THE SIZES OF INFRARED-EMITTING REGIONS IN HIGH LUMINOSITY GALAXIES

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ABSTRACT. We have made measurements of the 12 - 25 μm sizes of 17 galaxies with high infrared luminosities. Most of the galaxies are extended on a scale of 0.6 to 1 kpc diameter. Deep silicate absorption features are common. We discuss some of the difficulties in explaining how an extended source can have a deep silicate feature.

1. Introduction

The diameter of the infrared-emitting region of a galaxy is an important clue to the nature of the physical processes causing the emission. One way of determining the size of an infrared galaxy is to compare its flux density as measured with a small aperture from the ground with the flux density measured with the much broader-beamed IRAS satellite. In this paper we apply this technique to a number of galaxies selected from the IRAS catalog in the basis of their high 12 - 100 μm luminosities.

2. Observations

Observations were made on the IRTF on Mauna Kea. We used the standard single-element bolometer system with a 5.7" diaphragm, and a series of filters with wavelengths between 8 μm and 32 μm. Of particular importance were the measurements at 12 μm and 25 μm which coincided with wavelengths used in the IRAS survey. Figure 1 shows a good example of how our data compare with the IRAS data.

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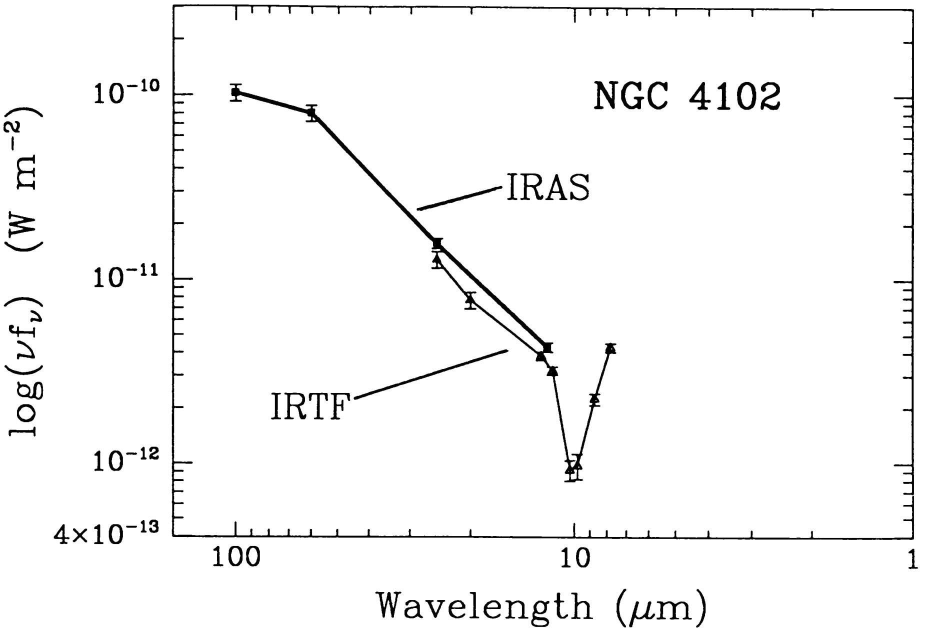

Figure 1. Sample observational data. The difference between the small-beam IRTF and large-beam IRAS measurements is a measure of the size of the source. The deep absorption feature at 10 μm is due to silicates.

3. Results

We obtained photometry for 17 galaxies. Their infrared luminosities were typically of order 10^{11} $L_{\odot}$. The sample included some well-known merging systems such as NGC 6240 and Arp 220. For each galaxy we estimated a size using the ratio of the small diameter (IRTF) to large diameter (IRAS) flux densities and a simple model consisting of an exponential disk. We found that most galaxies were significantly extended with diameters of the order 0.6 - 1 kpc. No systematic differences between 12 μm and 25 μm sizes were found. For most galaxies the sizes we estimated were consistent with models in which the bulk of the luminosity is produced by extended regions of star formation in the centers of the galaxies. A few were unresolved, including NGC 7469, a known Seyfert galaxy: Arp 220, a galaxy with a broad Brackett-gamma line (Depoy *et al.* 1987): and IRAS 12112+0305, the most distant object in our sample.

A second interesting result is that in all eight galaxies for which we made measurements through the silicate band we saw a strong absorption feature. The galaxies were Arp 220, NGC 520, NGC 1614, NGC 2623, NGC 4102, NGC 4194, NGC 4818, and NGC 6240. (An even deeper silicate absorption has been found in NGC 4418 by Roche *et al.*, 1986).The absorptions typically corresponds to a silicate optical depth in the range 1 - 2. The implication of this result is that the source of the mid-infrared emission is hidden behind 15 - 30 magnitudes of visual extinction.

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4. Discussion

The combination of extended emission and silicate absorption is surprising and substantially constrains the physical conditions in these galaxies. Inside our Galaxy much of the infrared luminosity of a major star formation region derives from its HII regions. As a rule HII regions do not have deep silicate absorption features unless they are very compact. If the central regions of our sample galaxies were filled with Galaxy-like HII region/molecular cloud complexes we would not expect to see the deep silicate feature that we do. Possible models that *could* explain the deep silicate feature in the galaxies include:

- Surrounding the whole kpc-sized central region with a "wall" of obscuring matter. The problem with this approach is that if the wall had holes in it, the deep silicate absorption feature would quickly be filled in by emission from the HII regions.

- Surrounding individual HII regions with obscuring molecular cloud material. The problem with this approach is that in most models the timescale for stars to emerge from a molecular cloud is shorter than the estimated time for the starburst.

- Producing the infrared emission from a small number of compact but very luminous star forming regions rather than from a kpc-wide distribution of smaller ones. Our recent studies of the near-infrared morphology of the interacting system Arp 299 (Eales *et al.*, 1990, Zhou *et al.* 1990) provide some support for such a model.

Full details of this work will be described in a paper currently in preparation for Astrophysical Journal.

5. Acknowledgments

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6. References

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