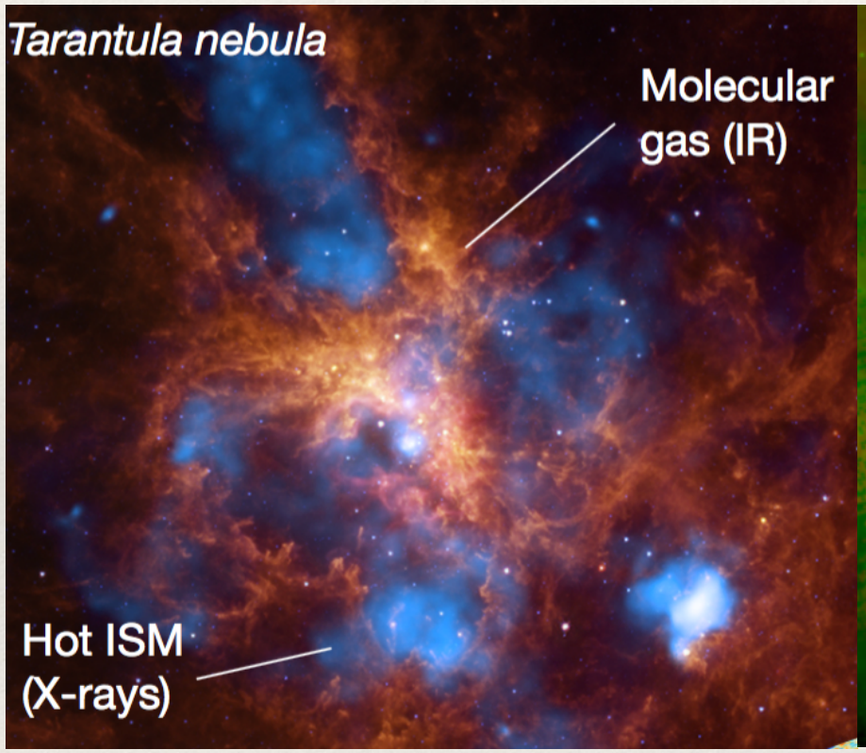
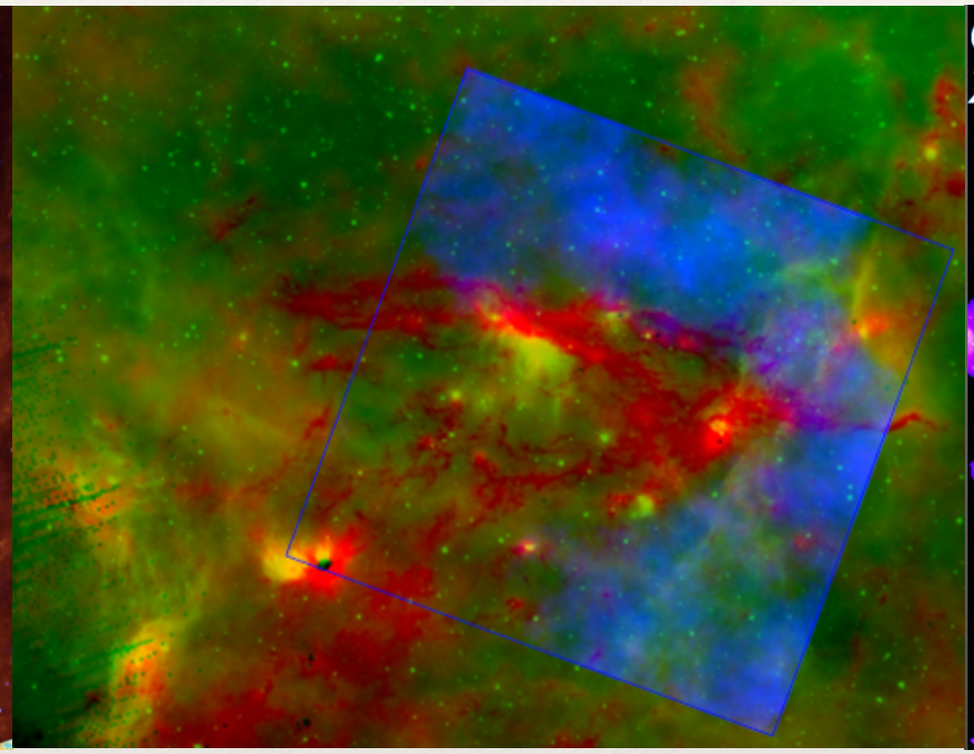
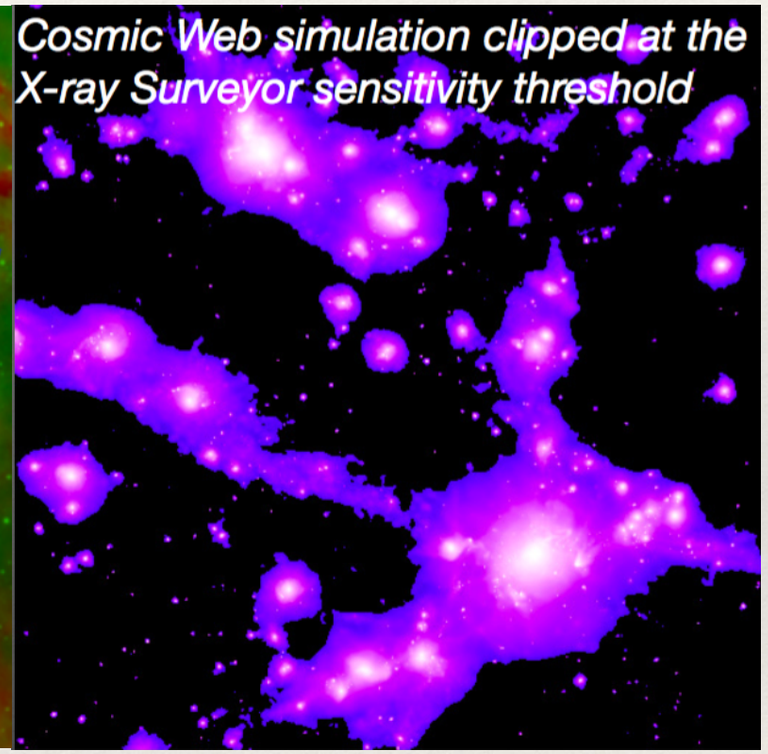
Lynx Mission Concept
Progress Report to APAC







Alexey Vikhlinin & Feryal Ozel
on behalf of the Science and Technology Definition Team
July 20, 2017

Lynx Team Activities

- A very active membership comprising 8 Science WGs, Optics WG, Instrument WG
- Weekly telecons, face-to-face meetings, virtual day-long meetings, industry days
- Active & large community participation

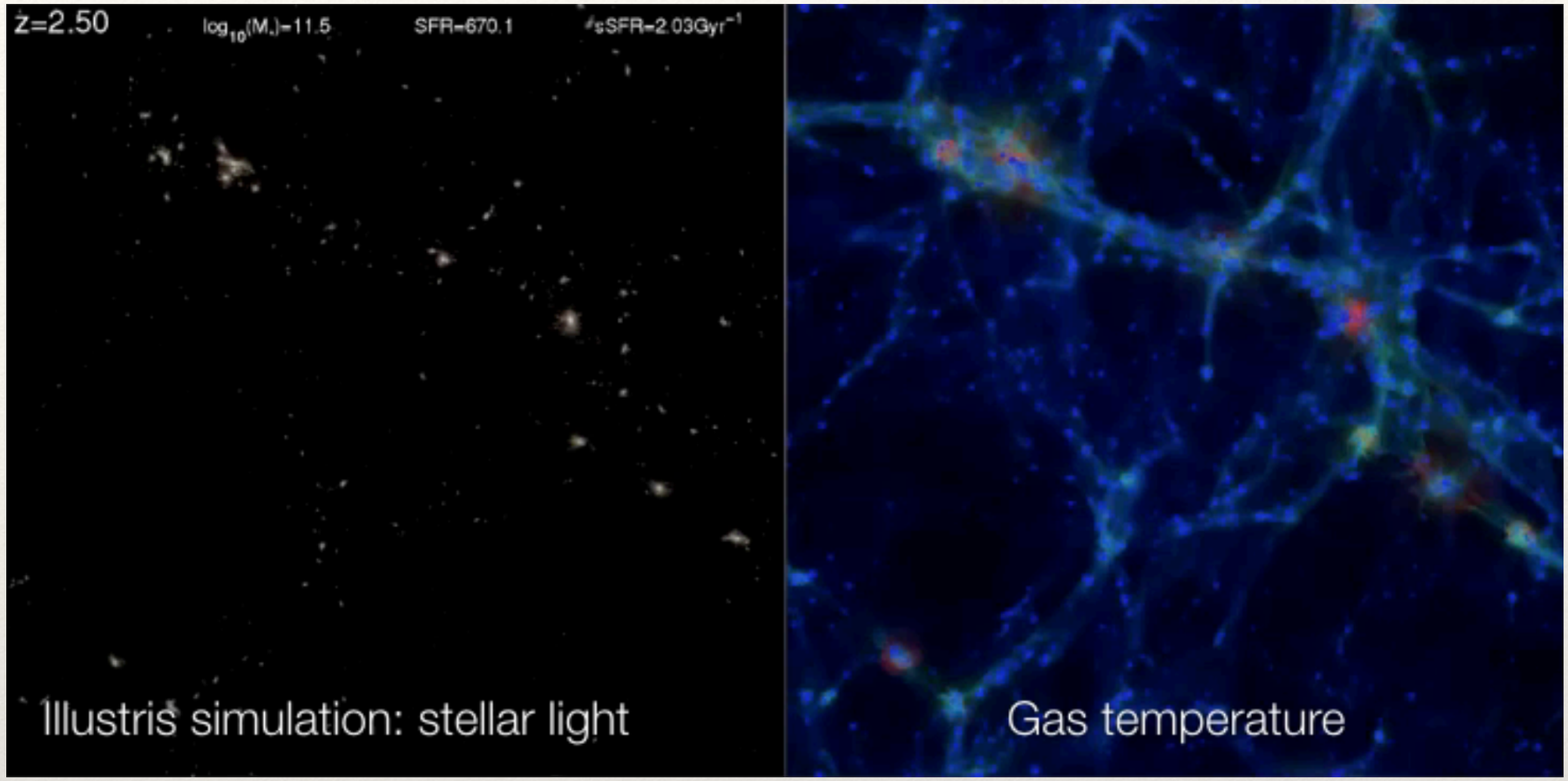
Key decisions and work topics for the *Lynx* STDT

- ✓ What kind of observatory *Lynx* should be?
- ✓ How big?
- ✓ Detailed requirements on the optics
- ✓ **Science instrument suite, and requirements**
- ● Complete mission design
- ● Progress in technology, develop technology roadmap
- ● Write up the science case

Compelling Science Pillars

- The Invisible Drivers of Galaxy Formation and Evolution
- The Dawn of Black Holes

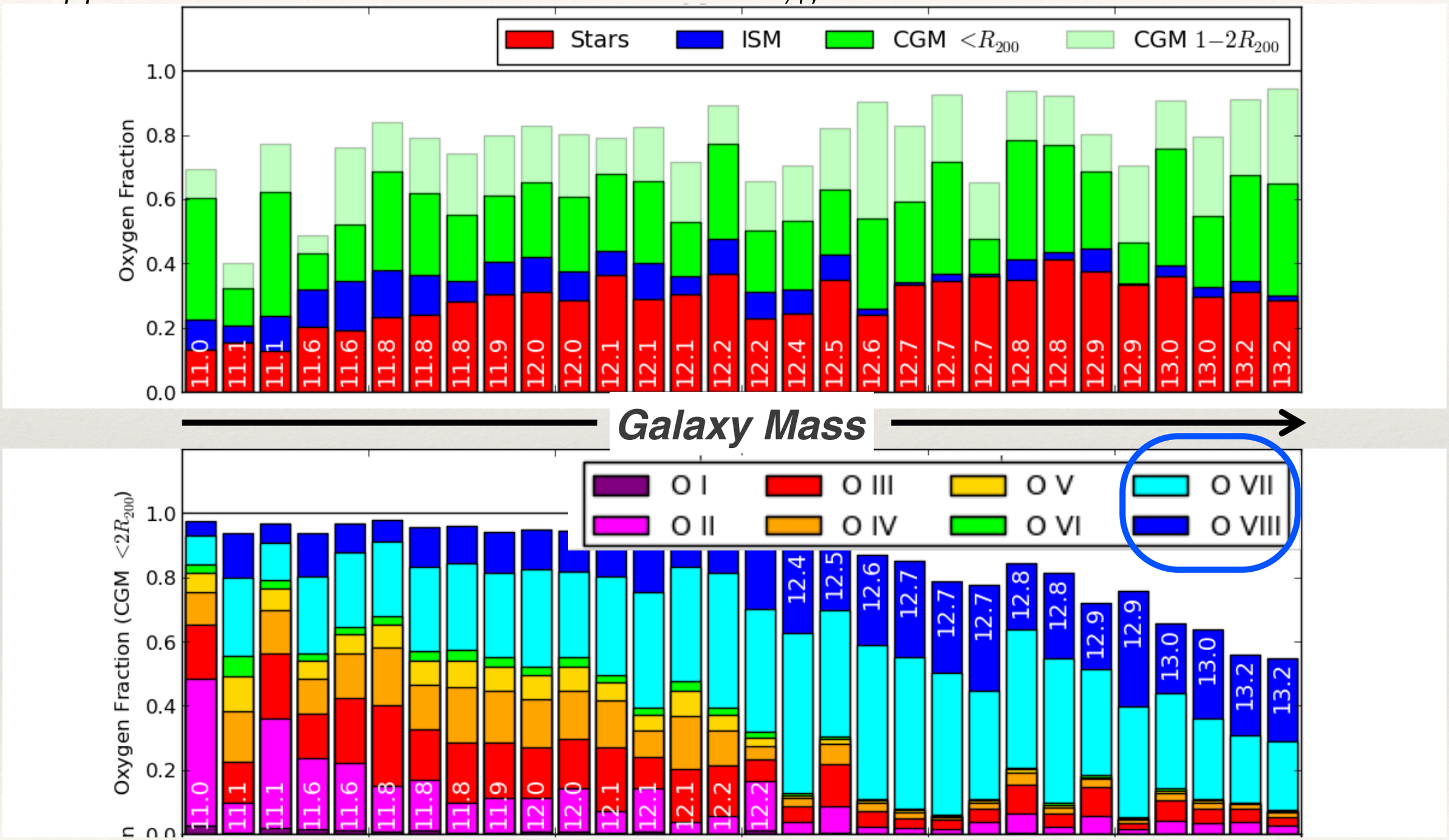
The Invisible Drivers of Galaxy Formation and Evolution



- This topic concentrates on a critical and well-defined aspect of the broader subject of galaxy formation. It is related to numerical cosmology, extragalactic astronomy, AGNs, ISM physics, star formation, etc.
- **Breakthrough progress:** *Lynx* will be uniquely capable of observing the state of baryons in galactic haloes with M>Milky Way; measure the energetics and statistics of all relevant feedback modes; new unique insights on the physics of feedback to inform numerical models.
- **Unique *Lynx* contribution:** In galaxies with M>~Milky Way, the relevant baryonic component is heated and ionized to X-ray energies. Needed observations rely on high-resolution spectroscopy and the ability to detect low surface brightness continuum emission (both unique to *Lynx*), and on a capability to map large areas in the sky in OVII, OVIII etc.

Incisive Diagnostics of CGM/IGM

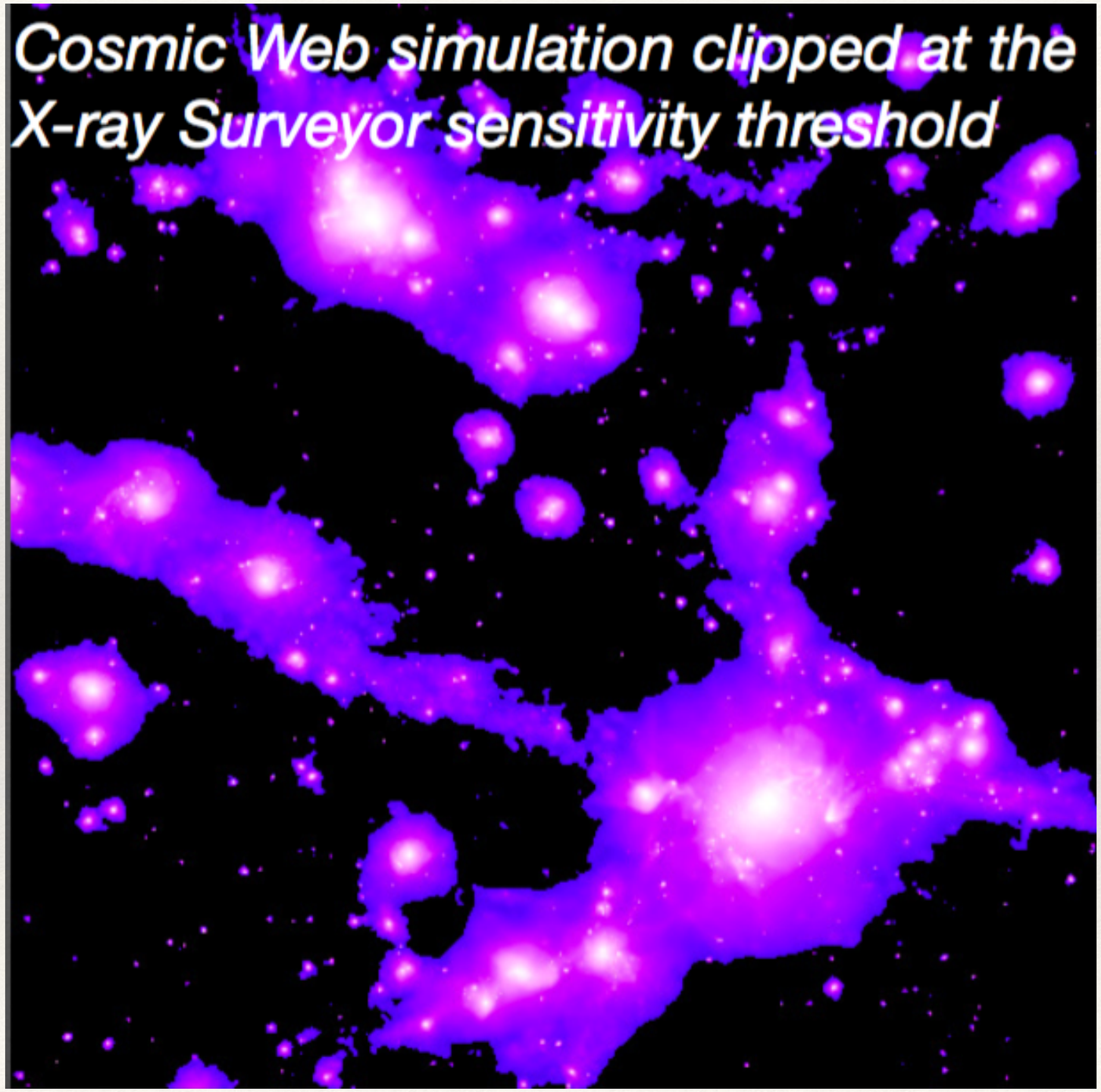
Oppenheimer et al '16: EAGLE simulation: Oxygen census and Ionization Fractions



*L** galaxies: >50% of O is in CGM

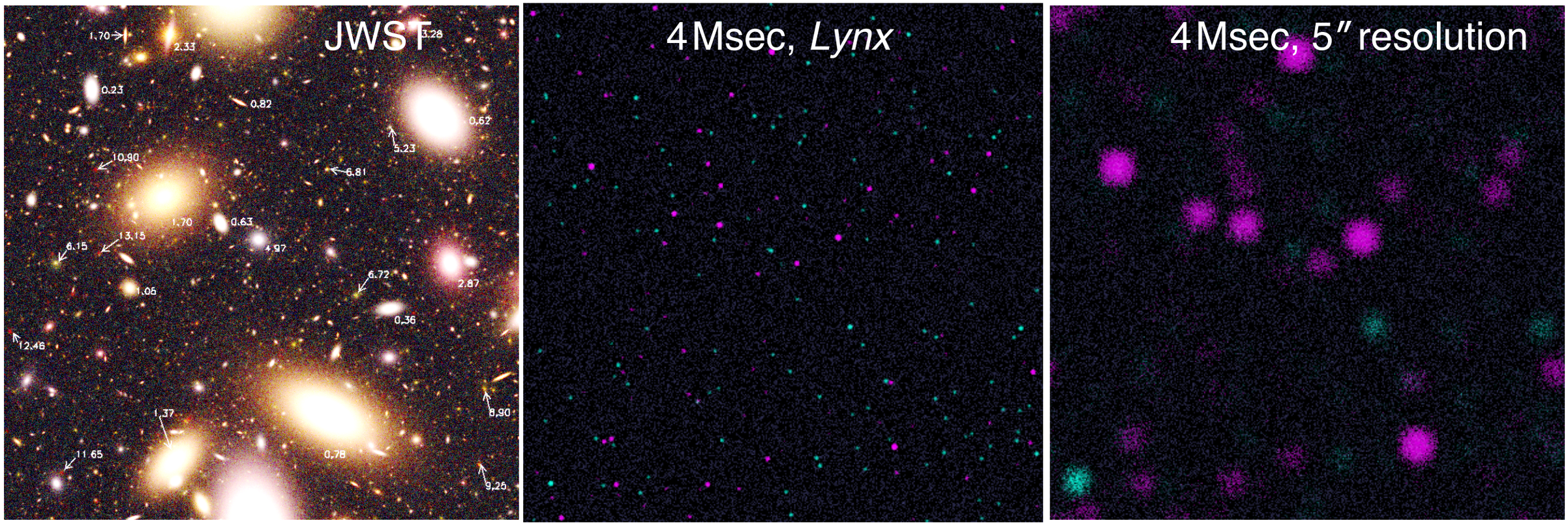
~80% of that is observed in X-ray transitions (OVII at 0.57 keV, OVIII at 0.65 keV)

Mapping out the IGM



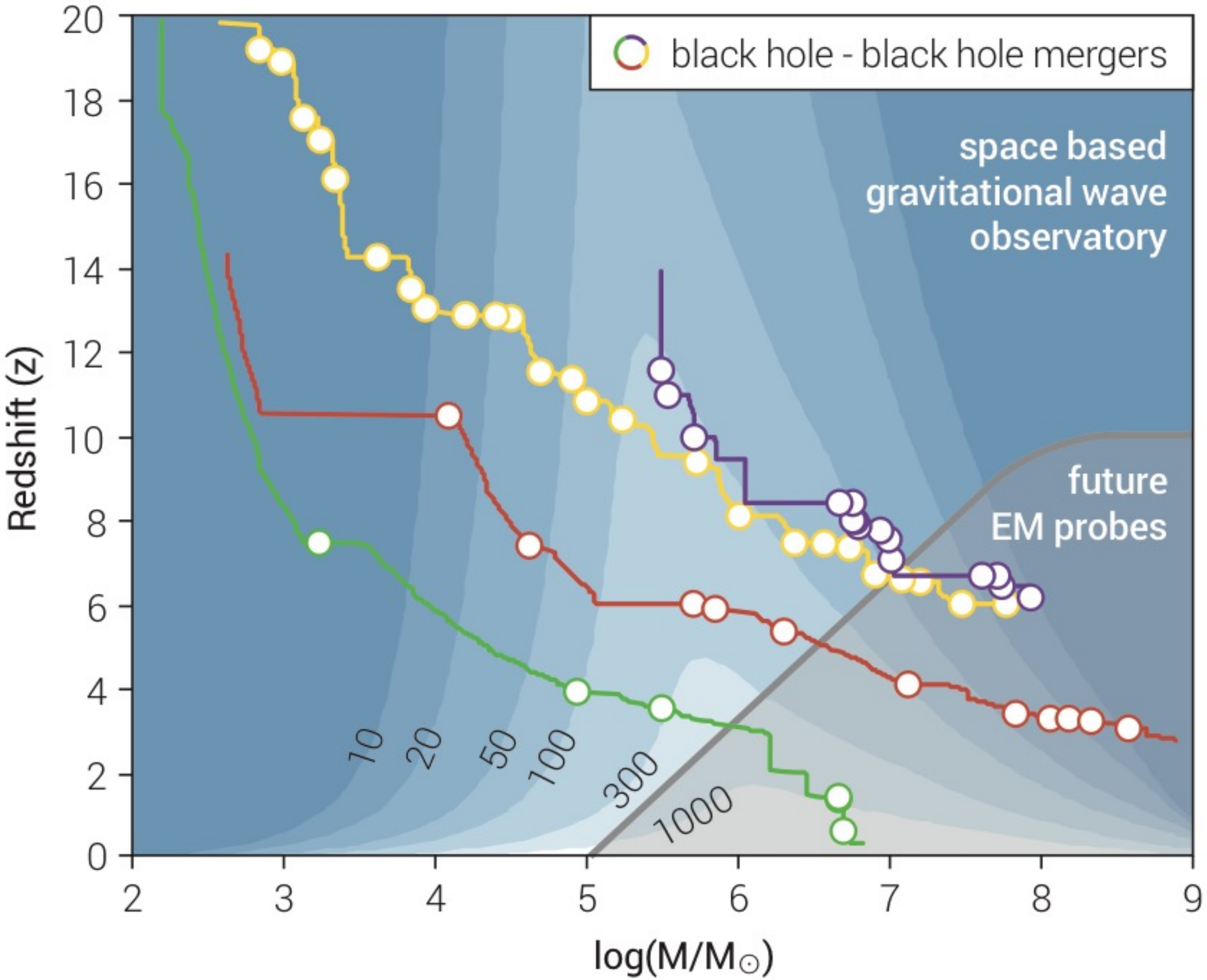
The Dawn of Black Holes

Simulated 2x2 arcmin deep fields observed with JWST, Lynx, and ATHENA

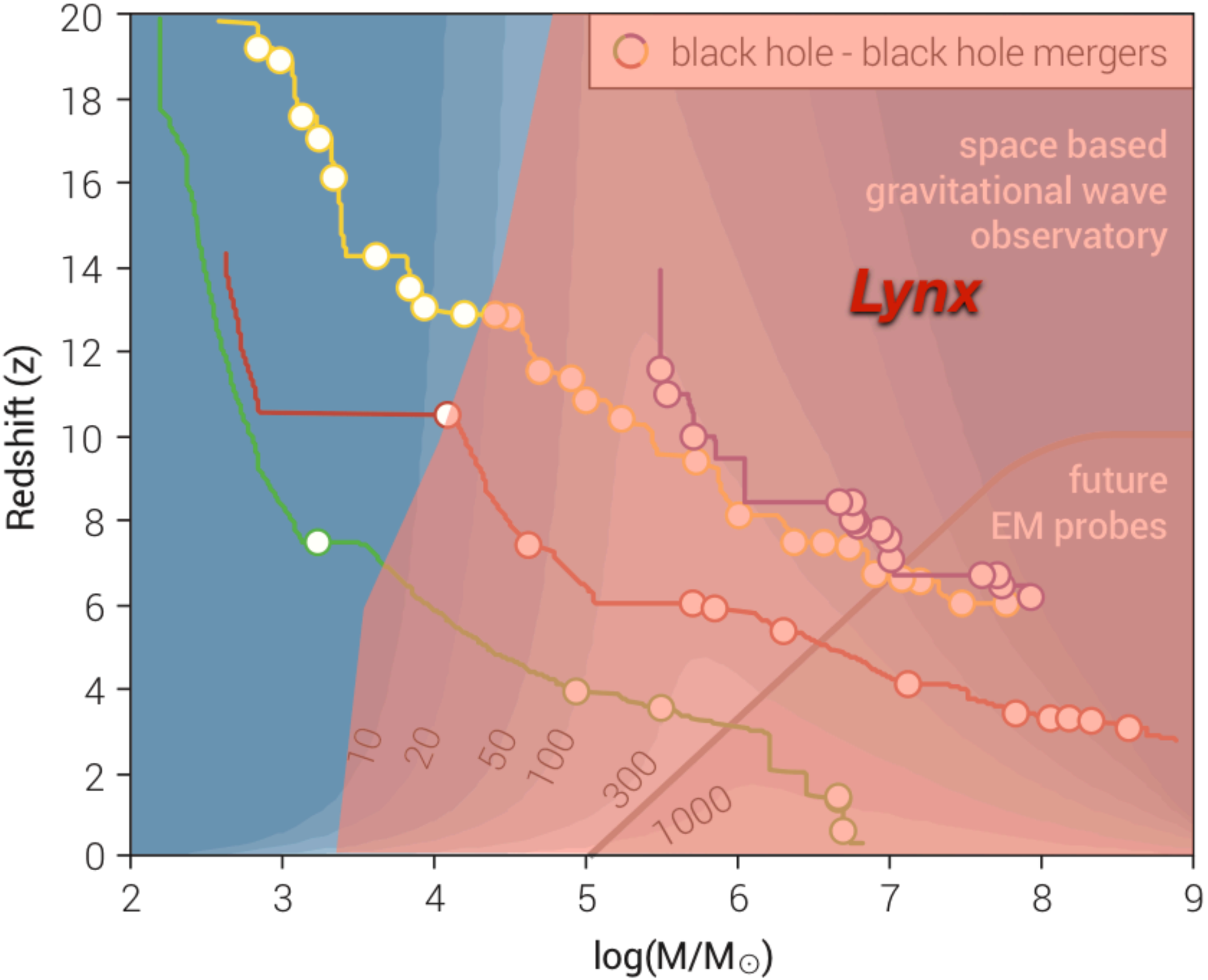


- This topic is an essential component of the broad subject of the Early Universe as it goes through the reionization epoch and the first generations of galaxies emerge. Of interest to all astronomers working on the early universe, galaxy formation, black holes.
- **Breakthrough progress:** The origin of SMBHs is a mystery and will likely remain the mystery until 2030s. *Lynx* is uniquely positioned to detect the SMBH at their seed stage or soon after.
- **Unique *Lynx* contribution:** Low-mass black holes, generically, are best observed at X-rays. Reaching into the seed regime requires sensitivities ~ 1e-19 erg/s/cm^2, which only *Lynx* can achieve.

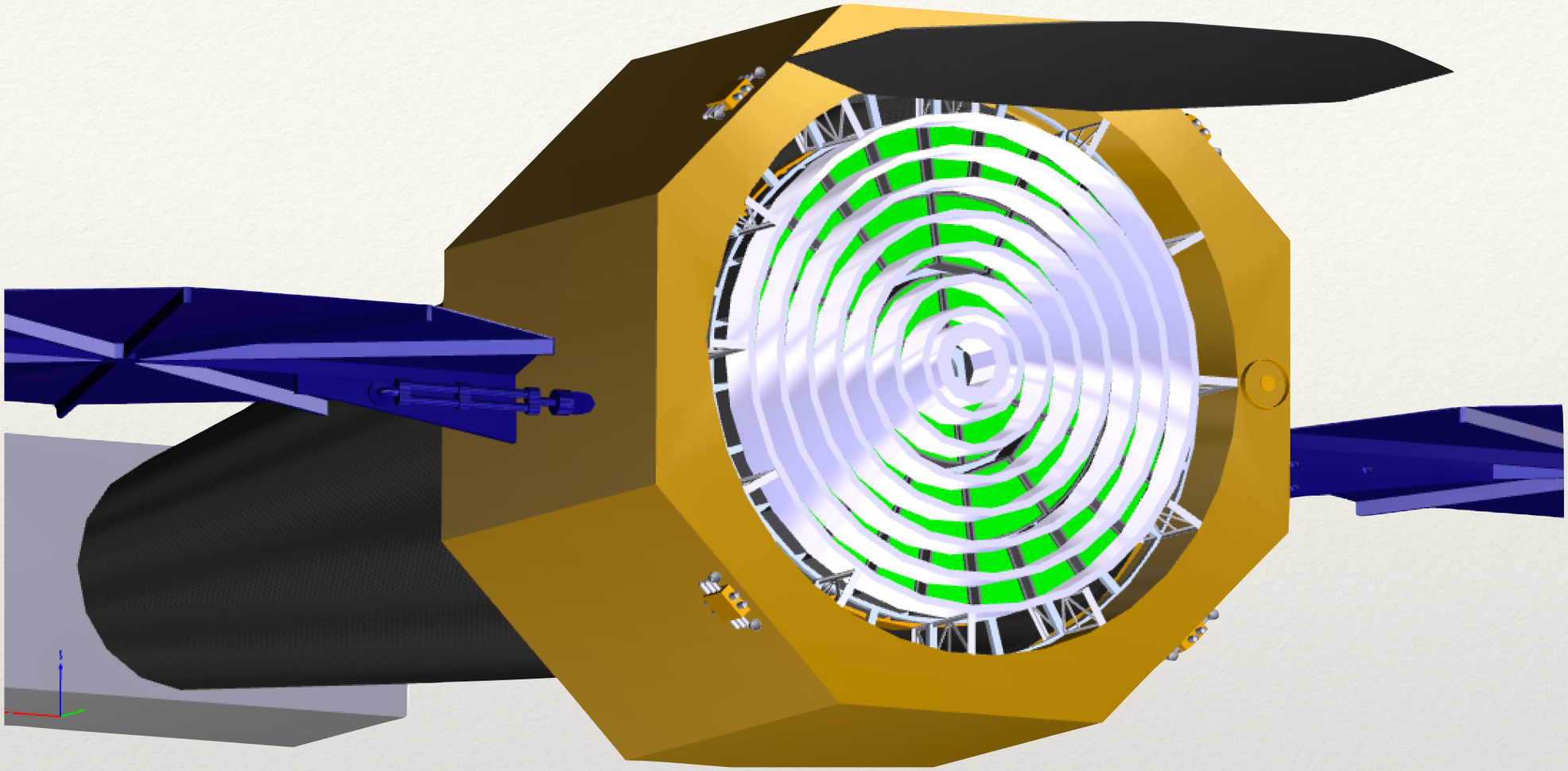
The Dawn of Black Holes



The Dawn of Black Holes



Lynx mission requirements



- 0.5″ angular resolution on-axis
- 2 m^2,effective area at ~1 keV. Implies a 3 m diameter for the mirror system — can be accommodated by current launch vehicle fairings
- Sub-arcsec imaging out to 10 arcmin radius
- “Invisible Drivers” science requires very high resolution spectroscopy with gratings and microcalorimeter

Current Technical Readiness

Lynx

	Total Gaps	TRL 2 Gaps	TRL 3 Gaps	TRL 4+ Gaps
Enabling+ enhancing	5	1	3	1
Enabling only	5	1	3	1

ID	Technology Gap	TRL	Note
1	High-resolution lightweight X-ray optics	2	Should the required system-level angular resolution be achievable with mirror-level resolution of 2 arcsec, and/or if the factor currently limiting mirror-level performance to 2 arcsec and a credible technological extension are identified, this TRL would be at 3.
2	Non-deforming X-ray reflecting coatings	3	Thin glass substrate coated with Pt showed identical thickness coatings on two sides resulted in minimal net distortion
3	Megapixel X-ray imaging detectors	3	
4	Large-format, high spectral resolution X-ray detectors	3	
5	X-ray grating arrays	4	

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from the recent "Pause and Learn" session presentation, extracted from the Decadal Studies Technology Assessment