



Jet-Induced Star Formation in Seyfert Galaxies Unveiled Through Radio-UV Correlations



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Introduction

Alignment of the rest-frame UV continuum emission from the parent galaxies with the nonthermal radio emission has been discovered in high-redshift radio galaxies. The nature of this continuum and "alignment effect" has remained however unclear. It appears that interactions between the radio plasma and the ambient gas determine the morphology of the UV with the radio ejecta sweeping up and compressing the interstellar medium. In nearby radio galaxies, evidence has been found for jet-induced star formation, scattered light from hidden quasar-like AGN and nebular recombination continuum. Little to none is known however about the UV and radio correspondence in Seyfert galaxies.

NGC 7319 - The first case

During the course of MERLIN L-band observations of the compact galaxy group, Stephan's Quintet, we found that the Seyfert 2 galaxy, NGC 7319, the brightest member of the compact group, has a triple radio structure

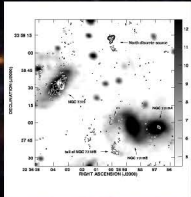


Figure 1. 20 cm naturally weighted VLA archive data image of Stephan's Quintet at a resolution of 4.3'' overlaid on a Digital Sky Survey image. The peak flux is 10.3 mJy/beam and the rms noise level is 27 microJy/beam.

typical of many extra-galactic radio sources which have a flat spectrum core and two steep spectrum lobes with hot spots. The two lobes are asymmetrically distributed on opposite sides of the core along the minor axis of the galaxy. Ultraviolet emission revealed in a high resolution HRC/ACS HST (F330W filter) image is strongly aligned with the radio plasma and we interpret the intense star formation in the core and north lobe as an event induced by the collision of the north radio jet with over-dense ambient material.

Discussion

The findings from the present work are:

- a) In an evolutionary scenario from spiral dominated group of galaxies to elliptical dominated groups, Stephan's Quintet is probably in an intermediate transition. Its most dominant member, NGC 7319, is most possibly an example of a spiral in which jets are present but smothered by dense interstellar clouds and a galaxy that may eventually evolve into a classical double-lobed radio galaxy.
- b) A bright UV core is seen for the first time in NGC 7319 and is in agreement with blue emission.
- c) The data show that there is substantial turbulence produced by a jet-cloud interaction in the vicinity of the radio components B and A and that the emission lines from the galaxy are probably related either to the star-forming region or to emission from radiative cloud shocks rather than excitation by UV-X-ray emission from the active nucleus.

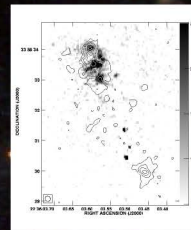


Figure 3. The 20 cm naturally weighted MERLIN image of NGC 7319 (resolution 0.15'') overlaid on the ACS/HRC UV image. North is up and East to the left. The sidebar shows the relative intensity of the grayscale image. (Right) Enlarged image of the Figure to the Left isolating the bright core and north lobe.

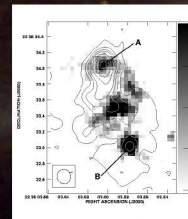


Figure 4. HST ACS/HRC UV image smoothed to 0.13'' resolution. This enhances and reveals star formation to the West of NGC 7319.

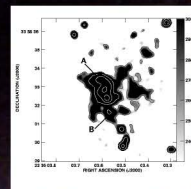


Figure 2. HST ACS/HRC UV (F330W) image of NGC 7319 (resolution 0.027''). Components A, B and C are indicated in the image. North is up and East to the left. The sidebar shows the relative intensity of the grayscale image. Contour levels are overlaid to accentuate features.

IC5063, other candidates & future plans

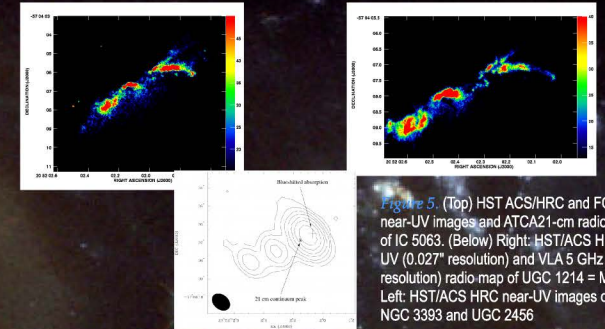
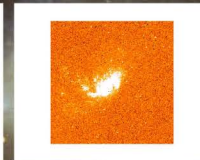
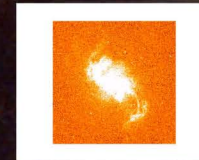
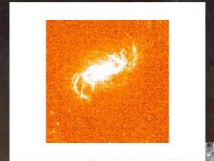


Figure 5. (Top) HST ACS/HRC and FOC near-UV images and ATCA21-cm radio map of IC 5063. (Below) Right: HST/ACS HRC near-UV (0.027'' resolution) and VLA 5 GHz (0.4'' resolution) radio map of UGC 1214 = Mrk 573. Left: HST/ACS HRC near-UV images of NGC 3393 and UGC 2456

Table: Promising new candidates

1. (From FIR-Radio plot selection)
Mrk 231 NGC 3031 NGC 4258 NGC 5194
2. (NGC 7319-like)
NGC 1144 NGC 3393 UGC 1214 UGC 2456



Using high-resolution HST/ACS/HRC (F330W) and archival images of a large sample of Seyfert galaxies, as well as published radio maps and their FIR properties we identified new promising jet-induced star formation candidates using two methods: (1) Seyferts that in the FIR (60 micron) vs Radio (1.4 GHz) plot fall in the > 40 Jy FIR and > 100 mJy Radio area (2) Objects that show the same UV and Radio characteristics/signs as NGC 7319.

Future plans: (a) We intend to follow NGC 7319 with a detail analysis (star formation rates and kinematical data) for its UV components, as well as a proposed model/simulation for the jet-cloud interaction (b) We plan to apply for MERLIN high resolution L-band radio observations of all the promising candidates in order to align with the HST near-UV images.