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THE AGN POPULATION IN THE AKARI NEP DEEP FIELD

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ABSTRACT

The AKARI North Ecliptic Pole Deep Field is a natural location to accomplish deep extragalactic surveys. It is supported by comprehensive ancillary data extending from radio to X-ray wavelengths, which have been used to classify radio sources as radio-loud and radio-quiet objects and to create a catalogue of Active Galactic Nuclei (AGN). This has been achieved by using a radio-optical classification and colour-colour diagrams rather than the more usual way based on spectroscopy. Furthermore, we explore whether this technique can be extended by using a far-Infrared (FIR) colour-colour diagram which has been used to identify 268 high redshift candidates.

Key words: NEP— multi-wavelength survey — galaxies — AGN — high redshift

1. NORTH ECLIPTIC POLE (NEP) DEEP FIELD

The NEP Deep Field is in a favourable location for space telescopes, it was observed by AKARI several times per day, allowing the study of very faint sources. It covers a 0.54 deg\textsuperscript{2} circular area centered at RA = 17h 55m 24s Dec = 66° 37′ 32″ (Matsuhara et al., 2006), and has been observed at many different wavelengths including far-infrared (FIR) (Pearson, et al., in prep); infrared (IR) and optical (Murata et al., 2013); and X-ray (Krumpe, et al., 2015) wavelengths. We have used these data to identify both Active Galactic Nuclei (AGNs) and high redshift candidates.

2. RADIO-OPTICAL SELECTION

The AKARI point source catalogue (Murata et al., 2013) has been cross-correlated with a GMRT 610 MHz radio catalogue (~2000 sources) (White, et al., in prep.), to search for positional matches, using a 4″ search radius. This provides a total of 399 reliable associations which are analyzed in this study.

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High radio/optical ratios can indicate radio-loud AGN candidates, whereas low radio/optical ratios may either be radio-quiet AGN, or star forming galaxies. This radio-optical selection technique has been used to classify the sample into radio-quiet (RQ) and radio-loud (RL) sources. Quantitatively, this classification can be made by using the radio-loudness parameter (Ivezic, et al., 2002) extrapolating the equation:

$$R_i = \log \left( \frac{0.779 \times \text{Flux (610 MHz)}}{\text{Flux (7840 Å)}} \right)$$  (1)

where $R_i > 2$ indicates RL, and $R_i < 1$ denotes RQ sources (see Figure 1).

We identify 32 RL and 65 RQ sources. This classification has been verified with IR colour-colour diagrams (see Figure 2).

3. AKARI COLOUR-COLOUR DIAGRAMS

In order to check the reliability of the radio-loudness classification given by Equation 1, the AKARI near and mid-infrared fluxes of the detected GMRT radio sources have been plotted in
4. AGN CLASSIFICATION

We have used the X-ray catalogue (Krumpe, et al., 2015) to confirm the AGN classification. This has been carried out by cross-correlating our sample of RQ and RL sources with the X-ray catalogue and plotting in the IR colour-colour diagram, as illustrated in Figure 3. There are 11 RQ and 10 RL sources with X-ray emission which are AGN candidates.

An AGN catalogue of the NEP Deep Field was then created. The objects included in the catalogue simultaneously satisfied the following criteria:

- Radio-optical selection based on radio-loud or radio-quiet sources (Figure 1).
- Suitable location in the infrared colour-colour diagram (Figure 2).
- Presence of X-ray emission (Figure 3).

Further studies will be made by spectral energy distribution (SED) fitting to confirm the classification.

5. FIR COLOUR-COLOUR DIAGRAM

We plot the sources additionally associated with Herschel sources on a far-infrared colour-colour plot in order to check if FIR colours can distinguish between RQ and RL sources.
and RL sources. Furthermore, high redshift candidates have been found following the properties of the FIR peak: $F_{500\mu m}/F_{250\mu m} > 0.75$ and $F_{350\mu m} > 35 mJy$ conditions (Amblart, et al., 2010).

Although the colour-colour diagram in Fig 4 does not allow a clear separation of the radio-loud and radio-quiet populations, it does allow us to select the general region occupied by possible high redshift sources. Further studies using SED fitting will be able to confirm the 268 high redshift candidates detected in Fig 4.

6. CONCLUSIONS

By using a radio-optical classification we have detected 65 radio-quiet sources and 32 radio-loud sources in the NEP deep field. Combining this criterion with infrared colour-colour diagrams and X-ray detection, we associate 11 RQ and 10 RL of these sources respectively with potential AGNs.

Although the radio source populations are not distinguishable in the far-IR (Herschel) colour-colour space, the additional constraints provided by these longer wavelength colours can be used as an indicator of high redshift sources, classifying 268 high redshift candidates.

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