EXPERIMENTAL DETERMINATION OF FeII Gf-VALUES

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Introduction

Though the problem of the solar iron abundance has been solved owing to reliable measurements of FeI gf-values, it seems that the situation is still open to improvements with basing abundance studies on the ions FeII which are about ten times more numerous than the neutrals in the photosphere. Unfortunately, reliable measurements of FeII gf-values are scarce (Ref./1/ to /5/) and each deals with a few lines so that comparisons are not always possible. The only comprehensive experimental work is that of WARNER /6/ in which the results have been shown to depend with the upper excitation potential. Because it is the most complete set of data, these are still commonly used and SMITH /7/ has proposed a correction-formula. On the other hand, the semi-empirical calculations of KURUCZ and PEYTREMANN /8/ must be used with carefulness in abundance studies. The work we present hereafter was undertaken with a view to a future extensive study of FeII lines and to tie the various data above-mentionned together by one accurate experiment.

Experiments and results

The FeII lines were excited in a wall-stabilized arc operated in argon with 5% hydrogen for the diagnostic purpose. A continous mixing of $Fe(CO)_5$ vapour was fed into the center section of the arc by bubbling a stream of pure argon through the liquid carbonyl at slow rates (50 or 100 cm^3/mn). The FeII spectrum was photographed end-on with a 3.40 m Ebert-type spectrograph and the ArI-4300 Å and H_β lines were photoelectrically recorded. The low-current carbon arc was used as standard radiation. The physical conditions in the FeII emission zone have been varied in the ranges $[4-1.7] \times 10^{16}$ e^-/cm^3 measured from the H_β profile and [11250 K - 10150 K] derived from LTE equations, ArI-4300 Å intensity measurement and the measured electron density.

The procedure used to derive the FeII relative gf-values is classical and they have been put on an absolute scale by using some FeI lines of known gf-values and the Saha equation. Our results are presented in the final table and compared with the other works (G.H.P. refers to /2/, B.G.H.R. /3/, W.B.W. /4/ and K.P. /8/). The uncertainty in our relative gf-values is better than 25% for the majority of lines and it may reach 50% for the faintest lines. We think that our absolute scale is reliable to within ± 0.15 dex.

Discussion

Our values generally lie slightly above the other recent measurements but they nearly all agree to within the mutual uncertainty ranges, except for the lower multiplets of G.H.P. who, moreover, have some doubtful results (3285.42 and 3247.17). As for the calculations of K.P., their scale seems to vary with the multiplet (see mult. 7,8) but, on an average, it roughly lies at 0.25 dex below ours. The figures hereafter show that systematic errors still remain in the corrected WARNER gf-values : one with the upper excitation potential for the higher multiplets and another with the wavelength, below 3000 Å, which is here reported for the first time.

As soon as the stability of the iron concentration in the arc over periods of hours will be achieved, photoelectrical measurements will be extended to numerous other FeII lines.

References

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/4/ Wolnick S.J., Berthel R.O., Wares G.W.: 1971, Astrophys. J. 166, L31.

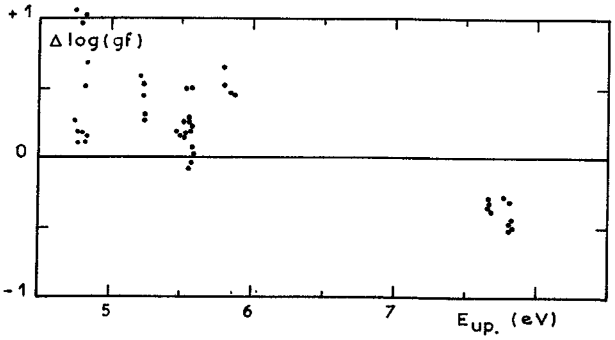
/5/ Huber M. : 1974, Astrophys. J. 190,237.

/6/ Warner B. : 1967, Mem.R.Astr.Soc.70, 165.

/7/ Smith P.L. : 1976, Mon. Not. R. Astr. Soc. 177, 275.

/8/ Kurucz R.L., Peytremann E. : 1975, A table of semi-empirical gf-values, Smithsonian Astrophys. Obs. Special Rep. 362.

Figures : plots of Δ log(gf), the difference between our data and the corrected Warner gf-values versus upper excitation potential and wavelength.



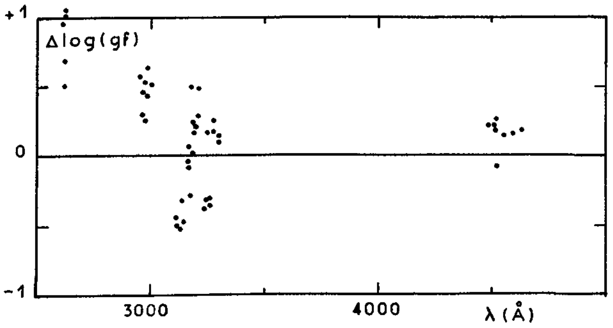


Table of results :

* Data of Warner /6/ corrected according to Smith /7/.

Mult.	log(gf) this exp.	log(gf) : other exp.		WARNER (*)	log(gf) K.P. (1975)
UV(1)		HUBER (1974)			
2599.39	0.85	0.71			0.44
2611.87	0.41	0.21			0.06
2617.62	-0.25	-0.29		-1.21	-0.48
2620.41	-1.80			-2.31	-1.75
2621.67	-0.76	-0.60		-1.45	-0.91
2585.88	0.24	0.04			-0.10
2598.37	0.33	0.15			-0.01
2607.09	0.24	0.07			-0.08
2613.82	-0.03	-0.12			-0.30
2625.66	-0.14	-0.20		-1.20	-0.43
2631.32	0.04	-0.22			-0.26
2631.05	0.06	-0.15			-0.26
2628.29	-0.14	-0.21		-1.16	-0.41

Mult.	log(gf) this exp.	log(gf) : other exp.			WARNER (*)	log(gf) K.P. (1975)
(1)			G.H.P. (1969)			
3277.35	-2.20		-2.79		-2.46	-2.45
3302.86	-3.37				-3.47	-3.60
3255.88	-2.36		-2.74		-2.53	-2.50
3281.29	-2.56		-2.81		-2.74	-2.69
3295.81	-2.91				-3.02	-3.00
3303.47	-3.17				-3.32	-3.34
3285.42	-3.25		-2.87			-3.85
(2)						
2953.77	-1.13				-1.71	-1.51
2970.51	-1.40				-1.93	-1.74
2979.35	-1.80				-2.24	-2.11
2975.94	-2.46				-2.72	-2.65
2961.27	-2.47				-2.77	-2.66
(6)						
3227.73	-0.74					-1.08
3213.31	-1.00		-1.46		-1.49	-1.31
3210.45	-1.39		-1.52		-1.68	-1.69
3192.92	-1.71				-1.88	-1.89
3186.74	-1.45				-1.70	-1.69
3193.81	-1.40		-1.68		-1.62	-1.73
3166.67	-2.91				-2.83	-2.95
3170.34	-2.42				-2.49	-2.54
(7)						
3196.07	-1.53		-1.72		-1.79	-2.23
3183.11	-1.89				-2.39	-2.59
3185.31	-2.70				-2.72	-3.30
3163.09	-2.73				-2.70	-3.22
(8)						
2984.83	-0.06				-0.70	-0.60
2965.04	-1.11				-1.57	-1.47
2964.63	-1.34				-1.79	-1.73
3002.65	-0.57				-1.09	-1.03
2985.54	-0.60					-1.03
(37)		RODER (1962)	B.G.H.R. (1970)	W.B.W. (1971)		
4629.34	-2.29	-2.10	-2.44	-2.27	-2.48	-2.50
4555.89	-2.35	-2.19			-2.50	-2.51
4515.34	-2.44	-2.43	-2.63	-2.35	-2.63	-2.66
4491.40	-2.60				-2.82	-2.89
4520.22	-2.32	-2.64	-2.76	-2.43	-2.58	-3.09
(38)						
4583.83	-1.80	-1.82	-1.98	-1.85	-1.96	-1.92
4549.47	-2.01	-1.89				-2.07
4522.63	-2.30	-2.08		-2.12	-2.23	-2.22
4508.28	-2.27	-2.34	-2.46	-2.29	-2.49	-2.41
(81)			G.H.P. (1969)			
3259.05	-0.69		-0.79		-0.40	-0.94
3258.77	-0.89		-0.98		-0.54	-1.05
3247.17	-0.91		-0.69		-0.60	-1.13
3237.81	-1.17		-1.38		-0.80	-1.42
3237.40	-1.79					
(82)						
3177.53	-0.62				-0.34	-0.88
3135.36	-0.92				-0.61	-1.09
3114.29	-1.32				-0.88	-1.41
3144.75	-1.47				-1.00	-1.58
3116.59	-1.31				-0.82	-1.45
3133.05	-1.78				-1.26	-1.74
3114.68	-1.69				-1.18	-1.73