Too Young to Shine? Nearby Primordial Starbursts and the X-ray Scaling Relations in the Early Universe

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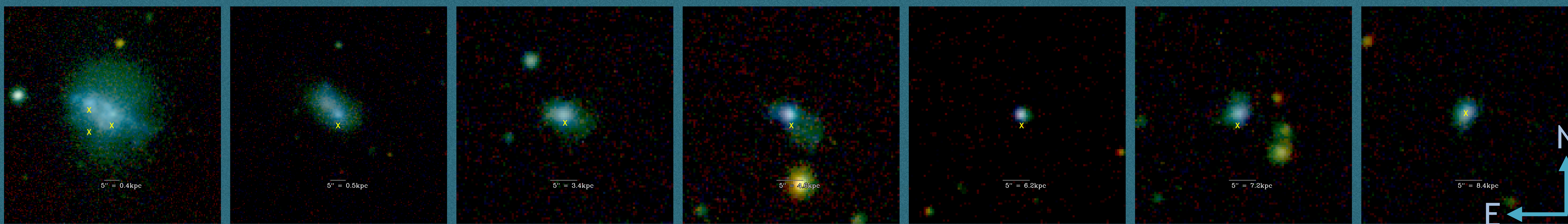
Motivation: Measuring the X-ray emission from galaxies in the early universe — *Do X-rays from the "first" galaxies contribute to the heating of the IGM?*



Above: We show the optical images for our sample of nearby (z<0.1) "primordial" galaxies from SDSS u' (blue), g' (green), z' (red) ordered by increasing star formation rate (SFR). Physical and angular sizes are given. The yellow X's correspond to X-ray sources.

The Sample: Ha Emitters (HAEs)

We select our sample of *nearby (z<0.1) "primordial" galaxies* from the SDSS spectroscopic catalog with

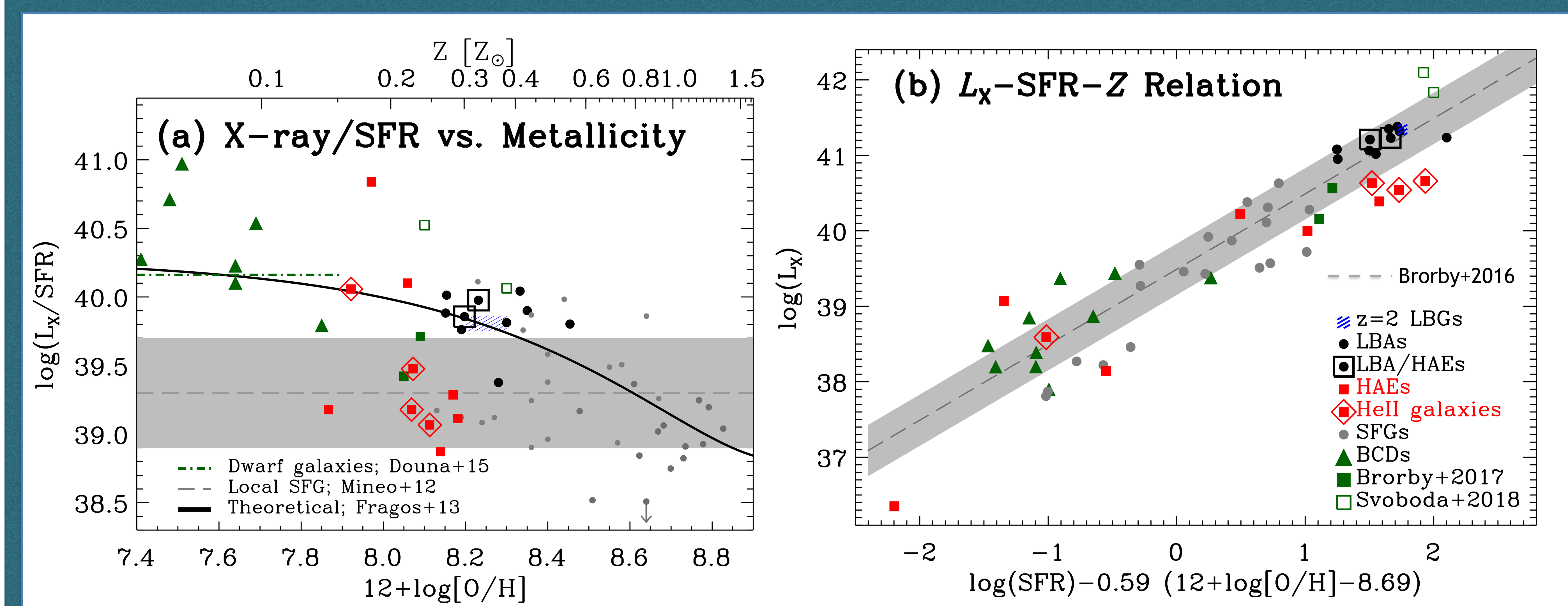
EW(Ha) > 500 Å,

log [NII]/Ha <-1.0.

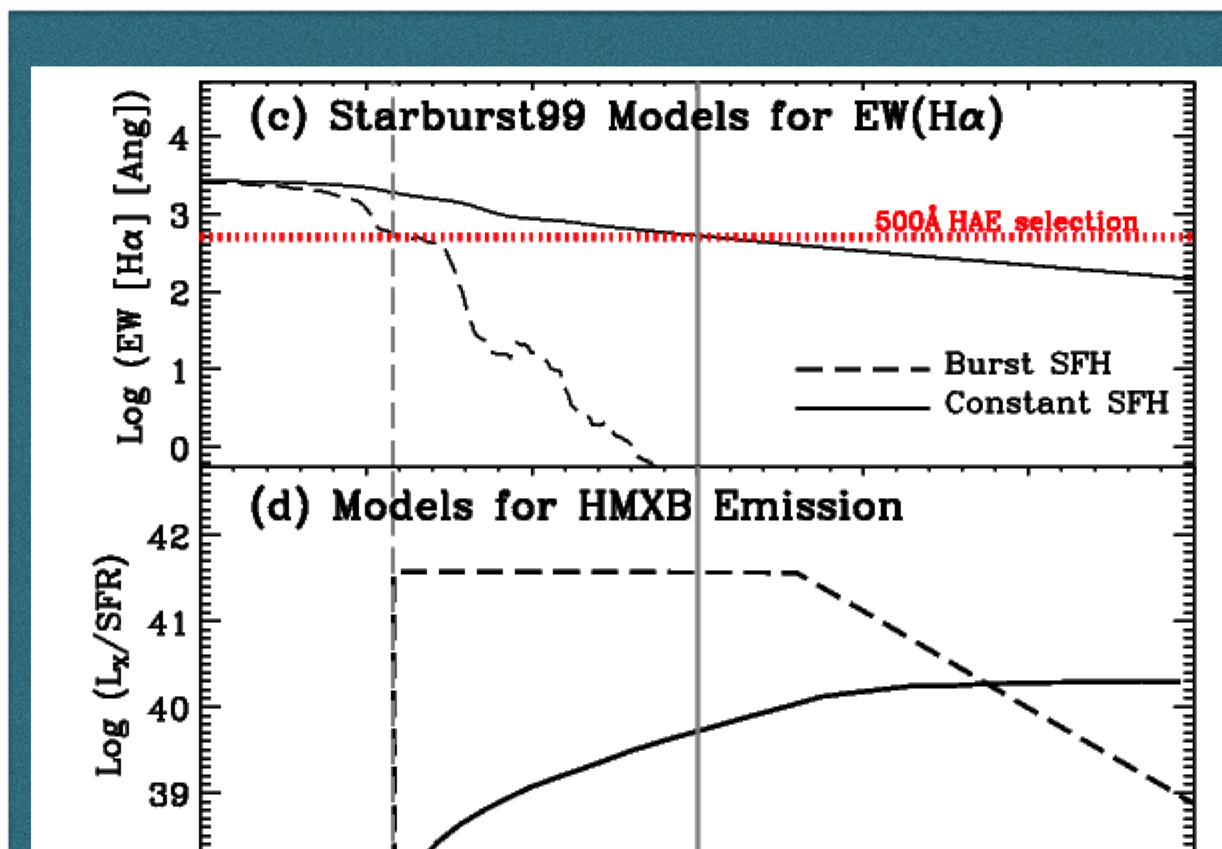
Extreme emission-line galaxies selected in this way have been shown to have properties similar to high redshift galaxies (Shim & Chary 2013), e.g., low metallicities (Izotov+2011), hard-ionizing stellar spectra (Jaskot & Oey 2013), strong Lyman alpha emission (Henry+2015) and unusual optical emission line ratios (Steidel+2014).

We use archival Chandra X-ray observations.

Are HAEs *less* X-ray luminous given their SFRs and metallicities?



Above: The X-ray emission from high mass X-ray binaries in star-forming galaxies depends on SFR and metallicity. Theoretically, weaker winds in low-metallicity galaxies result in more massive compact objects and higher X-ray luminosity (solid black line on left panel). However, many of the HAEs (red squares) and HeII galaxies (diamonds) have lower Lx/SFR than predicted based on their SFRs and metallicities.



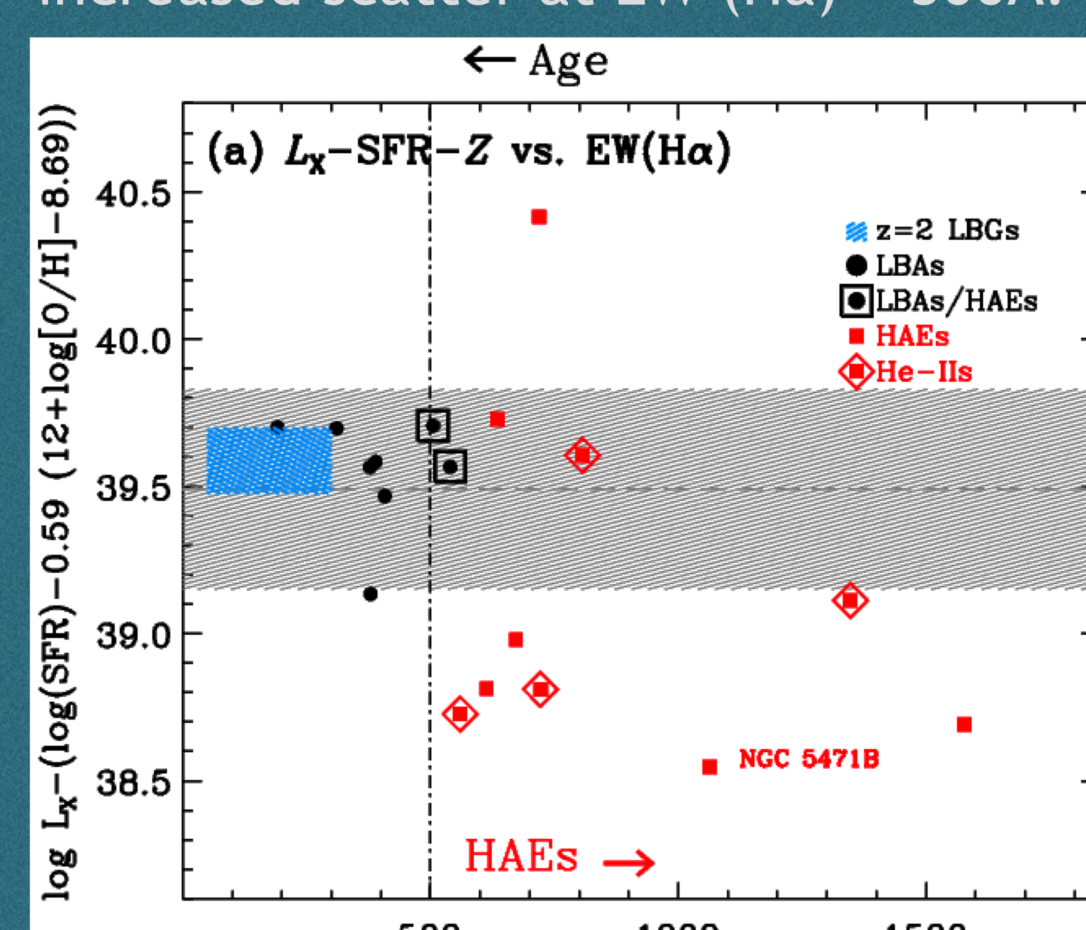
Is youth to blame?

* High mass X-ray binaries form fully over 10 Myr (burst) - 200 Myr (constant star formation history) timescales (see Rappaport+2005; Jusham & Schawinsky 2013).

* Meanwhile, EW(Ha) > 500Å during stellar ages < 10 —100 Myr (see *left*).

* Therefore, primordial galaxies might have lower X-ray luminosities given their SFRs and metallicities.

Below: We don't see obvious trends between EW(Ha) and offset from X-ray-SFR-metallicity relation, but do find increased scatter at EW (Ha) > 500Å.



Left: An Ha EW >500Å corresponds to very young ages (< 7 Myr or <70 Myr) depending on the star formation history (single burst vs. constant). At these young ages, high mass X-ray binaries have not fully formed (see Jusham & Schawinski 2013, Rappaport+2005)