# 1 J2310–4347

J2310−4347 has a high X-ray luminosity, which is dominated by thermal emission from an extended atmosphere and power-law emission from an unresolved core (Worrall et al. 1999). A recent *Chandra* observation of the source also found evidence for an X-ray jet which is associated with the bright southern jet found in our ATCA mapping (Bliss et al. 2007; Fig. 1). While the existence of the X-ray jet is unusual in an FR I radio galaxy object of this redshift ($z = 0.0886$; Tucker et al. 1995), the real puzzle of J2310−4347 is that its host galaxy is entirely unremarkable and that there is no detectable optically active nucleus.

The ordinariness of the galaxy J2310−4347 makes it an extraordinary object. Despite careful optical spectroscopy, no optical emission lines have been detected from the core of the galaxy (Worrall et al. 1999), but the spectrum does not show the characteristics of a BL Lac object, in that there is no evidence for significant blue or UV emission from the core. Detailed imaging with excellent seeing from the NTT has also failed to find any blue core (Bliss et al. 2007), and near-IR imaging with the same telescope also finds no evidence for central dust that might obscure the core. The galaxy has an unremarkable profile and the integrated colour and colour gradients typical of large elliptical galaxies.

So what is J2310−4347? The absence of optical emission lines strongly suggests that it is an extreme type of BL Lac object, and the moderate radio polarization of the core is consistent with this, but the lack of any detectable optical or UV light from the core would then make J2310−4347 one of the most extreme BL Lacs known in terms of its position in the radio/optical vs optical/X-ray colour plane. Furthermore, unlike most BL Lac objects, J2310−437 shows little or no evidence of radio or X-ray variability.

An alternative to the BL Lac interpretation might be that J2310−4347 is a wide angle tail radio source (as is suggested by its large-scale radio morphology; Fig. 2), but that the nuclear optical emission has dropped to a low level without a corresponding decrease in the radio and X-ray output.

In either case, the bright radio and X-ray emission suggests that the core X-ray emission is dominated by synchrotron self-Compton emission from a small angular scale (few milli-arcsec), while the core radio emission arises principally from the base of a jet. The X-ray emission seen from the jet on arcsec scales is likely to be X-ray synchrotron emission from extremely energetic electrons re-excited by some acceleration process a few kpc from the core, in the same way that synchrotron X-rays are seen from other FR I radio jets (Worrall et al. 2001).

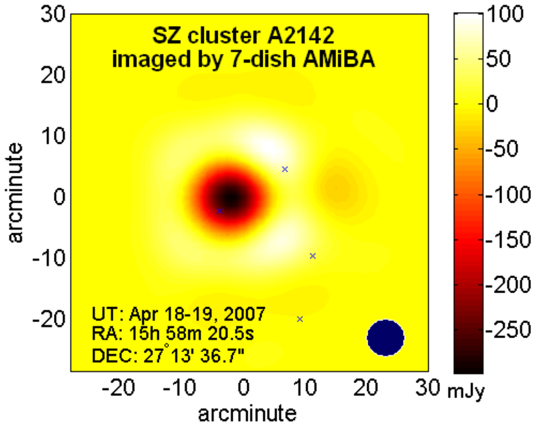


Figure 1: A C-band map of J2310−4347 made with the ATCA in the 6.0A array. The compact core is clearly seen, and significant polarization at the core is characteristic of a BL Lac object, as is the one-sided radio jet.

An alternative is that we are dealing with a low-redshift version of a quasar jet such as that in PKS 0637−752 (Schwartz et al. 2000), where relativistic motion in the jet persists to scales of hundreds of kpc, and the X-rays arise from inverse-Compton emission where the seed photons are relativistically boosted microwave background photons.

We want to know which of these emission mechanisms is in play, and to find out if the core is still active, or whether we are dealing with the slow decay of an old energetic jet emission. To do this, we wish to make a high resolution image of the inner regions of the source using the LBA — to attempt to trace the jet into the inner regions of the source, and check that the X-ray emission is consistent with the synchrotron self-Compton process. If we do detect one or more small non-nuclear components, then a second LBA proposal in a few years might lead to the detection of relativistic motion which could alter our concept of the physics of the large-scale X-ray jet.

# 2 Technical feasibility

The core of J2310−437 has a flat spectrum from L to X bands, suggesting that on milliarcsec scales it contains one or more compact (milliarcsec) components. At C band the core had a flux density of $20.6 \pm 0.5$ mJy in 1997, and no strong change in the brightness of the core was evident in our later imaging in 2000 (Worrall et al. 1999; Bliss et al. 2007). In order to investigate the structure of the core, and to investigate whether the arcsec-scale radio jet (Fig. 1) extends into the core, we wish to use the LBA with baselines that extend the angular resolution by a factor $\sim 50$. This can be accomplished with the antennas at Parkes, ATCA, Mopra, Ho-

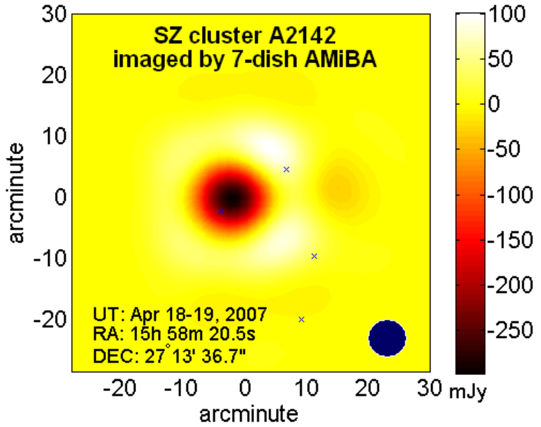


Figure 2: The large-scale radio structure of J2310−4347 at L band, showing the source's overall resemblance to a classical wide-angle tail radio galaxy. However, unlike such objects, there is no indication of emission lines even in a deep spectrum, and no optical obscuration that might conceal the emission lines is seen in the core of the galaxy (Worrall et al. 1999).

bart, and Ceduna. The core is sufficiently bright at C band that we do not need more than one ATCA antenna. With this choice of antennas, and 512 MHz bandwidth with dual polarization, the signal/noise for the core if unresolved will be $\gtrsim 10$ on all baselines in 60 sec, and in a 12 hour track an image with a noise of $\sim 30\ \mu$Jy should be achieved with a synthesised beam of order 10 milliarcsec.

We observe with dual polarization, since at this signal/noise we should be able to detect $10\%$ polarization in an inner jet containing only 10% of the total core flux density — such levels of emission and polarization are seen in the bright knots in milliarcsec-scale BL Lac jets (Gabuzda et al. 2000).

(Jim any more technical material here?)

## 3 References

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