Constraining the Outburst Properties of the SMBH in Fornax A through X-ray, Infrared, and Radio Observations

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Abstract

Combined Chandra, Spitzer, XMM-Newton, and VLA observations of the nearby (D_0 = 22.7 Mpc (Tonry et al. 2001)) giant radio galaxy NGC 1316 (Fornax A) show features indicative of an AGN outburst most likely triggered at least 0.4 Gyr ago by a merger with a galaxy with a stellar mass of 0.9-7.8x10^9 M_☉. X-ray cavities in the Chandra and XMM-Newton images likely result from the radio jet and the expansion of the radio lobes. The dust emission seen at 5.8, 8.0, and 24 microns is strongest in the regions with little or no radio emission, suggesting that the expanding radio plasma removes or destroys the dust as well as the gas. These results constrain properties of the outburst and the merger galaxy. The size of the X-ray cavities implies a minimum outburst energy of 1.2x10^55 ergs. The present size of the radio lobes, spanning 33' (215 kpc) (Ekers et al. 1983) implies that the outburst was at least 0.4 Gyr old.

Infrared Morphology

NGC 1316 was observed as part of the Spitzer SINGS Legacy program (Kennicutt et al. 2003). At 3.6 μm and 4.5 μm, its emission is dominated by stellar light. We fit all the images using GALFIT (Peng et al. 2002) with a Sérsic profile and a central point source, using the 3.6 μm image to fit the shape of the Sérsic profile used to model the stellar emission. Input and residual images are shown in Figure 1. The remaining structure is primarily due to dust emission. Aside from emission in the nuclear region, the dust appears to be concentrated in two irregular regions, one 23.8'' (3.1 kpc in the plane of the sky) southeast of the nucleus and the other extending 43.9'' (4.8 kpc) to the northwest and forming a clumpy arc.

X-ray and Radio Morphology

The XMM soft (0.5-2.0 keV) exposure-corrected image shows cavities in the X-ray emission to the west and southeast (yellow arrows). Their existence is confirmed by the azimuthal profile (Fig. 3) which shows the lowest emission at 0° and 210°. The western cavity is more clearly delineated by the bright rims circled in blue. The green contours show radio lobe emission at 20 cm (Fomalont et al. 1989).

Referenes

Bettoni, D. et al. 2003, AA, 409, 5
Horellou, C. et al. 2001, AA, 376, 837
Patil, M. et al. 2007, AA, 461, 103