The First Ionized Bubbles in the Cosmic Dawn

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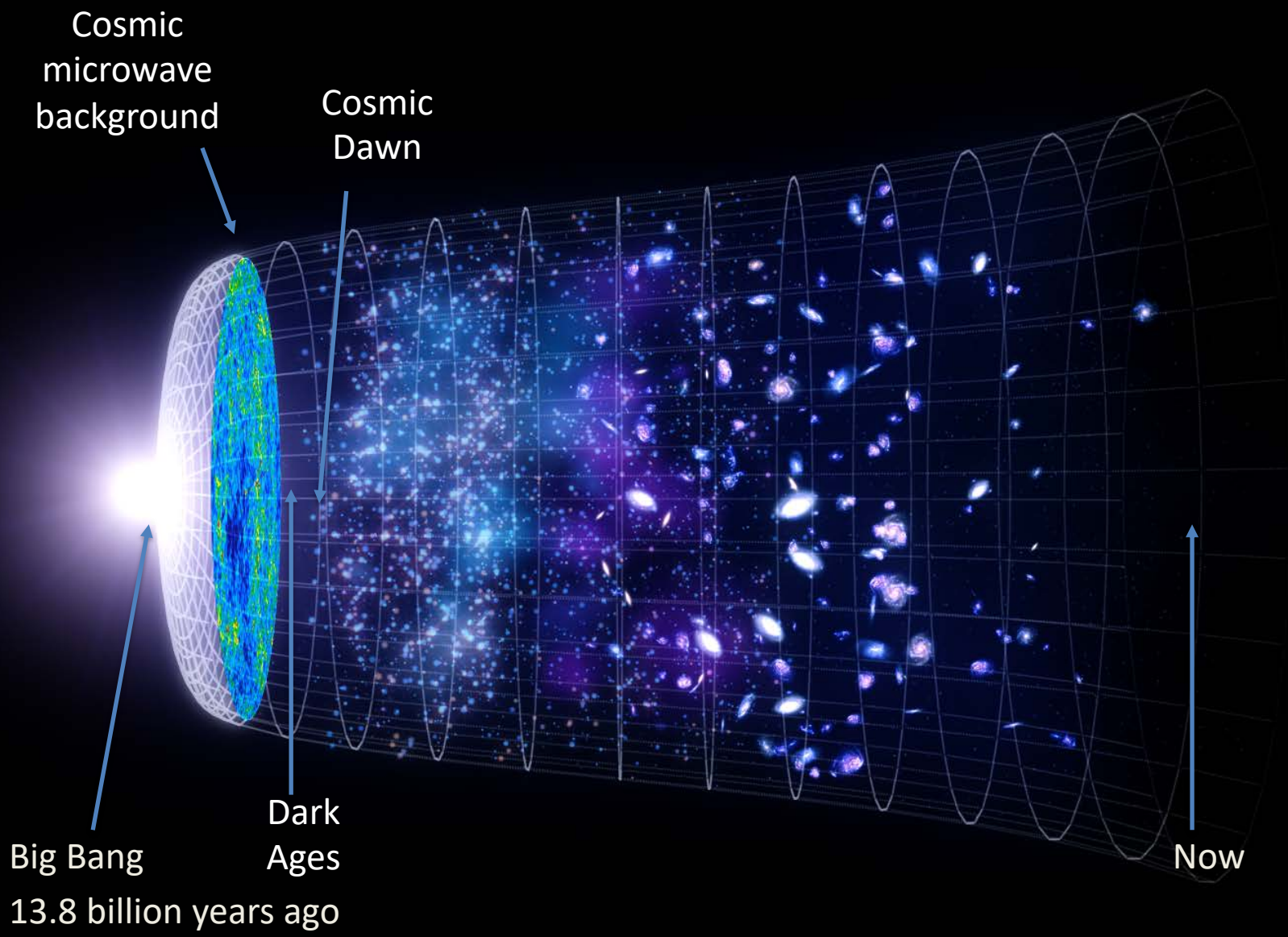
A Sketch of Cosmic History

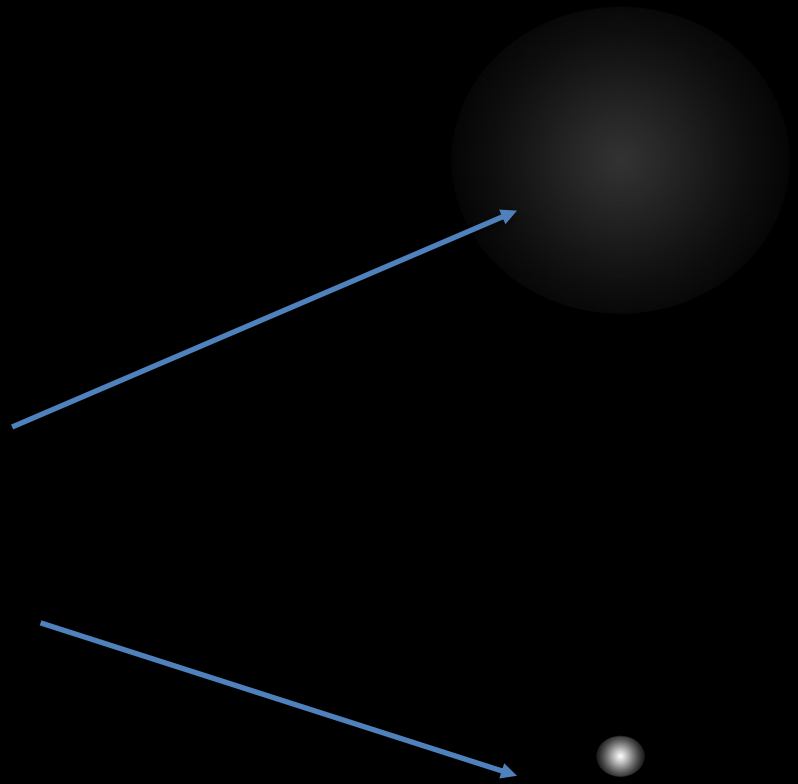


Growth of Ionized Bubbles

Simulation by M. Alvarez, R. Kaehler, and T. Abel

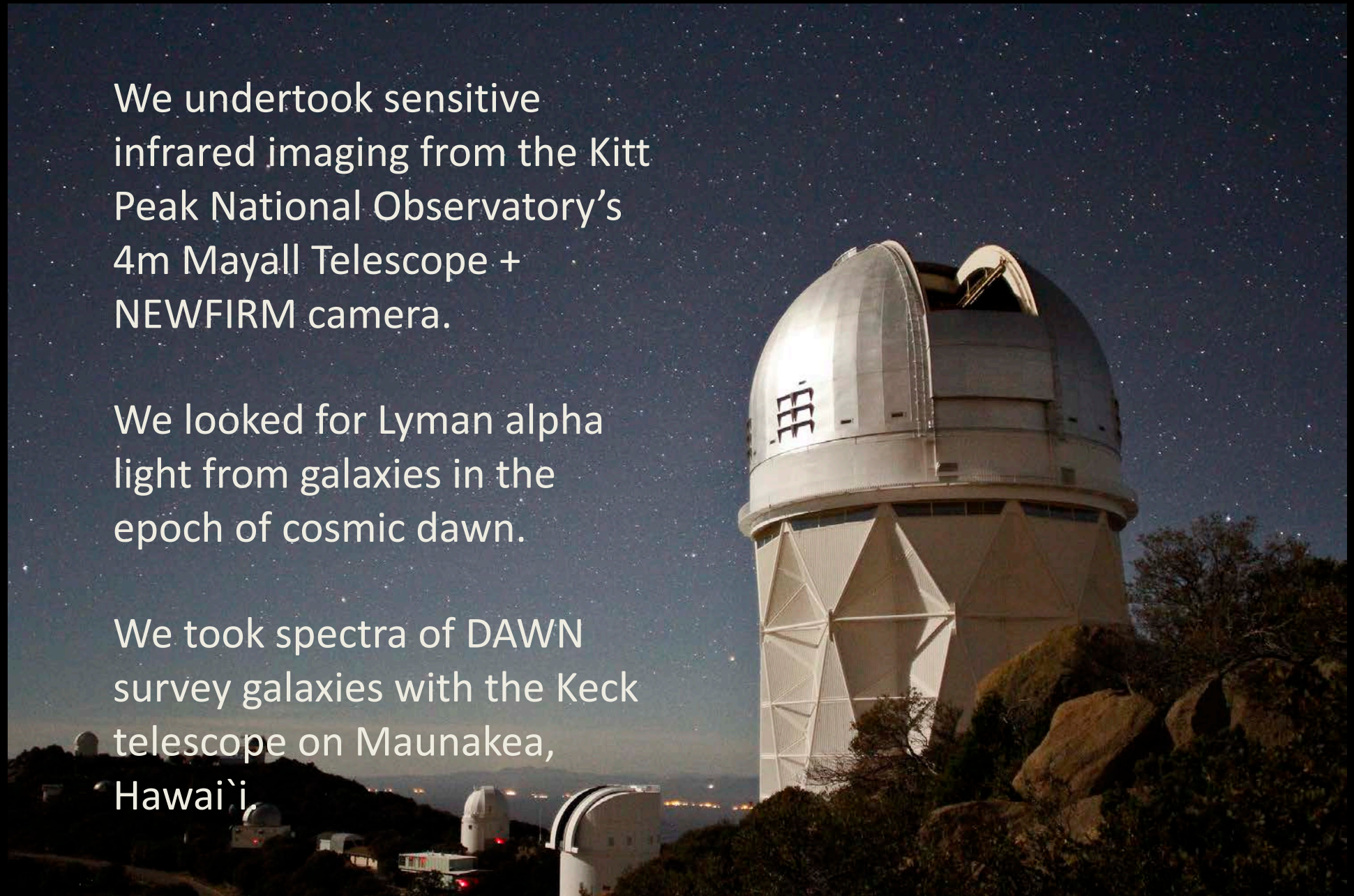
Lyman Alpha

- A particular wavelength of light, produced by young galaxies.
- Before reionization – it is scattered, like headlights in fog.
- After reionization– we can see it clearly now.



By looking for Lyman alpha from galaxies we can determine if their surroundings are neutral or ionized.

The Cosmic DAWN Survey



We undertook sensitive infrared imaging from the Kitt Peak National Observatory's 4m Mayall Telescope + NEWFIRM camera.

We looked for Lyman alpha light from galaxies in the epoch of cosmic dawn.

We took spectra of DAWN survey galaxies with the Keck telescope on Maunakea, Hawai`i.

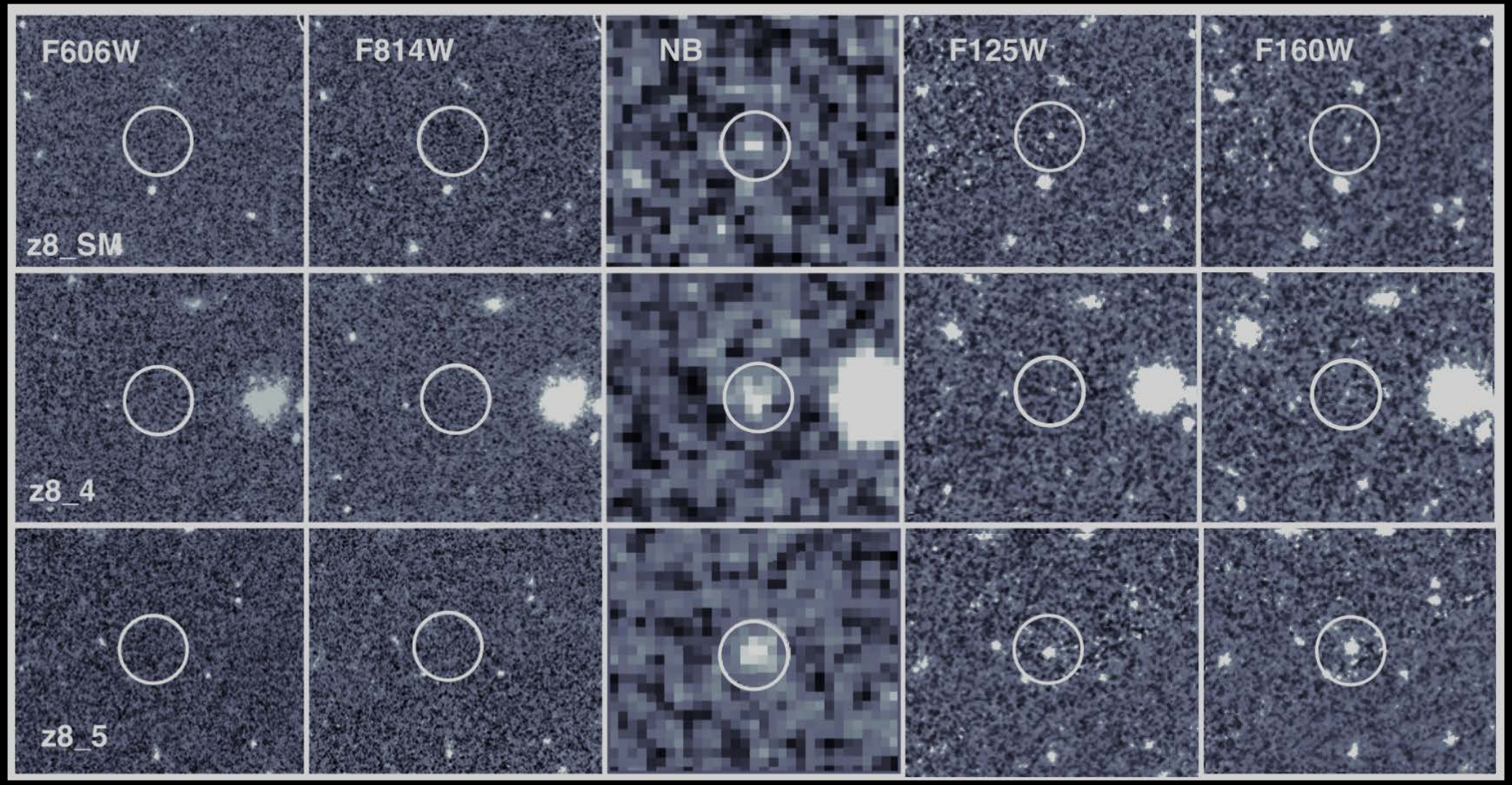
The Group EGS77 in the Cosmic DAWN Survey

Galaxy Group EGS77

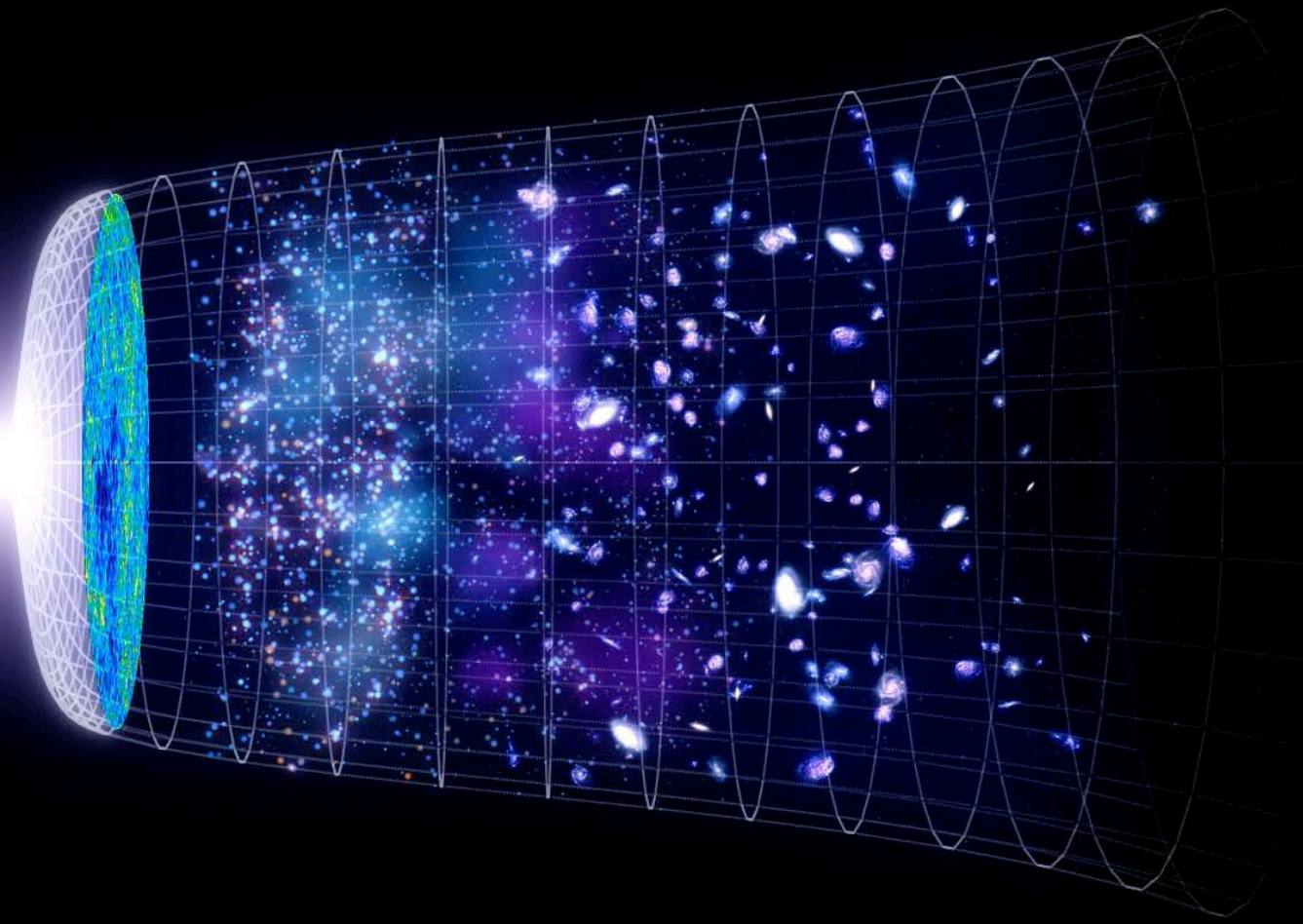
Bluer light – galaxies not detected

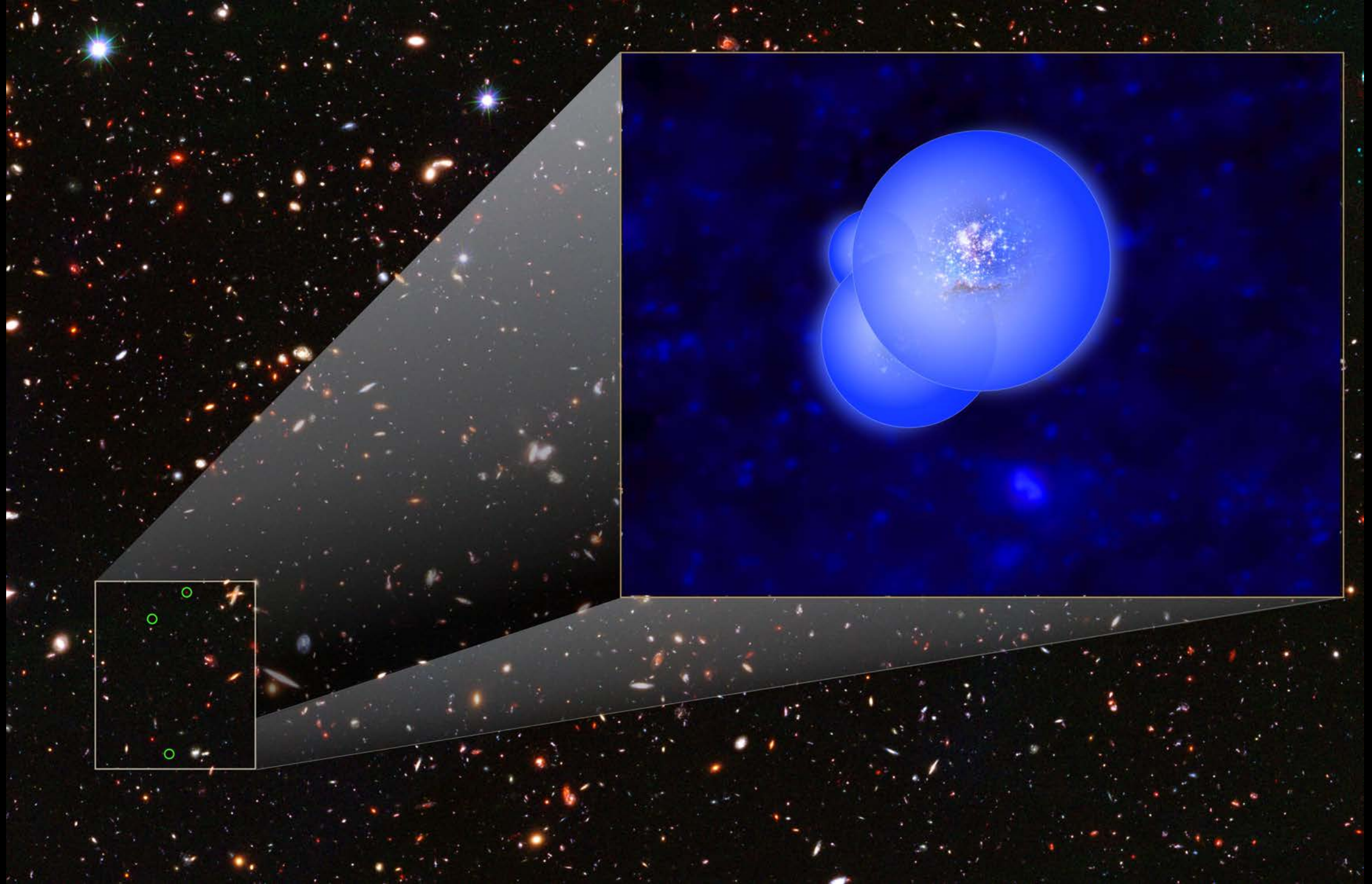
Lyman alpha light - bright

Redder starlight – detected but faint



Galaxy Group EGS77 in Cosmic History





Summary

- Reionization was the last time that anything interesting happened to a typical atom, and we want to understand its history.
- We have found an ionized bubble, traced by the earliest known galaxy group (EGS77), when the universe was 5% of its current age.
- This sheds new light on Cosmic Dawn.
- There is a bright future for studying EGS77 with JWST, and finding more like it with WFIRST.

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The Cosmic DAWN Survey Team

These results are described in more detail in a manuscript submitted to The Astrophysical Journal Letters and led by V. Tilvi.

The DAWN team consists of

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