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Millimetre Continuum Observations of AGNs and IRAS Galaxies

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The 3 mm radio continuum emission from active galaxies consists of three components:

(1) Synchrotron emission from the active galactic nucleus (AGN), which is over 1 Jy in 3C 273 but which is not significant in most of the types of galaxy considered here.
(2) Free–free emission from H II regions. The flux of this in a starburst galaxy is typically of the order of 10 mJy and could be imaged with a 3 mm-capable Australia Telescope Compact Array (ATCA).
(3) Emission from the tail of the 50–100 K blackbody spectrum of the dust. For example, the dust in Arp 220 (redshift of 0·02) at a temperature of 50 K has a flux of 30 mJy at 3 mm. Interestingly, this flux does not decrease substantially with redshift, as the decrease in brightness is compensated for by the redshifting of the steep edge of the blackbody curve, and so infrared-bright galaxies can be studied up to high redshifts with existing instruments.

Of these three components, the last two are of most interest for studying radio-quiet AGNs. Present instruments are limited in their study of AGNs by both sensitivity and resolution, since galaxies like Arp 220 are substantially unresolved even with the longest baselines currently available. The significant increase in sensitivity and resolution available from the ATCA, compared with existing instruments such as the Berkeley–Illinois–Maryland Array (BIMA) and Owens Valley, will enable us to improve significantly our understanding of these objects. (The sensitivity of the ATCA at 90 GHz should be 2–3 times that of any existing array, primarily because of the larger collecting area. This factor is sufficient to make the synthesis mapping of dust a powerful tool for the study of AGNs, and places the ATCA in a valuable and exciting niche.) However, for these objects, resolution is even more important than sensitivity.

Existing mm observations of AGNs show that most have a thermal core which is unresolved with existing instruments, and higher resolution is needed to probe this core. Our best information, derived partly from the observations described above, partly from CO and near-IR observations, and partly from brightness temperature arguments, indicates that dust is concentrated towards the centre of an AGN, with an additional cooler extended component. If dust tori exist around AGNs, as predicted by most 'unified models', then the mm core may represent the torus, which should be visible with longer baselines on mm telescopes. The expected range of scale sizes falls neatly within the range of the ATCA.

Present studies of AGNs provide tantalising glimpses of the dust and gas which are in the nuclei of these galaxies, and which are probably crucial to understanding the physics of these objects, but we have so far seen only the tip of the iceberg. Even a modest increase in resolution and sensitivity will open up an unexplored part of the observational phase space, which may hold the key to understanding these galaxies. For this type of work, the sources are small, and so short spacings are not necessary, and instead the longer spacings are important. A 3 mm AT Compact Array will be able to break exciting new ground in this field.