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THE VARIATION OF THE DUST TEMPERATURE WITHIN LATE-TYPE SPIRAL GALAXIES

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ABSTRACT We use HiRes 60 and 100 μm data to investigate the variation of the dust temperature in a sample of 4 late-type spiral galaxies. We have investigated the radial variation of the azimuthally averaged 60 and 100 μm surface brightness profiles to see how the dust temperature (or, more correctly, the relative strength of the two components) varies as a function of radius within the galaxies. We find strong evidence for a decrease in the dust temperature (or an increase in the relative contribution of the 100 μm flux compared to the 60 μm flux) as a function of radius. We discuss these results in the light of the continuing debate as to whether massive star formation or the general interstellar radiation field is the major heating source of the dust.

DISCUSSION

The profiles (Figs. 1 – 4) in general show a decrease in the relative contribution of the 60 to 100 μm flux, as one would expect from a cirrus component heated by a weakening general interstellar radiation field. However, there is also clear evidence for warmer regions, which can be tied in with spiral arm features seen in the HiRes images. Because we have azimuthally smoothed the images we are not able from these data to determine the relative temperatures of the “warm” and “cool” dust components. However, by doing aperture photometry on individual giant H II complexes, where we would expect the warm component to nearly totally dominate the cool component, we hope to be able to better tie down the warm dust component. The cooler component can then also be determined, as it will be just the excess required to fit the observed 60 to 100 μm flux ratios in other regions. HiRes and KAO data thus provide a unique opportunity to better determine the relative contributions of each of these components in both individual galaxies and individual regions of galaxies.

Elsewhere in this workshop Devereux has shown 60 to 100 μm ratio profiles for the galaxies M101 and M81 which show a constancy of dust temperature with increasing radius. In fact, Devereux (1993) has also found a constancy for the same galaxies as in this study, a discrepancy which is disconcerting, but could be due to the different default values used in the HiRes images used in this studies and those in Devereux's. Clearly this vital question needs further study.

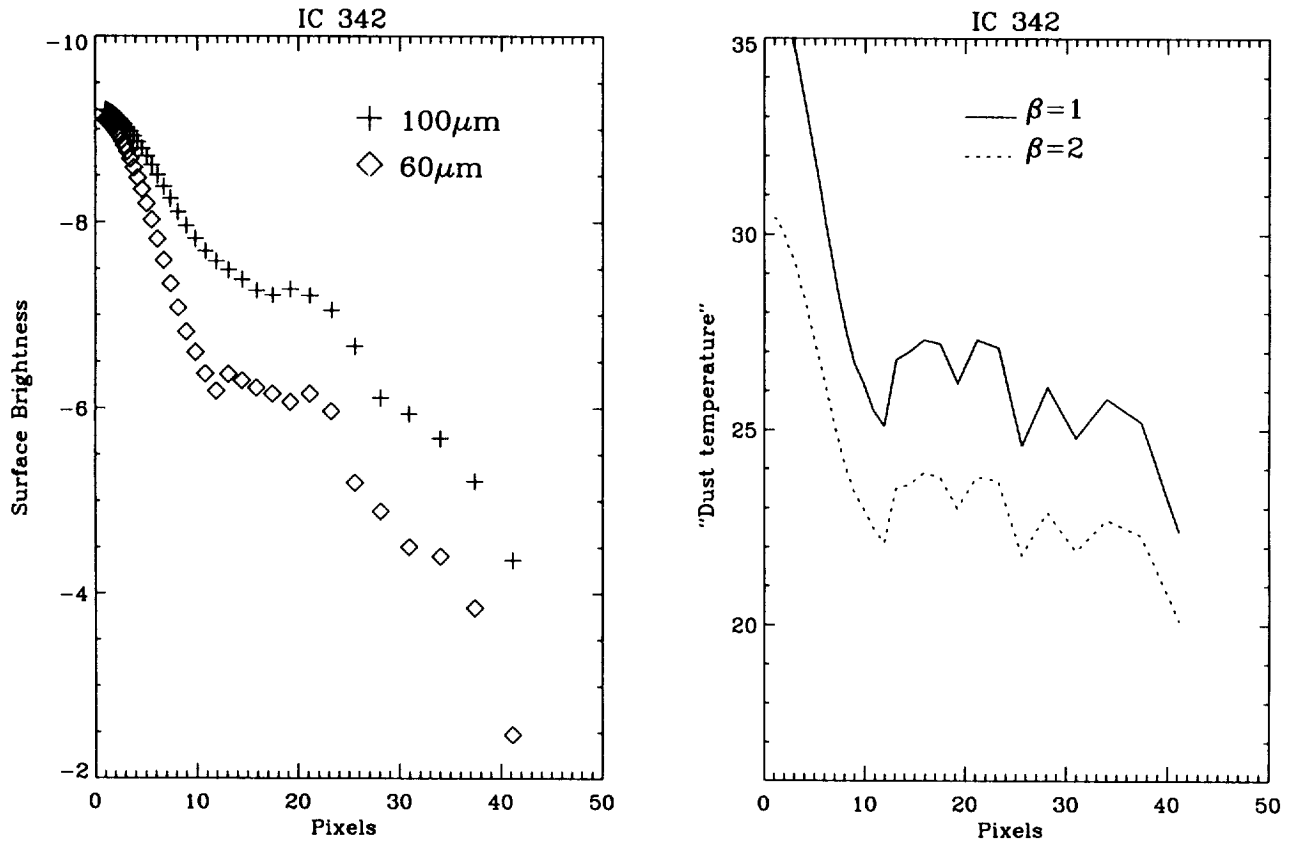


FIGURE 1 The 100 and 60 μm surface brightness profiles of IC 342, and the “dust temperature” derived from the 60 to 100 μm flux ratios, for the two emissivity indices $\beta = 1$ and 2. In addition to the increase in 60/100 ratio due to the spiral arms, which can still be seen in the convolved 60 μm image of IC 342, the underlying disk shows a decrease in temperature with radius. The global “dust temperatures” (i.e., those found by measuring the total 60 and 100 μm fluxes from the whole galaxy) are 32.2 K and 27.4 K in the $\beta = 1$ and 2 cases, respectively.

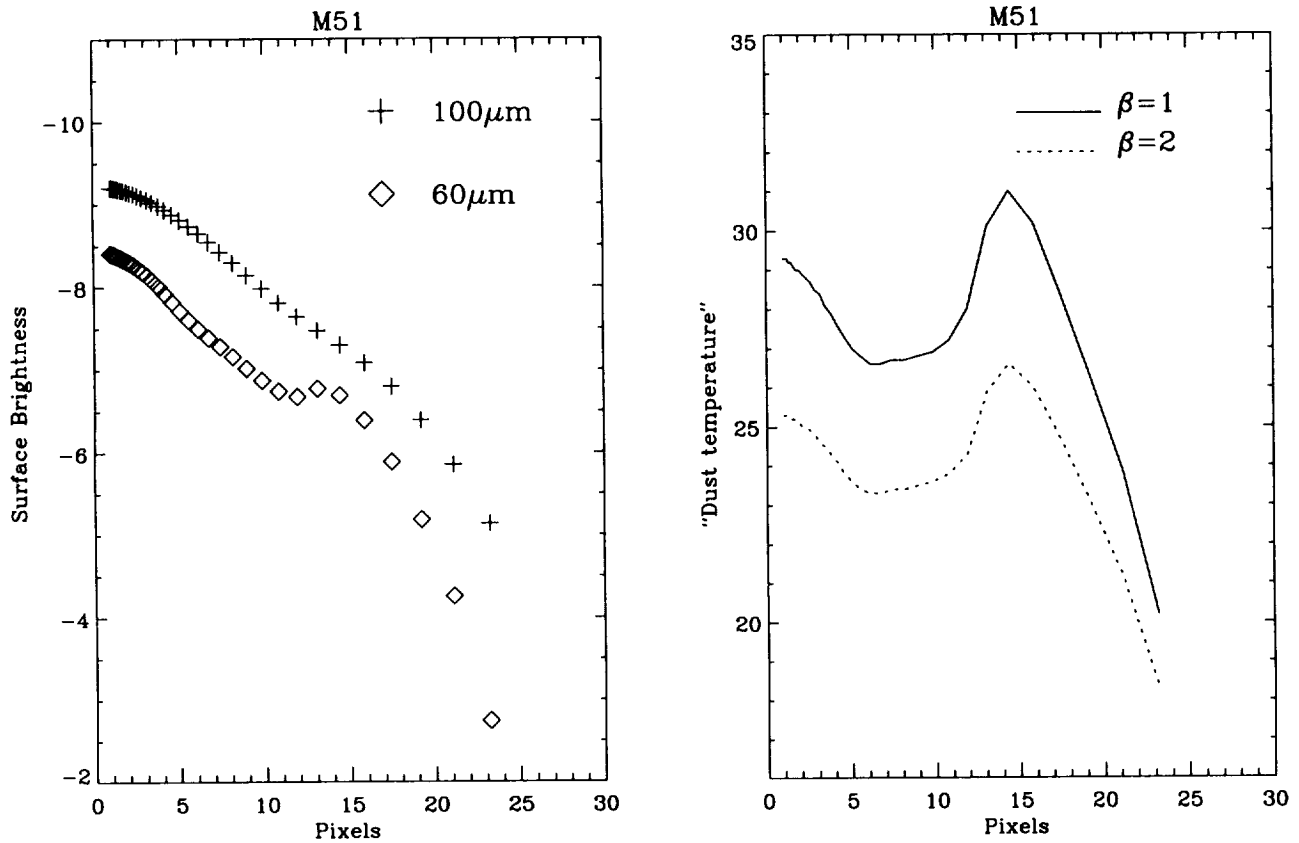


FIGURE 2 The 100 and 60 μm surface brightness profiles of NGC 5194, and the "dust temperature" derived from the 60 to 100 μm flux ratios, for the two emissivity indices $\beta = 1$ and 2. NGC 5195 was removed from the image (using the IRAF badpixel routine) before profiling the image. Apart from a prominent spiral arm feature, which can be seen in the 60 μm profile and is shown by the two maxima in the full resolution 60 μm image of M51, the underlying disk shows a decrease in temperature with radius. The global "dust temperatures" are 33.7 K and 28.5 K in the $\beta = 1$ and 2 cases, respectively.

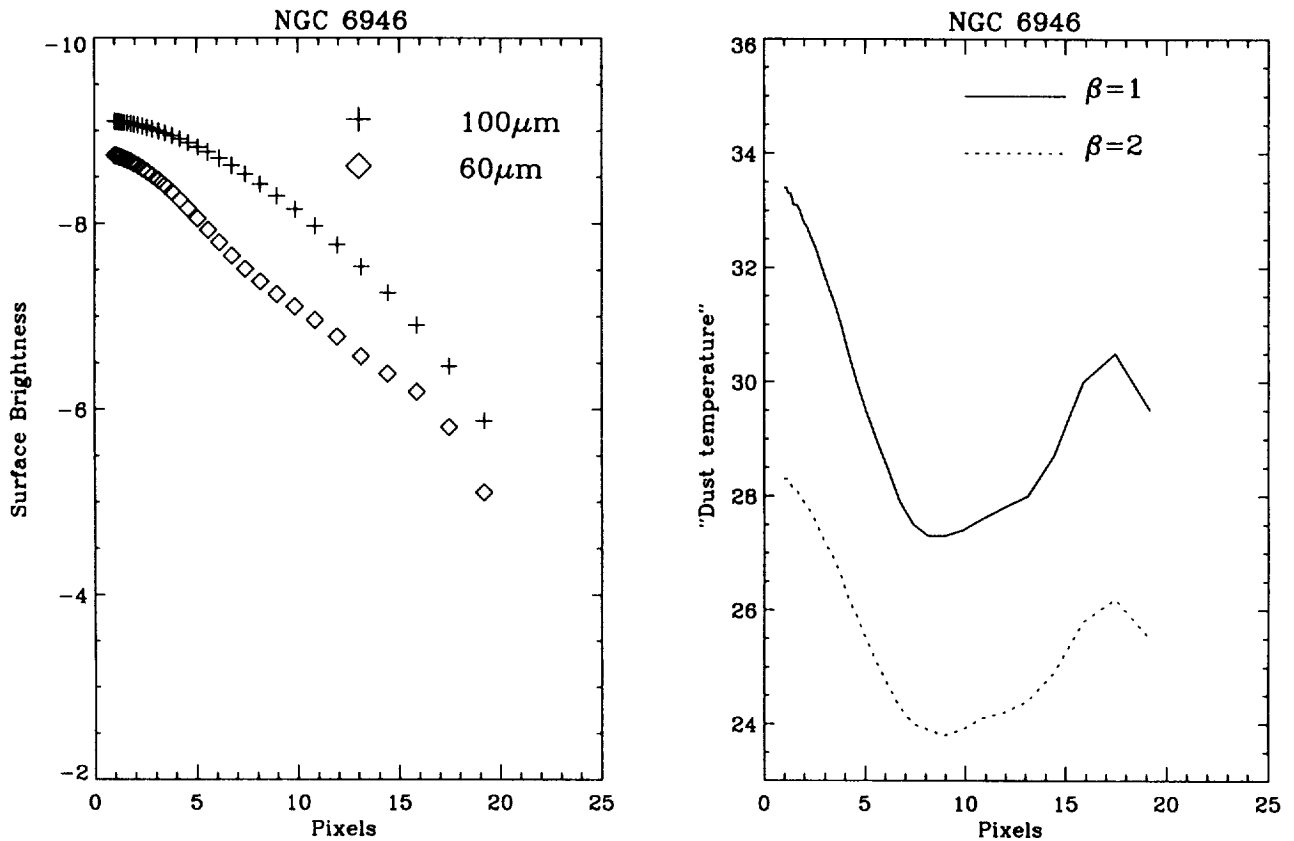


FIGURE 3 The 100 and 60 μm surface brightness profiles of NGC 6946, and the “dust temperature” derived from the 60 to 100 μm flux ratios, for the two emissivity indices $\beta = 1$ and 2. The sharp rise in the 60/100 ratio at the outer radii is probably due to the two features which cause extensions either side of the nucleus in the HiRes image of NGC 6946. The global “dust temperatures” are 32.9 K and 28.0 K in the $\beta = 1$ and 2 cases, respectively.

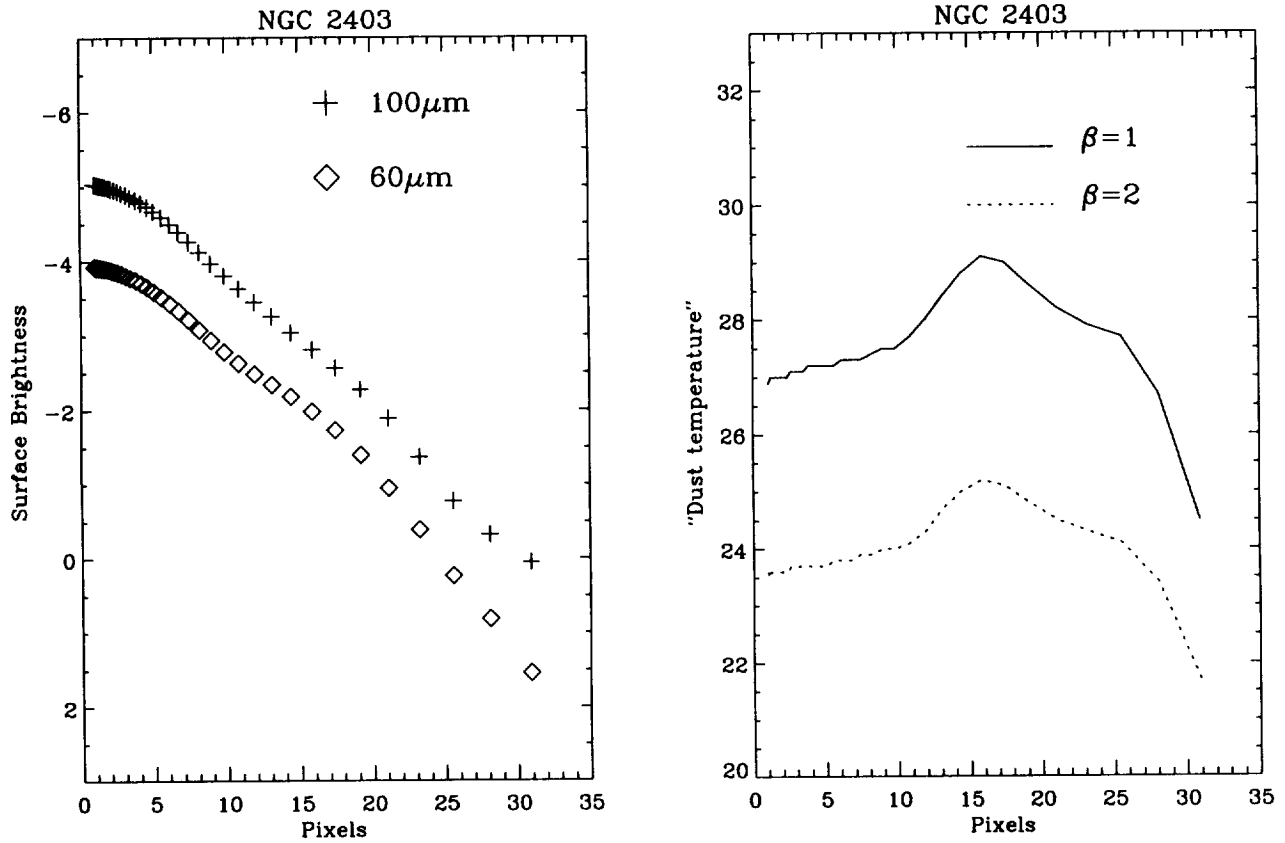


FIGURE 4 The 100 and 60 μm surface brightness profiles of NGC 2403, and the “dust temperature” derived from the 60 to 100 μm flux ratios, for the two emissivity indices $\beta = 1$ and 2. The 60/100 flux ratio shows a near constant behavior for the inner parts, after which it falls. The rise in 60/100 is due to the feature picked up in the 60 μm profile at ~ 15 –20 pixels, but not in the 100 μm profile. The global “dust temperatures” are 31.1 K and 26.6 K in the $\beta = 1$ and 2 cases, respectively.

REFERENCES

Devereux, N.A., 1993, Private communication