The Thermal Component of the Seyfert Galaxy NGC1275

E I ROBSON & W K GEAR
School of Physics & Astronomy
Lancashire Polytechnic
Preston PR1 2TQ UK

Abstract

We have been observing a range of galaxy type over the IR through millimetre region to determine the contribution of thermal emission from heated dust. It is now clear that the 'Starburst' phenomenon is widespread and has a range of luminosity. By studying the continuum spectrum of the radio-loud Seyfert galaxy NGC1275 over many years, we have shown that it possesses a thermal component of luminosity comparable to the synchrotron luminosity. We interpret this thermal component as emission from dust heated by stars forming from material in an X-ray cooling accretion flow.

NGC1275 was selected as part of our multifrequency monitoring programme (1) chiefly because of the presence of a radio-jet in its core. This jet may be similar to that occurring on a grander scale in the high luminosity blazars. An early attempt was made to determine the overall radio through optical continuum spectrum by Longmore et al (2) (see Fig 1). The authors acknowledged that their data were obtained from differing epochs and with a range of aperture size and so there were uncertainties in the interpretation of the continuity of the overall spectrum. Nevertheless the radio through infrared emission was identified as being basically synchrotron, although the presence of thermal emission from heated dust could not be ruled out. This was because of measurement uncertainties between 800μm and 20μm and the problems of observations being made at different epochs with a source which is clearly variable.

Our early submillimetre data on NGC1275 had shown that the descending synchrotron millimetre through 800 μm spectrum flattened slightly at 350μm indicating the possibility of a thermal component in the overall spectrum. Although for some sources it is very difficult to distinguish a thermal from a non-thermal component (eg 3) our observations described below show that in this case it is very clear that the component is thermal in origin. We had in addition been undertaking a

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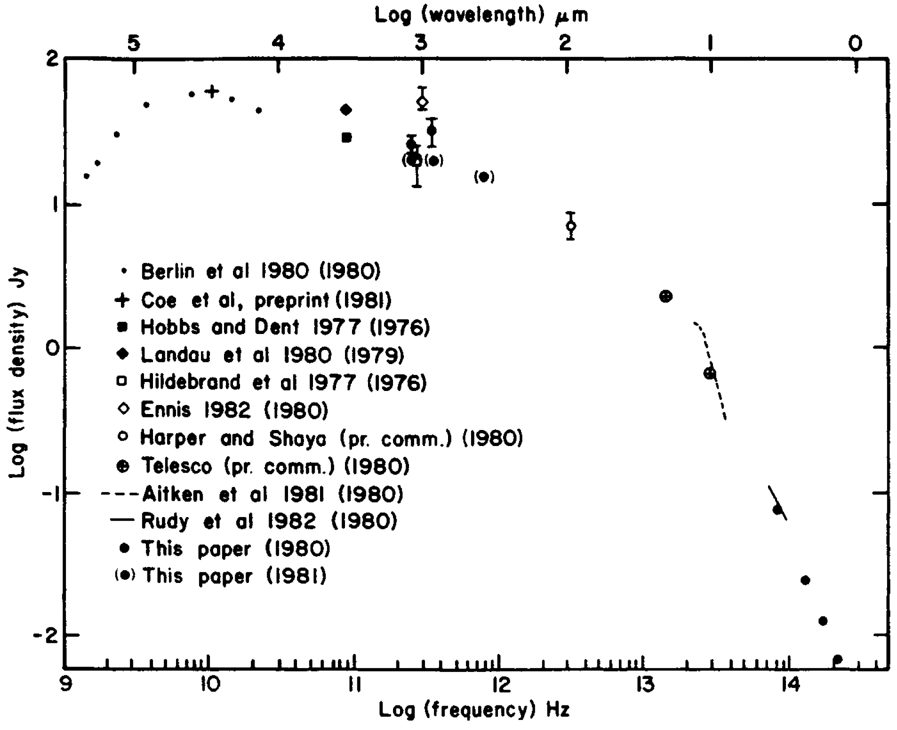

Fig 1. The radio through optical continuum spectrum of NGC1275 adapted from (2).

programme to investigate 'starburst' galaxies (4,5) and to search for thermal emission from radio galaxies (6) and quasars (7).

Continued millimetre through IR monitoring of NGC1275 showed that the source was fading during 1983-4. The availability of 12μm through 100μm IRAS data in 1983 along with our millimetre and submillimetre measurements revealed the single epoch far-IR continuum spectrum uncontaminated by variability effects. The most obvious feature of the spectrum (Fig 2) is the presence of a wide excess around 100μm over and above a power law. In addition, the IRAS flux values were the same as those determined by the Kuiper Airborne Observatory four years previously. This strongly suggests a steady component compared with the mm/submm flux which had varied noticeably between the two epochs. It is clear that there is a synchrotron spectrum in NGC1275 and when this underlying power-law is subtracted from the total spectrum, a component, which is almost certainly thermal in origin, is even more clearly seen (Fig 3). There is clearly a wide range of temperature with the long wavelength fitted by a 47 K grey body

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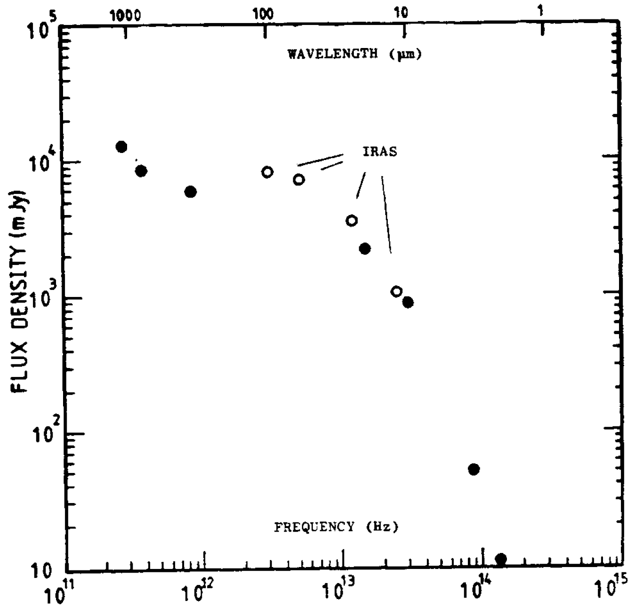

Fig 2. The mm-IR continuum spectrum of NGC1275 during 1983

radiator. From considerations of the flux and aperture size used for our observations the emission must be restricted to sizes 160 pc<D<8kpc in NGC1275. The luminosity in this thermal component is 7×10^{10} $L_\odot$ compared with the 1mm to 1μm synchrotron luminosity of 2×10^{10} $L_\odot$ in the low state. Obviously the observability of this cool thermal component depends critically on the strength of the underlying synchrotron spectrum. When this brightens the contrast between it and the thermal component is drastically reduced and would easily escape notice.

For comparison the spectrum of Fig 3 is shown alongside the normalised spectrum of the Seyfert galaxy NGC1068. The long wavelength part is typical of emission from cool dust as seen in galactic HII regions, molecular clouds and Starburst galaxies. The question of the location of the heated dust and the origin of the heating photons is discussed in (8). We assess that the thermal emission is probably due to extensive star formation and is in agreement with suggestions that the star formation is caused by an X-ray cooling accretion flow from the Perseus intra-cluster gas (9) forming essentially low-mass stars rather than massive stars seen in HII regions in our galaxy.

These observations of NGC1275 demonstrate the value of long term monitoring programmes. A Seyfert galaxy with a radio-jet has been demonstrated to have a cool thermal component, qualitatively similar to that from Starburst galaxies. This is yet another piece of evidence for grand unification schemes whereby galaxies are basically ensembles of stars and gas with varying degrees of

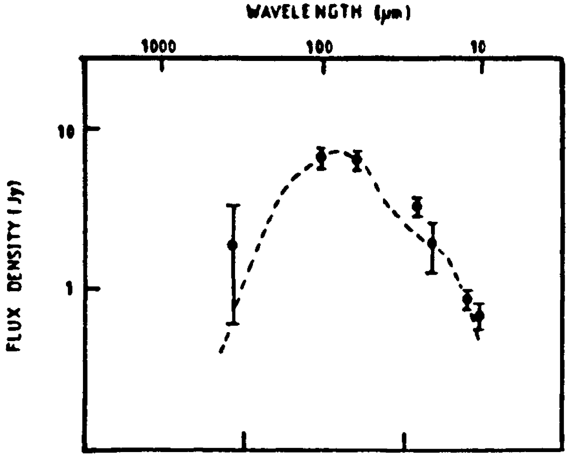

Fig 3. The far-IR spectrum of NGC1275 after subtraction of the synchrotron component. The dotted line shows the normalised far infrared spectrum of NGC1068.

central engine-to-hot disc-to-cool disk domination. The degree of activity then gives rise to the 'category' in which the object is classified ie quasars through LINERS. NGC1275 may be very rare in that it shows Seyfert, Blazar and Starburst phenomena on about the same order of magnitude. How many other active galaxies possess Starburst properties ? To put the emission of NGC1275 into perspective, we note that if its thermal luminosity were present in a strong synchrotron source, such as the radio-loud quasar 3C273, then it would be totally unobservable from the continuum spectrum alone, being a factor of 100 less than the synchrotron power.

REFERENCES

1 Robson,E.I., Gear,W.K & Brown,L.M.J. this volume.
2 Longmore,A.J.,Sharples,R.M.,Tokunaga,A.T.,Rudy,R.J., Robson,E.I.,Ade,P.A.R. & Radostitz,J.V. 1984 Mon.Not.R.astr.Soc. 209,373
3 Neugebauer,G.,Soifer,B.T. & Rowan-Robinson,M.1984 PASP 96, 973.
4 Emerson,J.P.,Clegg,P.E.,Gee,G.,Cunningham,C.T.,Griffin,M.J., Brown,L.M.J.,Robson,E.I. & Longmore,A.J. 1984 Nature 311,237
5 Gear,W.K.,Gee,G.,Robson,E.I. & Duncan,W.D. 1986 Mon.Not.R.astr.Soc.
6 Cunningham,C.T.,Ade,P.A.R., Robson,E.I. & Radostitz,J.V. 1984 Mon.Not.R.astr.Soc. 211,543
7 Robson,E.I.,Gear,W.K.,Smith,M.G.,Ade,P.A.R. & Nolt,I.G. 1985 Mon.Not.R.astr.Soc. 213,355
8 Gear,W.K.,Gee,G.,Robson,E.I. & Nolt,I.G. 1985 Mon.Not.R.astr.Soc. 217,281
9 Fabian,A.C. et al. 1981 Ap.J. 248,47