

## The systematic search for $z \geq 5$ active galactic nuclei in the *Chandra* Deep Field South

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### Abstract

We investigate early black hole growth through the methodical search for  $z \geq 5$  AGN in the *Chandra* Deep Field South. We base our search on the *Chandra* 4-Ms data which at  $z \sim 5$  makes us sensitive to luminosities as low as  $\sim 10^{42}$  erg s<sup>-1</sup> ( $\sim 10^{43}$  erg s<sup>-1</sup>) in the soft (hard) band. The deep X-ray data should allow us to detect Compton-thin AGN with  $M_{\text{BH}} > 10^7 M_{\odot}$  accreting at Eddington ratios  $> 0.1$ . The field contains over 600  $z \sim 5$  Lyman Break Galaxies. These high-redshift galaxies are the progenitors of massive, local galaxies and based on lower redshift relations we would expect  $\sim 20$  of them to host AGN. We combine the *Chandra* data with optical GOODS/ACS and infrared CANDELS/WFC3 and *Spitzer*/IRAC data. After excluding clear low-redshift sources and objects with insufficient filter coverage, our main sample consists of 58 high-redshift candidates. We use a range of redshift estimators including a photo- $z$  code, stacking, colour criteria and the Lyman Break Technique. We also use the X-ray Hardness Ratio as additional information. The final  $z \geq 5$  candidates that remain after we combine our redshift tests, are likely to be low-redshift interlopers. We thus conclude that, contrary to our expectation of finding at least a few high-redshift AGN, the field does not contain any convincing  $z \geq 5$  AGN candidates. Our results place interesting constraints on early black hole growth and we discuss a range of possible explanations.