The Spectra of Sc IV,* Ti V, Mn VIII and Fe IX in the Isoelectronic Sequence A I to Fe IX

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The successful excitation of scandium in a vacuum hot spark has enabled the completion of the spectroscopic data in the isoelectronic sequence A I to Fe IX and has led to the identification of radiation connecting the higher terms with the ground state ($^1S_0$) in all ions up to and including Fe IX.

IN a previous report[1] the radiation $3p^6\,{}^1S_0-3p^55s\,{}^3P_1{}^0$, ${}^1P_1{}^0$ for various ions in this sequence was reported. Since then the spectrum of scandium has been strongly excited and thus it is possible to fill the gaps in the previous report due to a lack of scandium data at that time. At the same time additional data have been obtained in Ti V, Mn VIII and Fe IX.

Newly identified lines are given in Table I. In order to correlate the new data with those previously presented, displaced frequency graphs for ions of the sequence are given in Figs. 1 and 2 and the corresponding data in Tables II and III.

In Table IV are listed the series limits calculated from two members of the $3p^6\,{}^1S_0-3p^5ms\,{}^1P_1{}^0$ series (designated by $L({}^1P_1{}^0)$), and the limits $L({}^3P_1{}^0)$ calculated from the first two members of the $3p^6\,{}^1S_0-3p^5ms\,{}^3P_1{}^0$ series. A comparison between the difference $L({}^1P_1{}^0)-L({}^3P_1{}^0)$ and the known ${}^2P_{3/2,\,1/2}$ splitting in the chlorine-like ions is shown in columns 4 and 5.

Tables V and VI give the revised term values and ionization potentials for all ions of the sequence.

TABLE I. *Newly identified lines in argon-like ions.*

IONS	RELATIVE INTENSITIES	λ(A)	ν(cm⁻¹)	TRANSITIONS
Sc IV	6	298.027	335540	$3p^6\,{}^1S_0-3p^54s\,{}^3P_1{}^0$
	8	293.260	340994	$3p^6\,{}^1S_0-3p^54s\,{}^1P_1{}^0$
	3	217.187	460432	$3p^6\,{}^1S_0-3p^55s\,{}^3P_1{}^0$
	2	215.317	464432	$3p^6\,{}^1S_0-3p^55s\,{}^1P_1{}^0$
Ti V	6	164.450	608088	$3p^6\,{}^1S_0-3p^55s\,{}^3P_1{}^0$
	5	163.140	612970	$3p^6\,{}^1S_0-3p^55s\,{}^1P_1{}^0$
Mn VIII	10	124.055	806094	$3p^6\,{}^1S_0-3p^54s\,{}^3P_1{}^0$
	15	122.168	818544	$3p^6\,{}^1S_0-3p^54s\,{}^1P_1{}^0$
Fe IX	6	105.236	950245	$3p^6\,{}^1S_0-3p^54s\,{}^3P_1{}^0$
	8	103.580	965437	$3p^6\,{}^1S_0-3p^54s\,{}^1P_1{}^0$

* Some of these data have been reported by L. W. Phillips and P. G. Kruger. Bull. Am. Phys. Soc. Washington Meeting **12**, 28 (1937).

[1] P. G. Kruger and S. G. Weissberg, Phys. Rev. **48**, 659 (1935).

TABLE II. *Radiated frequencies with first and second differences. First series members.*

Ion	$3p^6\,{}^1S_0-3p^54s\,{}^3P_1{}^0$			$3p^6\,{}^1S_0-3p^54s\,{}^1P_1{}^0$		
A I	93743			95392		
K II	163237	69494	11196	166462	71070	10161
Ca III	243927	80690	10923	247693	81231	12070
Sc IV	335540	91613	9723	340994	93301	9485
Ti V	436876	101336	11088	443780	102786	11087
V VI	549300	112424	10608	557653	113873	10919
Cr VII	672332	123032	10730	682445	124792	11307
Mn VIII	806094	133762	10389	818544	136099	10794
Fe IX	950245	144151		965437	146893	

TABLE III. *Radiated frequencies with first and second differences. Second series members.*

Ion	$3p^6\,{}^1S_0-3p^55s\,{}^3P_1{}^0$			$3p^6\,{}^1S_0-3p^55s\,{}^1P_1{}^0$		
A I	113635			114965		
K II	212993	99358	16229	215019	100054	16325
Ca III	328580	115587	16265	331398	116379	16655
Sc IV	460432	131852	15804	464432	133034	15504
Ti V	608088	147656	16015	612970	148538	17417
V VI	771759	163671	15680	778925	165955	15460
Cr VII	951110	179351	(15039)	960340	181415	(17245)
Mn VIII	(1145500)	(194390)		(1159000)	(198660)	

TABLE IV. *Series limits calculated from two members of each series.*

Ion	$L({}^1P_1{}^0)$ (cm⁻¹)	$L({}^3P_1{}^0)$ (cm⁻¹)	$L({}^1P_1{}^0)-L({}^3P_1{}^0)$ (cm⁻¹)	$\Delta\,{}^2P_{3/2,\,1/2}$ (cm⁻¹)
A I	128,854	127,398	1456	1432
K II	258,234	256,776	1458	2165
Ca III	415,568	413,267	2301	3124
Sc IV	599,413	596,295	3118	4328
Ti V	809,040	805,465	3575	5825
V VI	1,046,420	1,040,090	6330	7657
Cr VII	1,308,280	1,299,700	8580	9944
Mn VIII		(1,585,000)		
Fe IX		(1,893,000)		

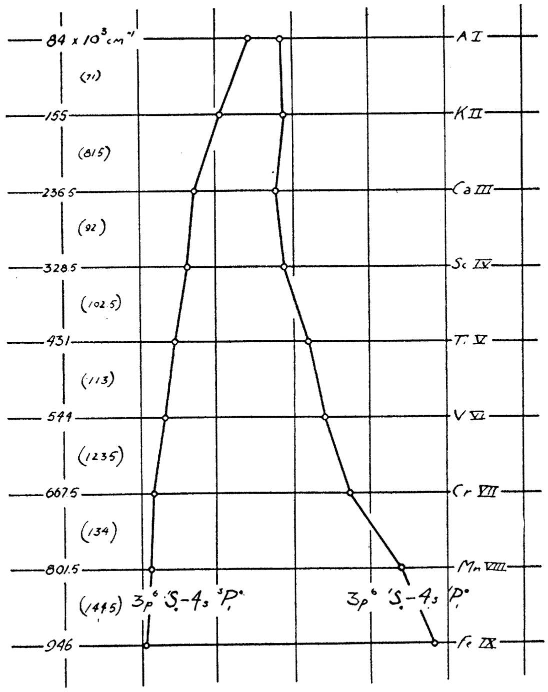

FIG. 1. Displaced frequency diagram. First series members $3p^6\,{}^1S_0 - 3p^54s\,{}^3P_1{}^0$, ${}^1P_1{}^0$. Horizontal scale, 1 div. $=4000$ cm^{-1}. Vertical scale, constant second difference is 10500 cm^{-1}.

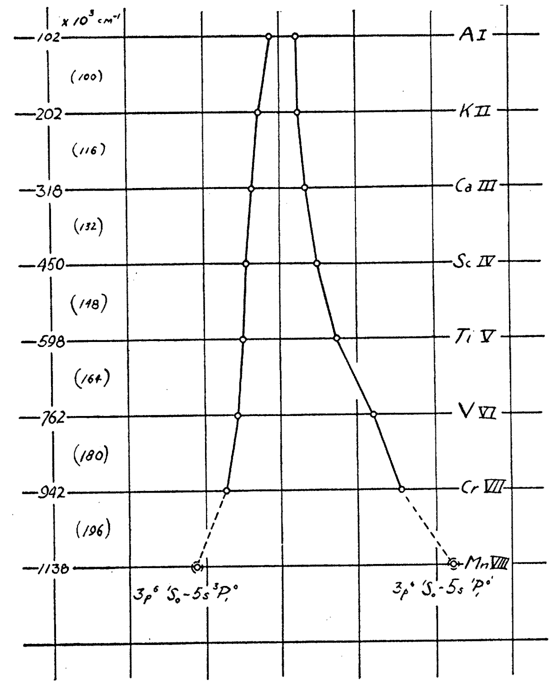

FIG. 2. Displaced frequency diagram. Second series members $3p^6\,{}^1S_0 - 3p^54s\,{}^3P_1{}^0$, ${}^1P_1{}^0$. Horizontal scale, 1 div. $=4000$ cm^{-1}. Vertical scale, constant second difference is 16000 cm^{-1}.

TABLE V. *Term values.*

Ion	$3p^6\,{}^1S_0$ (cm^{-1})	$3p^54s\,{}^3P_1{}^0$ (cm^{-1})	$3p^54s\,{}^1P_1{}^0$ (cm^{-1})	$3p^55s\,{}^3P_1{}^0$ (cm^{-1})	$3p^55s\,{}^1P_1{}^0$ (cm^{-1})
A I	127103.8	33360.86	31711.62	13468.4	12138.4
K II	256637	93400	90176	43644	41618
Ca III	413127	169200	165434	84547	81729
Sc IV	596295	260755	255301	135863	131863
Ti V	805465	368589	361685	197377	192485
V VI	1040090	490790	482437	268331	261165
Cr VII	1299700	627368	617256	348590	338360
Mn VIII	(1585000)	(778906)	(766456)	(439500)	(426000)
Fe IX	(1893000)	(942755)	(927563)	(538000)	

TABLE VI. *Ionization potentials.*

ION	IONIZATION POTENTIAL (volts)	FIRST DIFFERENCE (volts)	SECOND DIFFERENCE (volts)
A I	15.69	15.98	3.35
K II	31.67	19.33	3.3
Ca III	51.0	22.6	3.2
Sc IV	73.6	25.8	3.1
Ti V	99.4	28.9	3.1
V VI	128.3	32.0	(3)
Cr VII	160.3	(35)	(3)
Mn VIII	(195.5)	(38)	
Fe IX	(233.5)		