Honey! Where Is My Super… Massive Black Hole?

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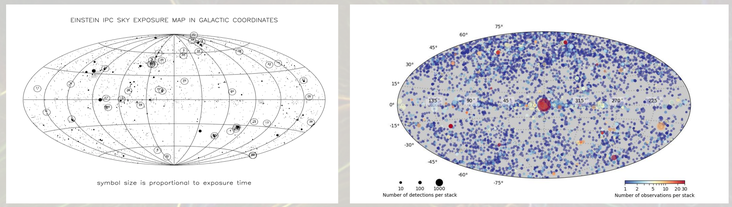
Introduction

- It is widely accepted that most (and perhaps all) galaxies host a supermassive black hole at their centers. Some of these black holes are actively accreting material, which increases their mass and produces radiation. Such objects are called active galactic nuclei (AGN). Currently, the accretion histories of massive black holes, and how they relate to the evolution of their host galaxies, are not well understood.
- X-ray emission is directly linked to black hole accretion; thus black hole accretion can be studied with orbiting X-ray telescopes such as the *Einstein Observatory* (launched 1978), *ROSAT Observatory* (launched 1990), and *Chandra X-Ray Observatory* (launched 1999).
- Dramatic, long-term changes in an AGN's X-ray luminosity could reflect a change in the way its black hole is being fueled.
- However, the durations of accretion episodes in AGNs are long compared to the history of X-ray astronomy, so dramatically variable AGN are rare.

Methods and Design



The sky coverage for the Einstein Observatory (left) and the Chandra X-ray observatory(right).

- We search the Chandra Source Catalog (CSC; Evans et al. 2010) for counterparts to sources from the Einstein 2 Sigma Catalog (Moran et al. 1996). This allows us to investigate AGN variability over a 20-40 year time baseline.
- We examine the sources' X-ray brightness over time and perform statistical tests for strong variability.
- We also search for sources detected by Einstein that were observed and but detected by Chandra.

Results

Chandra Non Detections:

(1) J081331.13+040949.4, flux ratio: 198.42

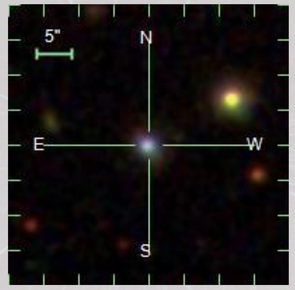


Figure 1: Optical image of the galaxy J0813+04094 from the Sloan Digital Sky Survey.

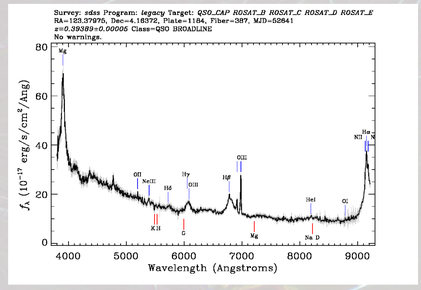


Figure 2: The spectrum of J0813+0409 shows broadened Balmer series lines, evidence of black hole activity in the galactic center.

(2) J140927.84+261818.7, flux ratio: 1184.5

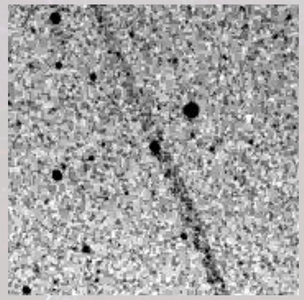


Figure 3: An optical field with J1409+2618 at the center. Image from NASA/IPEC Extragalactic Database.

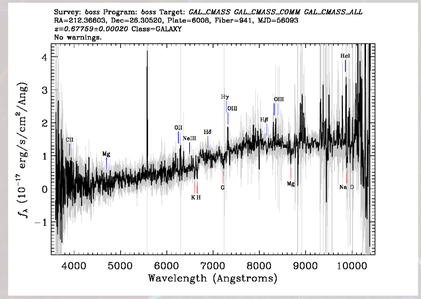


Figure 4: The spectrum of J1409+2618 demonstrates that the object is not active evidenced by the missing OIII line and missing broad line features.

Variable Chandra Detections:

(3) J180115.2+662401, flux ratio: 21.64

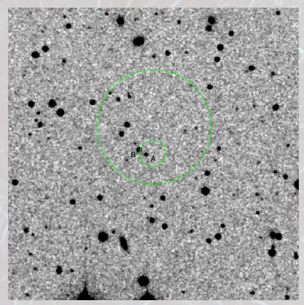


Figure 5: The optical field around J1801+6624 (object A) is shown with the *Einstein* (large) and *ROSAT* (small) position error circles.

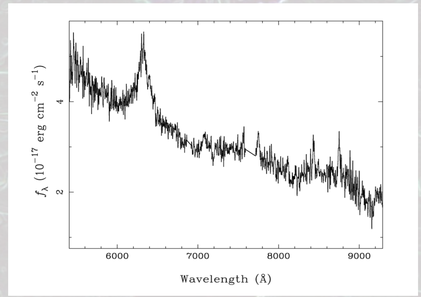
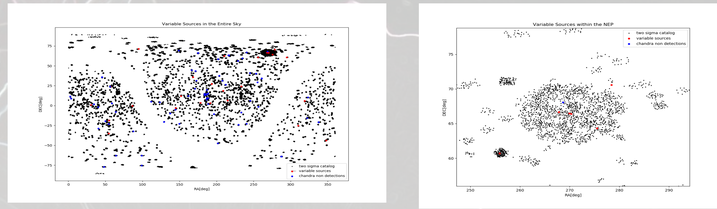


Figure 6: The broad Mg II line in J1801+6624's spectrum is evidence that the galaxy has an active nucleus.

Conclusions

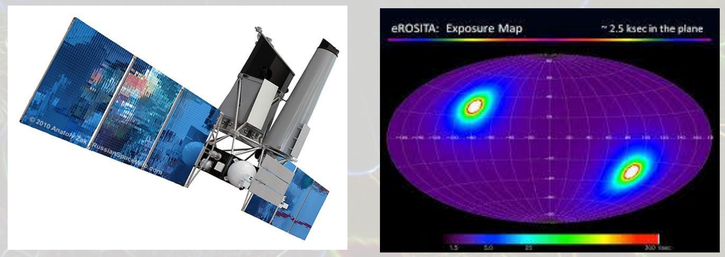
- Variability in AGN is rare, with only 24 of 46186 (0.052%) sources exhibiting variable x-ray flux . Additionally, only 80 of the 46186 (0.17%) were observed but not detected with the Chandra X-Ray telescope.
- While a source may go undetected, as demonstrated by J0813+0409, it does not indicate that the source has completely turned off and stopped accreting.



Variable sources found in the Einstein 2 Sigma Catalog for the full sky (left) and in the NEP region (right).

Future Work

- Find optical data for variable sources in catalogs such as the Sloan Digital Sky Survey.
- Conduct up-to-date optical and X-ray observations for the variable sources.
- Focus on the north ecliptic pole (NEP) region to prepare for eROSITA's X-ray mission.



The eROSITA Observatory (left) and its sky coverage (right).

References

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