ANISOTROPIC CONTINUUM EMISSION IN SEYFERTS

Martin J. WARD
Institute of Astronomy
Cambridge CB3 0HA
U.K.

ABSTRACT. The evidence for anisotropic continuum emission in some Seyferts, is increasingly convincing. However, the generality of this phenomenon has not yet been determined. I present new observations which suggest that its occurrence is widespread.

1. Introduction

The term *Anisotropic Continuum Emission*, henceforth ACE, is preferred over other descriptions such as *Beaming*, because it does not carry the model-dependent connotation of intrinsic collimation close to the central engine. The latter process may be relevant to BL Lac objects and the powerful radio galaxies. However, other types of active nucleus, such as the Seyferts, may exhibit ACE, caused by *shadowing* or *funnelling* of an isotropically radiating source by optically thick blocking material. Perhaps the most likely example of this phenomenon is NGC1068 (Antonucci and Miller 1985).

2. Evidence for ACE

A variety of diverse observations support the ACE hypothesis. The evidence given below concerns mostly relatively nearby Seyfert galaxies, but work on bipolar outflow from starburst galaxies such as M82 and NGC253 suggests the possibility of a link, which is beyond the scope of this short paper.

2.1. KINEMATIC CLUES

In several Seyferts the velocity field of the extranuclear ionized gas has significant non-circular motions. The most favoured model is one in which *low-excitation* emission lines are formed in a kiloparsec scale disc which shares the rotational motion of the parent galaxy. While the higher excitation component has a velocity field consistent with outflow (possibly conical) from the nucleus. The emission line asymmetries observed may arise because we cannot see the outflowing component from the opposite side of an opaque disc.

2.2. EXTENDED NARROW LINE REGION

Recently, long integrations have revealed high excitation emission lines extending up to 20kpc from the nuclei of some Seyfert nuclei - far beyond the extent of the classical narrow-line region (Unger *et al.* 1987). It is significant that this ionized gas is much more extended

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in the direction parallel to the radio axis, than perpendicular to it. This clearly indicates an anisotropic optical/ultraviolet radiation field.

2.3. DEFICITS: IONIZING PHOTONS AND HEATING FLUX

If the Balmer lines are used to estimate the number of ionizing photons required to produce the observed flux, a deficit of such photons is often inferred. A similar situation is found if we equate the observed mid-far infrared emission believed to arise from dust grains heated by the continuum source, with the available heating flux based on the observed continuum. Clearly these calculations rely on many assumptions, and corrections for reddening need to be applied, for details of the calculations see Wilson, Ward, and Haniff (1988).

2.4. HIDDEN BROAD LINE REGIONS

Evidence for highly obscured BLR's in some Seyfert 2s is increasing. In addition to NGC1068, elsewhere in these proceedings Miller has reported polarisation studies of other nuclei which reveal an electron or dust scattered BLR component. A more indirect argument in support of an obscured BLR in Seyfert 2s may be used. It is known that Seyfert 2s are on average intrinsically about 100 times weaker in X-rays than Seyfert 1s. It is also known that the strengths of the high ionization lines [FeVII] and [NeV] are roughly similar in the two classes, allowing for redshift differences in the samples. It is the continuum above 100eV that photoionizes these species. Therefore we must explain why the line strengths are similar, while the soft X-ray continuum is much weaker in Seyfert 2s. An obvious explanation is that we do not see the compact X-ray continuum in Seyfert 2s, but the [FeVII] and [NeV] region lies beyond the zone blocked by obscuring material.

3. Future Prospects

Developments in infrared imaging offer some exciting new avenues for the study of ACE. In collaboration with staff at the UKIRT (Smith, McLean and Aspin) I have obtained narrow-band Brackett γ images of NGC1068 and NGC4151, and a molecular hydrogen line image of NGC1068. Although it is probable that the scale height of the putative molecular disc in NGC1068 is only a few parsecs, this may be only part of a much larger distribution of giant molecular clouds. The narrow-band H_2 image of NGC1068 shows some indication of a bar or disc like structure, perpendicular to the inner radio contours. The Brackett γ image of NGC4151 shows a *blotchy* distribution of circumnuclear material, not seen in Hα images presumably because they are heavily obscured HII regions. Although we see the BLR directly in NGC4151 *i.e.* through gaps in the patchy obscuration, this material may strongly modify the morphology of the extended ionized gas. Indeed, the jet-like structure seen in [OIII], extends in a direction relatively free of Brackett γ blobs. Thus, infrared imaging may be used to probe the geometry of the obscuring material.

References

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