SET ABSORPTION LINE PROFILES OF THE BETA-LYRAE SYSTEM

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ABSTRACT. The paper describes a set of profiles of 19 selected absorption spectral lines of the β Lyrae system with the continuum reduced to unity. The profiles have been measured on spectrograms well spread throughout the whole cycle

The reduced profiles may be a suitable material for testing radiative transfer calculations for stellar atmospheres with convenient physical characteristics.

НАБОР ПРОФИЛЕЙ АБСОРПЦИОННЫХ ЛИНИЙ СИСТЕМЫ β ЛИРЫ. Работа представляет совокупность 19 контуров избранных абсорпционных спектральных линий β Лиры редуцированных к одиничной интенсивности континуума полученных из спектрограмм хорошо покрывающих всю кривую блеска.

Редуцированные контуры являются подходящими для тестов исчислений переноса излучения в атмосферах отвечающих физических характеристик.

SADA PROFILOV ABSORPČNÝCH ČIAR SÚSTAVY β LYRAE. Práca predstavuje sadu 19 profilov vybraných absorpčných spektrálnych čiar β Lyrae, získaných zo spektrogramov pokrývajúcich celú svetelnú krivku a redukovaných k jednotkovej intenzite kontinua.

Redukované profily sú vhodné pre testy výpočtu prenosu žiarenia v atmosférach hviezd odpovedajúcich fyzikálnych charakteristík.

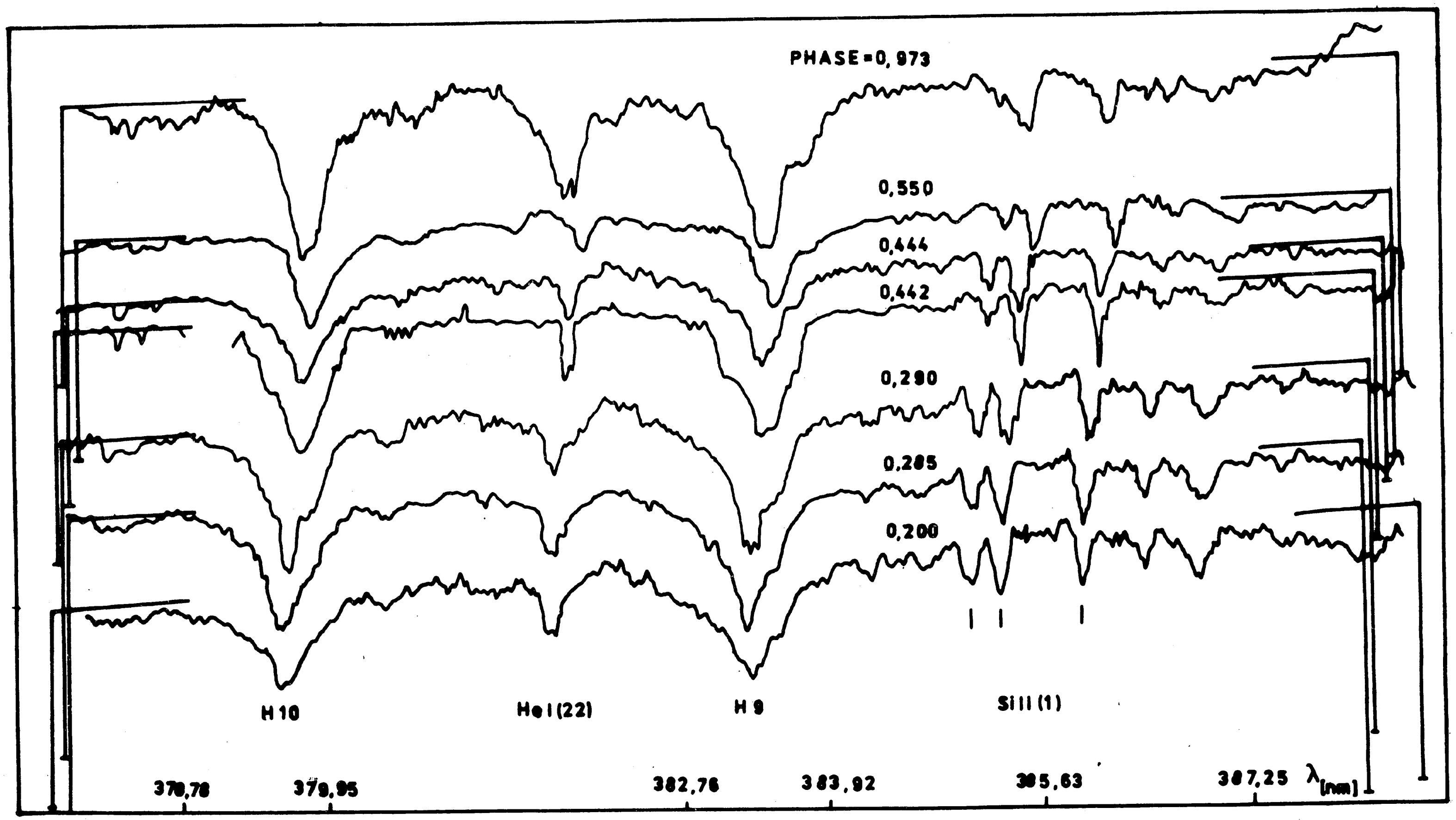

Fig. 1 Set of the parts of the intensity tracings of the β Lyrae spectrum with continuum nonreduced to unity. The continuum intensity is marked by vertical bars on the both edges of the tracings.

During the years 1971, 1972 and 1975, 36 high-dispersion spectrograms of the β Lyrae system were obtained at the Ondřejov Observatory. So far they have partly been treated in (Kříž and Ždárský,1974; Bahýl',1979), where the details of the spectrograms and of the method of treatement and observation have been published.

The intensity tracings were used to select 19 spectral lines which are not visibly influenced by the emission component of the β Lyrae spectrum. The list of these absorption spectral lines is in Table 1, the columns of which contain the following data: the first and the third contain the spectral line's name and the second and the fourth columns contain the corresponding wavelengths in nanometres. The selected profiles were reduced to unit continuum intensity and introduced according to phase in the following tables. They contain the following data: the name of the line with its wavelength are in the first row. This is followed by the text of the heading and under it in two rows are the number of the plate according to the Ondřejov numbering of plates (Kříž and Ždárský,1974) and the phase computed from the ephemeris of Rocznik Astronomiczny (1971, 1972 and 1975). The wavelength difference between the measured place on the profile and the line centre is given in the first column of each table. Individual columns of the Tables 2 - 20 contain the residual intensities with the continuum reduced to unity.

The continuum reduction was made with the aim of studying the changes of the absorption line profiles independently of the continuum changes. The radiation intensities in selected wavelengths in steps of 0.1 nm to 0.05 nm were measured on each intensity tracing.

The mean error of this profile never exceeded 3% of the measured intensity. But each profile was manually smoothed before reduction, i.e. a mean curve was fitted to the profile eliminating the disturbances caused by the photographic emulsion. If the profile was affected by another near spectral line, only the unaffected wing was reduced. The appertaining place for the data from the affected wing remained empty in the profile table. For example, the profile of the hydrogen spectral line Hϵ is affected by the Ca II H line. Similarly, some spectral lines were not reduced in spectrograms of rather low quality. Their place in the table remained empty, too. This situation occurred predominantly around the primary minimum.

To illustrate the influence of the reduction on the profile, we have included Fig. 1 in this paper. It shows parts of seven intensity records on an arbitrary scale without the continuum being reduced to unity. Some reduced profiles from the same interval of wavelengths are shown in Figs 2, 3 and 4, arranged in columns by phase. If we compare Fig. 1 with them, we can see that, owing to the smoothing, the details have vanished, but greater changes, which are essential to us are more striking. The phase dependence of the line can be seen well in Figs 2, 3 and 4. The spectral lines are strongest in the primary minimum and with growing phase they become shallower and weaker. The absorption in the spectral lines increases again around phase 0.5 and then it

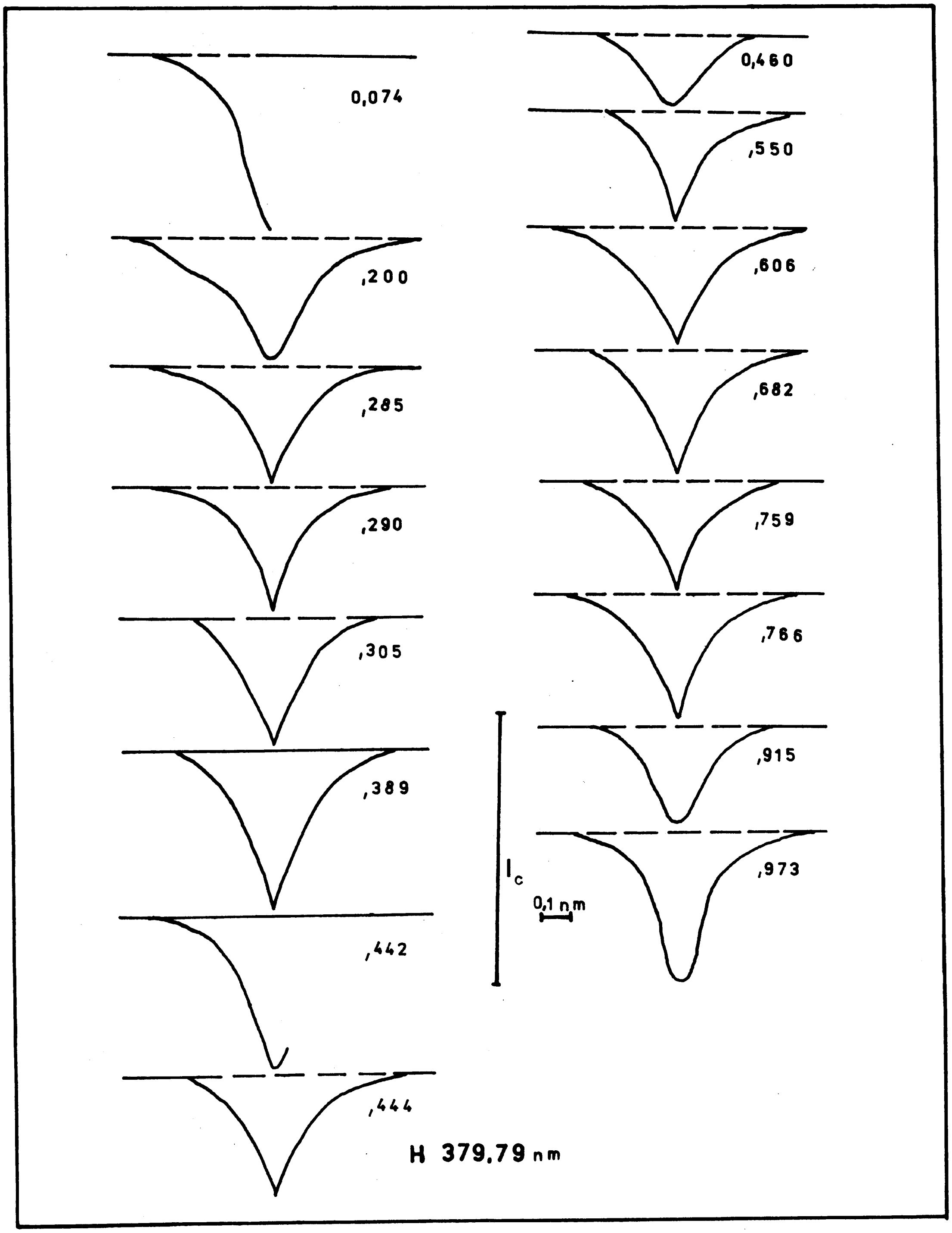

Fig. 2 Reduced profiles of the hydrogen spectral line H 10 in various phases. The number near the profile is the phase.

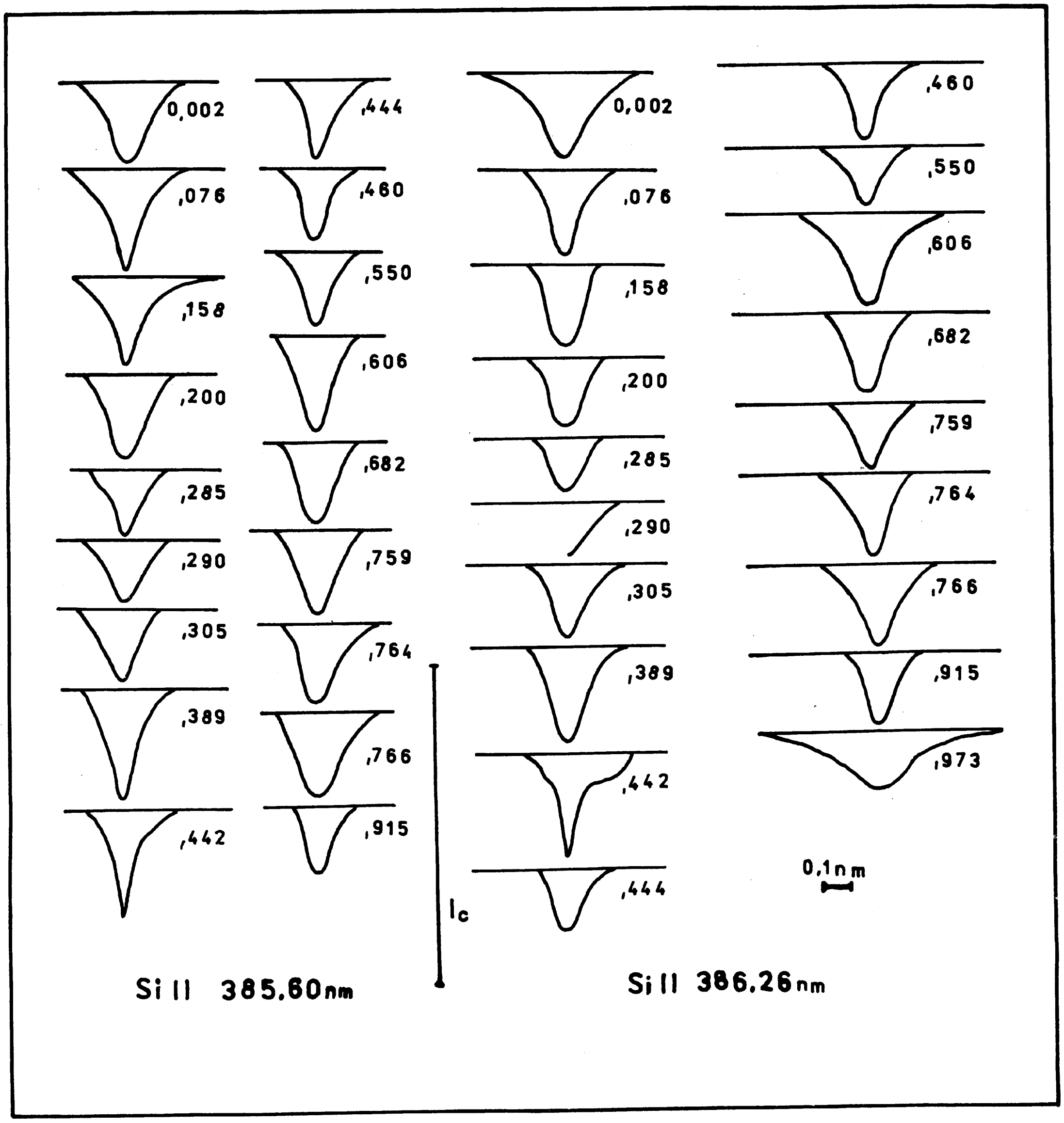

Fig. 3 Reduced profiles of two silicon spectral lines in different phases. Next the same as Fig. 2.

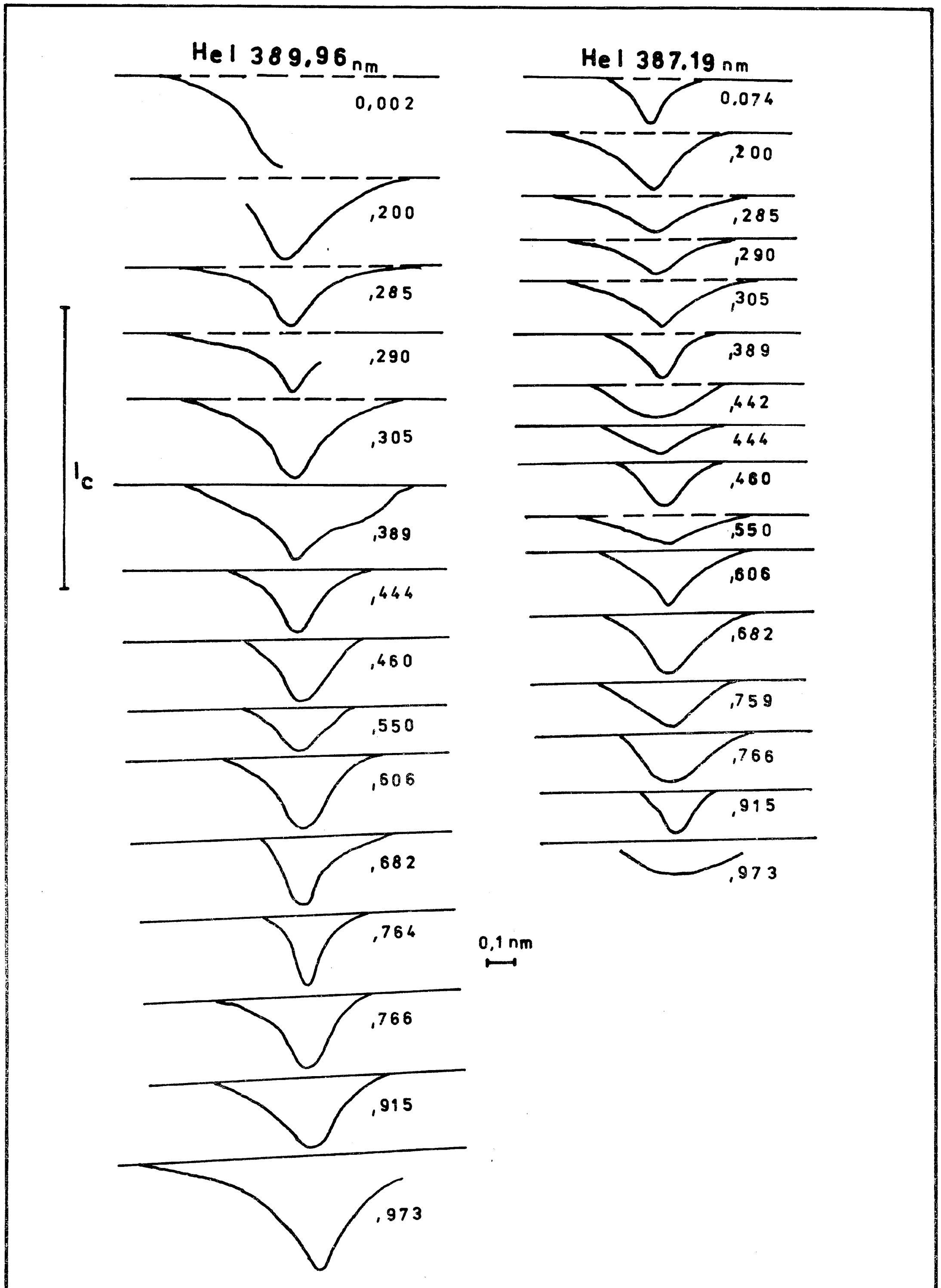

Fig. 4 Reduced profiles of two neutral helium spectral lines in different phases. Next the same as Fig. 2.

does not change much until the end of the cycle. We can only see a moderate rise of absorption around phase 0.75.

This kind of spectral-line observation in different phases is very important from the point of view of profile selection, if its theoretical shape is to be computed. Previous authors (Struve and Zebergs, 1961 and others) have used spectrograms around the secondary minimum. This is logically correct. But the results of investigating the equivalent-width phase dependence (Bahýľ, 1979, this paper) indicate that it is better to select the spectrum around phases 0.25 or 0.75. On the other hand, we must take into account the radiation of the system's envelope. Otherwise we may arrive at rather overestimated conclusions concerning the chemical composition of the primary component.

Our reduced profiles may serve as a foundation for the β Lyrae chemical composition study. They may also be used in comparison between the theoretical and the observed profiles for stars with the same physical characteristics as the β Lyrae primary component has.

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Struve, O., Zebergs, V.: 1961, Astrophys. J. 133, 519.

Table 1

line	λ (nm)	line	λ (nm)
H 11	377.06	Si II	385.37
H 10	379.79	Si II	385.60
H 9	383.54	Si II	386.26
H 7	397.06	Si II	412.80
H 6	410.16	Si II	413.09
He I	381.90	Si II	634.71
He I	387.19	Si II	637.14
He I	392.65	Ca II	393.36
He I	400.93	Mg II	448.12
He I	414.37		

Table 2

H 11 λ = 377.06 nm

	Nº of plate / phase																				
Δ λ	903	906	910	914	922	1144	1153	1160	923	932	1168	1169	2317	1281	854	861	870	852	891	877	1148
/nm/	.002	.005	.006	.076	.158	.200	.285	.290	.305	.389	.442	.444	.460	.550	.606	.682	.759	.764	.766	.915	.973
-0.9				1.00					1.00												
0.8				0.99		0.97		1.00	0.98		1.00								1.00		
0.7				.97		.95	1.00	0.99	.96		0.99	1.00					1.00		0.99		1.00
0.6				.95		.92	0.98	.97	.94		.96	0.98		1.00	1.00	1.00	0.99		.96	1.00	0.98
0.5				.92		.90	.95	.94	.90	1.00	.92	.96	1.00	0.99	0.96	0.95	.96		.91	0.96	.95
0.4				.87		.86	.91	.91	.86	0.94	.84	.92	0.99	.97	.92	.90	.92		.86	.91	.91
0.3				.80		.78	.84	.86	.80	.84	.72	.87	.96	.93	.87	.82	.88		.79	.84	.83
0.2				.68		.70	.74	.79	.74	.75	.60	.78	.91	.82	.77	.73	.82		.73	.76	.71
-0.1				.51		.63	.65	.70	.65	.56	.47	.67	.83	.66	.61	.65	.68		.64	.69	.52
0.0				0.37		.57	.56	.55	.51	.46	.40	.56	.74	.57	.50	.50	.60		.45	.63	.42
+0.1						.67	.65	.72	.66	.57	.53	.69	.83	.68	.60	.65	.66		.63	.68	.52
0.2						.79	.74	.77	.77	.71	.67	.80	.90	.79	.72	.75	.78		.74	.77	.70
0.3						.86	.84	.83	.85	.82	.80	.86	.95	.87	.83	.82	.85		.82	.86	.82
0.4						.90	.91	.93	.91	0.92	.90	.92	.98	.91	.90	.88	.91		.88	.95	.89
0.5						.94	.96	0.99	.95	1.00	0.96	.95	0.99	.94	.95	.93	.96		.92	0.99	.93
0.6						.96	0.98	1.00	.98		1.00	.98	1.00	.96	0.98	0.97	0.97		.94	1.00	.95
0.7						.98	1.00		0.99			0.99		.98	1.00	1.00	1.00		.96		.97
0.8						0.99			1.00			1.00		0.99					.97		.98
+0.9						1.00								1.00					0.98		0.99

Table 3

H 10 λ = 379.79 nm

Δλ	№ of plate / phase																				
	903	906	910	914	922	1144	1153	1160	923	932	1168	1169	2317	1281	854	861	870	852	891	877	1148
/nm/	.002	.005	.006	.076	.158	.200	.285	.290	.305	.389	.442	.444	.460	.550	.606	.682	.759	.764	.766	.915	.973
-1.1						1.00															
0.9				1.00		0.98	1.00	1.00			1.00	1.00			1.00						1.00
0.7				0.97		.92	0.97	0.98	1.00	1.00	0.98	0.98	1.00	1.00	0.95	1.00	1.00		1.00	1.00	0.98
0.5				.92		.86	.94	.95	0.99	0.94	.93	.95	0.99	0.98	.91	0.97	0.99		0.96	0.98	.95
0.4				.88		.83	.91	.93	.92	.88	.89	.92	.96	.97	.88	.92	.94		.91	.92	.92
0.3				.82		.79	.87	.88	.83	.81	.81	.87	.92	.95	.84	.85	.87		.84	.88	.85
0.2				.67		.73	.81	.80	.75	.72	.67	.80	.86	.87	.77	.78	.80		.77	.78	.73
-0.1				.47		.62	.70	.72	.65	.59	.53	.70	.79	.68	.67	.68	.71		.67	.69	.53
0.0				0.36		.56	.59	.55	.54	.43	.44	.56	.74	.59	.58	.54	.61		.54	.64	.44
+0.1						.62	.70	.72	.65	.56	0.52	.65	.79	.68	.67	.68	.73		.71	.71	.51
0.2						.72	.79	.75	.75	.69		.76	.84	.79	.77	.80	.85		.81	.81	.75
0.3						.81	.86	.84	.83	.78		.85	.90	.88	.85	.85	.90		.86	.88	.84
0.4						.88	.90	.92	.91	.86		.89	.94	.93	.89	.89	.93		.92	.93	.89
0.5						.93	.95	.96	0.97	.92		.93	0.98	.95	.93	.93	0.96		.95	0.97	.93
0.7						.96	.98	0.99	1.00	0.96		.97	1.00	0.98	0.98	0.98	1.00		0.99	1.00	.96
0.9						0.99	0.99	1.00		1.00		0.99		1.00	1.00	1.00			1.00		0.98
+1.1						1.00	1.00					1.00									1.00

Table 4

H 9 λ = 383.54 nm

Nº of plate / phase

$\Delta\lambda$	903	906	910	914	922	1144	1153	1160	923	932	1168	1169	2317	1281	854	861	870	852	891	877	1148
/nm/	.002	.005	.006	.076	.158	.200	.285	.290	.305	.389	.442	.444	.460	.550	.606	.682	.759	.764	.766	.915	.973
-1.3						1.00				1.00	1.00	1.00									
1.1						0.99	1.00	1.00	1.00	0.99	0.99	0.99			1.00					1.00	
0.9						.96	0.98	0.98	0.98	.93	.96	.97			0.99	1.00	1.00		1.00	0.97	1.00
0.7						.89	.94	.94	.94	.86	.94	.94			.96	0.97	0.98		0.98	.93	0.96
0.5						.80	.90	.89	.88	.79	.91	.90			.91	.92	.93		.96	.86	.88
0.4						.76	.86	.86	.85	.75	.85	.88			.87	.87	.89		.93	.81	.82
0.3				0.80		.70	.82	.83	.80	.71	.78	.83	0.85		.81	.83	.86		.89	.74	.75
0.2				.69		.66	.78	.76	.74	.65	.67	.79	.78		.74	.79	.80		.84	.68	.64
-0.1				.51		.56	.69	.68	.64	.58	.54	.69	.74		.64	.70	.71		.70	.60	.47
0.0				.38		.48	.55	.56	.55	0.48	0.46	0.55	.71	0.61	.53	.51	.59		.60	.50	.43
+0.1				.51		.59	.66	.67	.63				.74	.70	.65	.65	.71		.71	.61	.49
0.2				.74		.69	.75	.71	.73				.78	.81	.75	.74	.80		.84	.70	.72
0.3				.83		.76	.82	.79	.82				.84	.85	.81	.79	.84		.92	.75	.80
0.4				.90		.83	.89	.89	.87				0.93	.89	.85	.85	.88		.95	.81	.85
0.5				.94		.87	.92	.92	.91					.91	.88	.88	.92		.96	.85	.88
0.7				.96		.91	.96	.94	.96					.94	.93	.91	.95		0.98	.90	.93
0.9				.98		.94	.98	.96	.98					.96	.96	.93	0.98		1.00	.94	.96
1.1				0.99		.96	0.99	.97	0.99					.97	0.99	.95	1.00			.96	.98
1.3				1.00		.98	1.00	.98	1.00					.98	1.00	.98				.98	0.99
1.5						0.99		0.99						0.99		0.99				0.99	1.00
+1.7						1.00		1.00						1.00		1.00				1.00	

Table 5

H 7 λ = 397.06 nm

$\Delta\lambda$ /nm/	Nº of plate / phase: 903	906	910	914	922	1144	1153	1160	923	932	1168	1169	2317	1281	854	861	870	852	891	877	1148
	.002	.005	.006	.076	.158	.200	.285	.290	.305	.389	.442	.444	.460	.550	.606	.682	.759	.764	.766	.915	.973
-0.1																0.70	0.74				
0.0	0.54				0.46	0.45	0.64		0.63	0.54			.65	0.65	0.57	.62	.64	0.63	0.64	0.58	
+0.1	.71				.66	.58	.70		.72	.70			.68	.70	.71	.72	.75	.74	.72	.68	
0.2	.92				.82	.73	.78		.79	.81			.78	.83	.83	.79	.82	.80	.79	.76	
0.3	0.99				.88	.86	.87		.85	.89			.87	.87	.90	.83	.87	.84	.86	.81	
0.4	1.00				.93	.94	.93		.90	.93			.92	.90	.94	.84	.90	.88	.90	.86	
0.5					.96	.98	.96		.95	.96			.96	.91	.96	.87	.92	.91	.92	.90	
0.7					0.99	0.99	0.99		0.99	.98			0.98	.94	0.99	.95	.96	.96	.96	.96	
0.9					1.00	1.00	1.00		1.00	0.99			1.00	.95	1.00	0.99	0.98	0.98	0.98	0.98	
1.1										1.00				.96		1.00	1.00	1.00	1.00	1.00	
1.3														.97							
1.5														.98							
1.7														0.99							
+1.9														1.00							

Table 6

H 6 λ = 410.16 nm

$\Delta\lambda$	N° of plate / phase							
/nm/	914	922	1144	1153	2317	870	852	877
-1.5		1.00	1.00					
1.3		0.98	0.98					
1.1		.97	.97	1.00				
0.9		.96	.96	0.99				
0.7		.94	.94	.98				
0.5		.90	.89	.97				
0.4		.86	.85	.95				
0.3		.81	.82	.93				
0.2	0.63	.74	.73	.89				
-0.1	.51	.60	.61	.81				
0.0	0.39	0.50	0.50	0.69	0.67	0.71	0.69	0.60
+0.1					.71	.78	.78	.70
0.2					.80	.84	.84	.78
0.3					.91	.86	.88	.82
0.4					0.97	.88	.90	.85
0.5					1.00	.90	.92	.88
0.7						.94	.95	.92
0.9						.96	.96	.95
1.1						.97	0.98	.97
1.3						0.99	1.00	0.99
+1.5						1.00		1.00

Table 7

He I λ = 381.90 nm

Δλ /nm/	903 .002	906 .005	910 .006	914 .076	922 .158	1144 .200	1153 .285	1160 .290	923 .305	932 .389	1168 .442	1169 .444	2317 .460	1281 .550	854 .606	861 .682	870 .759	852 .764	891 .766	877 .915	1148 .973
-0.7																					1.00
-0.6								1.00													0.99
0.5	1.00						1.00	0.99													.97
0.4	0.98						0.99	.97	1.00	1.00									1.00	1.00	.94
0.3	.94						.98	.96	0.97	0.97		1.00			1.00				0.99	0.99	.89
0.2	.89						.96	.95	.93	.92		0.99	1.00	1.00	0.97	1.00		1.00	.96	.93	.84
0.15	.85					0.90	.94	.93	.89	.89		.96	0.98	0.97	.94	0.99	1.00	0.99	.94	.89	.81
0.1	.76					.84	.91	.91	.85	.86		.92	.90	.94	.89	.91	0.96	.96	.87	.85	.76
-0.05	.69					.74	.84	.86	.77	.81		.84	.83	.88	.79	.80	.87	.86	.78	.79	.68
0.0	0.66					.71	.79	.79	.72	.73		.78	.78	.85	.75	.75	.80	.74	.74	.76	.62
+0.05						.75	.84	.85	.77	.78		.84	.82	.91	.79	.87	.86	.86	.80	.80	.68
0.1						.80	0.90	0.90	.85	.82		.91	.88	.95	.88	.92	.94	.93	.92	.88	.75
0.15						.85	.93		.88	.85		.96	.96	0.98	.95	.94	0.97	.96	.96	.94	.80
0.2						.89	.94		.92	.88		0.98	0.99	1.00	0.99	.96	1.00	0.99	0.98	0.98	0.85
0.3						.95	.97		0.97	0.96		1.00	1.00		1.00	0.99		1.00	1.00	1.00	0.90
0.4						0.97	0.99		1.00	1.00						1.00					
+0.5						1.00	1.00														

Table 8

He I λ = 387.19 nm

$\Delta\lambda$ /nm/	N° of plate / phase 903 .002	906 .005	910 .006	914 .076	922 .158	1144 .200	1153 .285	1160 .290	923 .305	932 .389	1168 .442	1169 .444	2317 .460	1281 .550	854 .606	861 .682	870 .759	852 .764	891 .766	877 .915	1148 .973
-0.5						1.00															
0.4						0.99	1.00	1.00	1.00					1.00	1.00						
0.3						.97	0.98	0.99	0.99	1.00	1.00	1.00		0.99	0.99	1.00	1.00				
0.2				1.00		.94	.95	.98	.96	0.98	0.99	0.98	1.00	.96	.97	0.96	0.96		1.00		0.95
0.15				0.98		.91	.94	.97	.94	.97	.94	.96	0.99	.94	.95	.94	.93		.96	1.00	.93
0.1				.96		.88	.93	.94	.92	.95	.91	.94	.94	.93	.91	.90	.89		.89	0.97	.91
-0.05				.91		.83	.90	.90	.89	.89	.89	.92	.89	.91	.87	.82	.86		.84	.90	.90
0.0				.84		.79	.87	.88	.84	.84	.88	.90	.84	.90	.80	.78	.83		.83	.85	.89
+0.05				.91		.83	.90	.90	.87	.89	.89	.92	.87	.91	.85	.82	.86		.85	.90	.90
0.1				.95		.88	.92	.94	.91	.96	.91	.96	.92	.93	.90	.87	.91		.89	0.97	.91
0.15				0.98		.93	.94	.96	.93	.98	.94	.97	.97	.95	.93	.92	.95		.94	1.00	.92
0.2				1.00		.96	.96	.98	.96	0.99	0.98	0.99	.99	.97	.95	.96	0.98		0.98		0.94
0.3						0.99	0.98	0.99	0.99			1.00	1.00	0.99	.97	0.98	1.00		1.00		
+0.4						1.00	1.00	1.00	1.00					1.00	0.98	1.00					
+0.5															1.00						

Table 9

He I λ = 392.65 nm

Δ λ	903	906	910	914	922	1144	1153	1160	923	932	1168	1169	2317	1281	854	861	870	852	891	877	1148
/nm/	.002	.005	.006	.076	.158	.200	.285	.290	.305	.389	.442	.444	.460	.550	.606	.682	.759	.764	.766	.915	.973
-0.5									1.00	1.00											
0.4	1.00			1.00					0.99	0.99									1.00		
0.3	0.99			0.99		1.00	1.00		.98	.98	1.00	1.00		1.00			1.00		0.98		
0.2	.97			.97		0.98	0.98		.96	.96	0.98	0.99	1.00	0.97		1.00	0.97	1.00	.96		
0.15	.95			.95		.96	.96		.94	.94	.95	.98	0.98	.94		0.98	.95	0.99	.95		
0.1	.92			.91	0.92	.92	.94		.92	.91	.92	.96	.94	.92		.92	.93	.93	.90	0.94	
0.05	.85			.86	.82	.85	.89		.87	.84	.89	.93	.88	.90		.82	.88	.83	.83	.87	
0.0	.81			.80	.77	.81	.85		.84	.82	.84	.91	.82	.88		.79	.85	.82	.79	.84	
+0.05	.85			.85	.81	.85	.89		.87	.84	.91	.93	.88	.90		.82	.86	.83	.83	.86	
0.1	.90			.90	.90	.92	.94		.92	.92	.95	.96	.94	.93		.92	.93	0.97	.91	.90	
0.15	.94			.94	.92	.96	.97		.93	.97	.97	0.98	0.98	.96		0.97	0.98	1.00	.94	.93	
0.2	.97			0.97	.94	0.99	0.99		0.96	0.98	0.99	1.00	1.00	0.98		1.00	1.00		.96	0.97	
0.3	0.99			1.00	.97	1.00	1.00		1.00	1.00	1.00			1.00					0.99	1.00	
0.4	1.00				0.99														1.00		
+0.5					1.00																

Nº of plate / phase

Table 10

He I λ = 400.93 nm

$\Delta\lambda$	903	906	910	914	922	1144	1153	1160	923	932	1168	1169	2317	1281	854	861	870	852	891	877	1148
/nm/	.002	.005	.006	.076	.158	.200	.285	.290	.305	.389	.442	.444	.460	.550	.606	.682	.759	.764	.766	.915	.973
-0.6																					1.00
0.5							1.00		1.00	1.00											0.99
0.4							0.99	1.00	0.99	0.99		1.00		1.00					1.00	1.00	.97
0.3							.98	0.99	.97	.97	1.00	0.99	1.00	0.98	1.00		1.00	1.00	0.98	0.97	.94
0.2							.98	.99	.94	.94	0.99	.97	0.98	.96	0.99	1.00	0.98	0.98	.97	.94	.92
0.15							.97	.98	.92	.92	.96	.96	.96	.95	.97	0.97	.97	.95	.96	.91	.89
0.1					0.92	0.90	.96	.97	.90	.89	.93	.94	.93	.94	.94	.92	.94	.89	.94	.88	.87
-0.05					.85	.85	.92	.92	.84	.84	.87	.88	.90	.90	.90	.89	.87	.77	.87	.84	.86
0.0					.84	.79	.88	.89	.77	.79	.80	.86	.87	.86	.83	.81	.82	.74	0.78	.77	.85
+0.05					.85	.84	.92	.92	.85	.84	.85	.88	.89	.90	.88	.84	.87	.77		.83	.86
0.1					.89	.89	.96	.96	.89	.90	.91	.92	0.96	.94	.92	.90	.93	.88		.87	.88
0.15					.91	.92	.97	.98	.92	.93	.95	.95	1.00	.97	.95	.93	.95	.94		.90	.90
0.2					.94	.94	.98	.99	.94	.95	0.98	.97		.98	0.98	.96	.97	0.97		.95	.92
0.3					0.98	.96	.98	0.99	.97	.98	1.00	0.99		0.99	1.00	0.99	0.99	1.00		0.98	.94
0.4					1.00	.97	0.99	1.00	0.99	0.99		1.00		1.00		1.00	1.00			1.00	.97
0.5						.98	1.00		1.00	1.00											.98
0.6						0.99															0.99
+0.7						1.00															1.00

Table 11

He I λ = 414.37 nm

$\Delta\lambda$ /nm/	903 .002	906 .005	910 .006	914 .076	922 .158	1144 .200	1153 .285	1160 .290	923 .305	932 .389	1168 .442	1169 .444	2317 .460	1281 .550	854 .606	861 .682	870 .759	852 .764	891 .766	877 .915	1148 .973
-0.6	1.00		1.00																		1.00
0.5	0.99	1.00	0.99		1.00															1.00	0.98
0.4	.98	0.97	.96		1.00					1.00								1.00	1.00	0.98	.97
0.3	.95	.93	.93		0.99	1.00	1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.98	0.98	.96	.94
0.2	.90	.89	.87		.98	0.98	0.99	0.99	0.98	.97	0.99	0.99	0.99	0.99	0.99	0.97	0.99	.96	.96	.92	.91
0.15	.85	.86	.83		.96	.95	.98	.98	.96	.96	.97	.97	.97	.97	.97	.95	.97	.94	.94	.90	.89
0.1	.79	.83	.79		.92	.92	.97	.96	.94	.94	.95	.95	.94	.95	.94	.91	.94	.91	.90	.87	.87
-0.05	.72	.76	.74		.85	.87	.93	.94	.90	.89	.88	.89	.89	.90	.88	.83	.87	.84	.83	.81	.84
0.0	.70	.72	.67		.76	.85	.90	.92	.84	.84	.84	.85	.86	.87	.77	.78	.86	.82	.78	.76	.82
+0.05	.74	.75	0.75		.84	.87	.93	.94	.89	.90	.88	.89	.90	.90	.83	.83	.88	.84	.83	.81	.84
0.1	.80	.82			.90	.90	.96	.96	.92	.93	.94	.92	.95	.95	.92	.92	.94	.91	.87	.87	.88
0.15	.88	.86			.92	.91	.97	.96	.94	.95	.97	.95	0.98	.96	.95	.95	.97	.95	.92	.91	.91
0.2	.93	.92			.96	.94	.98	.97	.96	.97	0.99	.97	1.00	0.98	0.97	0.97	0.98	.97	.94	.94	.93
0.3	0.99	0.97			0.99	.97	.99	0.99	0.98	0.99	1.00	0.99		1.00	1.00	1.00	1.00	0.99	0.98	0.98	.95
0.4	1.00	1.00			1.00	0.99	0.99	1.00	1.00	1.00		1.00						1.00	1.00	1.00	.97
0.5						1.00	1.00														0.99
+0.6																					1.00

Table 12

Si II $\lambda = 385.37$ nm

N$^{\underline{o}}$ of plate / phase

$\Delta\lambda$	903	906	910	914	922	1144	1153	1160	923	932	1168	1169	2317	1281	854	861	870	852	891	877	1148
(nm)	.002	.005	.006	.076	.158	.200	.285	.290	.305	.389	.442	.444	.460	.550	.606	.682	.759	.764	.766	.915	.973
-0.2						1.00															
0.15	1.00				1.00	0.97	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00		
0.1	0.96			1.00	0.95	.93	0.98	0.97	0.98	1.00	0.96	0.99	1.00	0.99	0.97	0.98	0.97	0.97	0.98	1.00	
-0.05	.87			0.91	.84	.86	.91	.90	.93	0.88	.92	.93	0.96	.95	.88	.89	.89	.88	.89	0.95	
0.0	.81			.78	.80	.79	.85	.85	.82	.76	.84	.85	.81	.90	.81	.82	.83	.84	.82	.81	
+0.05	0.87			0.95	0.86	.86	.91	.91	.88	0.94	.92	.93	0.95	.93	.88	.89	.89	.88	.88	.91	
0.1	1.00			1.00	1.00	.92	0.97	0.98	0.97	1.00	0.95	0.98	1.00	0.98	0.98	0.97	0.98	0.95	0.96	0.98	
0.15						.98	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	
+0.2						1.00															

Table 13

Si II λ = 385.60 nm

Δλ	N^{o} of plate / phase																				
	903	906	910	914	922	1144	1153	1160	923	932	1168	1169	2317	1281	854	861	870	852	891	877	1148
/nm/	.002	.005	.006	.076	.158	.200	.285	.290	.305	.389	.442	.444	.460	.550	.606	.682	.759	.764	.766	.915	.973
-0.2	1.00			1.00	1.00																
0.15	0.99			0.98	0.99	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00		
0.1	.94			.93	.95	0.95	0.97	0.97	0.94	0.95	0.98	1.00	0.99	0.98	0.94	0.97	0.96	0.99	0.95	1.00	
-0.05	.82			.82	.86	.82	.90	.89	.82	.90	.93	0.93	.90	.89	.80	.83	.85	.85	.81	0.91	
0.0	.75			.69	.73	.74	.80	.82	.78	.66	.67	.75	.77	.77	.70	.75	.74	.76	.74	.79	
+0.05	.81			.86	.86	.82	.89	.89	.92	.86	.90	.86	.90	.89	.84	.85	.85	.85	.81	.91	
0.1	.94			.95	.94	.94	0.98	0.97	0.99	0.97	.95	.94	0.98	0.97	0.96	0.97	0.95	.94	.92	0.98	
0.15	0.98			0.98	.97	1.00	1.00	1.00	1.00	1.00	0.99	0.99	1.00	1.00	1.00	1.00	1.00	0.98	0.95	1.00	
0.2	1.00			1.00	0.98						1.00	1.00						1.00	1.00		
+0.3					1.00																

Table 14

Si II λ = 386.26 nm

Δλ /nm/	903 .002	906 .005	910 .006	914 .076	922 .158	1144 .200	1153 .285	1160 .290	923 .305	932 .389	1168 .442	1169 .444	2317 .460	1281 .550	854 .606	861 .682	870 .759	852 .764	891 .766	877 .915	1148 .973
-0.4																					1.00
0.3	1.00														1.00						0.98
0.2	0.97			1.00											0.98			1.00	1.00		.96
0.15	.94			0.99	1.00	1.00	1.00		1.00	1.00	1.00		1.00	1.00	.96	1.00	1.00	0.99	0.98	1.00	.93
0.1	.89			.97	0.97	0.98	0.99		0.98	0.97	0.97	1.00	0.98	0.96	.94	0.96	0.97	.93	.96	0.99	.90
-0.05	.79			.83	.81	.85	.90		.89	.80	.91	0.90	.91	.91	.79	.82	.88	.85	.85	.89	.85
0.0	.73			.73	.74	.78	.83	0.83	.78	.70	.67	.81	.77	.82	.72	.75	.80	.76	.75	.79	.82
+0.05	.81			.87	.81	.85	.90	.88	.86	.80	.88	.90	.89	.91	.79	.85	.88	.87	.85	.89	.85
0.1	.89			.95	0.99	0.92	0.99	.95	.96	.93	.91	0.96	0.97	0.97	.92	0.97	0.96	0.98	.94	0.98	.93
0.15	.94			0.98	1.00	1.00	1.00	0.98	0.98	0.98	.93	1.00	1.00	1.00	.96	1.00	1.00	1.00	0.96	1.00	.95
0.2	0.98			1.00				1.00	1.00	1.00	0.99				0.98				1.00		.96
0.3	1.00										1.00				1.00						0.98
+0.4																					1.00

Table 15

Si II $\lambda = 412.80$ nm

$\Delta\lambda$ (nm)	903 .002	906 .005	910 .006	914 .076	922 .158	1144 .200	1153 .285	1160 .290	923 .305	932 .389	1168 .442	1169 .444	2317 .460	1281 .550	854 .606	861 .682	870 .759	852 .764	891 .766	877 .915	1148 .973
-0.3	1.00																				1.00
0.2	0.97	1.00		1.00		1.00							1.00	1.00	1.00	1.00				1.00	0.97
0.15	.92	0.98		0.99	1.00	0.98	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.98	0.97	0.99	1.00	1.00	1.00	0.99	.95
0.1	.87	.92		.95	0.97	.94	0.98	0.98	0.99	0.98	0.98	0.98	.95	.95	.91	.97	0.97	0.97	0.94	.96	.91
-0.05	.78	.79		.80	.89	.89	.94	.95	.94	.88	.89	.87	.86	.89	.79	.85	.87	.87	.78	.83	.85
0.0	.71	.76		.71	.78	.83	.89	.92	.84	.75	.84	.83	.80	.83	.69	.74	.80	.75	.72	.75	.81
+0.05	.77	.79		.80	.88	.89	.94	.95	.92	.88	.95	.87	.87	.89	.79	.80	.88	.88	.78	.83	.85
0.1	.86	.90		.90	0.95	0.95	0.98	0.97	.96	0.98	0.99	.94	.95	0.96	.91	.91	0.97	0.99	0.94	.91	0.91
0.15	.92	0.96		.96	1.00	0.98	1.00	1.00	0.99	1.00	1.00	0.98	0.99	1.00	0.96	.97	1.00	1.00	1.00	0.98	
0.2	0.95	1.00		0.99		1.00			1.00			1.00	1.00		1.00	0.99				1.00	
+0.3	1.00			1.00												1.00					

Column headings: N^{o} of plate / phase

Table 16

Si II $\lambda = 413.09$ nm

$\Delta\lambda$	Nº of plate / phase																				
	903	906	910	914	922	1144	1153	1160	923	932	1168	1169	2317	1281	854	861	870	852	891	877	1148
(nm)	.002	.005	.006	.076	.158	.200	.285	.290	.305	.389	.442	.444	.460	.550	.606	.682	.759	.764	.766	.915	.973
−0.3	1.00	1.00																			
0.2	0.99	0.98	1.00	1.00		1.00				1.00	1.00			1.00	1.00	1.00				1.00	
0.15	.94	.95	0.99	0.97	1.00	0.98	1.00	1.00	1.00	0.97	0.99	1.00	1.00	0.98	0.99	0.99	1.00	1.00	1.00	0.97	
0.1	.88	.91	.94	.90	0.96	.93	0.97	0.98	0.99	.94	.97	0.97	0.97	.96	.94	.97	0.98	0.97	0.97	.91	0.90
−0.05	.76	.79	.76	.75	.86	.86	.92	.92	.93	.82	.89	.86	.91	.90	.75	.82	.90	.88	.82	.84	.85
0.0	.66	.70	.66	.66	.76	.83	.87	.90	.81	.72	.75	.80	.71	.81	.69	.74	.81	.76	.77	.76	.82
+0.05	.76	.82	.76	.75	.84	.86	.92	.92	.88	.84	.82	.86	.82	.88	.75	.82	.89	.84	.82	.84	.85
0.1	.87	.93	.96	.90	0.99	.93	0.97	.96	.95	.94	.90	.92	.93	.96	.93	.90	.95	0.97	0.93	.91	.95
0.15	.93	.96	0.99	.96	1.00	0.98	1.00	0.99	0.99	0.97	.97	0.97	0.98	0.99	0.97	.97	.98	1.00	1.00	0.96	.96
0.2	0.97	0.99	1.00	0.98		1.00		1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00	0.99	0.99			1.00	0.98
+0.3	1.00	1.00		1.00							1.00					1.00	1.00				1.00

Table 17

Si II λ = 634.71 nm

$\Delta\lambda$	$N^{\underline{o}}$ of plate / phase 901	905	908	912	1154	2310	935	1170	1279	856	860	849	895	873
/nm/	.000	.005	.008	.074	.287	.307	.392	.445	.540	.608	.682	.758	.771	.839
-0.6									1.00					
0.5									.02					
0.4				1.00	1.00				.04			1.00	1.00	
0.3	1.00		1.00	0.98	0.99	1.00			.04		1.00	.01	.01	1.00
0.25	0.97		0.99						.04	1.00	.02	.03	.02	.02
0.2	.92	1.00	.98	.93	.94	0.98	1.00	1.00	.03	0.99	1.02	1.02	.03	.06
0.15	.82	0.96	.96			.96	0.99	0.95	1.00	.95	0.98	0.97	1.01	1.05
0.1	.74	.90	.91	.86	.87	.91	.96	.87	0.91	.88	.91	.89	0.92	0.98
-0.05	.70	.85	.85			.87	.92	.75	.81	.81	.79	.82	.88	.87
0.0	.68	.81	.79	.80	.78	.84	.90	.68	.78	.76	.73	.78	.84	.79
+0.05	.69	.84	.85			.87		.75	.83	.80	.78	.82	.88	.84
0.1	.76	.90	.89	.85	.86	.92	.93	.84	0.93	.86	.86	.88	.94	.89
0.15	.86	.94	.93			.96		.90	1.03	.94	.93	.93	0.99	.95
0.2	.94	.98	.96	.90	.94	0.98	0.97	.94	.07	0.99	.96	.96	1.00	0.98
0.25	0.99	0.99	0.98			1.00		0.98	.09	1.00	0.99	.98		1.00
0.3	1.00	1.00	1.00	0.96	0.99		1.00	1.00	.09		1.00	0.99		
0.4				1.00	1.00				.07			1.00		
0.5				.02					.04					
0.6				.02					.01					
0.7									1.00					
0.8				1.00										

Table 18

Si II $\lambda = 637.14$ nm

$\Delta\lambda$	N° of plate / phase														
	901	905	908	912	1154	2310	935	1170	1279	856	860	849	895	873	1143
/nm/	.000	.005	.008	.074	.287	.307	.392	.445	.540	.608	.682	.758	.771	.839	.974
-0.5									1.00						
0.4	1.00			0.97	1.00				.01						
0.3	0.99			.95	0.98			1.00	.02				1.00		1.00
0.25	.96								1.01	1.00			.01		
0.2	.89		1.00	.92	.92		1.00	0.98	0.97	0.97	1.00	1.00	.02	1.00	0.96
0.15	.82		0.95				0.99	.96	.94	.93	0.96	0.97	1.02	0.97	.93
0.1	.77	0.84	.88	.87	.85		.96	.89	.88	.87	.90	.91	0.97	.93	.88
-0.05	.75	.78	.84				.91	.77	.80	.81	.82	.84	.91	.88	.83
0.0	.74	.74	.83	.81	.78		.89	.68	.74	.78	.79	.79	.89	.83	.80
+0.05	.75	.78	.84					.72	.80	.81	.83	.84	.90	.87	.83
0.1	.77	.85	.88	.87	.84		.93	.85	.90	.87	.88	.90	.94	.92	.88
0.15	.82	.90	.95					.94	0.96	.94	.94	.95	0.98	0.98	.93
0.2	.89	.95	0.99	.91	.91		0.98	0.99	1.01	0.98	0.98	0.98	1.00	1.00	0.96
0.25	.95	.98	1.00						.04	1.00	1.00	1.00			1.00
0.3	0.98	0.99		.94	0.98		1.00	1.00	.05						
0.4	1.00	1.00		.96	1.00				.03						
0.5				.98					1.00						
0.6				0.99											
+0.7				1.00											

Table 19

Ca II $\lambda = 393.36$ nm

N$^{\underline{o}}$ of plate / phase

$\Delta\lambda$	903	906	910	914	922	1144	1153	1160	923	932	1168	1169	2317	1281	854	861	870	852	891	877	1148
(nm)	.002	.005	.006	.076	.158	.200	.285	.290	.305	.389	.442	.444	.460	.550	.606	.682	.759	.764	.766	.915	.973
−0.4				1.00																	
0.3				0.96					1.00	1.00	1.00	1.00	1.00								
0.2				.88	1.00	1.00	1.00		0.98	0.99	0.99	0.99	0.98		1.00						
0.15				.78	0.97	0.98	0.99	1.00	.96	.97	.96	.97	.94		0.99	1.00	1.00	1.00	1.00		
0.1				.66	.93	.90	.94	0.96	.93	.91	.86	.93	.84		.93	0.97	0.92	0.94	0.92		
−0.05				.47	.79	.71	.78	.80	.77	.67	.65	.75	.73		.72	.70	.76	.73	.72	0.72	
0.0				.39	0.60	.63	.69	.70	.63	.53	.50	.62	.67	0.63	.58	.62	.68	.64	.63	.60	
+0.05				0.47		.70	.78	.80	.77	0.72	.65	0.75	0.78	.81	.72	.73	.75	.73	.72	.70	
0.1						.80	.91	0.95	0.89		0.86			.92	.93	0.91	0.93	0.94	0.91	.79	
0.15						.96	0.99	1.00			.94			0.99	0.99	1.00	1.00	1.00	0.97	.85	
0.2						0.83	1.00				0.98			1.00	1.00				1.00	.89	
0.3						1.00					1.00									0.96	
+0.4																				1.00	

Table 20

Mg II λ = 448.12 nm

N$^{\underline{o}}$ of plate / phase

$\Delta\lambda$	903	906	910	914	922	1144	1153	1160	923	932	1168	1169	2317	1281	854	861	870	852	891	877	1148
(nm)	.002	.005	.006	.076	.158	.200	.285	.290	.305	.389	.442	.444	.460	.550	.606	.682	.759	.764	.766	.915	.973
−0.4																					1.00
0.3				1.00										1.00					1.00		0.98
0.2				0.99		1.00	1.00	1.00	1.00		1.00	1.00		0.99	1.00	1.00			0.98	1.00	.94
0.15				.96	1.00	0.98	0.99	0.99	0.98	1.00	0.99	0.99	1.00	.96	0.98	0.98	1.00	1.00	.97	0.98	.90
0.1				.85	0.95	.93	.97	.96	.94	0.94	.97	.96	0.98	.92	.93	.95	0.97	0.93	.93	.94	.86
−0.05				.72	.83	.82	.90	.90	.84	.80	.78	.81	.89	.83	.74	.83	.91	.78	.78	.78	.80
0.0				.61	.69	.78	.84	.84	.79	.64	.65	.70	.77	.74	.68	.72	.85	.69	.68	.71	.76
+0.05				.76	.84	.84	.90	.90	.85	.74	.77	.79	.86	.84	.74	.80	.91	.78	.80	.78	.80
0.1				.90	0.95	.93	.97	.97	.94	0.90	.89	.88	0.96	.96	.93	.86	.97	.92	.94	.94	.93
0.15				0.98	1.00	0.97	0.99	0.99	0.98	1.00	.96	0.98	1.00	0.98	.97	0.96	0.99	0.98	.98	0.97	0.94
0.2				1.00		1.00	1.00	1.00	1.00		0.99	1.00		1.00	0.99	1.00	1.00	1.00	0.99	1.00	.96
0.3											1.00				1.00				1.00		0.98
+0.4																					1.00