IRS: THE INFRARED SPECTROGRAPH ON SIRTF

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ABSTRACT

The Infrared Spectrograph (IRS) is one of the three instruments on board the Space Infrared Telescope Facility (SIRTF) to be launched in December 2001. The IRS will provide high resolution spectra (R∼600) from 10–37 μm and low resolution spectra (R≥60) from 5.3–40 μm. Its high sensitivity and "spectral mapping-mode" make it a powerful instrument for observing both faint point-like and extended sources.

Key words: Infrared: general – SIRTF – IRS – NASA – JPL

1. The Infrared Spectrograph

The Infrared Spectrograph (IRS) (Houck et al. 1995) will provide the Space Infrared Telescope Facility (SIRTF) (Fanson et al. 1998) with low and moderate-spectral resolution spectroscopic capabilities from 5.3 to 40 microns. The IRS (see Fig. 3) is composed of four separate modules, with two of the modules providing R>60 spectral resolution over 5.3 to 40 microns and two modules providing R∼600 spectral resolution over 10 to 37 microns.

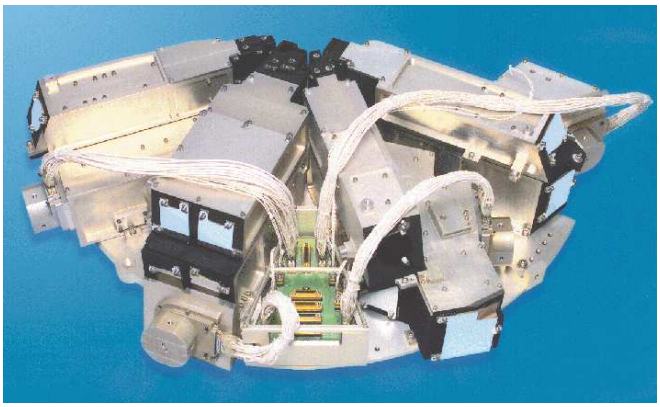

Figure 1. The 4 IRS modules on their common base plate.

The IRS instrument has no moving parts ("bolt-and-go" philosophy). Each module has its own entrance slit in the focal plane. The low-resolution modules employ long slit designs that allow both spectral and one-dimensional spatial information to be acquired simultaneously on the same detector array. Two small imaging sub-arrays ("peak-up cameras") in the short-low module (SL) will also allow infrared objects with poorly known positions to be accurately placed into any of the IRS modules' entrance slits. The high-resolution modules use a cross-dispersed echelle design that gives both spectral and spatial measurements on the same detector array.

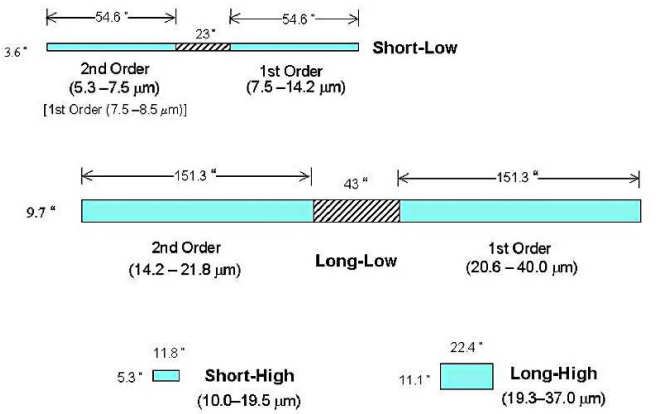

Figure 2. Details on the IRS slits

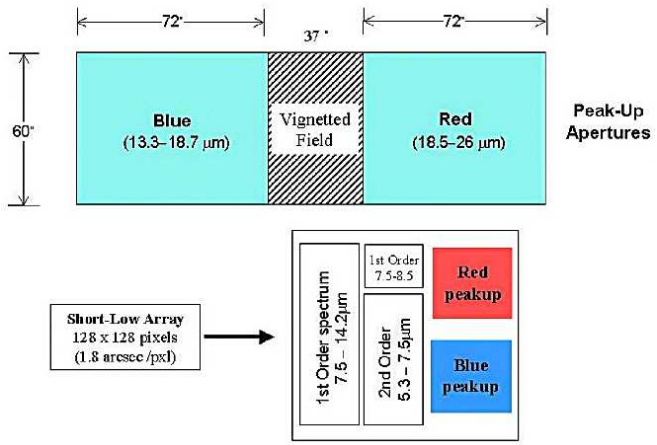

Figure 3. The IRS peakup camera

2. The IRS Sensitivity

The expected sensitivity of IRS is much higher than the one of the Infrared Space Observatory. The theoretical sensitivity plots for the four modules are presented in following figures.

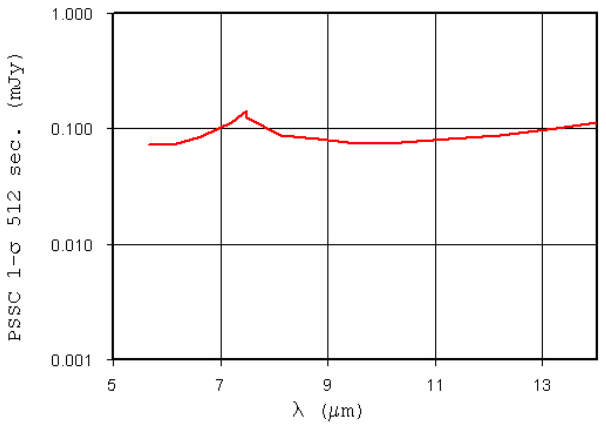

Figure 4. The IRS Short-Low Point Source Staring Continuum sensitivity

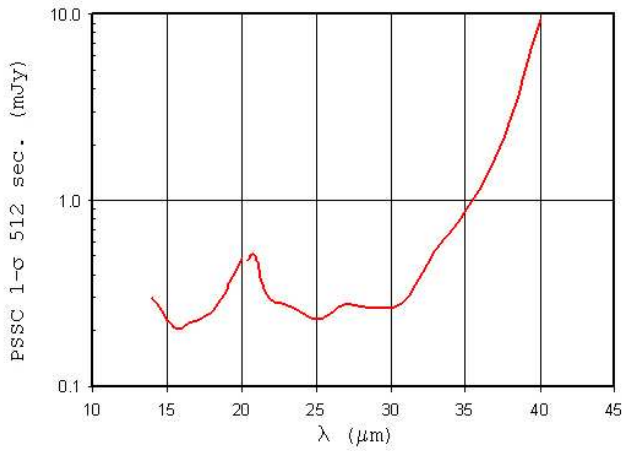

Figure 5. The IRS Long-Low Point Source Staring Continuum sensitivity

The continuum point source (7σ, 500 seconds) sensitivity of the low resolution module is 1 mJy at 12 μm. The line sensitivity of the high resolution module is 4×10^{-18} $\mathrm{Wm^{-2}}$ at 15 μm. The two peak-up cameras can center on sources as faint as 0.7 mJy.

The saturation limits in 8 seconds for point (extended) sources are 5 Jy (0.4 $\mathrm{Jy\,arcsec^{-2}}$) at 10 μm for the low resolution module and 50 Jy (2.1 Jy $\mathrm{arcsec^{-2}}$) at 15 μm for the high resolution module. The 4 s saturation limits for the peak-up cameras are 0.5 Jy for point sources and 40 $\mathrm{mJy\,arcsec^{-2}}$ for extended sources.

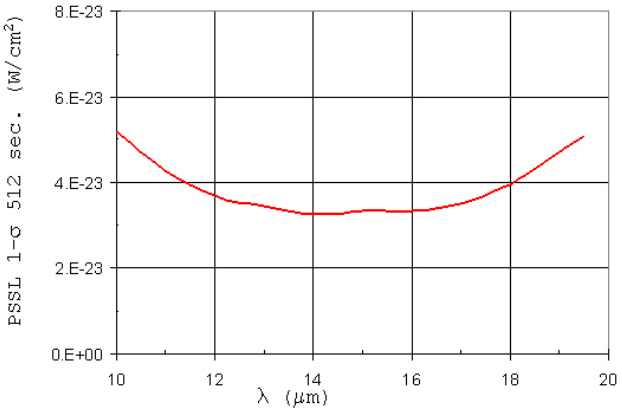

Figure 6. The IRS Short-High Point Source Staring Line sensitivity

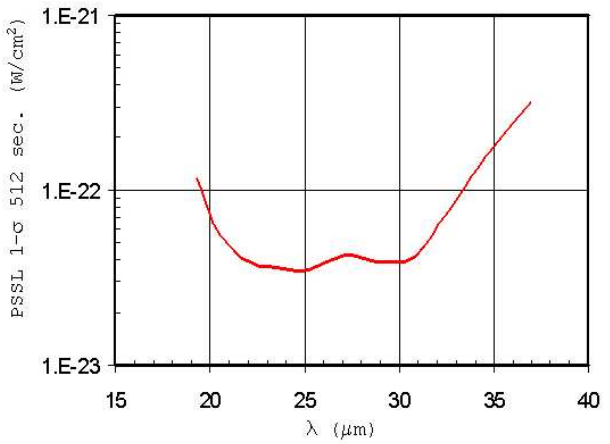

Figure 7. The IRS Long-High Point Source Staring Line sensitivity

3. Discussion

The diversity of the mid-infrared spectral features, became evident in this meeting. The intensity of the Unidentified Infrared Bands was shown to vary substantially as a function of the intensity of the radiation field. Their nature (molecules in aromatic bond structures) and physical properties are still under debate, while new features, such as the the 16.4 μm (Verstraete et al. 2000) are being discovered. It appears though, that the carriers of these bands are present in the photo-dissociation regions and their intensity reveals the presence of star formation activity, often obscured in the optical wavelengths.

In conjunction with the other two instruments of SIRTF, the mid-infrared camera (IRAC) and the mid/far-infrared photometer (MIPS), IRS provides unique opportunities for a wide range of research projects. It's worth mentioning that most of the sources detected by IRAS two decades ago are too bright to be observed by IRS! The superior sensitivity of IRS will allow to detect dust in galaxies at high

Table 1. Basic IRS characteristics

Module	Detector (128×128)	Pixel Size (arcsec)	Slit Size (arcsec)	λ (μm)	Resolving Power (R)
Short Low	Si:As	1.8	3.6×54.5	5.3 – 7.5	62-124
"	"	"	"	7.5 – 14	"
Long Low	Si:Sb	4.8	9.7×151.3	14 – 21	62-124
"	"	"	"	21 – 40	"
Short High	Si:As	2.4	5.3×11.8	10 – 19.5	600
Long High	Si:Sb	4.8	11.1×22.4	19 – 37	600

redshift (Brandl et al. 2000) and cool faint nearby stars. The small sizes of the slits, which are similar to the size of the point spread function, and the availability of the spectral-mapping mode will be powerful tools in tracing weak mid-infrared lines over a wide range of ISM conditions. This improved spatial resolution should permit a better comparison between the mid-infrared and the optical/radio properties of the ISM and result to a better understanding the underlying physical processes.

4. Conclusion

More information on the IRS and on upcoming deadlines for observing opportunities with SIRTF can be found at the following web sites:

http://www.astro.cornell.edu/SIRTF
http://sirtf.caltech.edu

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