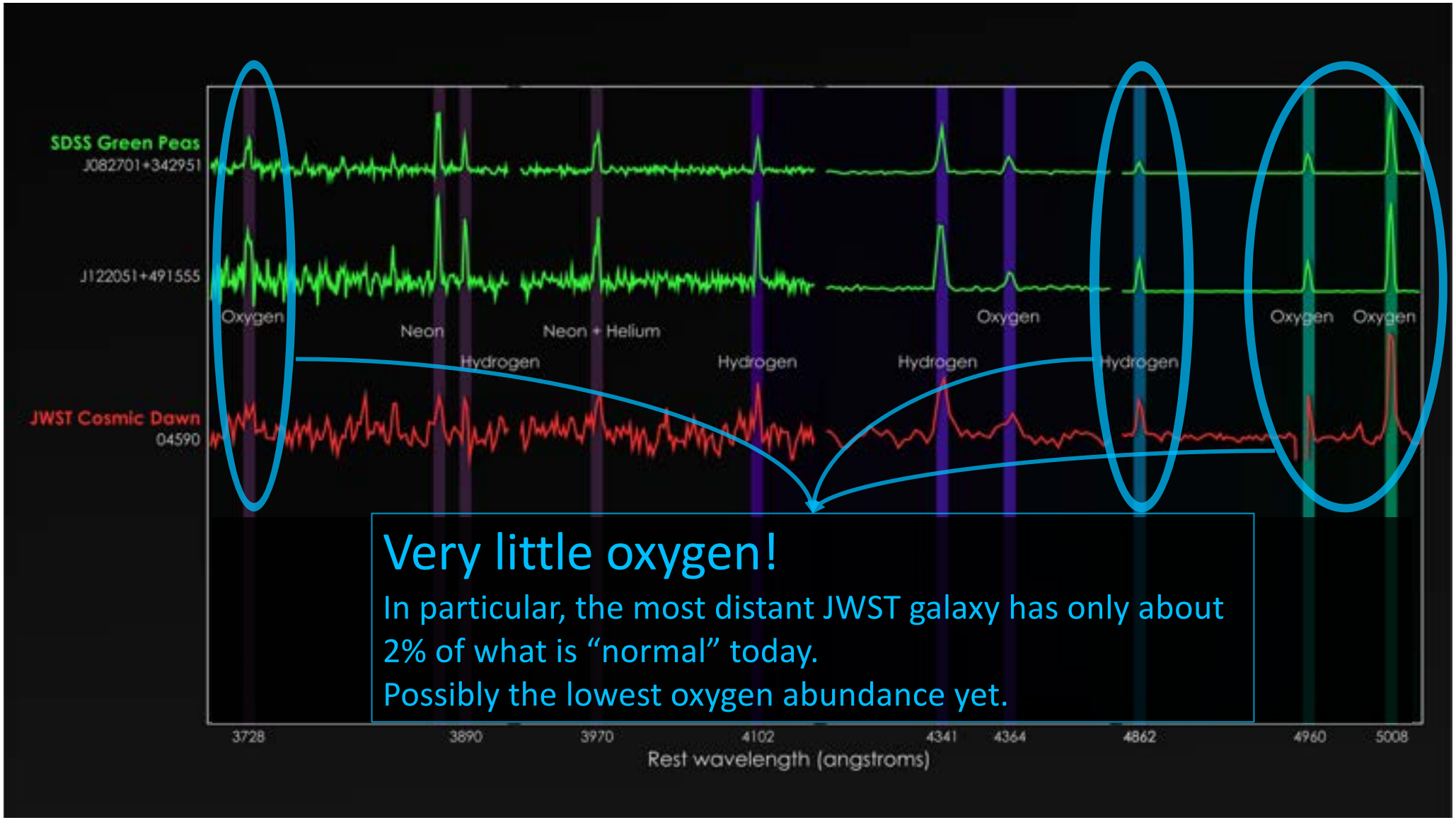
Image credit: Sloan Digital Sky Survey / Keunho Kim, 2022

Unique properties

- Light from glowing gas
- Small
- Young stars
- Relatively pristine composition

All properties shared by early galaxies!


SDSS Green Peas
J082701+342951
J122051+491555
JWST Cosmic Dawn
04590
Oxygen
Neon
Hydrogen
Neon + Helium
Hydrogen
Hydrogen
Oxygen
Hydrogen
Oxygen
Oxygen
Gas is HOT
3728
3890
3970
4102
4341
4364
4862
4960
5008
Rest wavelength (angstroms)


SDSS Green Peas
J082701+342951
J122051+491555
JWST Cosmic Dawn
04590
Oxygen
Neon
Hydrogen
Neon + Helium
Hydrogen
Hydrogen
Oxygen
Hydrogen
Oxygen
Oxygen
Very little oxygen!
In particular, the most distant JWST galaxy has only about 2% of what is “normal” today.
Possibly the lowest oxygen abundance yet.
3728
3890
3970
4102
4341
4364
4862
4960
5008
Rest wavelength (angstroms)

Similar Appearance

Small galaxies with intense star formation. Young in every sense!

SDSS Green Pea
Redshift 0.012,
light travel time 170 million years

JWST Green Pea
Redshift 8.5,
light travel time 13.1 *billion* years

Summary

We have found what may be the most chemically primitive galaxy yet ... among the first three “Cosmic Dawn” spectra from JWST.

Green Pea galaxies are comparable objects in our own backyard, but are very rare in the modern universe.

We can use the modern “peas” to better understand their distant counterparts.

James E. Rhoads
NASA Goddard Space Flight Center
James.E.Rhoads@nasa.gov
480-278-0192

Based on work in collaboration with Isak G. B. Wold, Santosh Harish, Keunho J. Kim, John Pharo, Sangeeta Malhotra, Austen Gabrielpillai, Tianxing Jiang, and Huan Yang

For more on Green Peas and their relationship to early galaxies, see Sangeeta Malhotra’s plenary talk on “Tiny Mighty Galaxies”, session 436.01, Thursday, January 12, 2023, 11:40 AM PT - 12:30 PM PT