The 3 μm Spectrum of NGC 4565 *

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1 Introduction

Three-micron spectroscopy of obscured galactic nuclei may provide important clues on the nature of the intervening dust material. Observations of the infrared sources in our own Galactic Centre (GC) have revealed the presence of absorption features at 3.0 and 3.4 μm (e. g. Whittet 1988). The strengths of these features vary independently, and they cannot therefore be produced by the same grain component (McFadzean *et al.* 1989). The 3.0 μm 'ice' feature indicates the chance occurrence of a molecular cloud in the line of sight, whereas the 3.4 μm feature is attributed to carbonaceous dust in the diffuse ISM (e. g. Schutte & Greenberg 1988). Recent observations of highly-reddened field stars in the Galaxy (Tapia *et al.* 1989; Adamson *et al.* 1989) show that the 3.4 μm feature is also present in other lines of sight, strengthening the conclusion that it is a characteristic signature of diffuse-cloud dust.

Infrared spectroscopy of normal spiral galaxies is potentially invaluable as an aid to understanding the significance of the dust features observed in the Milky Way, and as a means of comparing the interstellar media of separate systems. Since the composition of dust in the Galaxy is a function of galactocentric distance (Thronson *et al.* 1987), it is important to obtain spectra of relatively unobscured external galactic nuclei as a check that the 3.4 μm absorption is not an intrinsic feature of the ISM at small galactocentric radii. It may be possible to measure directly the 3.0 and 3.4 μm features in spirals which are seen edge-on.

NGC 4565 is a relatively nearby ($\sim$ 10 Mpc) field spiral of high inclination ($i \simeq 87°.6$). Its Hubble type (Sb) matches that of the Galaxy, and it displays no obvious nuclear activity. Whilst a substantial number of optical and I-band images exist in the literature, they are

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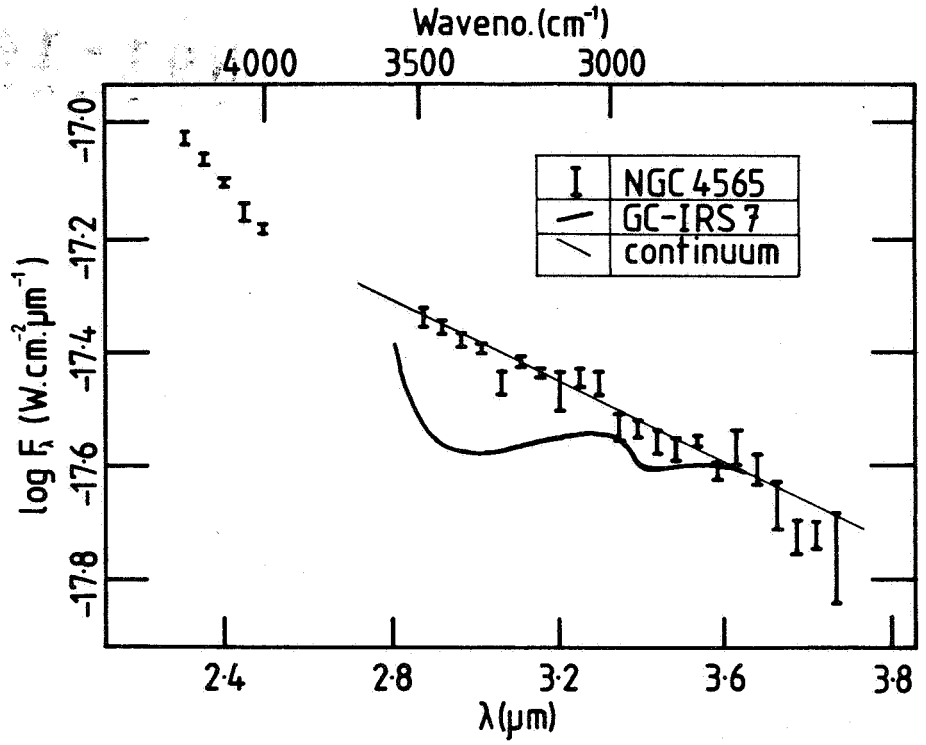

Figure 1: The 2.3–3.7 μm spectrum of NGC 4565. GC–IRS7 is also shown for comparison.

mainly deep exposures conveying little of use on the properties of the nucleus. Only two studies (Frankston & Schild 1976; Jensen & Thuan 1982) provide any real information on the obscuration of the nucleus, and to some extent they conflict as to whether it is situated behind the dust lane or not. However, following Schweizer (1978), a lower limit can be placed upon the extinction to the nucleus (excluding contributions from localized dark clouds) by adopting the observed dependence of extinction on galactic latitude in the solar-neighbourhood ($A_{pg} \simeq 0.25$ cosec $|b^{II}|$) within NGC 4565 itself. With the estimated inclination noted above, this gives $A_{pg} \geq 6^m$, or $A_V \geq 4^m.5$. Intrinsically weak interstellar features would be difficult to detect if this were the total extinction to the nucleus, but the proximity, brightness and high galactic latitude of NGC 4565 nevertheless make it the best available target for this type of observation outside our own Galaxy.

2 The Spectrum

The nucleus of NGC 4565 was observed with UKIRT in 1986 December, using a cooled CVF spectrometer with a 12″ aperture and 40″ E-W chop. The spectral range from 2.3 to 3.8 μm was covered at 1% spectral resolution and half-sampling. Figure 1 shows the resulting spectrum. For comparison, a schematic representation is included of the spectrum of GC–IRS7 between 3.0 and 3.6 μm, with an adjusted continuum slope.

Our spectrum of NGC 4565 is essentially featureless. The absence of the 3.0 μm feature ($\tau_{3.0} < 0.05$) implies that the extinction to the nucleus does not arise to a significant degree in molecular clouds. We deduce $\tau_{3.0}/A_V < 0.01$, compared with ~ 0.022 for GC–IRS7. These results support the conclusion (McFadzean *et al.* 1989) that the 3.0 μm absorption in the GC–IR sources is due to the presence of ice in a (probably single) foreground molecular cloud. The 3.4 μm feature is also weak or absent in our spectrum of NGC 4565 ($\tau_{3.4} \leq 0.07$). Hence, $\tau_{3.4}/A_V \leq 0.016$, compared with ~ 0.008 towards GC–IRS7. The absence of the feature in NGC 4565 at the signal-to-noise level of the current observations is consistent with a probable moderate degree of extinction towards the nucleus.

3 Conclusions

Our observations of NGC 4565 provide a useful comparison for studies of dust in the Galaxy. Limits have been set on the strengths of the 3.0 and 3.4 μm features in NGC 4565. The absence of 3.0 μm absorption is significant, and supports the view that the feature at this wavelength in the Galactic Centre is due to water-ice absorption in a foreground molecular cloud. The non-detection of the 3.4 μm absorption is less surprising and provides indirect support for the association between this feature and the diffuse interstellar medium. The current spectrum probably represents the best that can be achieved with a single-detector instrument within reasonable integration times. It will clearly be of interest in the future to obtain spectra of higher signal-to-noise, as a positive detection of the 3.4 μm feature in an external galaxy, even at a low level, would be of considerable astrophysical significance.

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