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ITHACA, N. Y.

CENTER FOR RADIOPHYSICS AND SPACE RESEARCH
CORNELL UNIVERSITY
ITHACA, NEW YORK

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A DOUBLY MULTIPLEXING DISPERSIVE SPECTROMETER

by

Perry G. Phillips and Martin Harwit

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Harwit et.al.(1) have shown that multiplexing techniques can be used to increase the throughput of dispersive spectrometers substantially while maintaining good resolving power. Multiplexing is accomplished by placing different masks at the entrance and exit apertures which alternately block or transmit various combinations of the desired spectral elements.

The analysis carried out by Harwit et.al. is based on an identical number of slots N for each mask and a total of N^2 measurements, even though only 2N-1 distinct spectral elements are present. Actually, 2N-1 measurements suffice to provide a spectrum. The authors mention, however, that the use of N^2 measurements can, in effect, give a one-dimensional image of the source at different wavelengths. More precisely stated, one obtains N individual spectra, one spectrum for radiation entering each of the N entrance slots of the spectrometer.

In this note we present results for an instrument which incorporates 19 entrance and 19 exit slots. We show the instrument's dual capability to perform either one-dimensional imaging or alternately to give a spectrum with high S/N ratio over the entire source.

The instrument operates in the Littrow mode at f/8. The slot width and length for each mask are 0.625 mm and 3.5mm, respectively, giving a total aperture length of 12.1 mm. The corresponding resolving power at 1.7μ is 230. For the moment the masks are moved manually using translation stages calibrated to an accuracy of ± 0.0025 mm. The 19 element code is based on the S codes given by Sloane et.al.(2).

Figure 1 shows the 1.7μ emission spectrum of mercury. The first 19 traces give the spectral distributions of radiation entering each of the 19 entrance slots. The individual spectra are not composed of identical spectral elements. Successive spectra are shifted by one resolution element as explained in (1).

The bottom trace is a spectrum with greatly enhanced S/N ratio of the entire source obtained by averaging identical spectral elements of the first 19 spectra. Spacial information, however, is lost.

For uniform illumination of the entrance aperture, determining 2N-1 distinct spectral elements requires only 2N-1 linearly independent measurements. We have also used this mode of operation to obtain spectra.

In astronomical applications, one may use the large entrance aperture to observe extended diffuse regions. For compact regions, however, a smaller entrance aperture with fewer slots suffices. We have obtained good laboratory spectra with 3 entrance and 19 exit slots.

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References

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Figure Captions

Figure 1: The first 19 traces represent a one-dimensional image of the mercury source at various wavelengths centered about 1.7μ. The bottom trace is an enhanced S/N spectrum of the same region. The second peak is actually a doublet which cannot be resolved by this instrument. The results are for $N^2 = 361$ measurements.

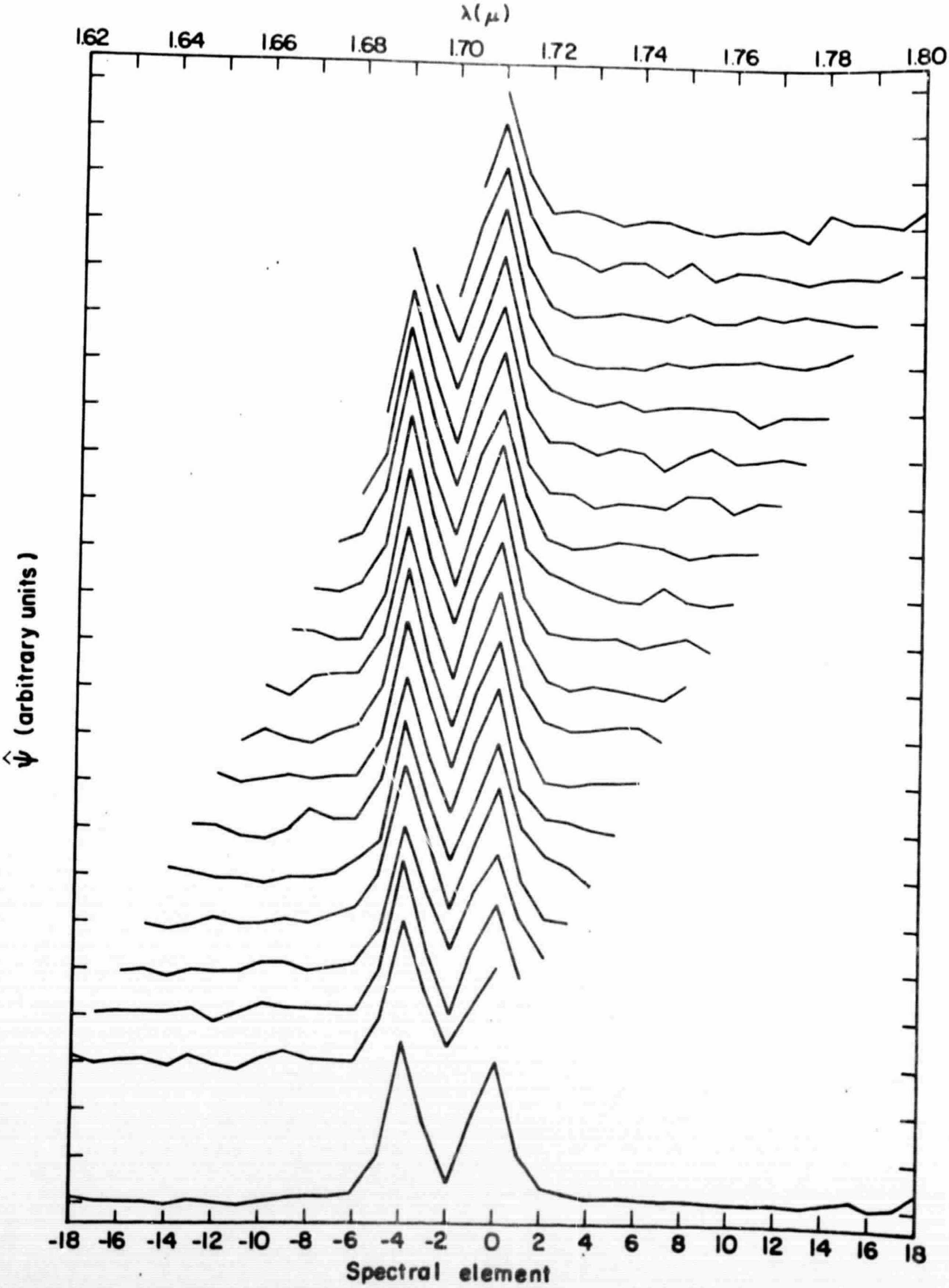
λ(μ)
1.62
1.64
1.66
1.68
1.70
1.72
1.74
1.76
1.78
1.80
ψ̂ (arbitrary units)
-18
-16
-14
-12
-10
-8
-6
-4
-2
0
2
4
6
8
10
12
14
16
18
Spectral element

Figure 1