Contents

Int	roduct	ion. B	y S. Bashkin	1	
1.	Experimental Methods. By S. Bashkin				
	1.1	Accele	rators	5	
	1.2	Ion So	urces	6	
	1.3	Beam R	equirements and Limitations	8	
	1.4	Mass A	nalyzers	9	
	1.5	Target	Chambers	12	
	1.6	Target	s	14	
	1.7	Analyt	ical Devices	17	
	1.8	Detect	ors	19	
	1.9	Detect	ion Geometry and Line Width	22	
	1.10	Beam M	onitors	25	
	1.11	Extern	al Fields	28	
	1.12	Conclu	ding Remarks	29	
Ref	erence	s		29	
2.	Studies of Atomic Spectra by the Beam-Foil Method. By I. Martinson				
	2.1	Experimental Methods			
	2.2	.2 Results of Spectral Studies		38	
		2.2.1	Previously Incompletely-Studied Systems	39	
		2.2.2	Hydrogen-Like Levels	43	
		2.2.3	Displaced Terms	48	
		2.2.4	Multiply-Excited States	50	
Ref	erence	s		57	
3.	Lifetime Measurements. By L. J. Curtis				
	3.1		Lifetime Studies as a Basic Area of Atomic Physics		
		3.1.1	The Need for Lifetime Measurements	65	
		3.1.2	Lifetime Measurements Prior to the Development		
	2.0		of the Beam-Foil Technique	66	
	3.2		tions of Basic Quantities	68	
		3.2.1	Instantaneous Populations	68	
		3.2.2	Transition Probabilities and Oscillator Strengths	69	

VIII

	3.3	Measurement of Beam-Foil-Excited Decay Curves			
		3.3.1	Strengths and Limitations of the Beam-Foil Technique	70	
		3.3.2	Details of Beam-Foil Apparatus and Measurement	70	
			Procedures	72	
			Cascade Repopulation - A Tractable Problem	76 70	
	3.4		ependence of the Measured Decay Curves	79 70	
		3.4.1	Solution of the Driven Coupled Linear Rate Equations	79	
		3.4.2	A Quantitative Indicator of Level Repopulation - The Replenishment Ratio	83	
		3.4.3	Intensity Relationships for an Aligned Source	83	
		3.4.4	Distortions Which Preserve the Mean-Life Content of a Decay Curve	85	
	3.5	Mean-Li to Indi	ife Extraction by Exponential Fits ividual Decay Curves	87	
		3.5.1	Maximum Likelihood Method	87	
		3.5.2	Non-Linear Least Squares Method	88	
		3.5.3	Differentiation and Integration of Decay Curves	90	
		3.5.4	Expansion About a Close-Lying Mean Life	91	
		3.5.5	Fourier-Transform Methods	92	
		3.5.6	Method of Moments	92	
	3.6	Mean-Life Extraction by Joint Analysis of Cascade-Related Decay Curves			
		3.6.1	Ambiguities in the Assignment of Fitted Mean Lives	93	
		3.6.2	Constrained Fits	96	
		3.6.3	Linearly-Fitted Normalizations of Cascade-Related Decay Curves	96	
	3.7	Cascad	e-Free Methods	100	
		3,7.1	Beam-Foil Coincidence Techniques	100	
		3.7.2	Use of Alignment to Discriminate Against Cascades	100	
		3.7.3	Laser Excitation	102	
	3.8	Conclu	ding Remarks	104	
Refe	erence	s	•••••••••••••••••••••••••••••••••••••••	104	
4.	Ioniz	ed Atom	Oscillator Strengths of Neutral, Singly-Ionized, and Multiply- ns: The Theory, Comparisons with Experiment, and Critically- ubles with New Results. By Oktay Sinanoğlu	111	
	4.1	The No	n-Closed-Shell Many-Electron Theory	114	
	4.2	A Spec	troscopic Interpretation of the Charge Wave Function	118	
	4.3	NCMET	Calculations	120	
		4.3.1	The L ² , S ² Symmetry of ψ_{c}	123	
		4.3.2	Dipole Length vs. Dipole Velocity	124	
		4.3.3	Semi-Internal Orbital Variations (Type A, Lowest-of-Symmetry, States)	125	

	4.4	States	Not Lowest of Their Symmetry	126
		4.4.1	Neutral and Singly-Ionized Atoms	127
		4.4.2	Variational Collapse and Its Avoidance	129
	4.5	New Os Transi	cillator Strengths for Intershell (KL \rightarrow KL'[M]) tions to Pre-Rydberg Levels ($\overline{V} \rightarrow pR$)	134
	4.6	Furthe	r Examination of Remaining Correlation Effects	
			illator Strengths with NCMET	136
	4.7	Conclu	sion	141
Ref	erence	s	•••••••••••••••••••••••••••••••••••••••	142
5.	Regu1	arities	of Atomic Oscillator Strengths in Isoelectronic	
	Seque	nces.	By Wolfgang Wiese	147
	5.1	Theore	tical Basis	149
		5.1.1	Definitions	149
		5.1.2	Nuclear Charge-Dependence of the f-Value	150
		5.1.3	Investigation of Lim $1/Z \rightarrow 0$	152
	5.2	Discus	sion of Established Trends	153
		5.2.1	Basic Trends	155
		5.2.2	Curves With a Maximum	156
		5.2.3	Curves With a Minimum	164
		5.2.4	Anomalous Curves	166
	5.3		ator-Strength Distributions in a Spectral Series an Isoelectronic Sequence	167
	5.4	Relati	vistic Effects and Corrections	169
	5.5	Summar	y	174
Ref	ference	s		175
6.	Appli	cations	to Astrophysics: Absorption Spectra. By Ward Whaling	179
	6.1	Branch	ing Ratios	180
		6.1.1	Light Sources	181
		6.1.2	Spectrometers	182
		6.1.3	Spectrometer Calibration	183
		6.1.4	Selection of Branches to be Measured	184
	6.2	Curve-	of-Growth Analysis	185
		6.2.1	Construction of a Curve-of-Growth	186
		6.2.2	Internal-Consistency Test	187
		6.2.3	Comparison of Transition Probabilities for Different Transitions	188
		6.2.4	Solar-Abundance Determination	188
	6.3	Beam-I	Foil-Spectroscopy Measurements Needed for physical Applications	189
Re	ference	•		190
110				120

7.	Applications of Beam-Foil Spectroscopy to the Solar Ultraviolet Emission Spectrum. By Leon Heroux				
	7.1	Ionizat	tion Balance in the Chromosphere and Corona	196	
	7.2	Excitat	tion Balance in the Chromosphere and Corona	196	
	7.3	Line-Ra	atio Measurements of Electron Temperature	198	
	7.4	Line-Ra	atio Measurements of Electron Density	203	
	7.5	The Det	termination of Chromospheric-Coronal Abundances	204	
	7.6	Beam-Fo	oil Measurements Needed for Diagnostic Methods	206	
Ref	erence	s 		207	
8.			ydrogen-Like and Helium-Like Ions of High Z. By us	209	
	8.1	The Lar	mb Shift in the One-Electron System	209	
		8.1.1	Quenching Measurements on Fast Ion Beams of High Z	212	
		8.1.2	Lamb Shift in Hydrogen Using Separated Oscillating Fields	214	
	8.2	Lamb SI	hift in Two-Electron Systems	215	
	8.3	Radiat of the	ive Decay of the 2S _{1/2} Metastable State One-Electron System	216	
		8.3.1	Theory	217	
		8.3.2	Experiments	220	
	8.4	Forbid	den Radiative Decay in the n=2 State Two-Electron System	224	
		8.4.1	Radiative Decay from 2 $\frac{1}{3}S_0$	224	
		8.4.2	Radiative Decay from 2 ${}^{3}S_{1}$	227	
		8.4.3	Radiative Decay from 2 ${}^{3}P_{2}$	229	
		8.4.4	Radiative Decay from 2 ${}^{3}P_{1}$	231	
	8.5	Study	of Doubly-Excited Configurations in the ectron System	232	
Dof				233	
Rei	erence	5		233	
9.	Coher Beam-	ence, A Foil Li	lignment, and Orientation Phenomena in the ght Source. By J. Macek and D. Burns	237	
	9.1	Genera	1 Theoretical Considerations	239	
		9.1.1	The Emission Process	239	
		9.1.2	Symmetry Considerations	243	
	9.2	Alignm	ent and Linear Polarization	246	
		9.2.1	Zero-Field Measurements	246	
		9.2.2	Electric Field	253	
		9.2.3	Magnetic Field	257	
	9.3	Orient	ation and Circular Polarization	260	
		9.3.1	Zero Field	260	
		9.3.2	Magnetic Field Measurements	261	
		9.3.3	The Quadratic Stark Effect	262	
Ref	erence	s	·	263	

х

10.			ment of Autoionizing Ion Levels and Lifetimes ectile Electron Spectroscopy. By Ivan A. Sellin	265
	10.1	The Fas	t-Projectile Electron Spectroscopy (FPES) Method	269
		10.1.1	Choice of an Analyzer	270
		10.1.2	Properties of a Cylindrical-Mirror Analyzer Suitable for FPES	271
		10.1.3	Kinematic Modification of Analyzer Optimization Criteria	274
		10.1.4	Relativistic Corrections to Analyzer Performance	275
		10.1.5	Broadening from Transverse Velocity Spread	276
		10.1.6	Further Kinematic Considerations: Sample Estimates of Net Line Widths Observed in FPES	277
		10.1.7	Summary of the Advantages of FPES	279
	10.2	Example	s of FPES	280
		10.2.1	Spectra of Long-Lived States of the Li-Like, Be-Like, and B-Like Ions	280
		10.2.2	Spectra of Long-Lived Core-Excited States of Sodium-Like Chlorine	282
		10.2.3	Core-Excited States of the Neutral and Nearly-Neutral Alkali Metals	283
		10.2.4	Electron Background in FPES with Foil Targets	286
		10.2.5	Electron Background in FPES with Gas Targets	287
	10.3	The Mea	surement of Auger Lifetimes by FPES	290
		10.3.1	Auger Lifetimes of Metastable Lithium-Like Ions	290
		10.3.2	Examples of Lifetimes from Optical Decay Channels of Auger-Emitting Levels	294
Ref	erence	es		295
APPENDIX (Up-dated bibliography)				299
SUB	SUBJECT INDEX			