We have carried out a program to search for very faint, extended emission in NGC 5907 using the InfraRed Array Camera (IRAC) aboard the Spitzer Space Telescope. This nearby, relatively bright edge-on spiral galaxy has been the subject of many such studies, but this is the first time it has been imaged in the mid-infrared from space with such high sensitivity and angular resolution, and low backgrounds. Our data place strong limits on the faint, extended halo emission implied by the rotation curve -- and imply the presence of a thick disk: a component composed of vast numbers of unresolved faintly luminous objects. These may comprise some kind of brown dwarf population, as suggested by analogy with the findings of the MACHO collaboration for the Milky Way halo. In this particular galaxy, the halo is believed to have a mass of 0.8-1.4 x 10^{11} solar masses.

NGC 5907 is the first galaxy in our sample of edge-on spirals to have been imaged in the mid-infrared with IRAC (another, NGC 891, has also been observed recently, and those data are being analyzed) to search directly for extended halo emission -- if the halo has a significant component of brown dwarfs or perhaps some other red population, IRAC is the ideal instrument to detect them and to characterize their mass distribution.

The images above are mosaics constructed from the rastered images acquired by IRAC at four wavebands: 3.6, 4.5, 5.8, and 8.0 microns. The observations were carried out at the end of December 2003 in two campaigns separated by 24 hours. To control for instrumental artifacts, observations of the galaxy were interleaved with identical exposures on three control fields, giving these mosaics their jagged appearance. Result: at separations of 2-5 kpc from the galaxy center, all emission within 45 degrees of the galaxymidplane was masked, as were all pixels containing more than roughly 6 electrons from photons originating in foreground stars and background galaxies. The solid black line, referenced to the right vertical axis, indicates the log of the expected slope is indicated by the dashed line. Conclusion: down to surface brightness levels of ~26 mag/arcsec^2, at 3.6 microns (and somewhat brighter limits for the longer wavelengths), there is no indication of detectable halo emission beyond 10 kpc from the midplane (i.e., beyond 2.5 arcmin; we assume a distance of 14 Mpc based on H-band Tully-Fisher following Zepf et al 2000, AJ, 119, 1701). But the profiles have more to say! See below.

Annular IRAC surface brightness profiles

 majors, minor axis surface brightness profiles

 Left: surface brightness profiles measured in all four IRAC bands along the galaxy disk (SE-NW tracks; open symbols) and perpendicular to the galaxy midplane along the minor axis (SW-NE tracks; solid symbols). Foreground stars and background galaxies were masked. Superficially, the disk appears thicker at longer wavelengths, but as red in [5.8]-[8.0] as the disk, which exhibits strong PAH emission. Away from the disk, these observations extend down to 25 mag/arcsec^2 at 3.6 and 4.5 microns. All magnitudes are on the Vega system.

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 Conclusion:

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 Major, minor axis surface brightness profiles

 IRAC composite [3.6] [4.5] [5.8] [8.0]

 Left: a composite IRAC image indicating where surface brightness profiles have been measured in rectangular bins along seven tracks perpendicular to the galaxy midplane at regular intervals of 5.2 kpc. Right: measured 3.6 micron surface brightnesses, and models that include a GALFIT best-fit thick disk+thin disk+bulge+halo model (green) and the same without the thick disk (red). The data have been folded about the midplane. Solid icons are for measurements to the NE, open icons are for tracks to the SW. The thin black line is the best fit to the IRAC data! We therefore infer a similar thick disk morphology as do Morrison et al, but also detect what appears to be a thick disk at 2-3 kpc having a scale height of roughly 2 kpc based on the fits. The results at 4.5 microns are very similar: we are resolving the last minor issues for the fitting at 5.8 and 8.0 microns, which require careful handling of the IRAC PSF. When compared to earlier, near infrared observations, it appears the profiles are consistent with a very red, thick disk.

 Expected profile from rotation curve

 There is no indication of detectable halo emission beyond 10 kpc from the midplane (i.e., beyond 2.5 arcmin; we assume a distance of 14 Mpc based on H-band Tully-Fisher following Zepf et al 2000, AJ, 119, 1701). But the profiles have more to say! See below.

 Major, minor axis surface brightness profiles

 Right: measured mid-infrared surface brightnesses (solid icons, referenced to the left vertical axis) within annuli at increasing radii from the galaxy center. All emission within 40 degrees of the galaxy midplane was masked, as were all pixels containing more than roughly 6 electrons from photons originating in foreground stars and background galaxies. The solid black line, referenced to the right vertical axis, indicates the log of the expected slope is indicated by the dashed line. Conclusion: down to surface brightness levels of ~26 mag/arcsec^2, at 3.6 microns (and somewhat brighter limits for the longer wavelengths), there is no indication of detectable halo emission beyond 10 kpc from the midplane (i.e., beyond 2.5 arcmin; we assume a distance of 14 Mpc based on H-band Tully-Fisher following Zepf et al 2000, AJ, 119, 1701). But the profiles have more to say! See below.

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