HET615 Project Poster by Ricky Leon Murphy

"Optically Identifying 20cm Radio Sources"

Background Image: Cygnus A by Ricky Leon Murphy

Abstract

Radio astronomy gives us a unique view of the Universe. Many of the emission processes powering phenomenon like quasars, radio galaxies, Seyfert galaxies and other active galactic nuclei as well as supernova remnants are invisible using standard optical imaging; however, the object of emission is visible on film (or CCD). For this project, I have a list of eight radio objects that I will identify optically. Using coordinates provided by NED (NASA/IPAC Extragalactic Database), I will train a remotely controlled, 0.5 meter telescope to each object and capture on CCD the optical counterpart. The goal is to match the CCD image to radio images from the NVSS (NRAO VLA Sky Survey) and FIRST (Faint Images of the Radio Sky at Twenty-Centimeters) and identify the optical counterpart to the radio emission. The purpose of the project will be to demonstrate my effectiveness in identifying the optical counterpart of the radio source, determine the source of emission, and justify the need to capture these types of objects in both the optical and radio wavelengths.

Discussion

This project included eight radio targets – seven of them from galaxies and one from a supernova remnant. The radio emission from the galaxies has one thing in common, the central engine providing the source of the emission. The radio images that were acquired were from the 3C and 3CR (Third Cambridge Revised catalog) surveys, a radio survey that detected 320 extragalactic radio sources (Burke and Graham-Smith, 2002).

At first, it was thought there were several varieties of active galaxies: Quasars, BL Lac Objects, Seyfert galaxies and radio galaxies. It is now widely accepted that all of these types of galaxies are really powered by the same engine – a supermassive black hole. The single group that covers all radio galaxies is Active Galactic Nuclei, or AGN (Sparke and Gallagher, 2000). The AGN model states that depending on the orientation of the galaxy core, the object will emit a different type of radiation (toward the observer) and therefore will appear to be a different object.

At the heart of an AGN is a supermassive black hole. As material accretes around the black hole, the debris is caught in the black hole's intense magnetic field. The magnetic field lines are perpendicular to the accretion disk and energetic particles are funneled through the magnetic field; the result are jets emanating from the core. This non-thermal radio emission is from these energetic particles moving through the magnetic field (Sparke and Gallagher, 2000), or synchrotron radiation. Sometimes there are two sources of emission: the particles themselves emit synchrotron radiation, but supersonic particles can impact the interstellar medium (ISM) and create a "hot-spot" that also emit synchrotron radiation.

The only non-galaxy object is Cassiopeia A, a supernova remnant. This formerly hot and bright star ended its life in a supernova about 300 years ago. All but the core of the star is blasted out at about 6,000 - 10,000 km/s in an expanding shell. It is this material that is emanating synchrotron radiation as the particles in this debris are charged and still within the strong magnetic field of the stellar remnant core - a neutron star - as well as with supersonic impacts with the interstellar medium (Chandra).

Summary

This project demonstrates that the radio emission differs greatly from the optical counterpart. Many of these eight objects look just like stars, but the radio emission reveals they are really active galaxies. Using CCD imaging software (Mira Pro) and data from TheSky's (planetarium software) GSC and USNO B stellar database, I was able to astrometrically calibrate the CCD images I captured in order to determine the exact position of the radio source. The results are the images in this poster with the optical and radio sources identified with an arrow. Additional arrows in the radio image mark additional radio emission. Surveys like the 3C and 3CR have provided valuable data on quasar and AGN research and even discovered a supernova remnant. By examining these images, the value of radio surveys is clear.

References

Burke, Bernard F. and Francis Graham-Smith. An Introduction to Radio Astronomy. Second Edition. Cambridge University Press, 2002.

Chandra Website: http://chandra.harvard.edu/photo/2000/cas_a062700/

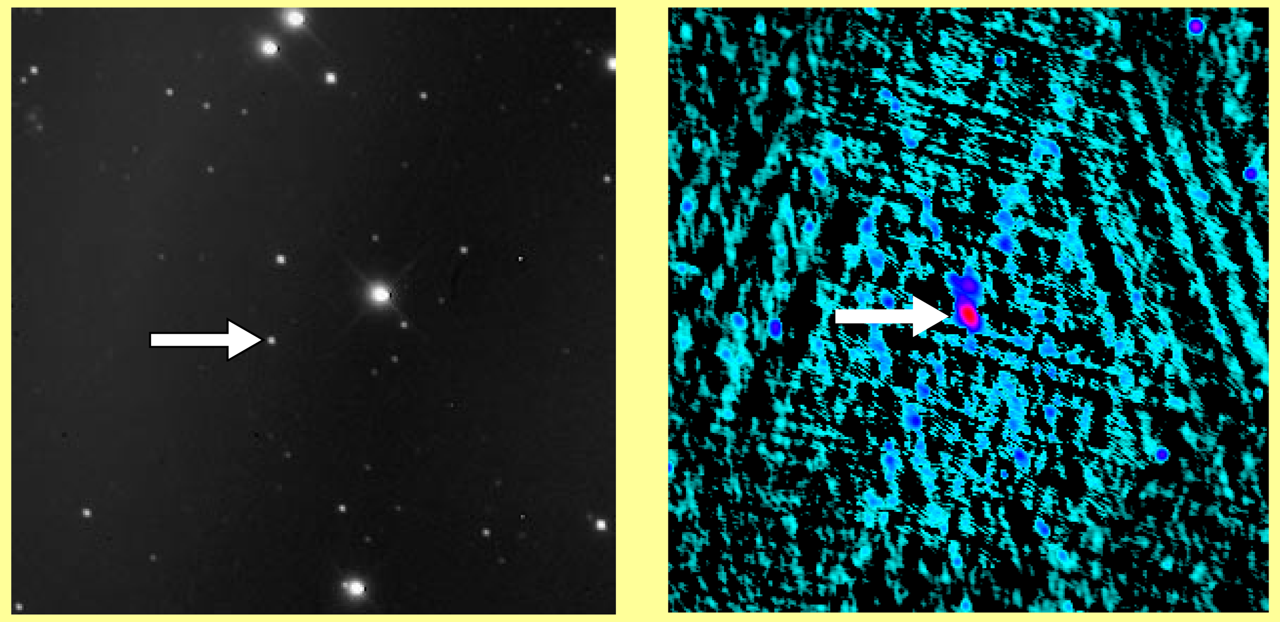
Sparke, Linda S. and John S. Gallagher. Galaxies in the Universe. An Introduction. Cambridge University Press, 2000.

VLA NVSS Survey: http://www.cv.nrao.edu/nvss/

VLA FIRST Survey: http://sundog.stsci.edu/

3C218 - Hydra A

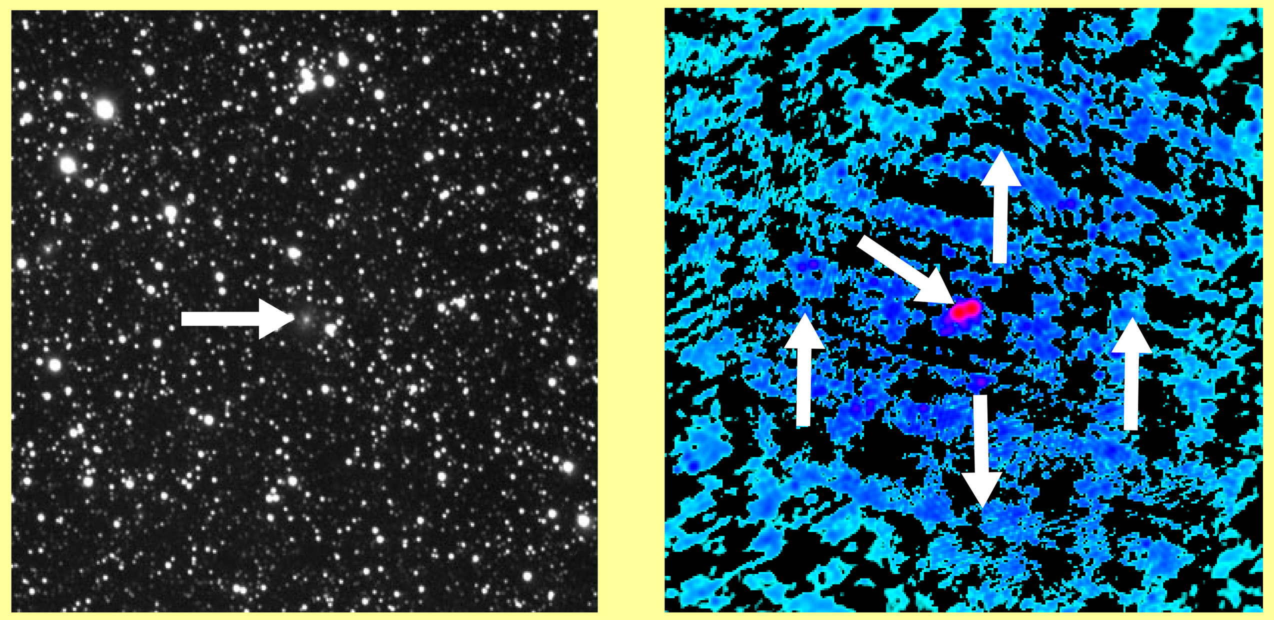
Radio Galaxy



CCD Image | NVSS Image

3C405 - Cygnus A

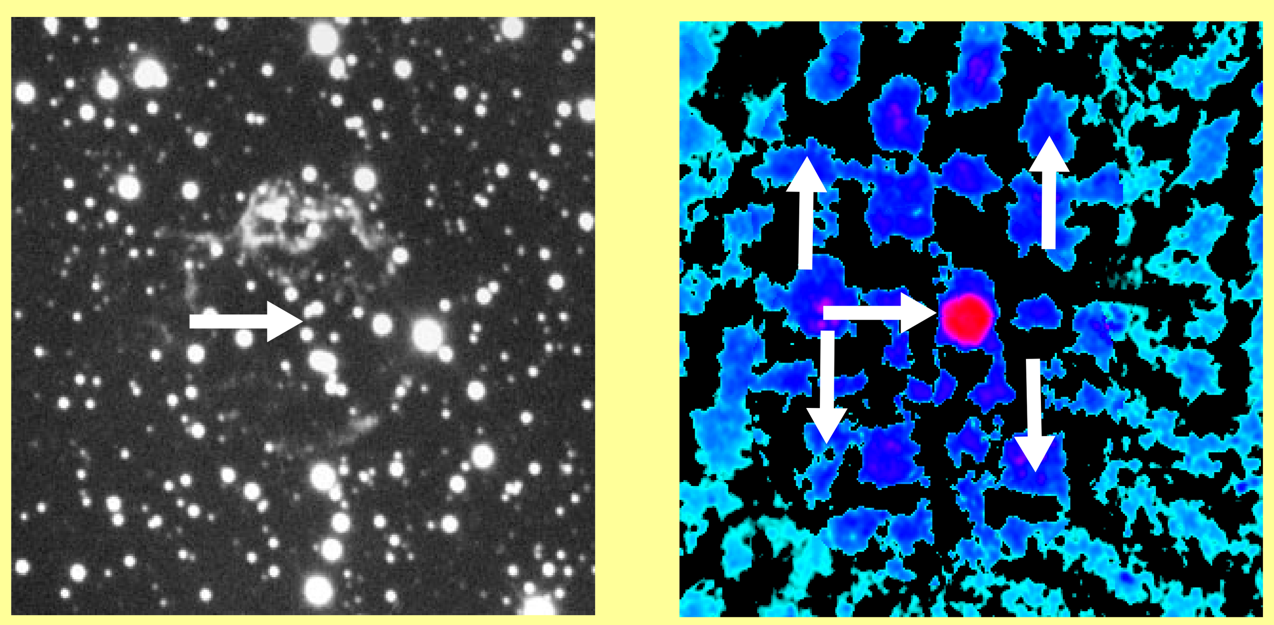
Bright Radio Galaxy



CCD Image | NVSS Image

3C461 - Cassiopeia A

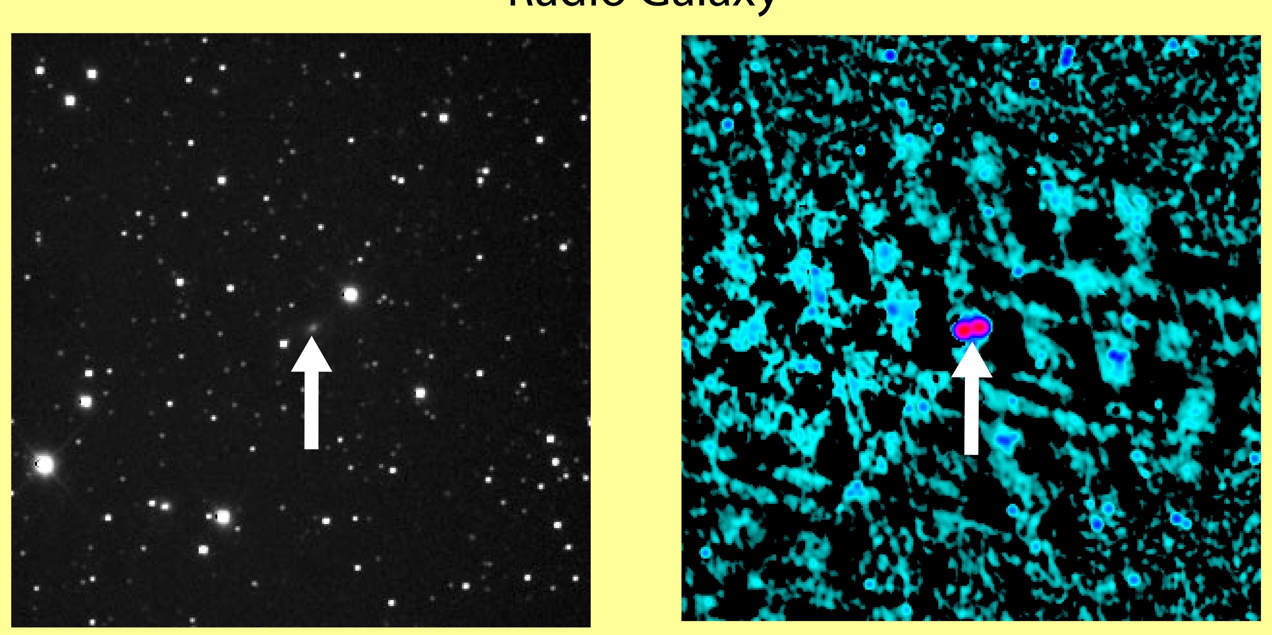
Supernova Remnant



CCD Image | NVSS Image

3C348 - Hercules A

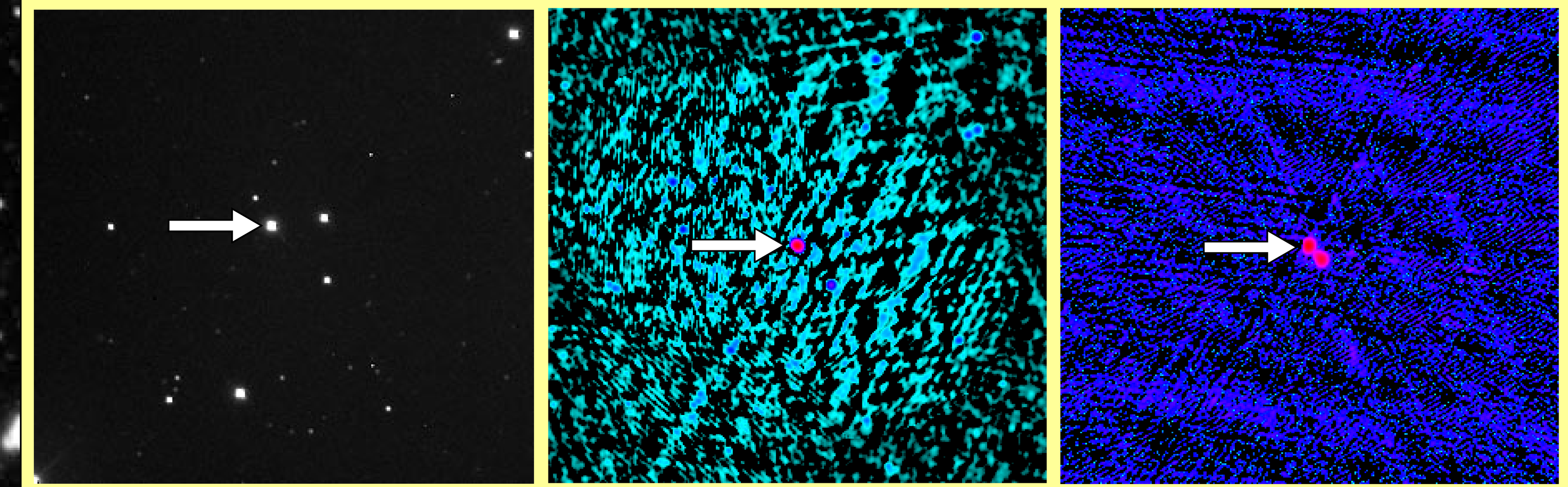
Radio Galaxy



CCD Image | NVSS Image

3C273

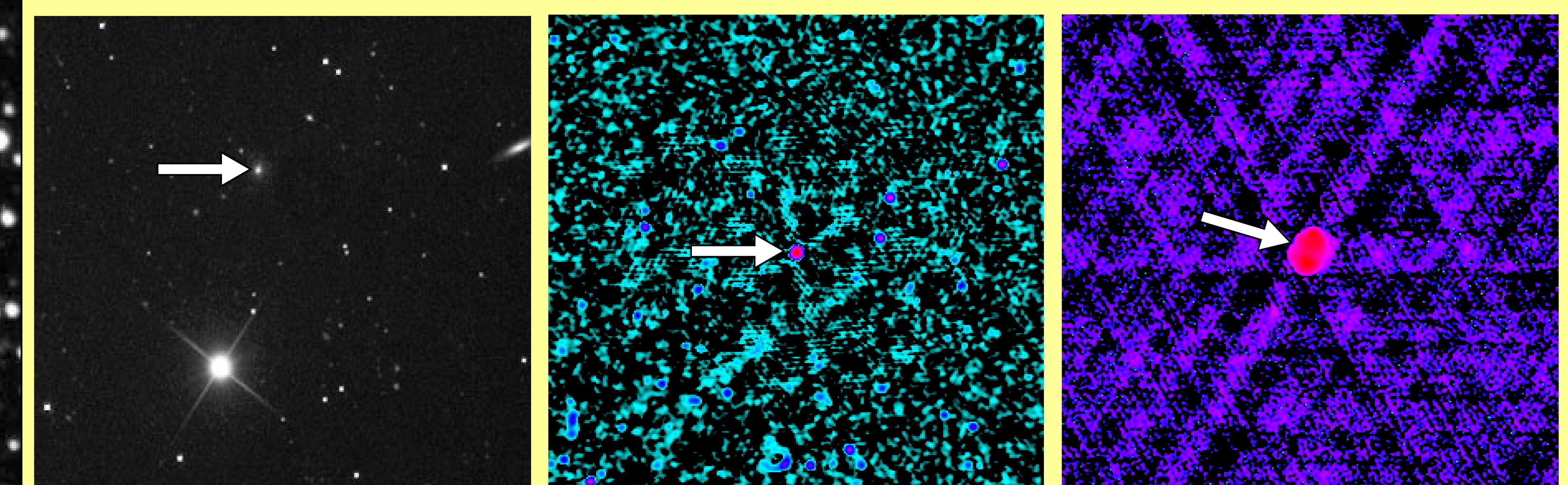
Quasar



CCD Image | NVSS Image | FIRST Image

3C277.3 - Coma A

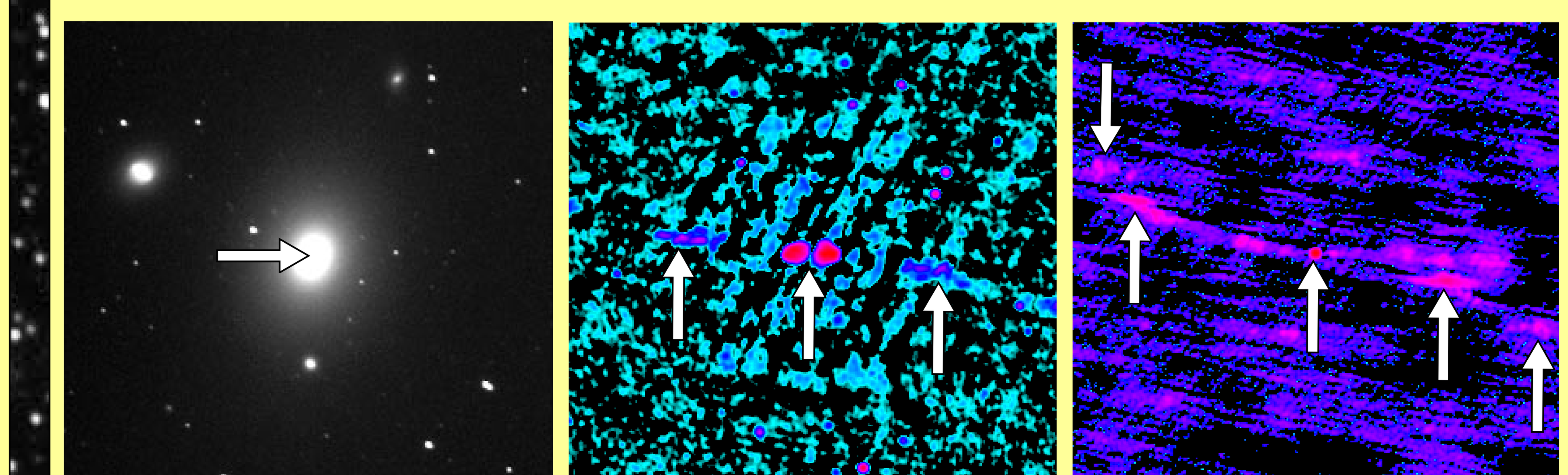
Radio Galaxy



CCD Image | NVSS Image | FIRST Image

3CR270.0 - NGC 4261

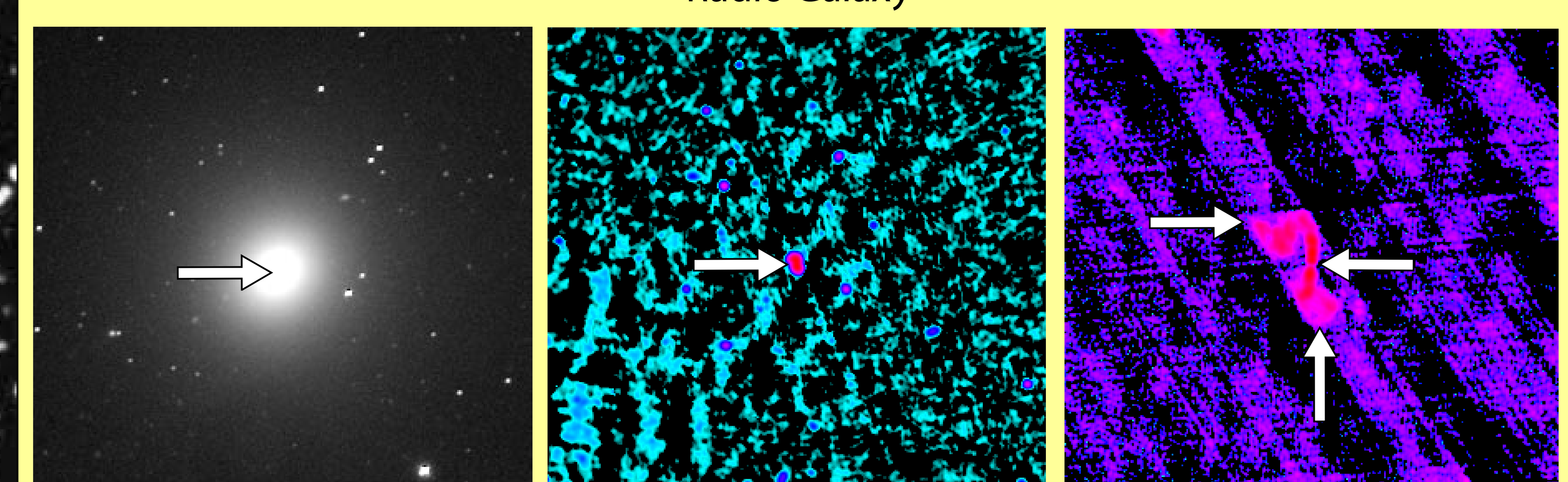
Radio Galaxy



CCD Image | NVSS Image | FIRST Image

3CR272.1 - M84

Radio Galaxy



CCD Image | NVSS Image | FIRST Image