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A *Chandra* search for hidden AGN in H II nuclei

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Abstract: We attempt to establish whether early-type spirals, which possess massive black holes, harbour X-ray sources, indicative of AGN activity. We identified 9, early-type spirals from the Palomar survey optical, spectroscopic sample of Ho, Fillipenko and Sargent (1997), classified as normal, H II nuclei, which fall within archived *Chandra* ACIS-S fields. We carried out a detailed search of the *Chandra* fields to identify possible X-ray counterparts, and obtained X-ray luminosity and hardness ratio of X-ray counterparts in order to search for hidden AGN. Our results suggest that three of the H II galaxies are candidates for harbouring a low luminosity AGN.

Traditionally, galaxies are classified in two main categories depending on whether or not they are hosting an active galactic nucleus (AGN). **AGN hosts** give off copious amounts of X-ray emission, reaching luminosities $L_X > 10^{42}$ erg s^{-1} and often show broad emission lines in their optical and UV spectra. **'Normal' galaxies** (NGs) are dominated by stellar processes and have lower L_X and no broad lines.

In practice, an NG classification may be the result of low AGN activity combined with observational limitations. Studies suggest that *all* galaxies with bulges may have central black holes with masses that scale with bulge mass as inferred from bulge luminosity or stellar velocity dispersion (Gebhardt et al 2000, Magorrian et al 1998). However, only a small fraction of bulge galaxies show evidence for AGN activity. **How can it be that in such gas-rich environments, there is no hint of AGN activity?** In this work we are looking for AGN hiding in galaxies classified as H II nuclei. Estimating the level of contamination of galaxy X-ray flux by a central AGN is vital for surveys which investigate galaxy luminosity function and evolution (Hornschemeier et al 2003, Norman et al 2004, Georgakakis et al 2004, Georgantopoulos et al 2005).

Source	Type	N_H (cgs)	Flux (cgs)	Distance/Mpc	log L_X		HR	±
0794-NGC891	SA(s)b?	7.64E+20	3.91E-014	9.6	38.63441	upper limit		
2149-NGC4303	SBc	1.67E+20	2.11E-013	15.2	39.76629		-0.88	0.03
2939-NGC3310	SBc	1.13E+20	2.64E-013	18.7	40.04287		-0.10	0.002
3006-NGC5905	SB(r)b	1.44E+20	3.35E-014	44.4	39.89772		-0.83	0.17
3014-NGC2782	SAB(rs)a pec	1.76E+20	4.36E-013	37.3	40.86082		-0.64	0.02
4014-NGC4102	SAB(s)b?	1.77E+20	5.55E-013	17.0	40.28287		-0.45	0.02
4738-NGC4217U	SAb	1.23E+20	2.31E-015	17.0	37.90242		0.30	0.08
4738-NGC4217D	SAb	1.23E+20	1.92E-015	17.0	37.82256	upper limit		
ALL-NGC2146	SB(s)ab pec	7.30E+20	5.47E-015	17.2	38.28704		0.79	0.11
ALL-NGC278U	SAB(rs)b	1.33E+21	9.09E-015	11.8	38.18024		-0.67	0.09
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U: upper source								
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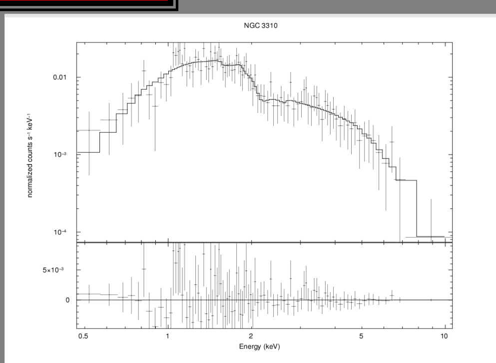
Sample used in this work. Details for 9 sources classified as H II nuclei in the optical sample of Ho et al (1997) are shown. Calculations assume power law spectra with Γ=1.8. Using the best optical counterpart position from Cotton et al (1999, cross in the X-ray images to the right) we isolated, where possible individual X-ray counterpart candidates.

Candidate hidden AGN:

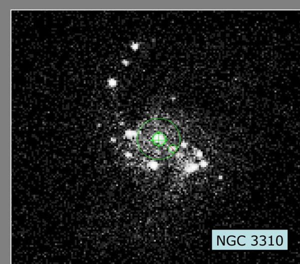


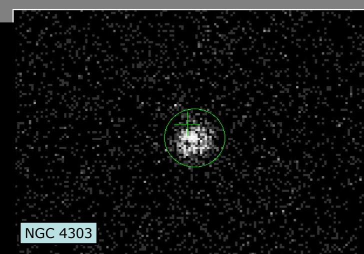
A central NGC 3310 source. The spectrum shown above was extracted for the central source shown encircled in the NGC 3310 (top, right). It is fitted well ($\chi^2/\nu \sim 1$) with a warm absorber power law model with Γ=1.4 ± 0.2 and a column density of (4.63±0.85) × 10^{21} . A similar result follows from the hardness ratio given in the table above.

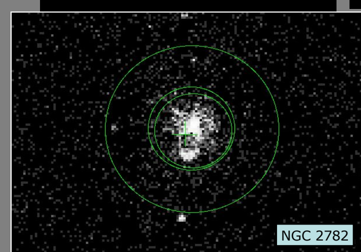
NGC 4217, top source. The upper source shown in the X-ray image of NGC 4217 is closest to the central optical position (cross). For a power law model Γ=1.8 the hardness ratio shown in the table above gives a logarithmic column density > 22.

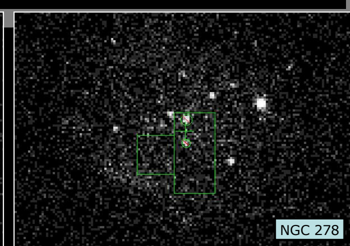
NGC 2146. The source shown encircled in the X-ray image of this galaxy shows excellent coincidence with the central optical counterpart (cross). For a power law model Γ=1.8 the high hardness ratio shown in the table above gives a logarithmic column density > 22.6 .

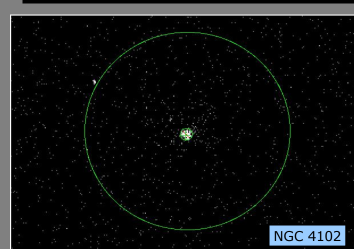
Chandra ACIS-S images of sources in this study. **Sources** are always shown as **circles**. **Background regions** are shown as **outer circles and boxes**. A cross indicates the best optical counterpart position estimated by Cotton et al (1999). Cross sizes are proportional to the error from Cotton et al.

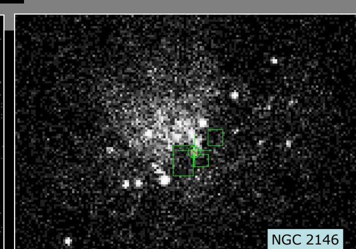


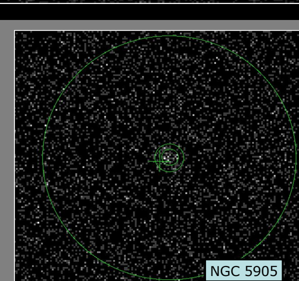


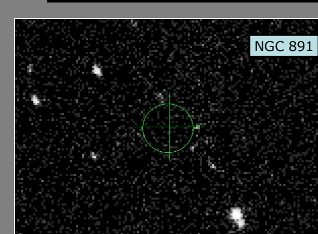












Conclusion
There are **3 candidates for AGN hiding in H II nuclei.** Further work is needed to estimate the level of such contamination in more galaxies previously considered as 'normal' (non-AGN dominated).

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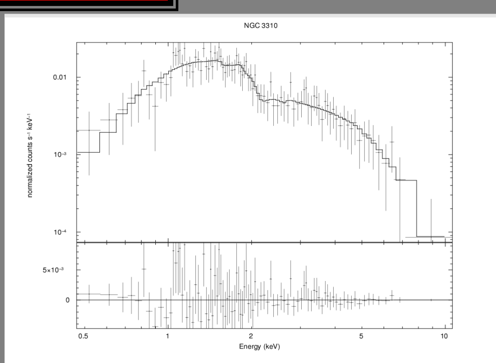

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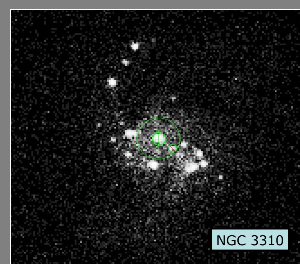

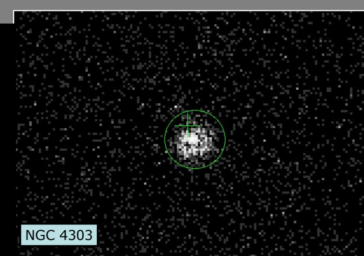

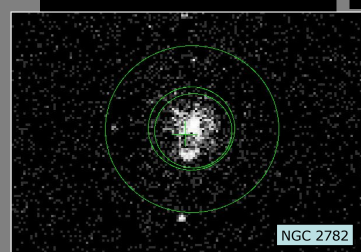

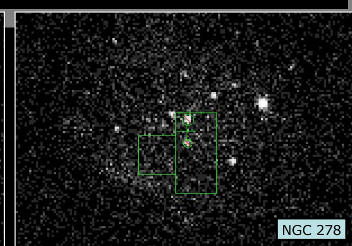

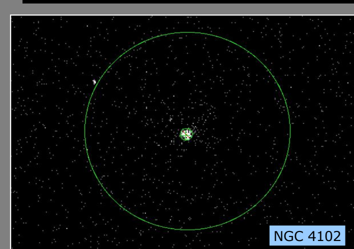

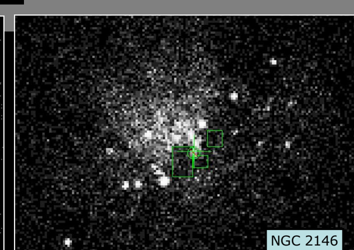

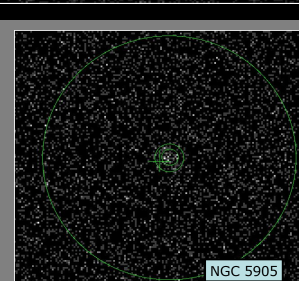

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