Determination of SWP Aperture Dimensions from Analysis of Trail to Point Flux Ratios

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Introduction

Trailed and point source net flux data were analyzed using a method similar to the one developed by Panek (1982) in order to derive a value for the SWP aperture dimensions and trail path length. An accurate measurement of the trail length is needed, as such information is used to calculate the trailed exposure time:

$$t_{TR} = Trail\ length\ /\ Trail\ rate \tag{1}$$

where t_{TR} is the trailed exposure time in seconds, *Trail length* is in arcseconds, and *Trail rate* is in arcseconds per second. In addition, knowledge of the effective aperture area is needed to properly calibrate spectra of extended objects. The images used in this analysis (listed in Tables 1 and 2) have all been reprocessed using the final archive (NEWSIPS) software and are a subset of the low-dispersion sensitivity monitoring database (Garhart 1991).

Analysis

The analysis was performed on the extracted net spectrum before application of the absolute calibration. Sections of the spectra affected by camera reseaux and absorption features were interpolated across. Several trailed and point source spectra from each standard star and within a given epoch (so as to eliminate camera sensitivity degradation effects) were averaged together. The average trailed and point source spectra were then ratioed to each other to provide a trail/point net flux ratio for each time period and for each standard star, resulting in a total of 20 flux ratios (5 per standard) for major axis trail length images and 4 flux ratios for minor axis trail length data. To determine the trail path lengths, begin with the basic premise of a trail/point flux ratio:

$$R_\lambda = FN_{TR}\ /\ FN_{PT} \tag{2}$$

also:

$$FN_{TR}\ /t_{TR} = FN_{PT}\ /t_{PT}. \tag{3}$$

Upon combining Equations 2 and 3 and solving for t_{TR}, we have:

$$t_{TR} = R_\lambda * t_{PT} \tag{4}$$

where R_λ is the trail/point flux ratio, FN_{TR} and FN_{PT} are the trailed and point source net fluxes, and t_{PT} is the effective point source exposure time in seconds after correcting for

OBC quantitization and camera rise time effects (Oliversen 1991). The trail path distance can be expressed as a function of the trail rate and the trailed exposure time:

$$Trail\ distance\ =\ Trail\ rate\ *\ t_{TR}. \tag{5}$$

After substituting Equation 4 into Equation 5, the trail path dimension can then be determined:

$$Trail\ distance\ =\ Trail\ rate\ *\ R_{\lambda}\ *\ t_{PT}. \tag{6}$$

The trail rates and the effective point source exposure times are known quantities (Table 1), therefore one can derive a trail path measurement by calculating R_{λ}. A set of trail lengths as a function of wavelength were determined for each of the 20 trail/point ratios and found to be in close agreement, so that they were averaged together to produce a final major axis trail length measurement. Following the method of Panek (1982), the data were then binned at 50 Å wavelength intervals and a mean value was determined. The same analysis was also performed on the minor axis trail length data using an average of 4 trail/point ratios.

Summary

The various trail/point ratios for each star as a function of wavelength are plotted in Figures 1–4 for major axis trail length images. These plots show a wavelength dependency which is most pronounced shortward of 1500Å. This would seem to indicate that the flux throughput for trailed exposures is not as good in that region. A similar wavelength dependency is seen in the trail length plot (Figure 8), since the trail length is R_{λ} multiplied by a constant value. The trail/point ratios as a function of wavelength for minor axis trail length data are shown in Figures 5, 6, and 7. Unlike the major axis trail length analysis, no wavelength dependency is seen. This trend is reflected in the minor axis trail length plot displayed in Figure 9. The mean values and the corresponding standard deviations (Table 3) are calculated using a wavelength range from 1190Å to 1990Å.

According to Panek (1982), the aperture width is 1.8 percent smaller than the trail length across the short axis and the aperture length is 0.8 percent larger than trail length across the long axis due to the 11 degree tilt with respect to the major and minor axis. Likewise, the aperture area is 0.91 times the product of the major and minor axis lengths because of the rounded aperture edges. The aperture dimensions (Table 3), derived using these corrections, are in close agreement with the measurements made by Panek (within one sigma). The preflight determinations by Bohlin, et al. (1980) are also shown for comparison purposes.

References

Bohlin, R.C., et al. 1980, *Astronomy and Astrophysics*, **85**, 1.
Garhart, M.P. 1991, *NASA IUE Newsletter*, **46**, 57.
Oliversen, N.A. 1991, *NASA IUE Newsletter*, **45**, 56.
Panek, R. 1982, *NASA IUE Newsletter*, **18**, 68.

Table 1

SWP Images Used in Aperture Length Analysis

Object	Pt. Source Image no.	Trailed Image no.	Date	Trail Rate ($\frac{arcsec}{sec}$)	t_{PT} (sec)
HD 60753	3226	3219	1978.8	0.49	9.7014
	3354	3240			
	17980	18062	1982.7		
	18092	18093			
	23620	23898	1984.6		
	23838	23906			
	23899	23910			
		23914			
	36958	37103	1989.7		
	36959	37111			
	36960				
	37214				
	42951	42950	1991.9		
	43087	43194			
	43345	43346			
BD+75° 325	19793	19794	1983.3	0.4608	13.797
	19918	19923			
	22250	22381	1984.1		
	22465	22466			
	37850	37852	1990.0		
	37949	37982			
	41125	41182	1991.2		
	41393	41392			
	42462	42463	1991.8		
	42925	42924			
	43159	43160			
	43290	43289			

Table 1 (continued)

SWP Images Used in Aperture Length Analysis

Object	Pt. Source Image no.	Trailed Image no.	Date	Trail Rate ($\frac{arcsec}{sec}$)	t_{PT} (sec)
BD+28° 4211	9841	9749	1980.6	0.2564	25.676
	10056	9753			
	14278	14279	1981.5		
	14311	14314			
	14426	14318			
	15324	15325	1981.8		
	15736	15326			
	29924	29919	1987.0		
	29927	29926			
	43148	43149	1991.9		
	43312	43313			
HD 93521	7057	6960	1979.8	1.6667	2.7382
	7058				
	16225	16226	1982.1		
	16296	16389			
	21502	21703	1983.9		
	21868	21870			
	25633	25569	1985.3		
	25831	26051			
	43126	42926	1991.9		
	43292	43291			

Table 2

SWP Images Used in Aperture Width Analysis

Object	Pt. Source Image no.	Trailed Image no.	Date	Trail Rate ($\frac{arcsec}{sec}$)	t_{PT} (sec)
HD 93521	10939	10940	1981.0	3.64	2.7382
BD+75° 325	9582	9581	1980.6	0.714	13.797
		9589		0.678	
HD 60753	44489	44488	1992.3	0.91	9.7014

Table 3

SWP Aperture Dimensions

Garhart	Panek	Bohlin	Dimension
21.48±0.39	21.4±0.4		Major Axis Trail Length (arcsec)
21.65±0.39	21.6±0.4	< 23.0	Aperture Length (arcsec)
9.24±0.11	9.1±0.3		Minor Axis Trail Length (arcsec)
9.07±0.11	8.9±0.3	< 10.3	Aperture Width (arcsec)
178.69±3.88	175.0±9.0	214.0	Aperture Area (arcsec^2)

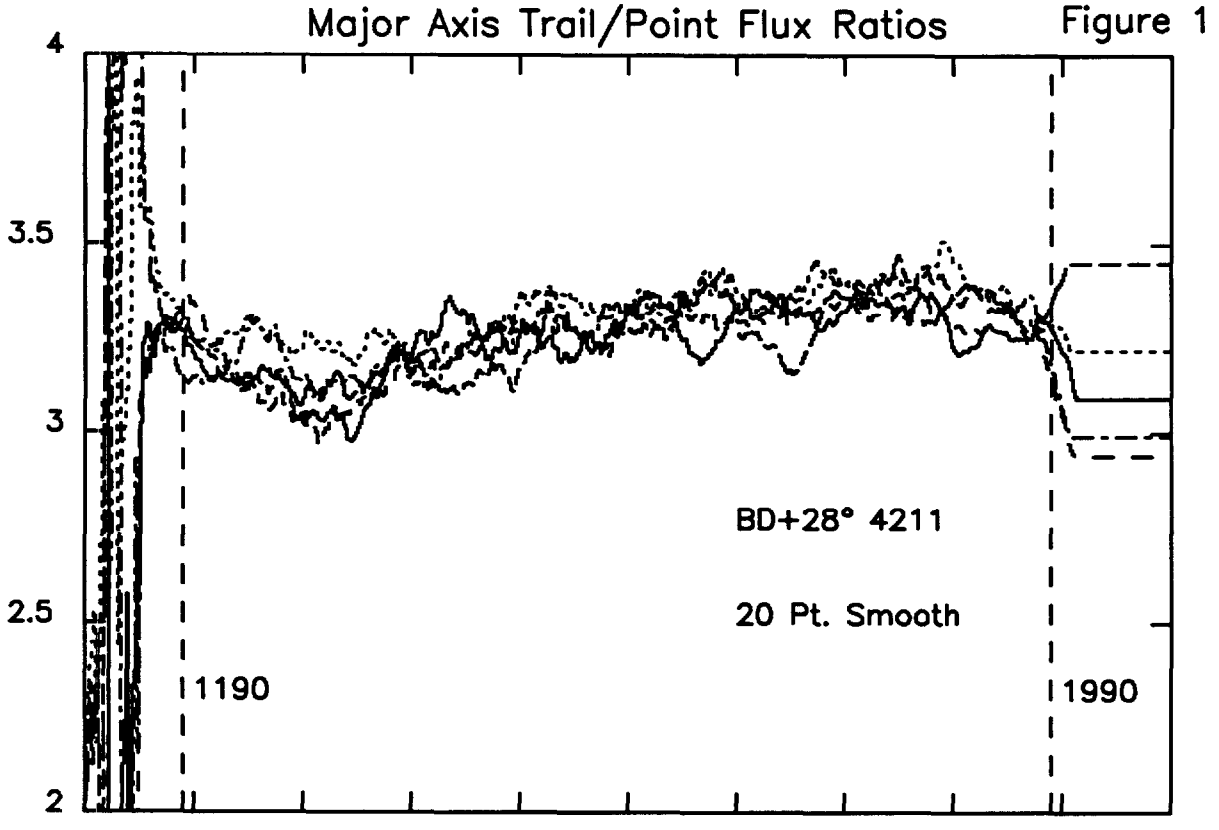


Figure 1

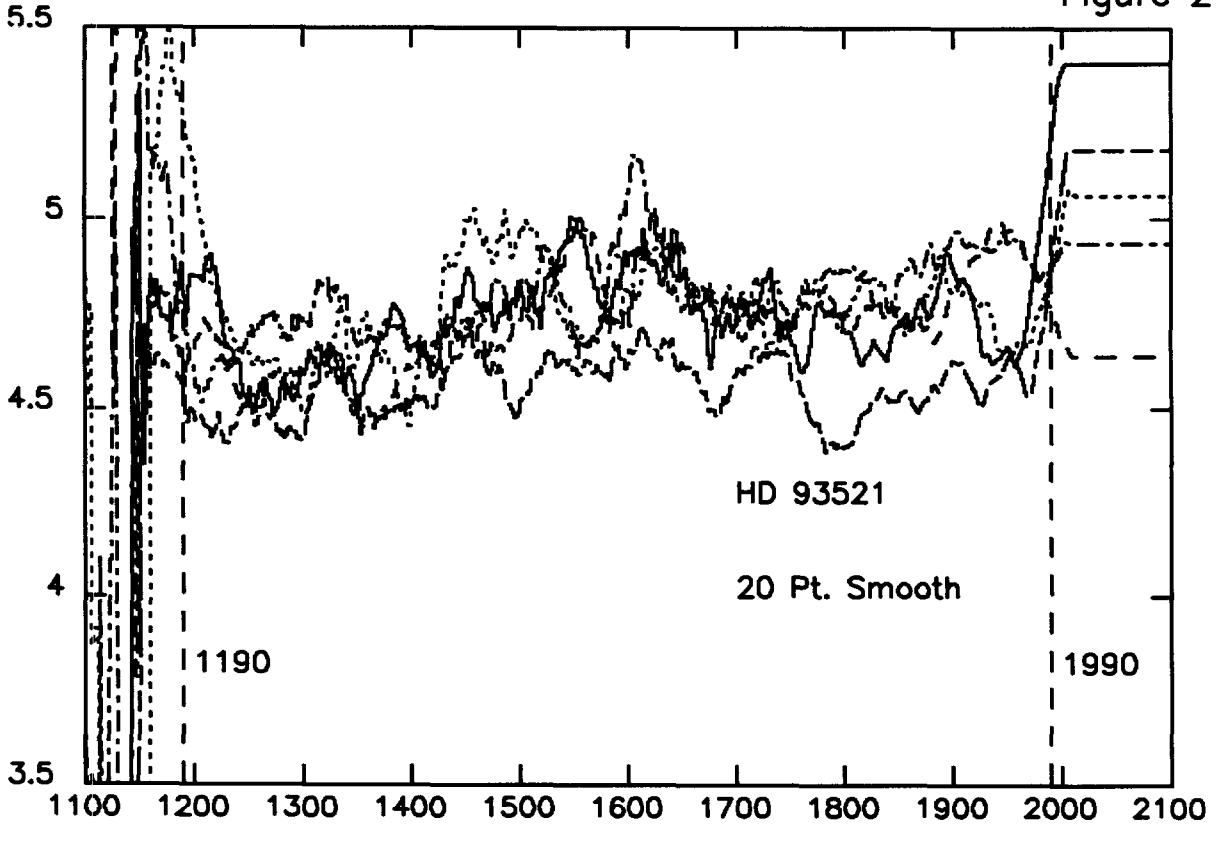


Figure 2

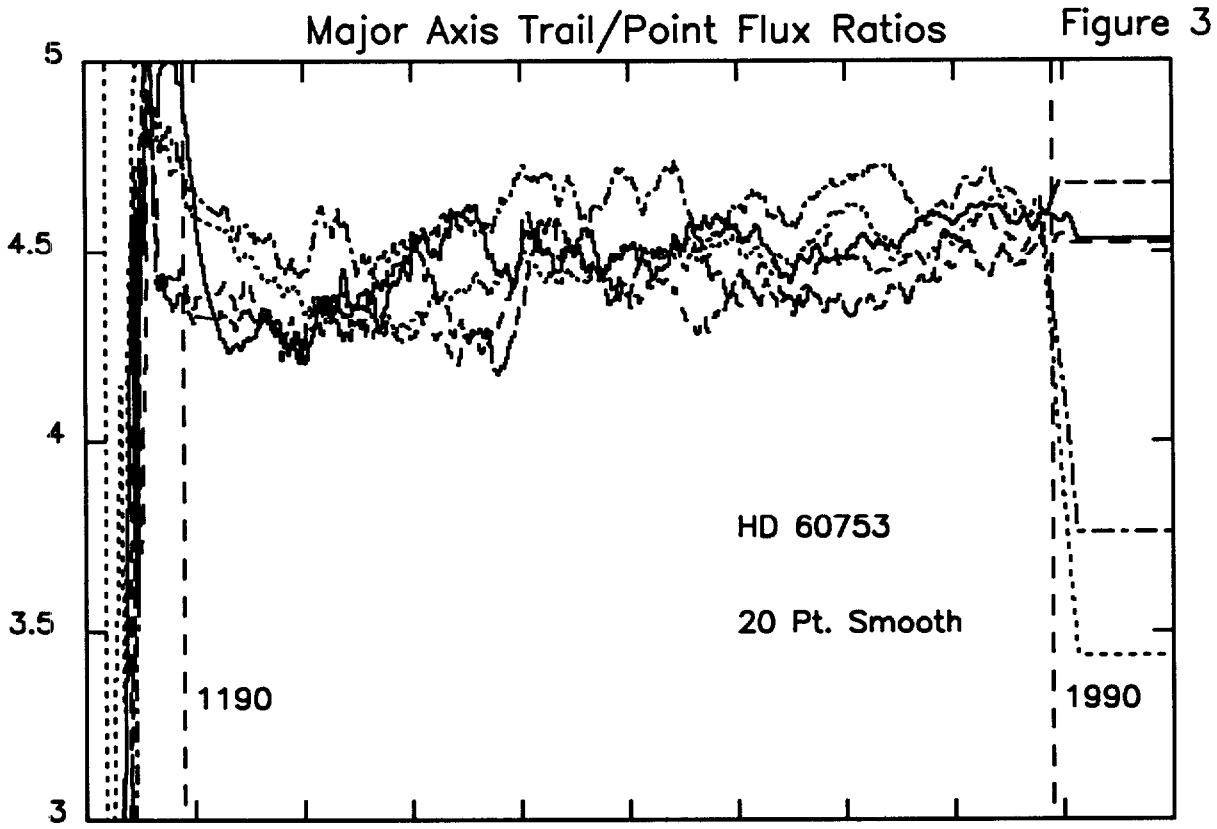


Figure 3

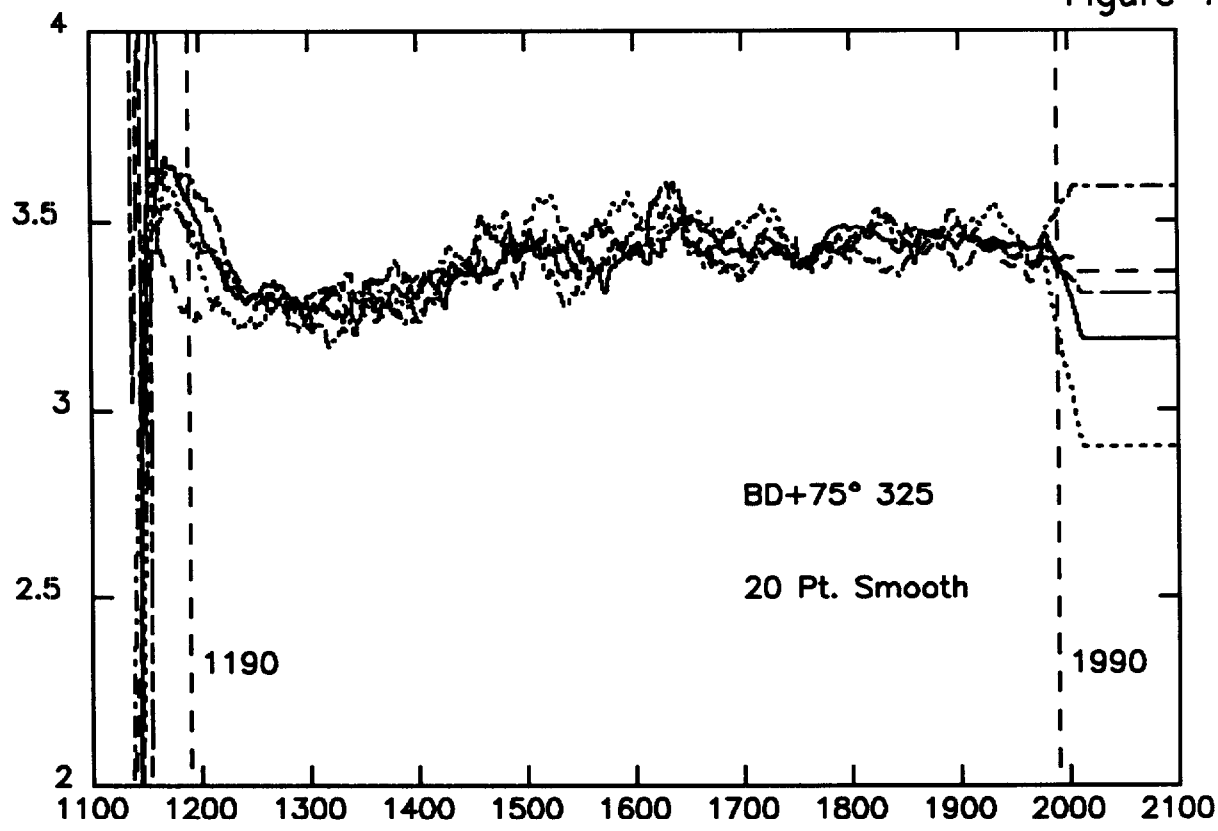


Figure 4

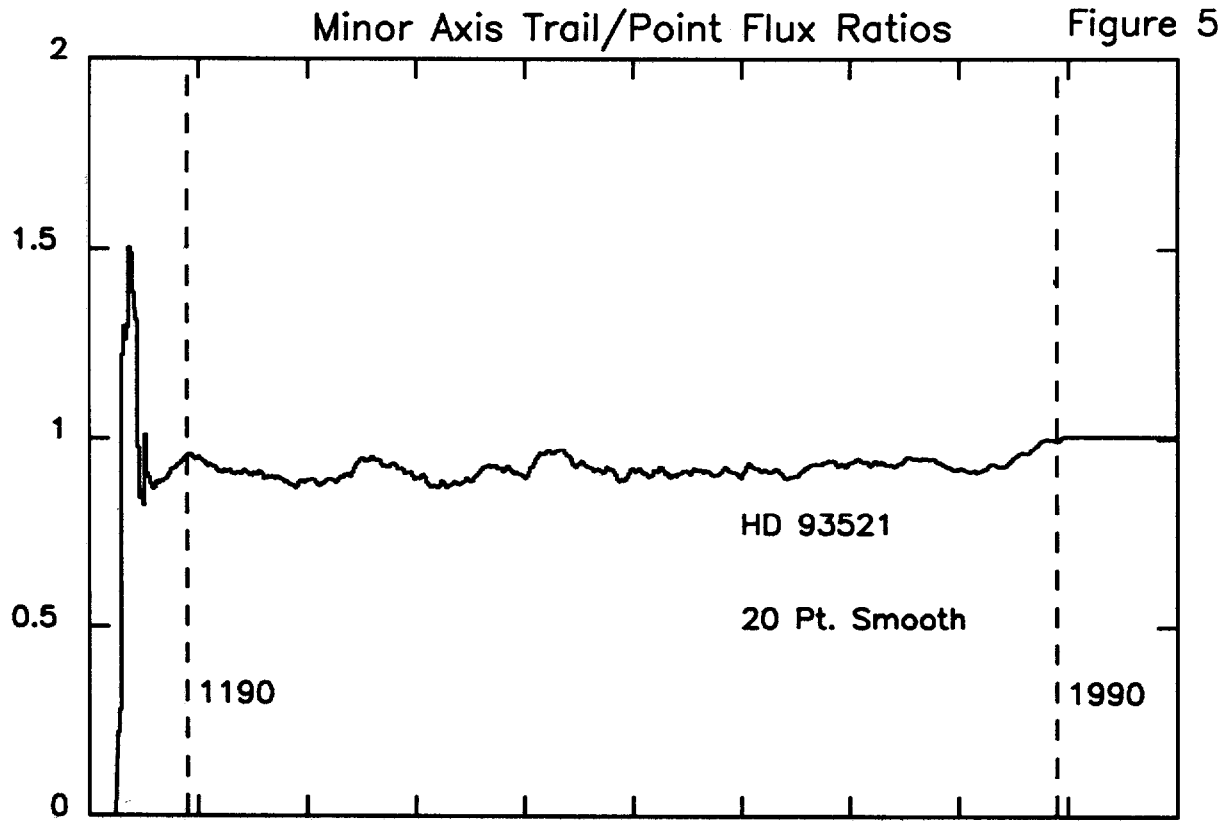


Figure 5

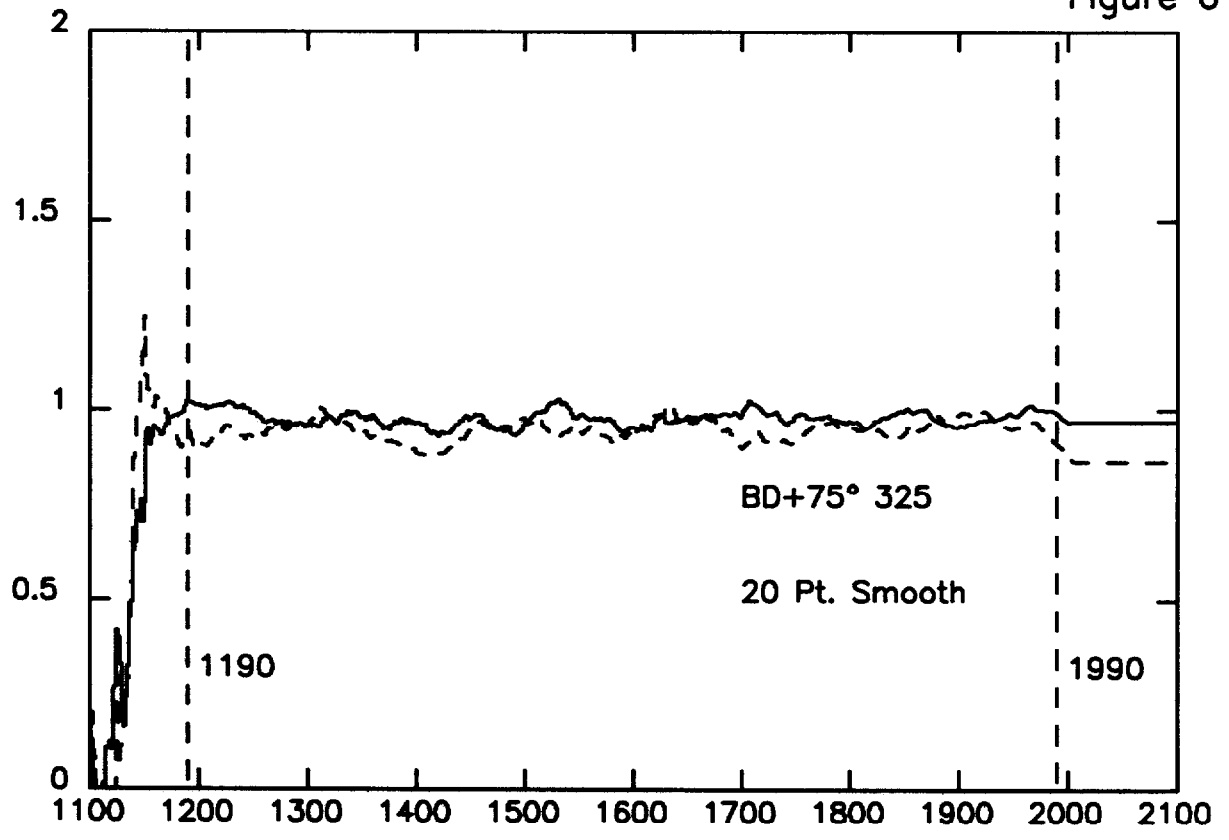
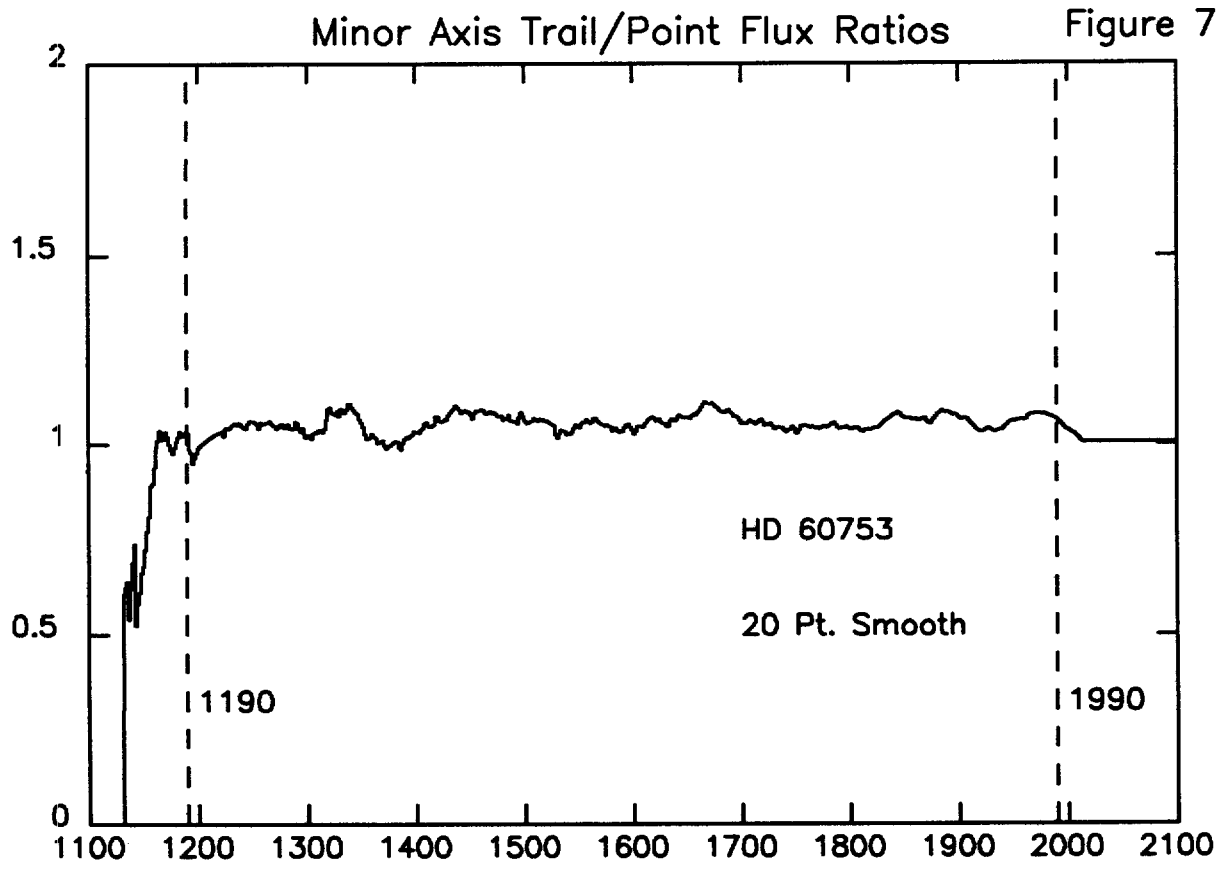


Figure 6


Minor Axis Trail/Point Flux Ratios
Figure 7
2
1.5
1
0.5
0
HD 60753
20 Pt. Smooth
1190
1990
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
2100

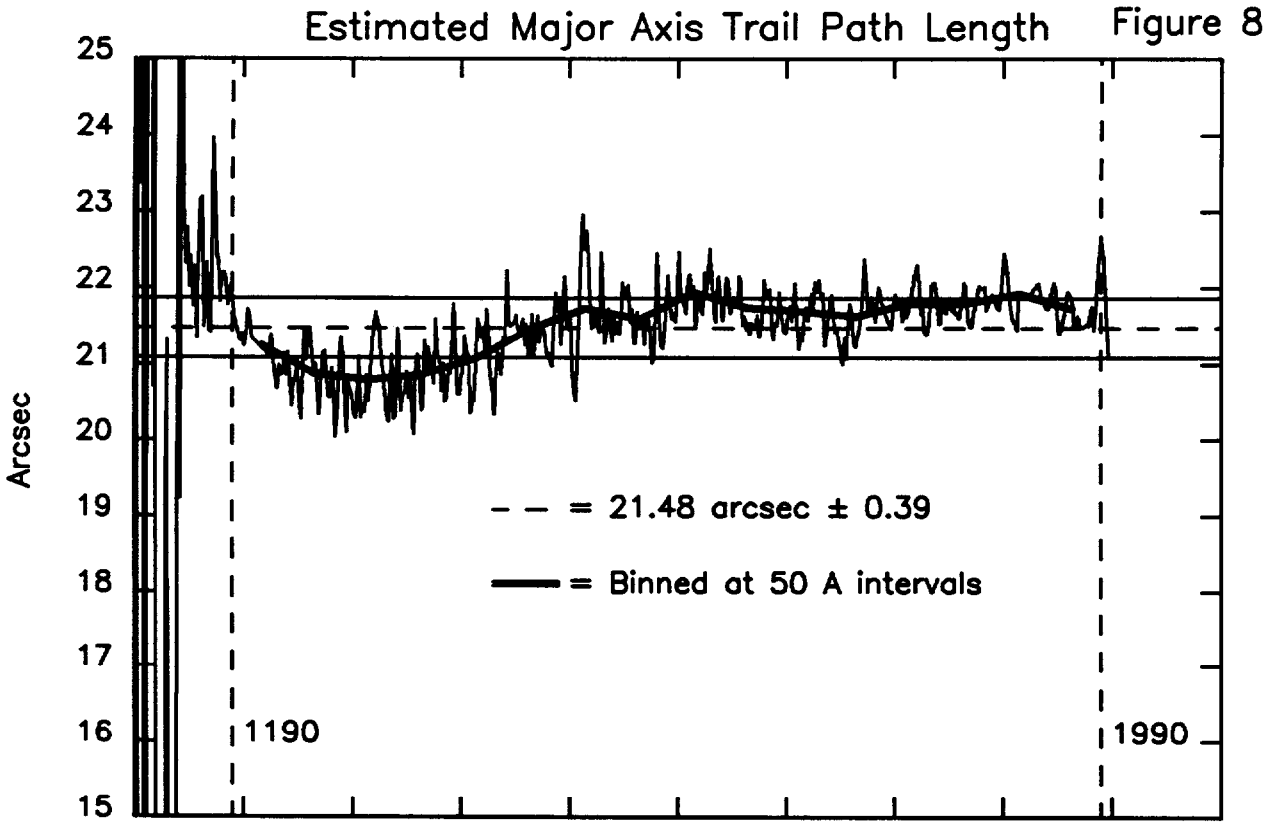


Figure 8

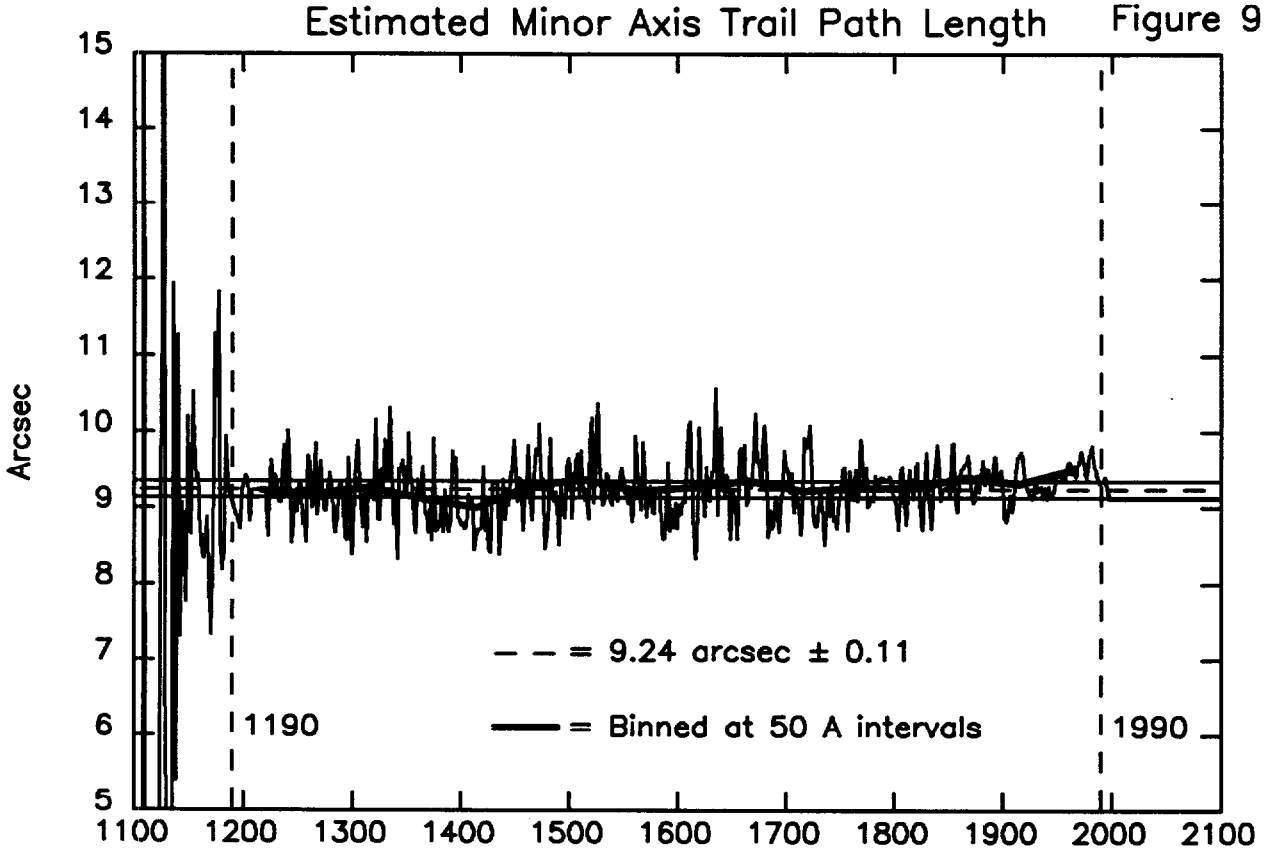


Figure 9