Radio Observations of Dual Active Galactic Nuclei in Nearby Galaxies

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ABSTRACT

Active Galactic Nuclei (AGN) are galaxies with an actively accreting supermassive black hole at the center. Theory indicates that black holes can become active due to mergers with other galaxies. AGN emits both radio and X-rays but from different mechanisms. We studied candidate merging pairs of AGN and nearby galaxies to identify radio signatures of AGN activity, to compare to rates of binary AGN detected in X-rays. We search multiple radio databases to determine the detection fraction of AGN in galaxy pairs at various radio frequencies. We generate contour maps of radio emission at all frequencies and compare them to optical images from the Sloan Digital Sky Survey (SDSS).

In addition to simply determining whether the companion galaxy is detected in various frequencies, in the cases where the companion is detected in more than one survey, we construct a spectrum across the observed frequencies. The radio spectrum's slope can indicate the source's physical nature.

Data Collection

We are determining whether looking for dual AGN through radio wavelengths is better, on par, or worse than the X-ray or optical imaging as presenting KOSS 2012. First, we take contour maps of the JVLA radio emission and overlap those with the VLASS and SDSS optical images to locate the AGN in the primary host galaxy. Then we look for radio flux in the merger companion. In addition to our own 22 GHz survey with the JVLA, we use the VLASS and FIRST databases. In detections, we measure the radio flux to make a data set of companion fluxes at different frequencies. The JVLA would be set at 22GHz, VLASS is about 3 GHz and the FIRST data is 1.4 GHz

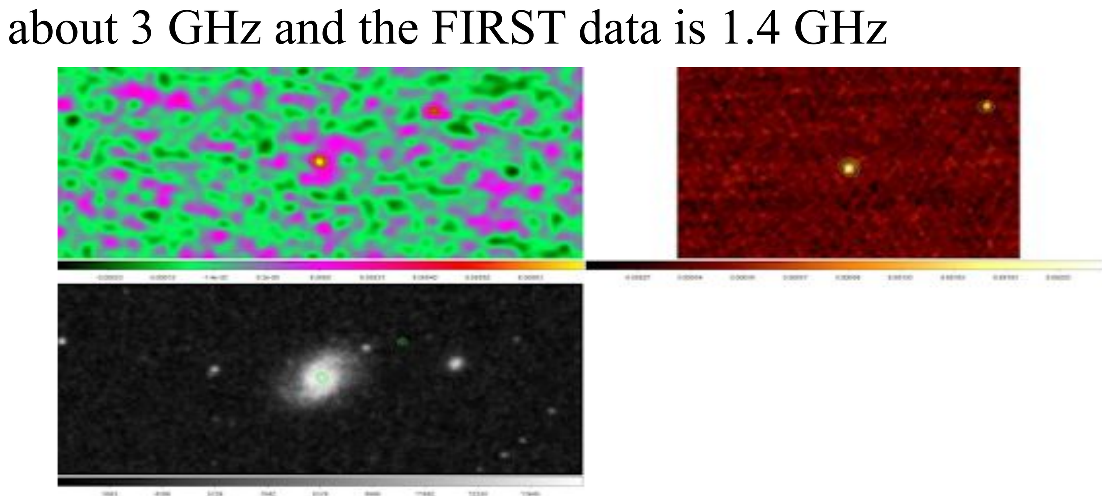
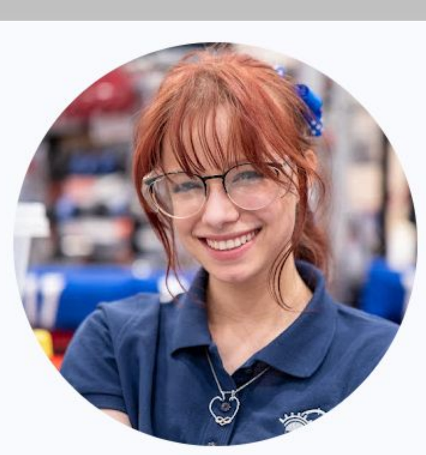


Figure 1. (NGC 5231) The 22 GHz image is very noisy but there are 2 high activities in that photo as well and the same hotspot shows in the VLASS image. Applying the contour lines on the optical image does not align with anything. The merger is not active or close to forming.



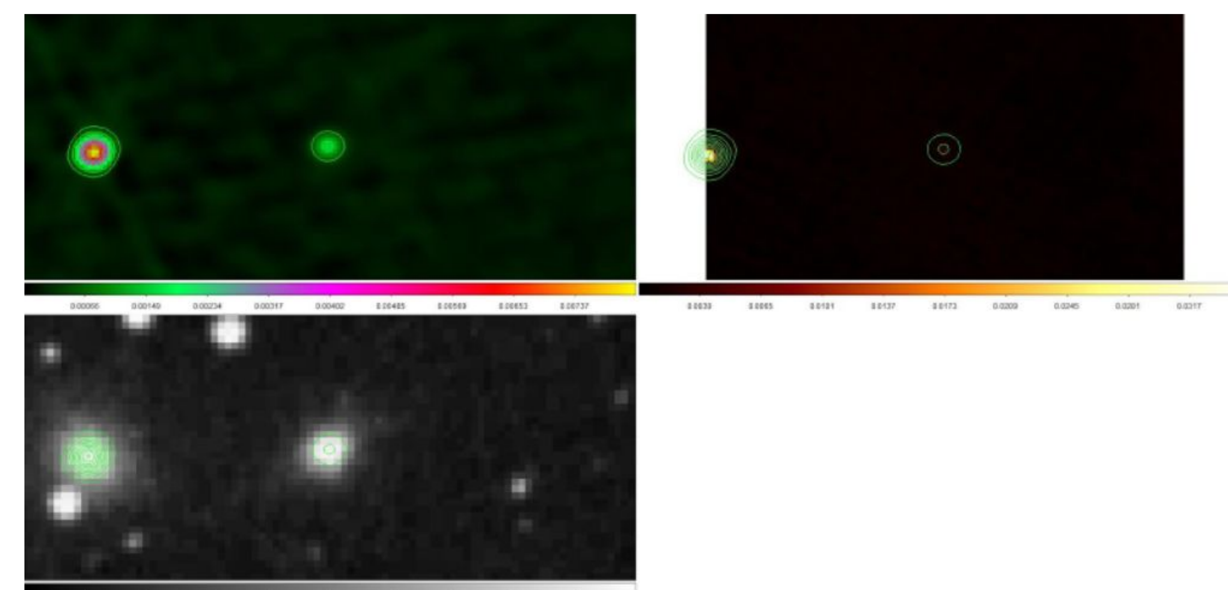


Figure 2. (LEDA 214543) The 22 GHz shows both the AGN and the companion activity. The VLASS image only shows the AGN off of the left side. and no activity in the competition. The optical perfectly lined up with the county line and shadowed the dust and gasses starting to mix

Spectrum Graphs

Then, we made a spectral energy distribution graph for each companion galaxy data. We did this by setting all the fluxes to Millijansky setting the frequency on the x-axis and flux on the y-axis. Lastly, the graph be set to a logarithmic scale to show a linear spectra line. If the slope is steeper, then it could be a sign of radio jets. The less steep slopes are unresolved natural occurrences.

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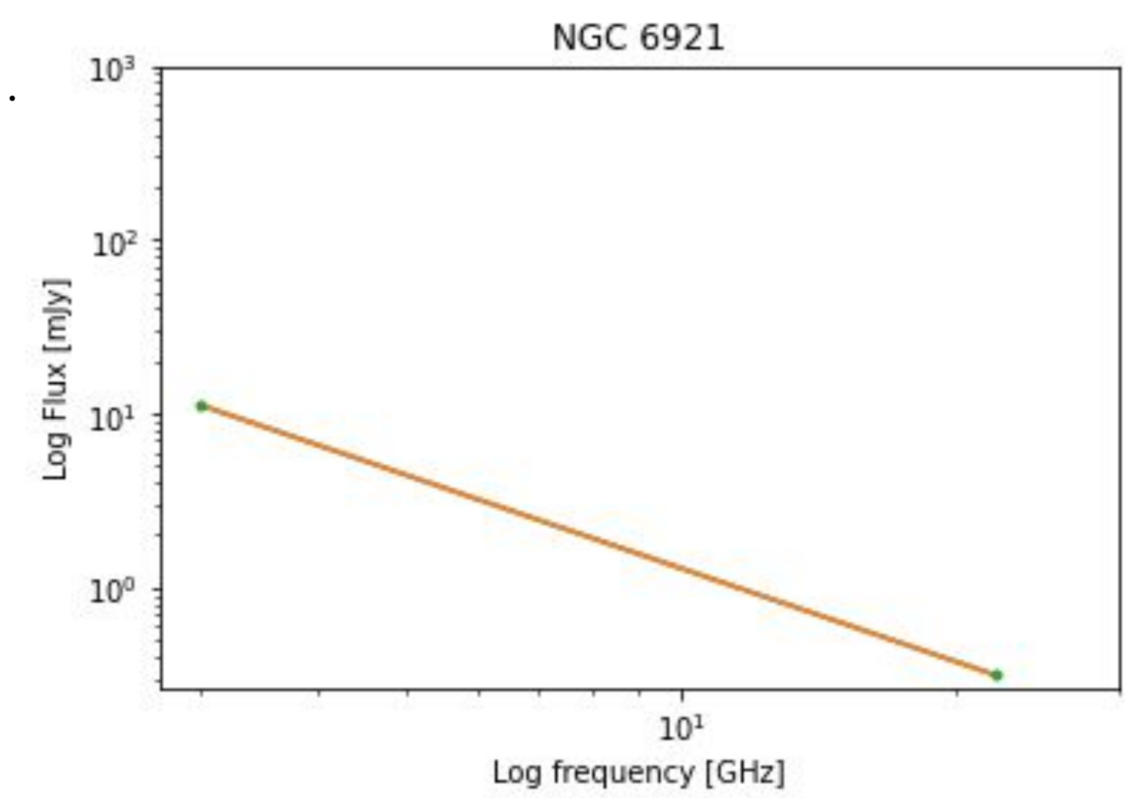

Figure 3. (NGC 6921) This image shows a negative linear spectral line on a logarithmic scale. NGC 6921 only had two points of the JLVA and VLASS flux that were present.

We used spectral indices to measure the radiation flux density in the host and companion galaxies. This helps find if the companion is radiating any radiative force that could be a sign of an AGN.

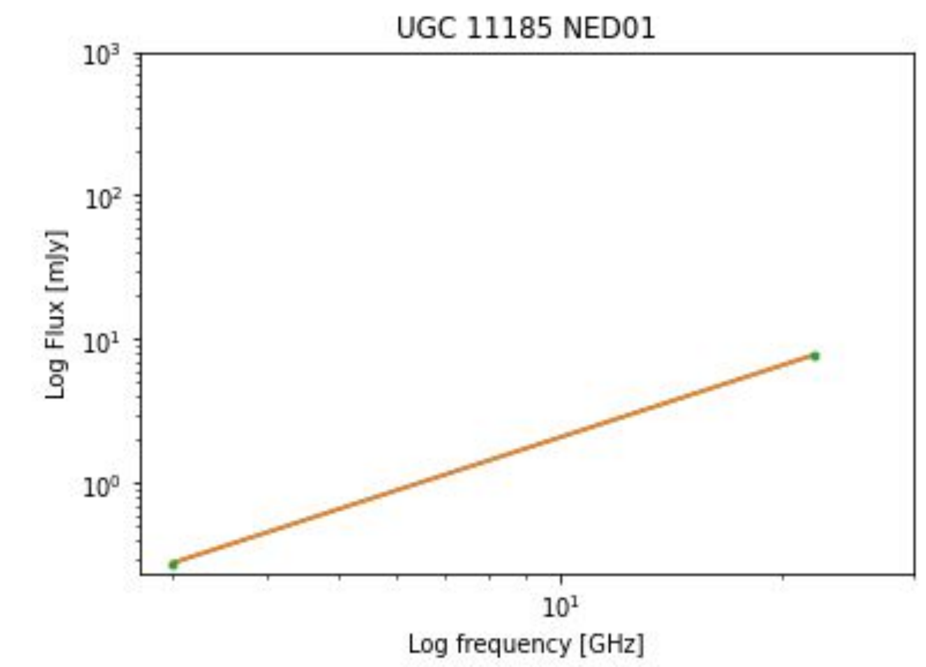

Figure 4. (UGC 11185 NED01) (Left) This image shows a linear line that is positive. This companion is the only one to have a positive slope.

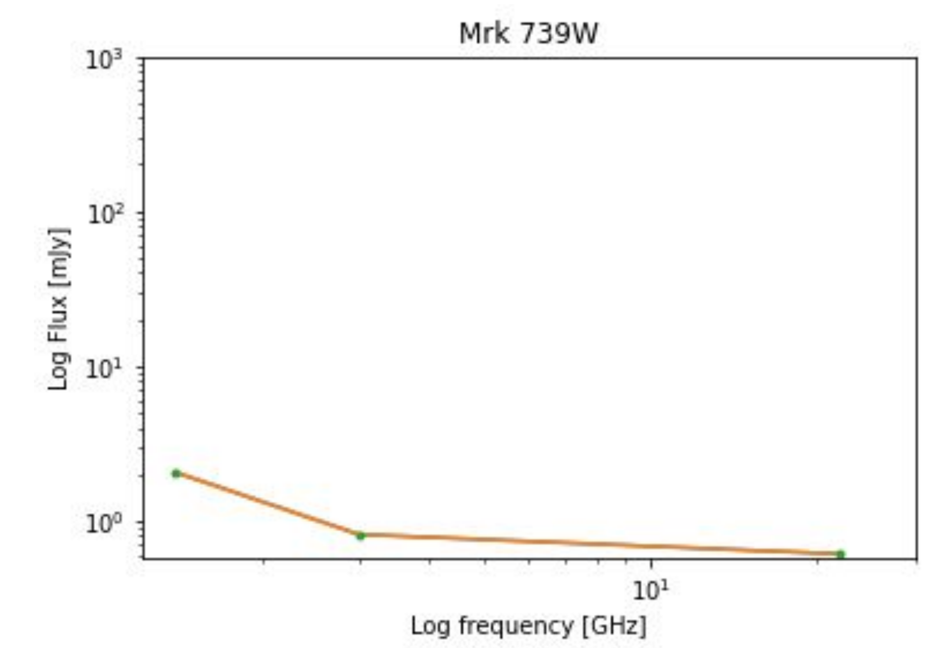

Figure 6. (Mrk 739W) (right) This image shows a linear line on a logarithmic scale. Mrk739W has all three points from FIRST, VLASS, and JVLA fluxes.

$$F \propto \gamma^{-\alpha}$$

Figure 7. Thei figure is the main equation that is used for the spectral index to measure the radiative flux density.

Lastly, make a histogram of all companion galaxy data with a range of frequencies from 1.4 to 22 GHz. The goal is to show that the frequency is approaching a flux to the power of - α. The goal is to have an alpha equal to 0.7.

RESULTS

In total, 104 starting galaxies were present within X-rays with set companions (KOSS, 2012), out of those there 73 (71%) were collected in our JVLA data with radio wavelengths. In the JVLA collection, only 12 (16%) had the companion visible. The VLASS Survey found 96 (92%) of both the AGN and the companion within its database. The FIRST database collected 22 (21%) companions from the sample. As a result, 71% of companions were detected at 22 GHz, out of that set there is 96% in VLASS and 16% in FIRST.

Follow our progress:
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Acknowledgments

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