

Signatures of **primordial** **origins** around **supermassive black holes**

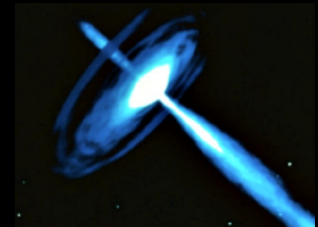
Phoebe R. Upton Sanderbeck

Cosmology from Home 2021

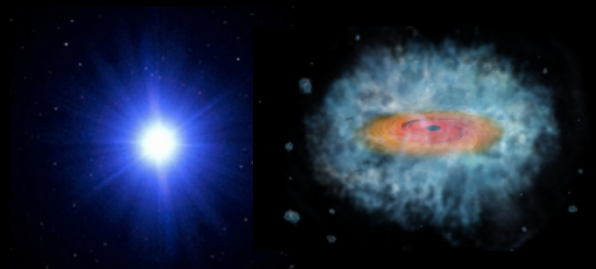


Supermassive black holes: open questions

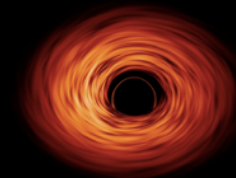
- How do early quasars host such massive SMBHs?



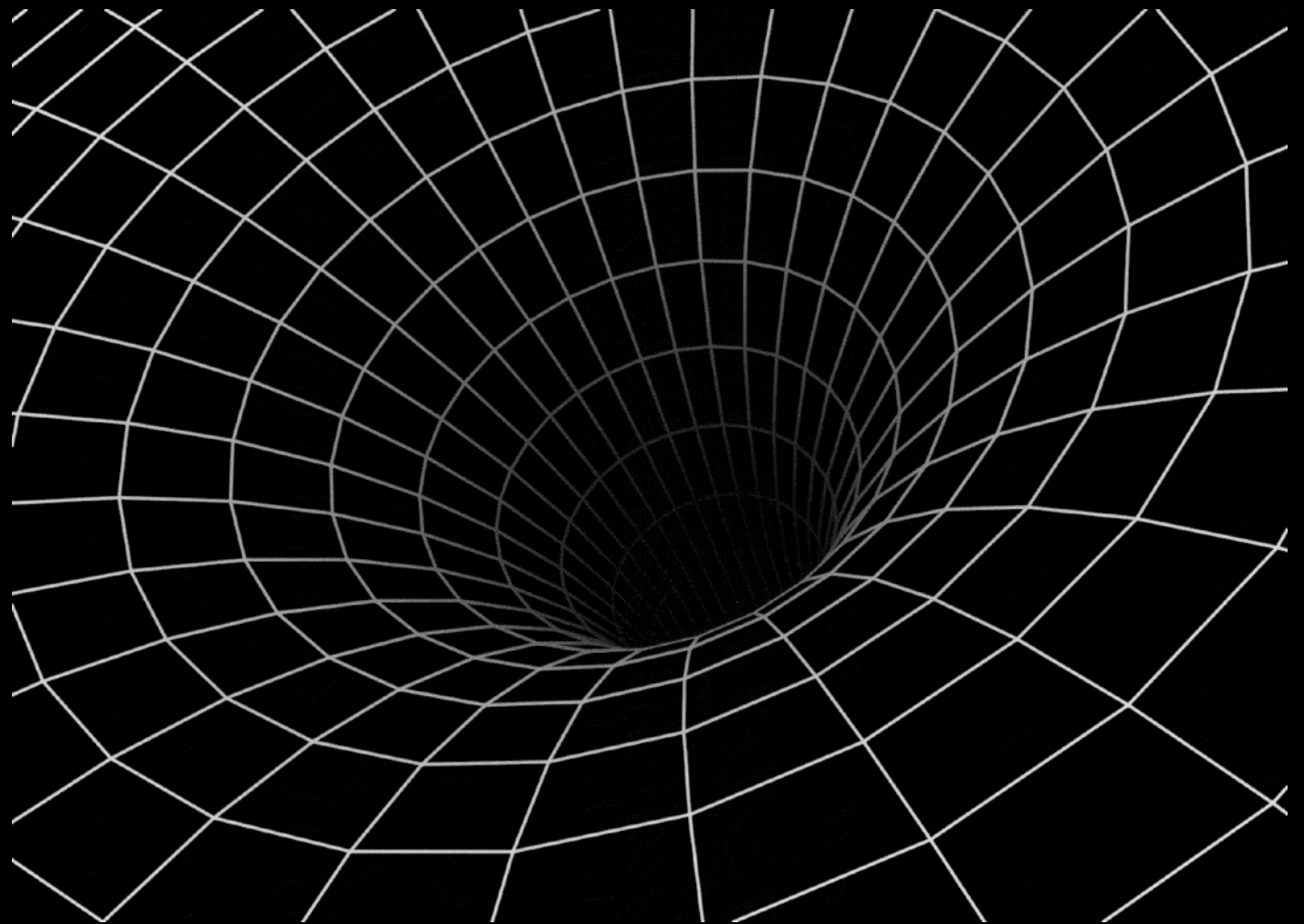
- What seeds supermassive black holes?



- How do supermassive black holes accrete?

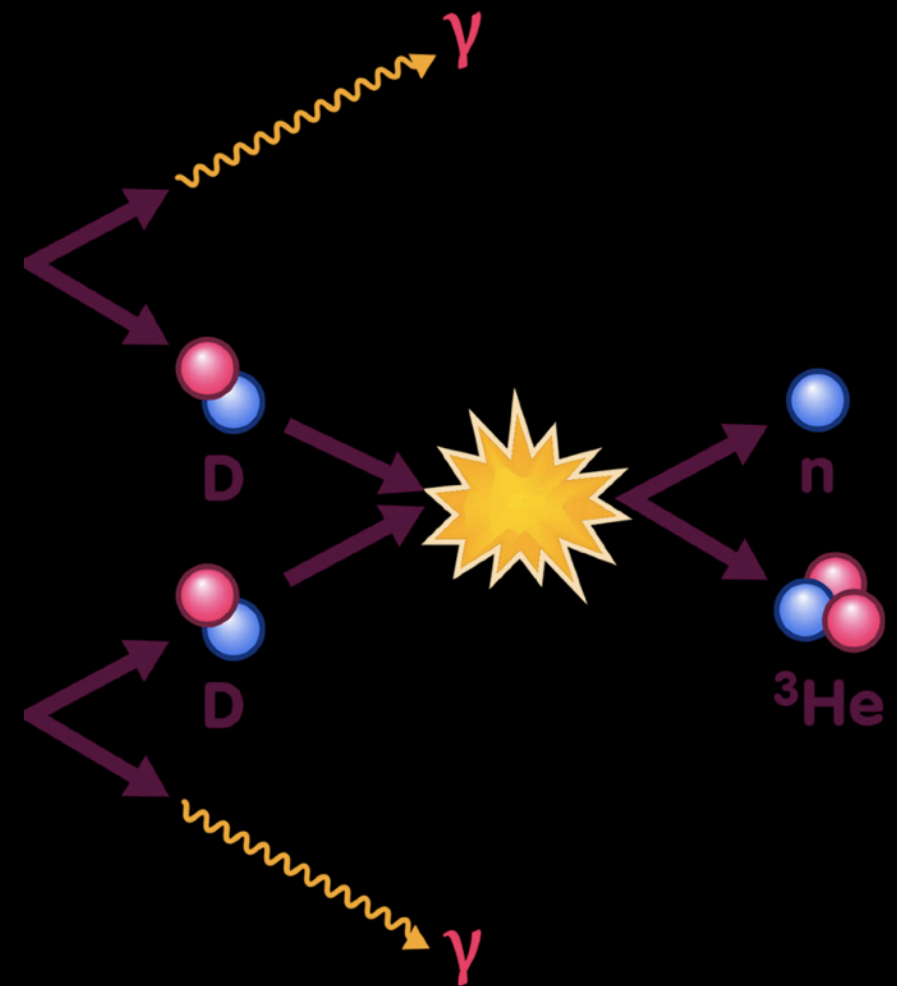
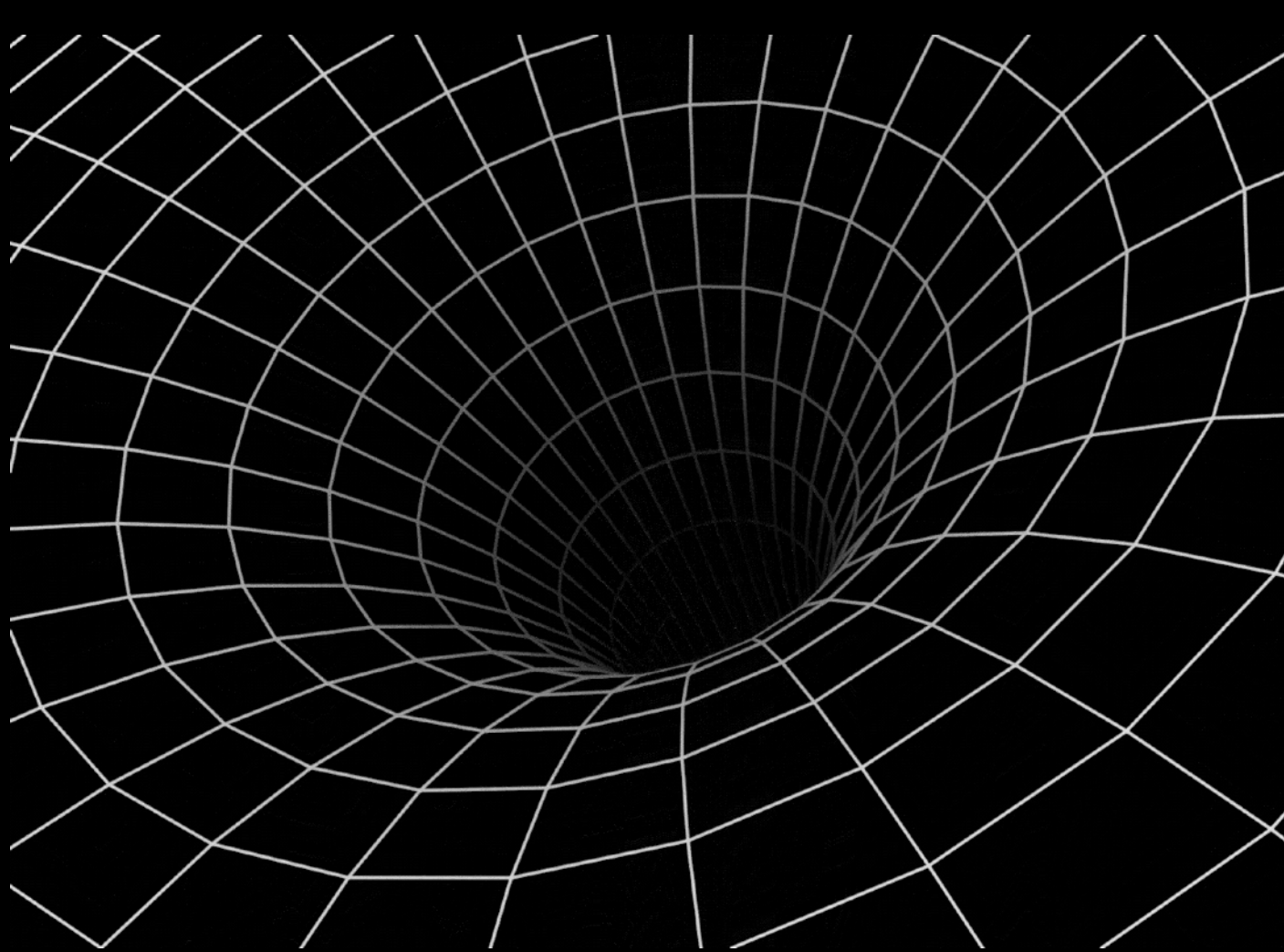


Finding signatures of primordial black holes as SMBH seeds



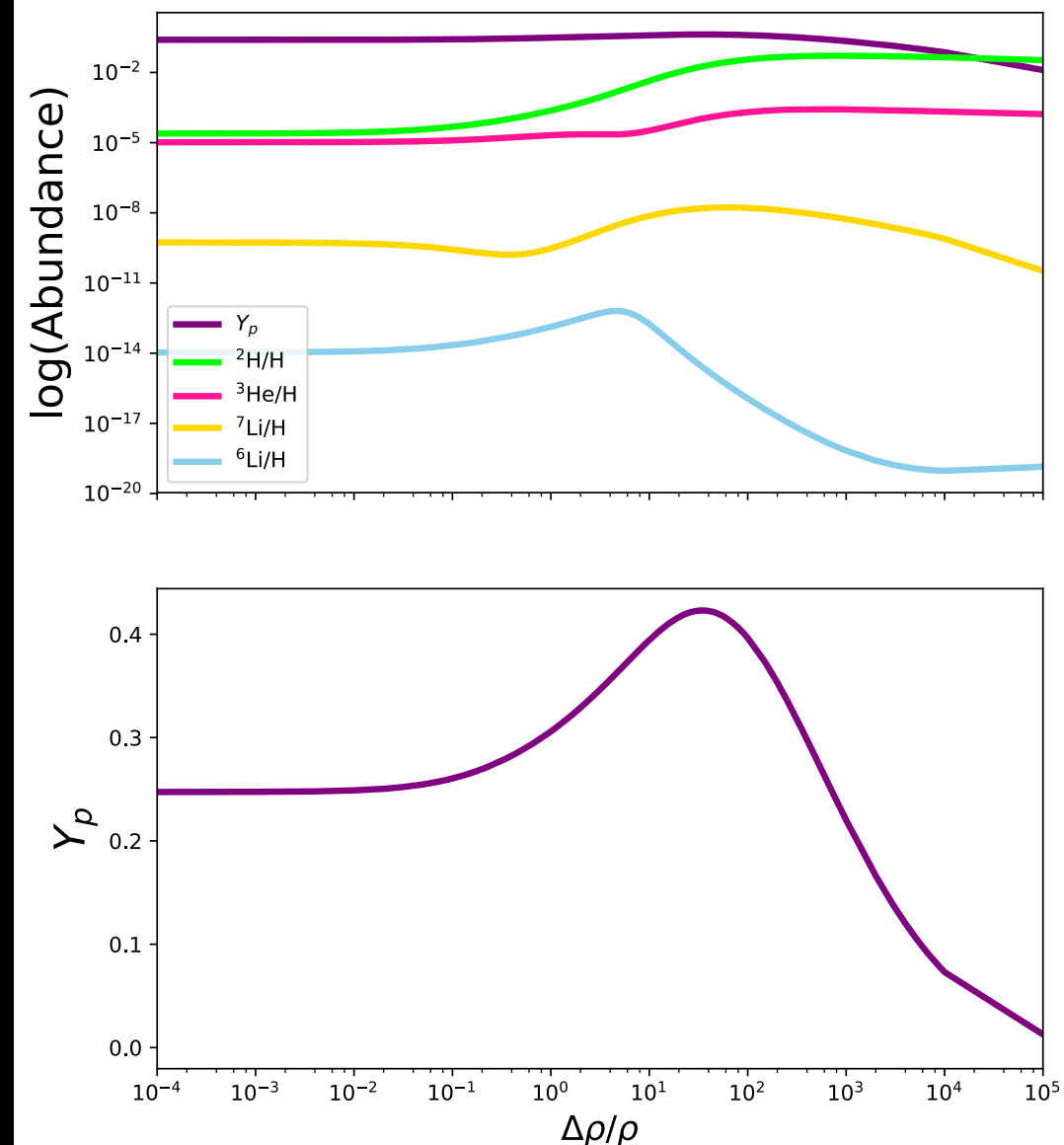
Credit: James Zanoni

The presence of a PBH would perturb Big Bang Nucleosynthesis



Finding signatures of primordial black holes as SMBH seeds

- Helium
- Deuterium/H
- $^3\text{He}/\text{H}$
- $^7\text{Li}/\text{H}$
- $^6\text{Li}/\text{H}$

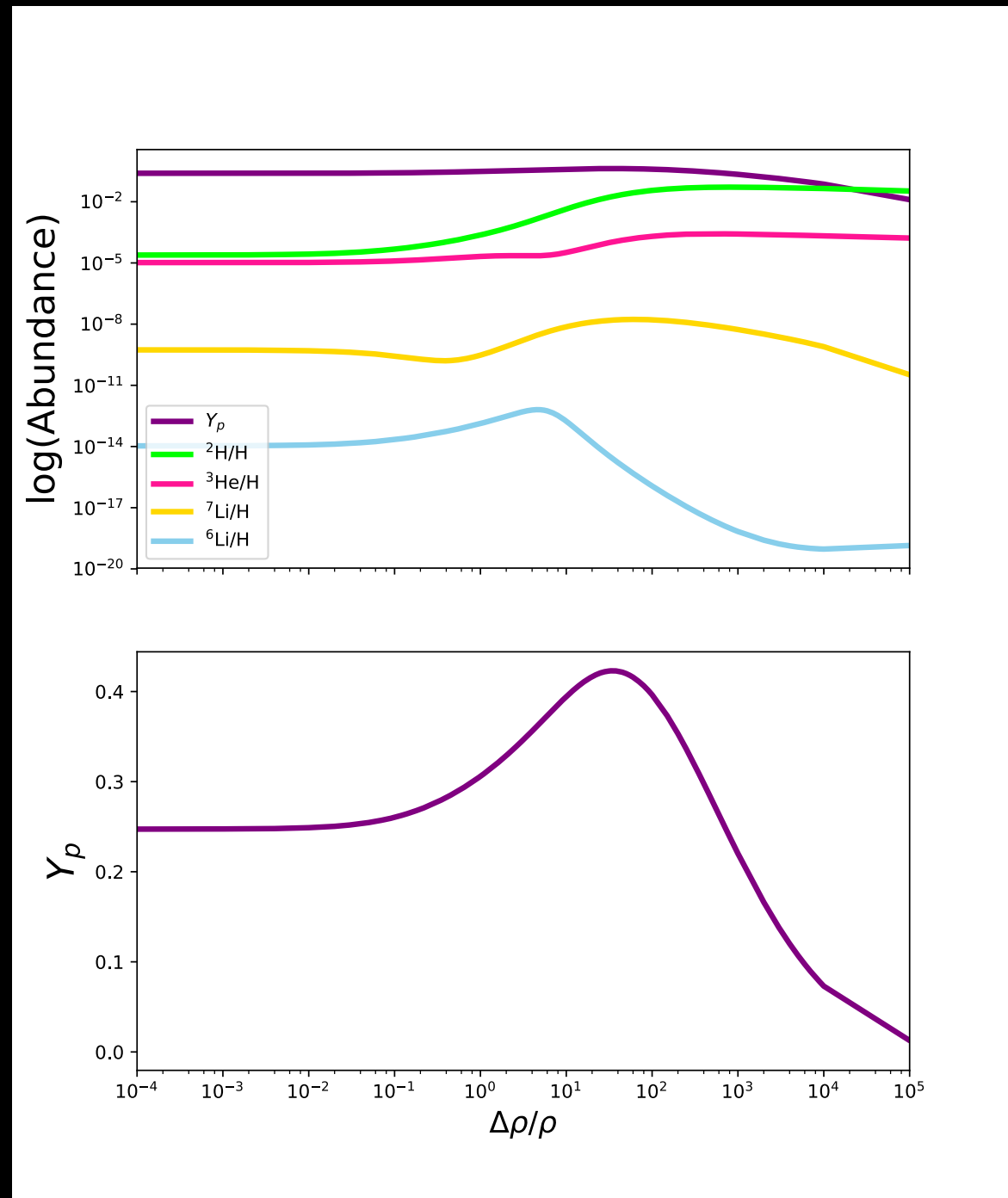


Upton Sanderbeck et al. (in prep)

Finding signatures of primordial black holes as SMBH seeds

- Helium
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$$H^2 = \frac{8\pi}{3}\rho + \rho_{\text{local}}$$

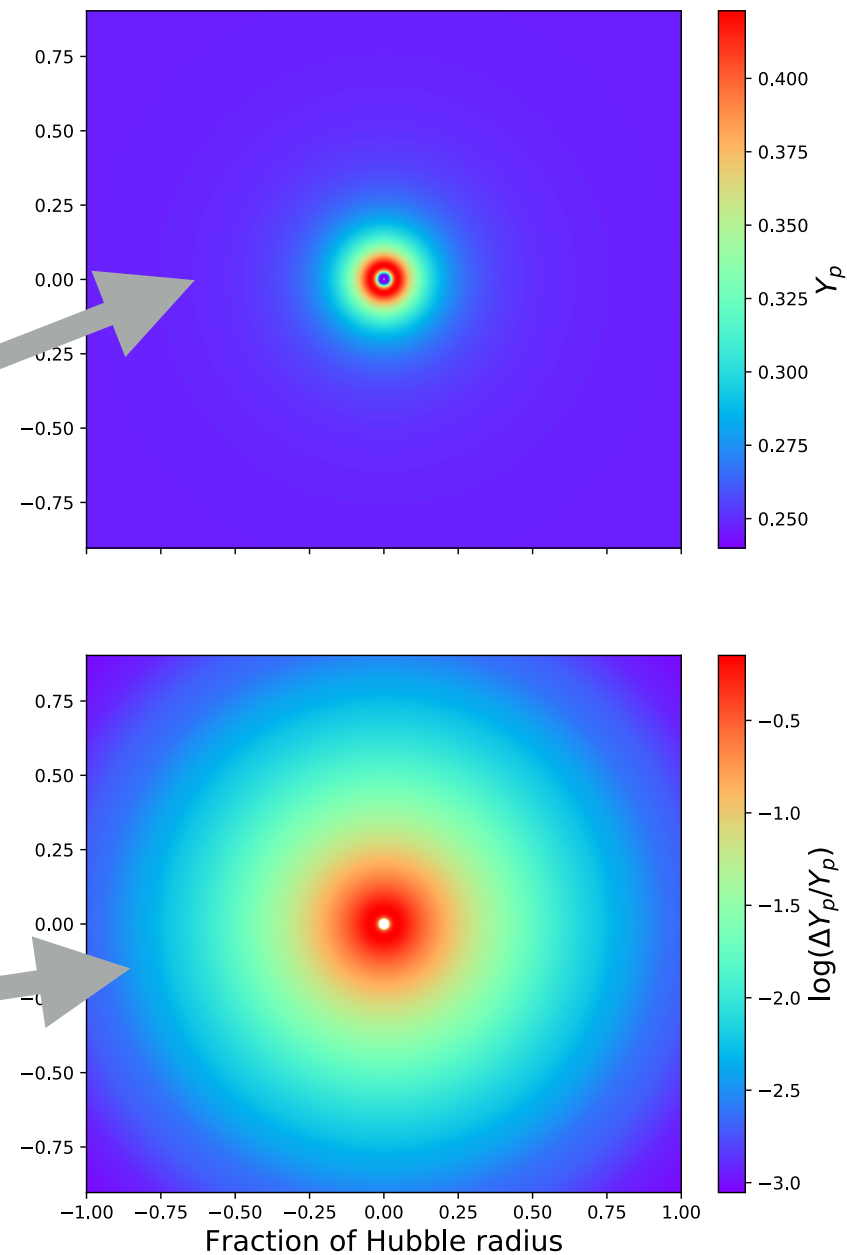


Upton Sanderbeck et al. (in prep)

Finding signatures of
primordial black holes
as SMBH seeds

Helium abundance centered
on a PBH at BBN

Fractional change in helium
abundance

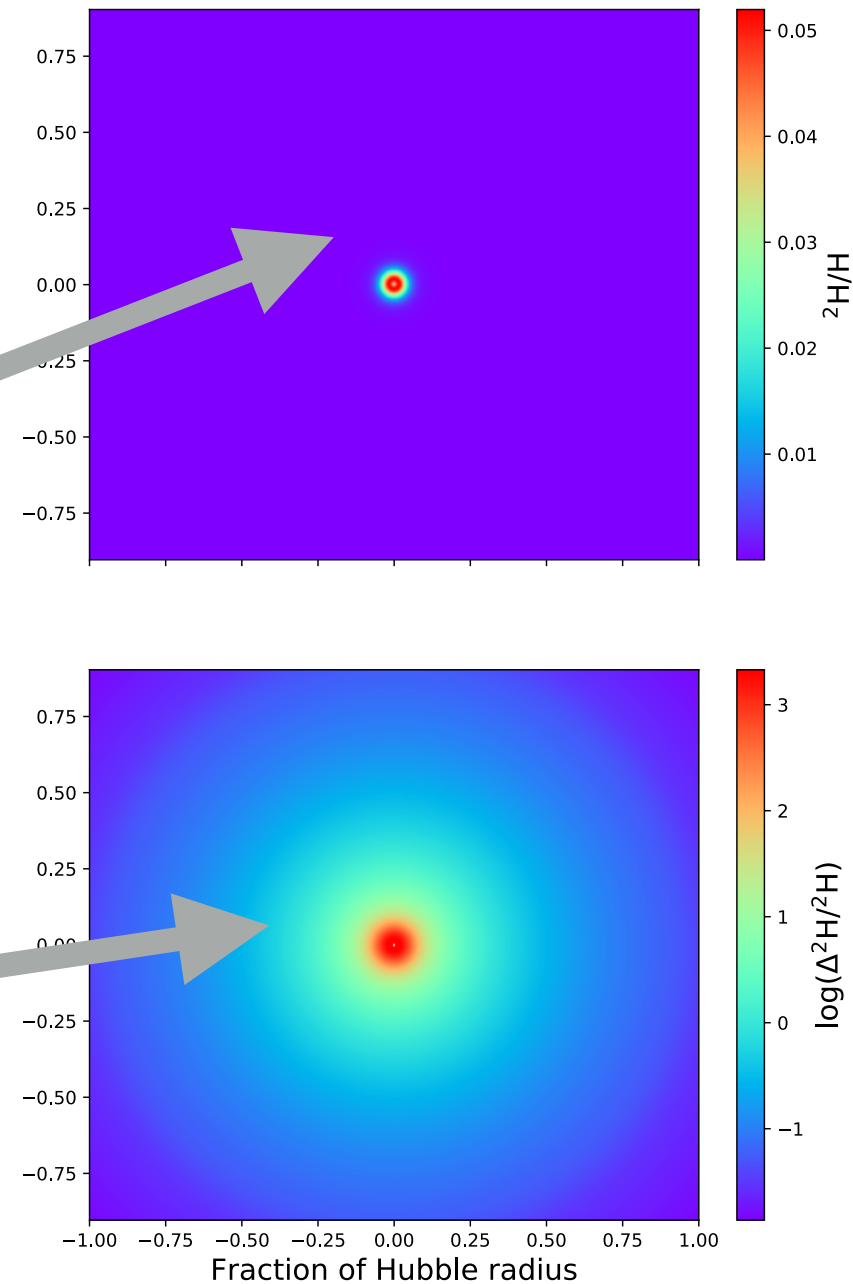


Upton Sanderbeck et al. (in prep)

Finding signatures of
primordial black holes
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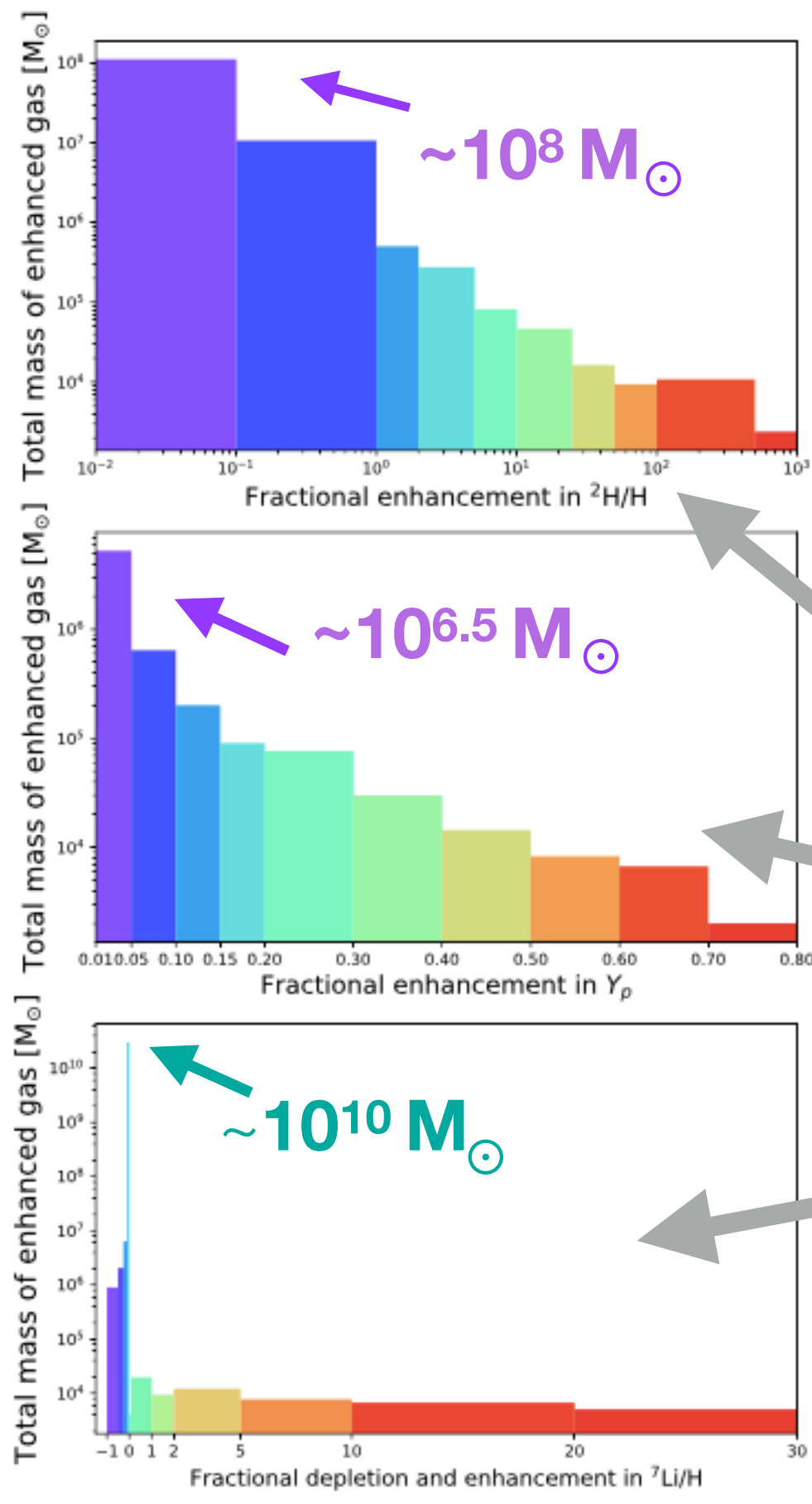
Deuterium abundance
centered on a PBH at BBN

**Fractional change in
deuterium abundance**



Upton Sanderbeck et al. (in prep)

How much enhanced and depleted gas is there?



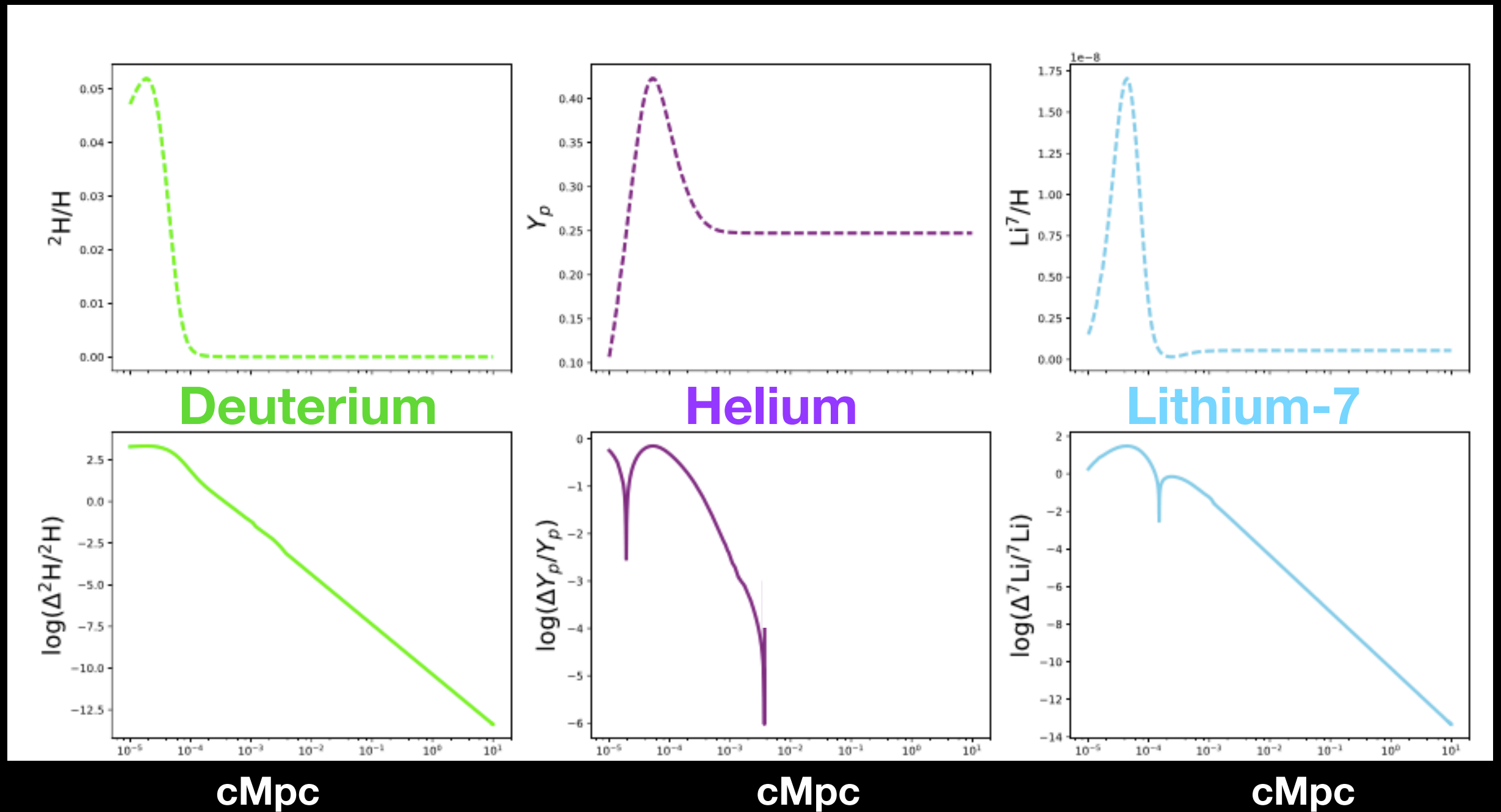
Fractional enhancement in **Deuterium**

Fractional enhancement in **Helium**

Fractional enhancement and depletion in **Lithium-7**

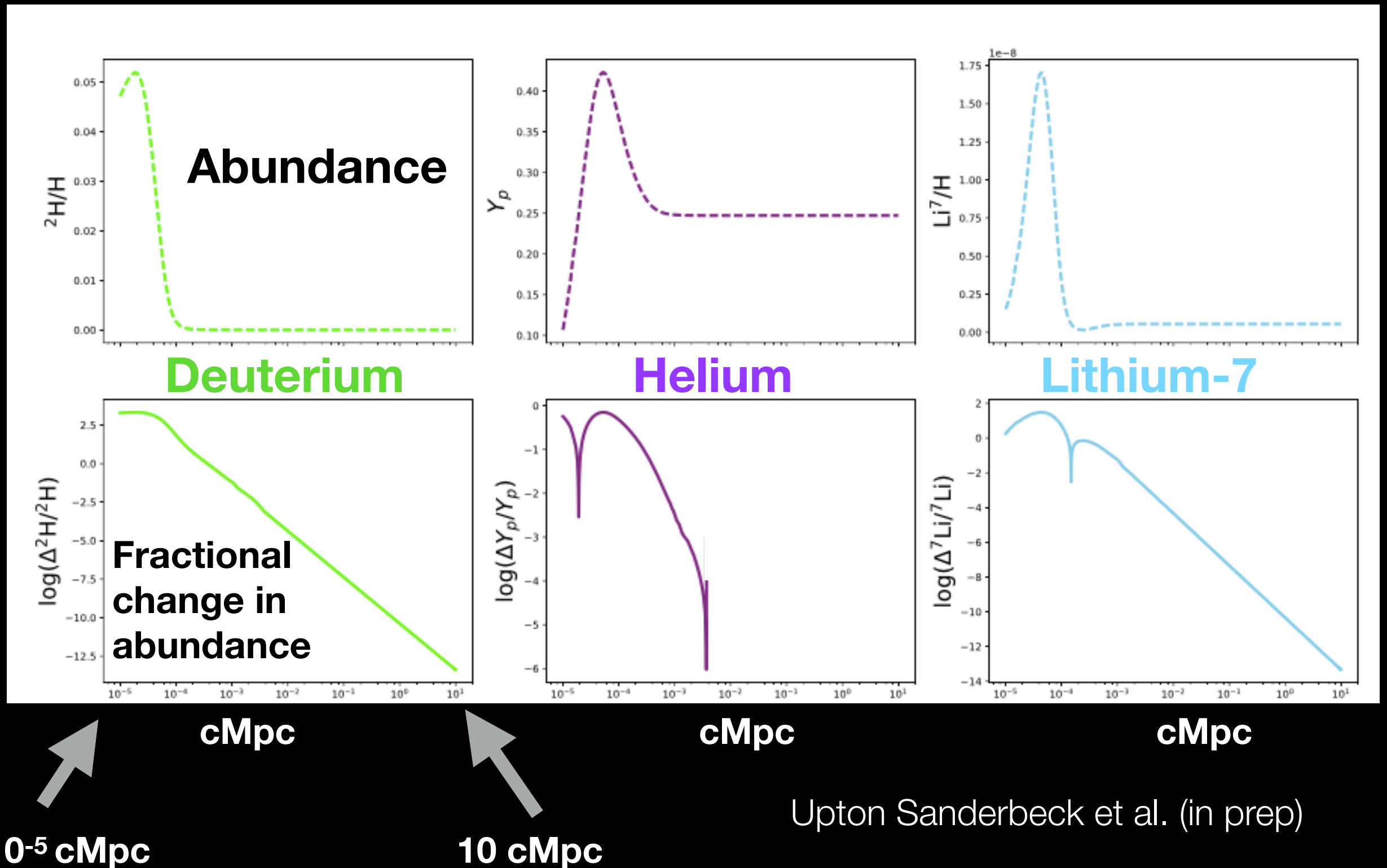
Upton Sanderbeck et al. (in prep)

What will this look like at lower redshift?

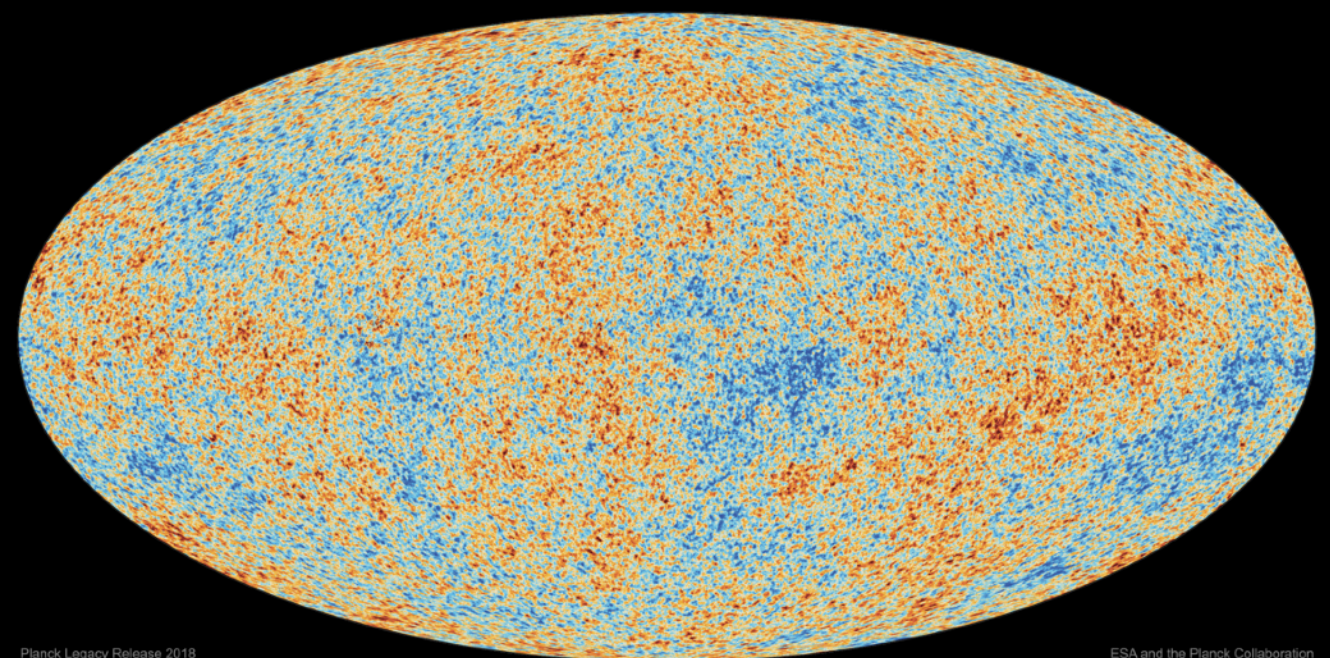
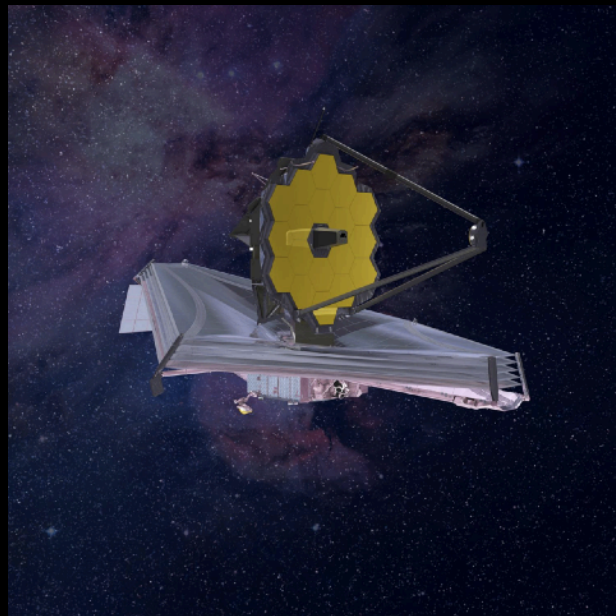


Upton Sanderbeck et al. (in prep)

What will this look like at lower redshift?



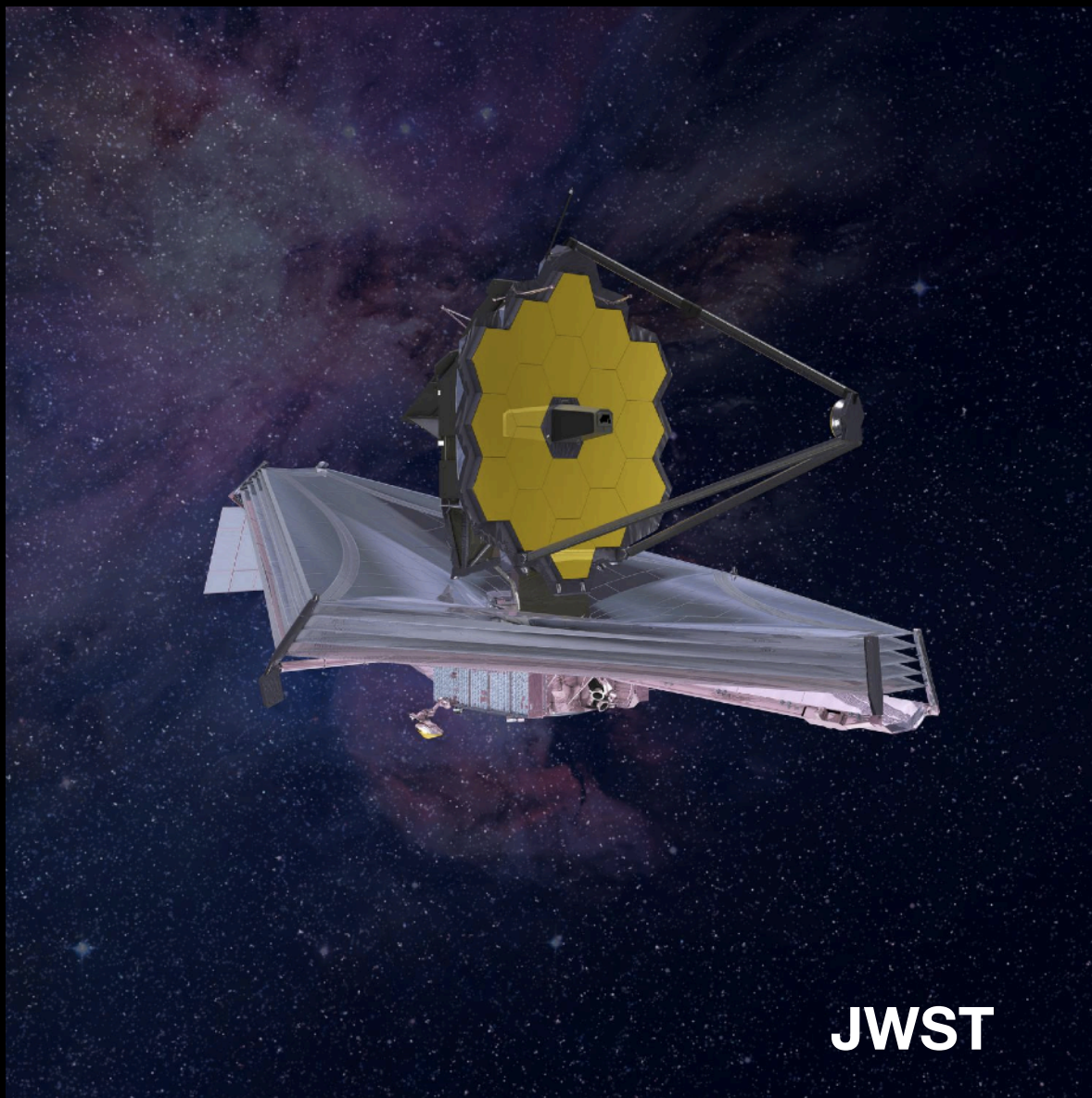
Potential observables



Planck Legacy Release 2018

ESA and the Planck Collaboration

Potential observables- He1640

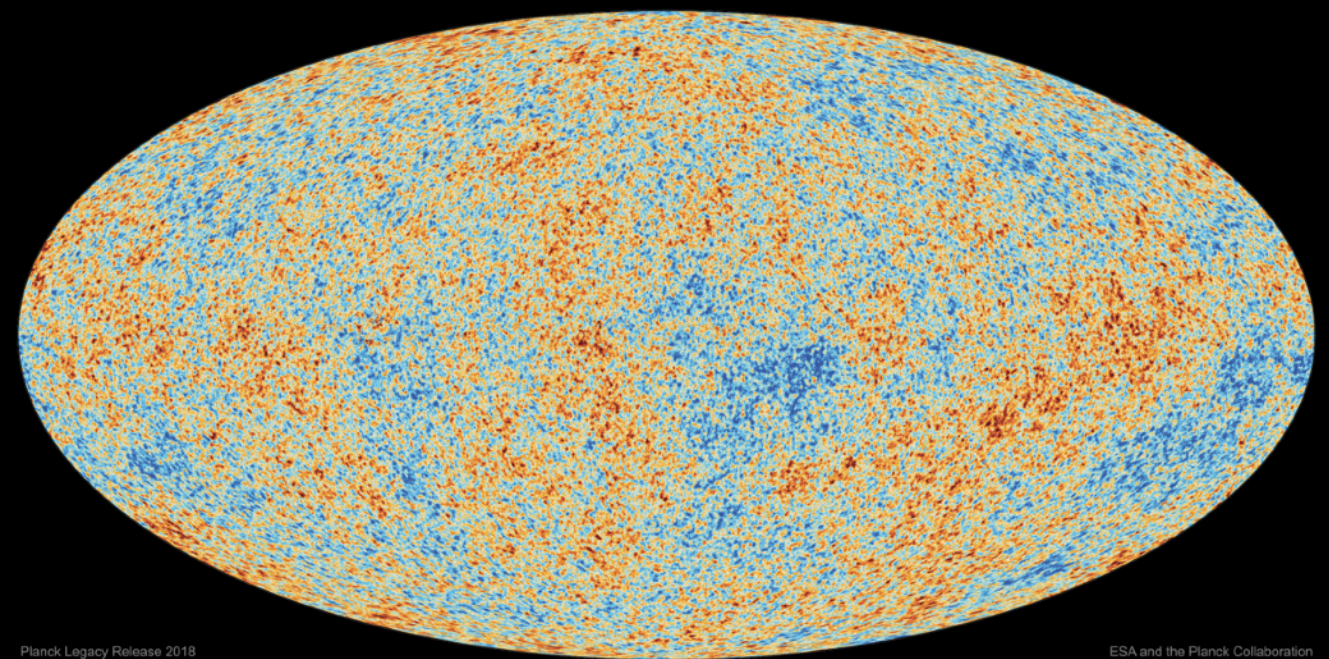
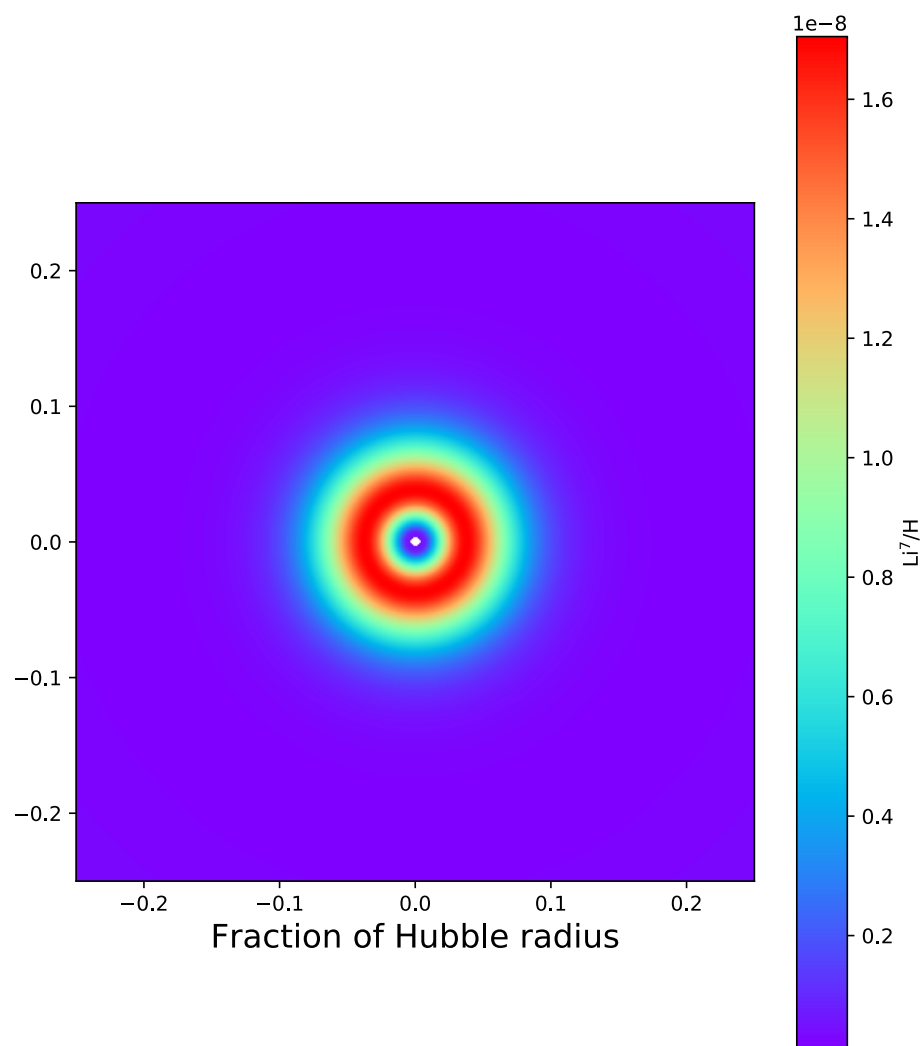


Potential observables- $^3\text{He}+$

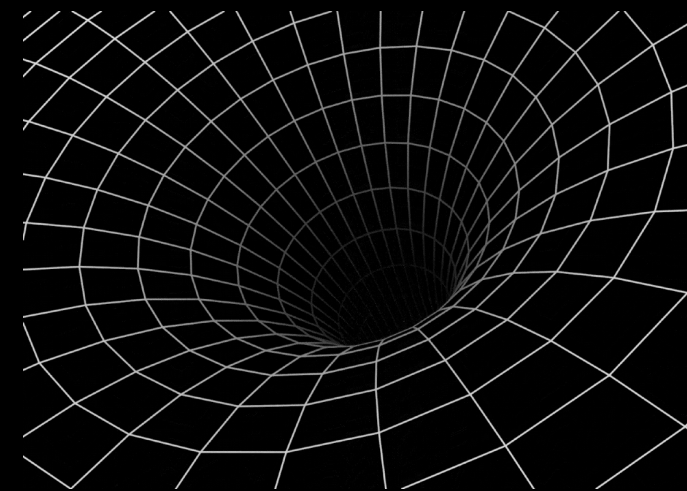
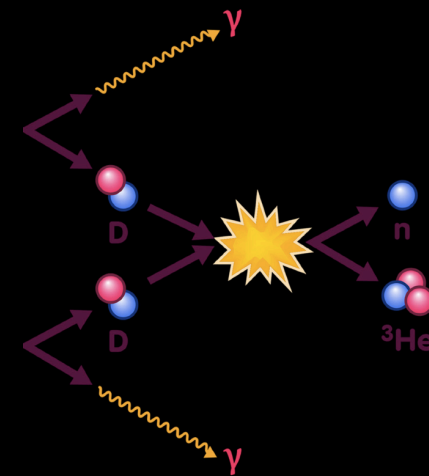


SKA

Potential observables- Lithium



Summary



- The presence of a PBH during BBN would perturb abundances
- Perturbed abundances around SMBHs could show compelling evidence for large PBHs as seeds of the SMBHs
- This could be observable with future instruments