Searching for True Type Two AGN With *Chandra*

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Goals and Motivation

- The canonical unified theory of active galactic nuclei states that **type 1 and type 2 AGN are fundamentally the same**, but we observe differences because of the angle of inclination (Antonucci 1993).
- Specifically, type 2 AGN are expected to contain a dusty torus along the line of sight which absorbs and blocks light from the broad line region.
- However, there is some evidence of type 2 AGN which **intrinsically lack a broad line region**, instead of it being present but obscured.
- This project uses *Chandra* observations to **search for more of these sources** which may prove to break the fundamental principle of the unified theory.

Sample

- Sources were taken from the *Chandra* Source Catalog (CSC) and Sloan Digital Sky Survey (SDSS) cross match (Rots et al. 2020).
- The Portsmouth Group's emission line analysis table `emissionLinesPort` was used to identify Seyfert galaxies (Thomas et al. 2013).
- **166 AGN candidates** were identified and investigated.

Selected Sources

- **24 unique AGN candidate sources** were identified as unabsorbed with a redshifted nH value + 1 σ less than 5×10^{20} atoms cm^{-2} (Bianchi et al. 2008).
- The optical spectra of these sources were visually analyzed to identify type
  - These identifications were corroborated by identifications in literature, selected using NED and Simbad.
  - **6 sources were identified as type 1, 7 were identified as type 2, and 11 were unable to be identified**
- A selection of these sources are presented:

Compton Thick Type Two AGN

- For AGN with column densities above 10^{24} cm^{-2}, the only X-rays which can penetrate the torus are those above 10 KeV (Bassani et al. 1999). This means that *Chandra* **is insensitive to all the unabsorbed X-ray emission.**
- Because of this, the X-ray spectra of these objects indicate **lower than reality column densities.**
- Compton thick sources can be identified by analyzing the ratio between the X-ray flux and the flux of the [O III] 5007 emission line. Compton thick sources have lower than usual X-ray fluxes compared to their [O III] 5007 flux (Bassani et al. 1999).

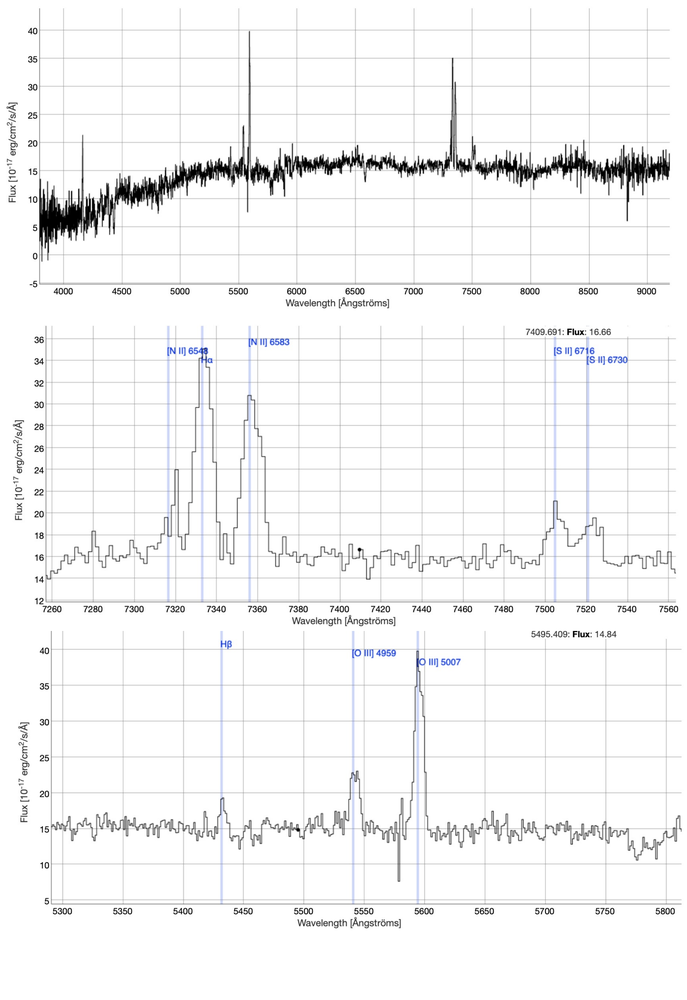
2CXO J135317.7+332927

- 2CXO J135317.7+332927 is an optical type 2 Seyfert AGN, with an X-ray spectrum which **indicates that it is unabsorbed.**
- However, a Fx/F[O III] ratio of **0.71 ± 0.059** indicates that it is **Compton thick.**
- In reality, the column density of this source is **greater than 10^{24} cm^{-2}.**

True Type Two Candidates

2CXO J152424.9+295931

- 2CXO J152424.9+295931 is an optical type 2 Seyfert AGN, with an X-ray spectrum which **indicates that it is unabsorbed.**
- Its Fx/F[O III] ratio of **25.8 ± 2.3** indicates that it is **not Compton thick.**



Full SDSS optical spectrum of 2CXO J152424.9+295931.

The Hα region of the SDSS spectrum of 2CXO J152424.9+295931 with emission lines labeled in blue. The permitted Hα line is no wider than the forbidden lines. This indicates this source is a **type 2 AGN.**

The Hβ region of the SDSS spectrum of 2CXO J152424.9+295931 with emission lines labeled in blue. The permitted Hβ line is no wider than the forbidden lines. This indicates this source is a **type 2 AGN.**

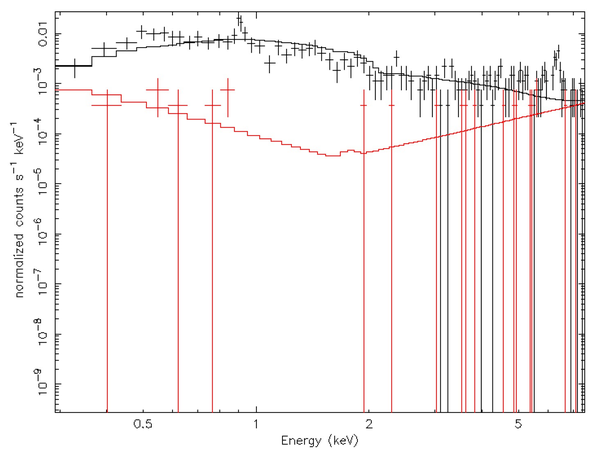
Data Reduction and Analysis

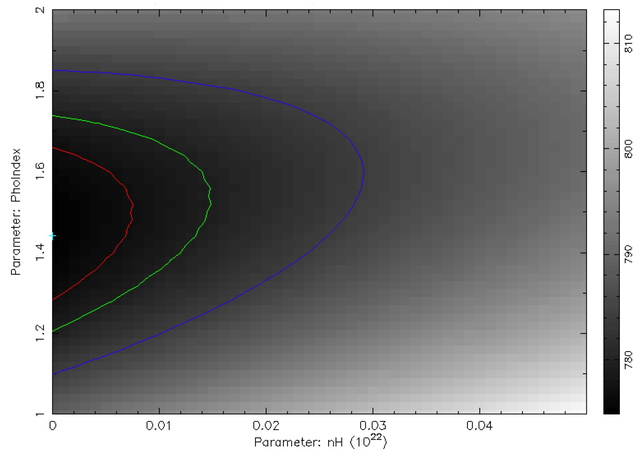
- The Ciao script `wavdetect` was run on identified archived *Chandra* observations to identify point sources and create elliptical source regions .
- Extracted spectra were processed using the Xspec command-line fitting package using a three-part spectral model (Arnaud 1996).
  1. `tbabs`: Absorption model accounting for the absorption of the intergalactic interstellar medium. The density of this model was fixed at a value determined by the nH Ftool (Blackburn 1995).
  2. `ztbabs`: Redshifted absorption model accounting for the local absorption of the AGN. This model is used to evaluate the column density of the AGN.
  3. `zpowerlaw`: Redshifted power law model accounting for the emission of the AGN.
- To account for the Poisson nature of low count sources, source fits were evaluated using the **Cash Statistic** (Cash 1979).
  - To preserve the Poisson distribution of counts, background spectra were **fit simultaneously** with broken power law models to simulate the noise in the ACIS detector.

Future Work

- The optical spectra of several sources require processing to **subtract host galaxy starlight emission** and **determine AGN type.**
- True type two Seyfert AGN candidates are ideal for **optical follow up** on larger telescopes in order to obtain higher quality spectra and rule out the presence of **hidden or weak broad line regions.**
- The Compton thick sources can be analyzed more in-depth including modeling the width of the Iron K α emission line to **confirm their Compton thick nature.**
- The size of the selected **sample can be increased** by including sources observed by *Chandra* too recently to be included in the source catalog.

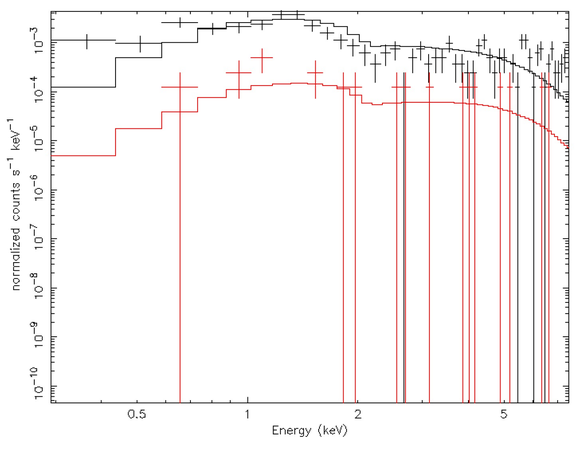
Right: One, two, and three sigma contours comparing the column density and power law slope of 2CXO J135317.7+332927. Due to the source's Compton thick nature, the shown model is **falsely unabsorbed.**

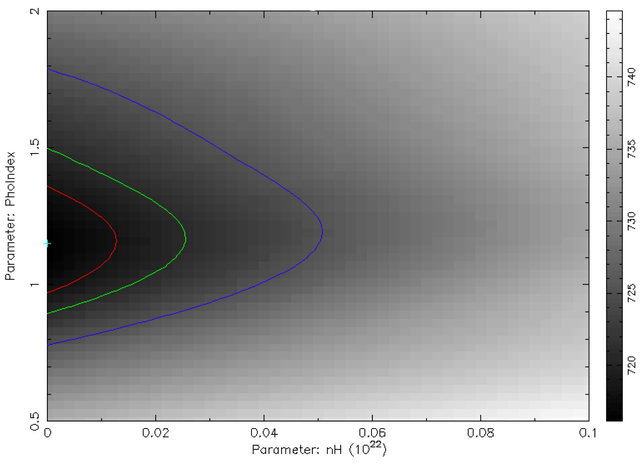




Left: Fit source (black) and background (red) X-ray spectra of 2CXO J135317.7+332927. Spectra are shown grouped every 10 counts for visual clarity.

Right: One, two, and three sigma contours comparing the column density and power law slope of 2CXO J152424.9+295931. The shown model is **confidently unabsorbed.**





Left: Fit source (black) and background (red) X-ray spectra of 2CXO J152424.9+295931. Spectra are shown grouped every 10 counts for visual clarity.

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