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**SUPPLEMENT 3**

**U.S. DEPARTMENT OF COMMERCE / National Bureau of Standards**

# **Bibliography on Atomic Energy Levels and Spectra**

**July 1979 through December 1983**

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**Arlene Musgrove and Romuald Zalubas**



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# Bibliography on Atomic Energy Levels and Spectra

## July 1979 through December 1983

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Arlene Musgrove  
and  
Romuald Zalubas

Center for Radiation Research  
National Measurement Laboratory  
National Bureau of Standards  
Gaithersburg, MD 20899



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U.S. DEPARTMENT OF COMMERCE, Malcolm Baldrige, Secretary

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## **Foreword**

The National Standard Reference Data System was established in 1963 for the purpose of promoting the critical evaluation and dissemination of numerical data of the physical sciences. The program is coordinated by the Office of Standard Reference Data of the National Bureau of Standards but involves the efforts of many groups in universities, government laboratories, and private industry. The primary aim of the program is to provide compilations of critically evaluated physical and chemical property data. These tables are published in the *Journal of Physical and Chemical Reference Data*, in the NSRDS-NBS series of the National Bureau of Standards, and through other appropriate channels.

The task of critical evaluation is carried out in various data centers, each with a well-defined technical scope. A necessary preliminary step to the critical evaluation process is the retrieval from the world scientific literature of all papers falling within the scope of the center. Each center, therefore, builds up a comprehensive well-indexed bibliographical file which forms the base for the evaluation task. Bibliographies derived from these files are published when they appear to be of value to research workers and others interested in the particular technical area.

Further information on NSRDS and the publications which form the primary output of the program may be obtained by writing to the Office of Standard Reference Data, National Bureau of Standards, Gaithersburg, MD 20899.

DAVID R. LIDE, JR., *Director*  
Standard Reference Data  
National Bureau of Standards

## **Contents**

	<i>Page</i>
1. Introduction .....	1
1.1. Reference Classification Scheme and Scope of Bibliography .....	1
1.2. Arrangement of Bibliography and Handling of Special Types of References .....	2
1.3. References .....	2
1.4. Compilations and Other Publications of Special Interest .....	3
2. Classified References for Individual Spectra .....	5
2.1. Index to Spectra.....	5
2.2. Reference Numbers for Individual Spectra.....	13
3. Bibliography Ordered by Reference Numbers .....	41
4. Author Index .....	91

# Bibliography on Atomic Energy Levels and Spectra

## July 1979 through December 1983

Arlene Musgrove and Romuald Zalubas

This is the third supplement to NBS Special Publication 363, *Bibliography on Atomic Energy Levels and Spectra, July 1968 through June 1971*. Supplement 1 covered the period from July 1971 through June 1975, Supplement 2 covered the period from July 1975 through June 1979, and this bibliography covers the literature from July 1979 through December 1983. It contains approximately 1200 references classified by subject for individual atoms and atomic ions. A number index identifies the references. An author index is included. References included contain data on energy levels, classified lines, wavelengths, Zeeman effect, Stark effect, hyperfine structure, isotope shift, ionization potentials, or theory which gives results for specific atoms or atomic ions.

Key words: Atomic energy levels; atomic spectra; bibliography; energy levels, atomic; spectra, atomic; wavelengths, atoms and ions.

## 1. Introduction

This is Supplement 3 for the publication *Bibliography on Atomic Energy Levels and Spectra* [1]<sup>1</sup> by the Atomic Energy Levels Data Center. We list references to new papers which have a publication date up to December 31, 1983 and were available to us as reprints or from the serial and book holdings of the NBS Library. Papers published by that date which were not yet available to us as of May 1984 will be included in Supplement 4. The format is the same as in previously published bibliographies.

### 1.1. Reference Classification Scheme and Scope of Bibliography

The references pertain to atomic structure and spectra that arise from interactions or excitations involving electrons in the outer shells of free atoms and atomic ions, or from inner shell excitations corresponding to frequencies up to the soft x-ray range. A paper was included if it gave results for a particular ion or spectrum falling into one of the following categories:

**EL Energy Levels.** Experimental energy differences, except Hfs or IS. Includes references that suggest the rejection of previously reported levels.

**ND New Designations.** New or changed designations or *J* values for known energy levels.

**CL Classified Lines.** Indicates the assignment of newly or previously observed lines to transitions between energy levels that are specified by theoretical designations and/or by their positions in a known level scheme.

**TA Transition Array.** Lines or groups of lines assigned to transition array(s) (but not to particular levels or terms).

**W Wavelengths (or wavenumbers).** New measurements, or wavelengths newly assigned to a particular spectrum. References that list measurements of other entities corresponding to energy differences between levels may also be included.

**ZE Zeeman Effect data or interpretation.**

**SE Stark Effect data or interpretation.**

**Hfs Hyperfine Structure.** Observations and theory.

**IS Isotopic or Isomeric (Nuclear) Shifts.**

**QF Quantum Field effects.** Lamb shifts, experimental and theoretical results.

**IP Ionization Potential.**

**SF Series Formulae.** Evaluated series constants.

**TE Theoretical Energies.** Restricted to a few references that give calculated energy levels with accuracies about equal to or exceeding those now obtainable by observation.

<sup>1</sup> Figures in brackets refer to literature references in section 1.3

**PT Parametric Theory.** Evaluations of the usual energy parameters of Slater-Condon theory, or extensions thereof, based on fitting the theory to experimental levels, *g*-factors and/or other observed quantities.

**AT Ab initio Theory.** These references are mostly to Hartree-Fock type calculations of energy parameters or levels.

In section 2.2 the above categories are arranged alphabetically.

References to atomic energy levels and spectra determined from solution or crystal data have category symbols enclosed in parentheses.

It is worth noting that this bibliography does not contain references to atomic transition probabilities, line intensities, or broadening. The NBS Data Center on Atomic Transition Probabilities and Atomic Line Shapes and Shifts publishes bibliographies on these subjects [2].

This bibliography is further restricted, with few exceptions, to original research papers or monographs. Textbooks, extensive compilations of special interest, and other selected publications that are not included in the classified references are given at the end of this introduction in section 1.4.

## 1.2. Arrangement of Bibliography and Handling of Special Types of References

Each reference has been assigned a number. In section 2.2 the appropriate reference numbers are given under headings for individual spectra (element and ionization stage). The reference numbers under each spectrum heading are listed separately for each of the content categories explained above. Reference numbers for papers reporting wavelengths of unknown ionization stage are given as the first group for the element.

The full references are given in order of the assigned numbers in section 3. Each such reference is followed by the spectra and category symbols appropriate to the content. Except for Russian titles, which are given in English, the titles of articles are given in the language in which they were published. References to articles from Russian journals that also appear in English translations are to the translation journals.

Section 2.1 is an index to the spectra for which there are references; an author index (sec. 4) follows the listing of the complete references.

The main exception from the arrangement described above is for the references 6050T through 6089T. Each of these papers gives theoretical results for a rather large number of elements and/or ionization stages and

their numbers are followed by a "T" to indicate that the papers give theoretical results only. These references are included in section 3, along with the usual information on their content, and in the author index. However, they were omitted from the reference numbers for the individual spectra (sec. 2.2).

Most of the reference numbers followed by an "A" indicate abstracts of theses in Dissertation Abstracts. Some of the other references are to theses for which the AEL Data Center has obtained copies. The assigned content categories for these abstracts are those thought to be applicable to the paper itself, as indicated by the abstract; the indicated results are not necessarily included in the abstracts. These abstracts frequently provide information about work in progress.

References to lanthanide and actinide atomic energy levels and spectra determined from solution or crystal data are included for atoms and atomic ions for which these data have not been determined for the free gaseous atom or ion. For these references, the reference classification categories which apply are enclosed in parentheses to differentiate them from articles to atomic energy levels and spectra of free gaseous atoms and atomic ions.

The abbreviations of periodical titles generally follow the style given in *Bibliographic Guide for Editors and Authors* [3].

We are grateful to Drs. W. C. Martin and J. Sugar for many valuable consultations during the preparation of this bibliography. We appreciate the assistance of Deirdre Thompson and Deana Ramsburg in obtaining and inputting pertinent references for inclusion into this publication. We thank the Data Systems Development Group of the Office of Standard Reference Data for their skills involved with creating the author and individual spectra indexes directly from each separate bibliographic entry and for placing these indexes and individual references into a computer-readable form for automatic typesetting.

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## 2. Classified References for Individual Spectra

### 2.1. Index to Spectra

Element	Z	Spectrum	Page	Element	Z	Spectrum	Page
Aluminum	13	Al I	16	Barium-Continued		Ba XXVIII	34
		Al II				Ba XXX	
		Al III					
		Al IV					40
		Al V		Berkelium	97	Bk I	
		Al VI				Bk II	
		Al VII		Beryllium	4	Be I	13
		Al VIII				Be II	
		Al IX				Be III	
		Al X				Be IV	
		Al XI					
		Al XII		Bismuth	83	Bi I	39
		Al XIII				Bi II	
						Bi III	
Antimony	51	Sb I	32	Boron	5	B I	13
		Sb II				B II	
		Sb VI				B III	
		Sb VII				B V	
		Sb XXIII					
Argon	18	Ar I	18	Bromine	35	Br I	26
		Ar II				Br VII	
		Ar III				Br VIII	
		Ar IV				Br IX	
		Ar VI				Br XXIV	
		Ar VII				Br XXV	
		Ar VIII				Br XXVI	
		Ar IX				Br XXVII	
		Ar X				Br XXVIII	
		Ar XI				Br XXXII	
		Ar XII		Cadmium	48	Br I	31
		Ar XIII				Cd II	
		Ar XIV				Cd III	
		Ar XV				Cd IV	
		Ar XVI				Cd V	
		Ar XVII				Cd XX	
		Ar XVIII				Cd XXXIX	
						Cd XLV	
Arsenic	33	As I	25	Calcium	20	Ca I	19
		As IV				Ca II	
		As V				Ca III	
		As VI				Ca IV	
		As VII				Ca VIII	
		As XVII				Ca IX	
		As XX				Ca XI	
		As XXI				Ca XII	
		As XXII				Ca XIII	
		As XXIII				Ca XIV	
		As XXIV				Ca XV	
		As XXV				Ca XVI	
		As XXVI				Ca XVII	
						Ca XVIII	
						Ca XIX	
						Ca XX	
Barium	56	Ba I	34	Californium	98	Cf I	40
		Ba II				Cf II	
		Ba III					
		Ba V					
		Ba X					
		Ba XI					
		Ba XII					
		Ba XXVII					

**2.1. Index to Spectra—Continued**

Element	Z	Spectrum	Page	Element	Z	Spectrum	Page
Carbon	6	C I C II C III C IV C V C VI	14	Cobalt	27	Co I Co II Co VII Co VIII Co IX Co XI Co XII Co XIII Co XIV Co XV Co XVI Co XVII Co XVIII Co XIX Co XX Co XXI Co XXII Co XXIII	23
Cerium	58	Ce III Ce VIII Ce IX Ce X Ce XI Ce XII Ce XIII Ce XIV Ce XV Ce XVI	35			Cu I Cu II Cu IV Cu VI Cu X Cu XI Cu XIII Cu XIV Cu XV Cu XVI Cu XVII Cu XVIII Cu XX Cu XXI Cu XXII Cu XXIII	24
Cesium	55	Cs I Cs II Cs III Cs IV Cs IX Cs X Cs XI	34		29	Cu Cu I Cu II Cu IV Cu VI Cu X Cu XI Cu XIII Cu XIV Cu XV Cu XVI Cu XVII Cu XVIII Cu XX Cu XXI Cu XXII Cu XXIII	24
Chlorine	17	Cl I Cl II Cl III Cl IV Cl V Cl VI Cl VII Cl VIII Cl IX Cl X Cl XI Cl XII Cl XIII Cl XV Cl XVI Cl XVII	17 18	Copper		Cm I Cm II	40
Chromium	24	Cr I Cr II Cr III Cr IV Cr V Cr XIII Cr XIV Cr XV Cr XVI Cr XVII Cr XVIII Cr XIX Cr XX Cr XXI Cr XXII Cr XXIII	21	Curium	96	Dy I Dy II Dy XX Dy XXI Dy XXXVII Dy XXXVIII Dy XXXIX Dy XL	36
				Dysprosium	66	Es I Es II	40
				Einsteinium	99	Er I Er III Er IV	37
				Erbium	68		

**2.1. Index to Spectra—Continued**

Element	Z	Spectrum	Page	Element	Z	Spectrum	Page
Erbium—Continued		Er XXXIX Er XL Er XLII	37	Gold	79	Au I Au II Au XIX Au LI	38 39
Europium	63	Eu I Eu II Eu III Eu XVII Eu XVIII	36	Hafnium	72	Hf I Hf IV Hf V Hf XLIII Hf XLIV Hf XLV Hf XLVI	37
Fluorine	9	F I F V F VI F VII F VIII F IX	14	Helium	2	He <sup>-</sup> He I He II	13
Francium	87	Fr Fr I	39	Holmium	67	Ho I Ho XXI Ho XXII Ho XXXIX	36
Gadolinium	64	Gd I Gd II Gd XII Gd XVIII Gd XIX Gd XXXV Gd XXXVI Gd XXXVII Gd XXXVIII Gd LXI	36	Hydrogen	1	H <sup>-</sup> H I	13
Gallium	31	Ga Ga I Ga II Ga VI Ga XV Ga XVI Ga XIX Ga XX Ga XXI Ga XXII Ga XXIII Ga XXIV Ga XXX	25	Iodine	53	In I In II In IV In VI In XXI In XL	33
Germanium	32	Ge IV Ge VI Ge VII Ge XIV Ge XV Ge XVI Ge XVII Ge XVIII Ge XIX Ge XX Ge XXI Ge XXII Ge XXIII Ge XXIV Ge XXV Ge XXVI Ge XXVII	25	Iridium	77	Ir I Ir XVII Ir XLIX	38
				Iron	26	Fe I Fe II Fe V Fe VI Fe VII Fe VIII Fe IX Fe X Fe XI Fe XII Fe XIII Fe XIV Fe XV Fe XVI Fe XVII Fe XVIII Fe XIX Fe XX	22

**2.1. Index to Spectra—Continued**

Element	Z	Spectrum	Page	Element	Z	Spectrum	Page
Iron—Continued		Fe XXI Fe XXII Fe XXIII Fe XXIV Fe XXV Fe XXVI	22 23	Lutetium	71	Lu I Lu II Lu III Lu IV	37
Krypton	36	Kr I Kr II Kr III Kr IV Kr V Kr VIII Kr IX Kr X Kr XI Kr XII Kr XIII Kr XIV Kr XX Kr XXI Kr XXII Kr XXIV Kr XXV Kr XXVI Kr XXVII Kr XXVIII Kr XXIX Kr XXX Kr XXXI Kr XXXII Kr XXXIII Kr XXXIV Kr XXXV	26 27	Magnesium	12	Mg I Mg II Mg III Mg IV Mg V Mg VI Mg VII Mg VIII Mg IX Mg X Mg XI Mg XII	15
Lanthanum	57	La I La II La VI La XI La XII La XXVIII La XXXI La XXXIX	34 35	Mercury	80	Hg I Hg II Hg III Hg LXXIII	39
Lawrencium	103	Lr I	40	Molybdenum	42	Mo I Mo VI Mo VIII Mo X Mo XII Mo XIII Mo XIV Mo XV	30
Lead	82	Pb I Pb II Pb XXI Pb XXII Pb LIV Pb LXXIX	39			Mo XVI Mo XVII Mo XVIII Mo XIX Mo XX Mo XXI Mo XXII Mo XXIII Mo XXIV Mo XXVI Mo XXVII Mo XXVIII Mo XXIX Mo XXX Mo XXXI Mo XXXII	
Lithium	3	Li Li <sup>+</sup> Li I Li II Li III	13				

**2.1. Index to Spectra—Continued**

Element	Z	Spectrum	Page	Element	Z	Spectrum	Page
Molybdenum-Continued		Mo XXXIII Mo XXXIV Mo XXXV Mo XXXIX	30	Niobium—Continued		Nb VII Nb IX Nb XII Nb XIII Nb XIV Nb XV Nb XVI Nb XVII Nb XXV Nb XXIX Nb XXX Nb XXXIII Nb XXXIV Nb XXXIX Nb XL	29
Neodymium	60	Nd I Nd II Nd IV Nd XIV Nd XV Nd XXXI Nd XXXII Nd XXXIV	35				
Neon	10	Ne I Ne II Ne III Ne IV Ne V Ne VI Ne VII Ne VIII Ne IX Ne X	14 15	Nitrogen	7	N I N II N III N IV N V N VI N VII	14
Neptunium	93	Np I Np II Np III Np IV Np V Np VI	40	Osmium	76	Os XLVIII	38
				Oxygen	8	O I O III O IV O V O VI O VII O VIII	14
Nickel	28	Ni I Ni II Ni IV Ni V Ni VI Ni IX Ni X Ni XI Ni XII Ni XIII Ni XIV Ni XV Ni XVI Ni XVII Ni XVIII Ni XIX Ni XX Ni XXI Ni XXII Ni XXIII Ni XXIV Ni XXV Ni XXVI Ni XXVII	23 24	Palladium	46	Pd I Pd XVIII Pd XIX Pd XX Pd XXI Pd XXII Pd XXIII Pd XXIV Pd XXV Pd XXVI Pd XXVII	31
				Phosphorus	15	P I P II P III P IV P XI P XII P XIII P XIV P XV	16 17
Niobium	41	Nb III Nb IV Nb V Nb VI	29	Platinum	78	Pt I Pt XLIX Pt L Pt LI Pt LII	38

**2.1. Index to Spectra—Continued**

Element	Z	Spectrum	Page	Element	Z	Spectrum	Page
Plutonium	94	Pu I Pu II Pu III Pu IV Pu V Pu VI	40	Samarium	62	Sm I Sm II Sm XVI Sm XVII Sm XXXIII Sm XXXIV Sm XXXV Sm XXXVI	35
Potassium	19	K I K II K III K VIII K X K XI K XII K XIII K XIV K XV K XVI K XVII K XIX	18 19	Scandium	21	Sc I Sc II Sc X Sc XII Sc XIII Sc XIV Sc XV Sc XVI Sc XVII Sc XVIII Sc XIX	19 20
Praseodymium	59	Pr I Pr IV Pr XIII Pr XIV	35	Selenium	34	Se I Se V Se VI Se XVI Se XVII	26
Promethium	61	Pm XVI	35			Se XVIII Se XIX	
Radium	88	Ra I	39			Se XX Se XXI	
Rhenium	75	Re I Re XLVI Re XLVII Re XLVIII Re XLIX	38			Se XXII Se XXIII Se XXIV Se XXV Se XXVI Se XXVII	
Rhodium	45	Rh XVII Rh XVIII Rh XIX Rh XX Rh XXI Rh XXXIV	31	Silicon	14	Si I Si II Si III Si IV Si V Si VI Si VII	16
Rubidium	37	Rb I Rb II Rb IX Rb XII Rb XXVI Rb XXVIII Rb XXIX Rb XXXVI	27			Si VIII Si IX Si X Si XI Si XII Si XIII Si XIV	
Ruthenium	44	Ru I Ru XVI Ru XVII Ru XVIII Ru XIX Ru XX Ru XXXIII Ru XLI	30 31	Silver	47	Ag I Ag II Ag IV Ag XVII Ag XVIII Ag XIX Ag XX Ag XXI Ag XXII Ag XXIII Ag XXXVIII	31

**2.1. Index to Spectra—Continued**

Element	Z	Spectrum	Page	Element	Z	Spectrum	Page
Sodium	11	Na I Na II Na IV Na X Na XI	15	Thorium	90	Th I Th II Th III Th VIII Th IX Th X Th XI Th XII Th XIII Th XIV Th XV Th XVI	39
Strontium	38	Sr I Sr II Sr IX Sr X Sr XI Sr XII Sr XIII Sr XIV Sr XXII Sr XXIII Sr XXVI Sr XXVII Sr XXIX Sr XXX	27 28	Thulium	69	Tm I Tm IV Tm XL Tm XLI Tm XLII Tm XLIII Tm XLIV	37
Sulfur	16	S I S II S III S IV S V S VI S VII S IX S X S XIV S XV S XVI	17	Tin	50	Sn I Sn II Sn V Sn XX Sn XXI Sn XXII Sn XLI	32
				Titanium	22	Ti I Ti II Ti III Ti IV Ti V Ti X Ti XI Ti XII Ti XIII Ti XIV Ti XV Ti XVI	20
Tantalum	73	Ta I Ta VI Ta XLIV Ta XLV Ta XLVI Ta XLVII	38				
Technetium	43	Tc I Tc XV Tc XXXII	30				
Tellurium	52	Te I Te II Te VII Te VIII Te XXIV	32 33	Tungsten	74	W VII W XIII W XIV W XXVIII W XLV W XLVI W XLVII W XLVIII W LXXI	38
Terbium	65	Tb III Tb XIX Tb XX	36				
Thallium	81	Tl I Tl II Tl LI	39	Uranium	92	U I U II U III U IV	39 40

**2.1. Index to Spectra—Continued**

Element	Z	Spectrum	Page	Element	Z	Spectrum	Page
Uranium—Continued		U V U VI U XXXII U LXIV U LXXXIX	40	Yttrium—Continued		Y X Y XI Y XII Y XIII Y XIV Y XV Y XXVIII Y XXX Y XXXI Y XXXVII	28
Vanadium	23	V I V II V III V IV V V V VII V VIII V IX V X V XII V XIV V XV V XVI V XVII V XVIII V XIX V XX V XXI V XXII	20	Zinc	30	Zn I Zn II Zn V Zn XIV Zn XVIII Zn XIX Zn XX Zn XXI Zn XXII Zn XXIII Zn XXIV Zn XXVII Zn XXIX	24
Xenon	54	Xe I Xe II Xe III Xe IV Xe VI Xe VII Xe VIII Xe IX Xe X Xe XVII Xe XXV Xe XXVI Xe XXVIII Xe XLIV Xe XLV Xe XLVI Xe XLVII Xe LI	33	Zirconium	40	Zr I Zr III Zr IV Zr V Zr VI Zr VII Zr VIII Zr IX Zr XI Zr XII Zr XIII Zr XIV Zr XV Zr XVI Zr XXI Zr XXII Zr XXIV Zr XXV Zr XXVI Zr XXVII	28
Ytterbium	70	Yb I Yb II Yb XLI Yb XLII Yb XLIII Yb XLIV	37			Zr XXVIII Zr XXIX Zr XXXI Zr XXXII Zr XXXIII	29
Yttrium	39	Y I Y IV Y V Y VII	28				

## 2.2. Reference Numbers for Individual Spectra

<b>Hydrogen</b>			<b>Li I—Continued</b>	
H <sup>-</sup>	AT	4950, 4992	CL	5261, 5607, 5608, 5751, 5982A
	CL	5238	EL	4964, 5017, 5347, 5751
H I	CL	4937	Hfs	5080
	EL	4937, 5036, 5183, 5225, 5663	IP	5401, 5783
	IP	5444	IS	5033, 5811
	QF	5065, 5098, 5127, 5481, 5934 5955	ND	5608
	SE	4902, 5610, 5890	PT	5367
	SF	5444	SE	4976
	TA	4860, 5780	TA	5041, 5777
	ZE	5631, 5890	<b>Li II</b>	
<b>Helium</b>				
He <sup>-</sup>	AT	5153, 5163, 5200, 5264	AT	4950, 5304, 5912, 5940, 5687
He I	AT	4950, 4992, 5075, 5199, 5353 5506, 5528, 5549, 5588, 5591 5742, 5860, 5867, 5940	CL	5612, 5778, 5982A
	CL	4939, 4962, 5009, 5161, 5170 5182, 5502, 5612, 5690, 5741 5806, 5814	EL	4923, 4964, 5092, 5778
	EL	4939, 4961, 4962, 4999, 5084 5088, 5101, 5161, 5182, 5201 5202, 5344, 5353, 5366, 5446 5460, 5546, 5597, 5690, 5741 5758, 5793, 5814, 5960A	Hfs	4870, 4923, 4929, 5092, 5094 5351, 5387, 5684, 5876, 5922A
	Hfs	5089, 5099A, 5202, 5259, 5377 5447, 5585, 5597, 5615, 5648 5649, 5650, 5651, 5795, 5865A	IS	4923, 5351, 5687
	IS	4942, 5099A, 5202, 5350, 5465 5649, 5693, 5814, 5867, 5960A	PT	5367
	ND	4990	QF	5092
	PT	4939, 5182, 5502	<b>Li III</b>	
	QF	5546, 5740	CL	5778
	SF	5496	EL	5095, 5778
	W	5546	Hfs	5095
He II	CL	5540	IP	5444
	EL	5540, 5552	AT	4903, 5074, 5686, 5846, 5961
	IP	5444	EL	4964
	QF	4868	IP	5964
	SE	5430, 5553, 5845	<b>Be II</b>	
	SF	5444	AT	4924, 4941, 5012, 5230, 5275 5526, 5565, 5589, 5669, 5776 5846, 5950
	ZE	5054	CL	5311, 5405, 5406, 5703
			EL	4964, 5236, 5703
			ND	5445
			PT	5367
			TA	5971
			<b>Be III</b>	
			AT	5576, 5867, 5940
			CL	5078, 5311
			EL	4964, 5078
			IS	5867
			TA	5971
			<b>Be IV</b>	
			IP	5444
			SF	5444
<b>Lithium</b>				
Li	CL	5001	<b>Boron</b>	
	EL	5001	<b>B I</b>	
Li <sup>-</sup>	AT	5164, 5165, 5686	AT	4968, 5265, 5310
	CL	5160, 5244	EL	4964
Li I	AT	4872, 4982, 4986, 5012, 5049 5153, 5230, 5241, 5262, 5275 5358, 5373, 5492, 5526, 5549 5551, 5767, 5776, 5805, 5828 5829	<b>B II</b>	
			EL	4964
			<b>B III</b>	
			AT	4941, 5012, 5230, 5275, 5468 5776
			<b>B V</b>	
			IP	5444
			SF	5444

**2.2. Reference Numbers for Individual Spectra — Continued**

<b>Carbon</b>				<b>Oxygen</b>			
C I	AT	5310, 5388, 5457, 5646, 5664		O I	AT	5058, 5274, 5310, 5412, 5903A	
	CL	5263, 5455, 5681			EL	4969, 5315	
	EL	4964, 5125, 5263, 5388, 5455			ZE	4969	
	IS	4928, 5936		O III	AT	4858, 4921, 5254, 5255, 5386	
C II	AT	5265, 5294, 5388, 5456, 5944			CL	5596	
	CL	5034			EL	5596	
	EL	4964, 5388			IP	5596	
	IP	5456		O IV	AT	5265, 5456, 5736	
	IS	5916A			CL	5114	
C III	AT	5053, 5388, 5407, 5423, 5443 5732			IP	5456	
	CL	5034, 5407, 5612		O V	AT	4984, 5053, 5060, 5091, 5270 5407, 5424, 5732	
	EL	4964, 5388, 5407			CL	5379, 5407, 5612, 5837	
C IV	AT	5230, 5275, 5776, 5878			EL	5035, 5379, 5407	
	CL	5171			IP	5035	
	EL	4964		O VI	AT	4872, 5195	
C V	AT	5878			CL	5114, 5162, 5837	
	CL	5171		O VII	AT	5146, 5404	
	EL	4964			CL	4881, 5114, 5530, 5837	
C VI	IP	5444			EL	4881	
	SF	5444			IP	5114	
	<b>Nitrogen</b>				QF	4881	
N I	AT	5197, 5786		O VIII	IP	5444	
	CL	5166, 5681, 5897			QF	5619	
	EL	5417			SF	5444	
	Hfs	5417		<b>Fluorine</b>			
	PT	5327, 5417		F I	AT	5310	
	W	5180			EL	5189	
N II	AT	5457			Hfs	5746	
	CL	5939		F V	CL	5602	
	EL	5939		F VI	AT	5053, 5060, 5732	
	Hfs	4973			CL	5602, 5752	
	IP	5939			EL	5752	
N III	AT	5265, 5456			W	4869, 5752	
	CL	5155		F VII	CL	5602, 5752, 5837	
	EL	5155			EL	5752	
	IP	5456			W	5752	
N IV	AT	5053, 5060, 5407, 5508, 5563 5732, 5961		F VIII	CL	5530, 5602, 5837	
	CL	5407, 5612			EL	5319	
	EL	5407			Hfs	5319	
N V	AT	5949		F IX	CL	5602	
N VI	CL	5834			IP	5444	
	EL	5834			SF	5444	
	SF	5834		<b>Neon</b>			
N VII	IP	5444		Ne I	AT	4953, 4955, 4981, 5176, 5211 5500, 5759, 5812, 5903A	
	SF	5444			CL	4934, 4963, 5401, 5642, 5725 5803, 5935, 5960A	

**2.2. Reference Numbers for Individual Spectra – Continued**

<b>Ne I–Continued</b>		<b>Na IV</b>	<b>PT</b>	<b>5131</b>
EL	4875, 4877, 4934, 4983, 5273 5290, 5305, 5725, 5855, 5935	Na X	CL	5243
Hfs	4857, 5219		SF	5453
IP	5401			
IS	4875, 5219, 5331, 5769, 5873	Na XI	CL	5243
TA	5154		IP	5444
ZE	4931, 4967, 5522		SF	5444
<b>Ne II</b>	<b>AT</b> 4898, 5066, 5418, 5419, 5812 5882			<b>Magnesium</b>
	EL 4983, 5882	Mg I	AT	5028, 5051, 5720
<b>Ne III</b>	<b>AT</b> 4898, 5490		CL	5123, 5152, 5559, 5914
	<b>CL</b> 5945		EL	5123, 5402, 5559
	<b>EL</b> 5305, 5859		IP	5827, 5964
	<b>W</b> 5709		IS	5899
			SF	5402, 5827
<b>Ne IV</b>	<b>AT</b> 4874, 4898, 5490	Mg II	AT	5050, 5467
	<b>ND</b> 4874		CL	5152
<b>Ne V</b>	<b>AT</b> 4874, 4898, 5490		Hfs	5372
	<b>W</b> 5709		ZE	5372
<b>Ne VI</b>	<b>AT</b> 5490	Mg III	AT	5475, 5759
<b>Ne VII</b>	<b>AT</b> 5053, 5060, 5269, 5299, 5732 5961	Mg IV	AT	5475
	<b>TA</b> 5853		CL	5142, 5278
<b>Ne VIII</b>	<b>TA</b> 5853		EL	5142
<b>Ne IX</b>	<b>AT</b> 5867, 5940		ND	5142
	<b>CL</b> 5626		PT	5142
	<b>EL</b> 5626	Mg VI	AT	5044, 5475
	<b>IS</b> 5867		CL	5945
	<b>TA</b> 5853		W	5071
<b>Ne X</b>	<b>IP</b> 5444	Mg VII	AT	5475
	<b>SF</b> 5444		CL	5316
			W	5071
				<b>Sodium</b>
<b>Na I</b>	<b>AT</b> 5049, 5050, 5188, 5467, 5551	Mg VIII	AT	5475
	<b>CL</b> 5029, 5216, 5279, 5689, 5726 5824, 5869, 5918		CL	5511
	<b>EL</b> 4888, 4946, 4994, 5029, 5216 5279, 5313, 5689, 5726, 5824		EL	5381
	<b>Hfs</b> 4878, 4949, 4954, 4993, 5151A 5569, 5682, 5726, 5768		W	5071
	<b>IP</b> 5783	Mg IX	AT	5018, 5422, 5475
	<b>IS</b> 4954, 5569, 5670, 5768		CL	5112
	<b>ND</b> 5869		EL	5071, 5112
	<b>PT</b> 5677			
	<b>SE</b> 4976, 5503	Mg X	AT	5314
	<b>SF</b> 5057		CL	4908, 5112, 5314, 5679
	<b>TA</b> 4888		EL	4908, 5314, 5679
	<b>W</b> 5014		PT	5068
	<b>ZE</b> 5383		W	4908, 5071, 5112
<b>Na II</b>	<b>AT</b> 4988, 5032	Mg XI	CL	5112, 5879
	<b>EL</b> 5209		SF	5453
			W	5071, 5112
		Mg XII	AT	4936
			IP	5444
			SF	5444

## **2.2. Reference Numbers for Individual Spectra – Continued**

Aluminum				Silicon	
Al I	AT	5194, 5266, 5493		Si II	AT 5307, 5355 CL 5307 EL 5307 PT 5895 SE 5924
	CL	5493			
	EL	5493			
	Hfs	4913, 5592			
	PT	5266, 5895		Si III	AT 5028, 5051 IP 5827 SF 5309, 5827 W 5323
	TA	5491			
	W	5491			
	ZE	5194			
Al II	AT	5028, 5051		Si IV	AT 5050
	IP	5827			
	SF	5827		Si V	AT 5475
Al III	AT	5050		Si VI	AT 5475 CL 5511
Al IV	AT	5475		Si VII	AT 4930, 5475, 5603 CL 5511, 5683 PT 5052 W 5683
Al V	AT	5475			
	CL	5511			
Al VI	AT	5475		Si VIII	AT 5044, 5475, 5603 CL 5072, 5683 EL 5381 W 4905, 5683
	CL	5131, 5511			
	EL	5131			
	PT	5052, 5131			
Al VII	AT	5475		Si IX	AT 5475, 5603, 5635 CL 4905, 5072, 5511, 5602, 5683
	CL	5659			
Al VIII	AT	5475			EL 4905 W 4905, 5683
	CL	5511			
Al IX	AT	5475		Si X	AT 5475, 5603 CL 4905, 5072, 5073, 5683
	CL	5511, 5659, 5892			
Al X	AT	5475			EL 4905 W 4905, 5683
	CL	5112, 5659, 5892			
	W	5112		Si XI	AT 5018, 5422, 5475, 5603, 5730 CL 4905, 5602, 5683
Al XI	AT	4863, 5314			
	CL	4863, 4908, 5112, 5314, 5879 5892			EL 4905 W 4905, 5683
	EL	4863, 4908, 5314, 5892		Si XII	AT 5195, 5314, 5603 CL 4905, 5243, 5314, 5602, 5683
	W	4908, 5112			
Al XII	CL	5112, 5243, 5879			EL 4905, 5314 W 4905, 5683
	EL	5237			
	SF	5453		Si XIII	AT 5416 CL 4852, 4905, 4957, 5243, 5416 5542, 5602, 5613, 5683, 5879
	W	5112			
Al XIII	CL	5243			EL 4905, 4957, 5416
	IP	5444			QF 5416
	SF	5444			SF 5453
					W 5683
Silicon				Phosphorus	
Si I	AT	5194, 5329		Si XIV	CL 5243, 5542
	PT	5895			IP 5444
	SE	5203			SF 5444
	ZE	5194			
				P I	AT 5148, 5194 CL 5148, 5149

**2.2. Reference Numbers for Individual Spectra—Continued**

P I—Continued			S V	AT	5028, 5420, 5536
EL	5148		CL	5337	
Hfs	5149		EL	5337	
IP	5148		IP	5337, 5827	
PT	5148		SF	5337, 5827	
W	5148				
ZE	5194		S VI	CL	4882
				EL	4882
P II	CL	5779		IP	4882
	EL	5779			
	IP	5779	S VII	CL	5875
	PT	5895		EL	5875
	SE	5747		PT	5875
P III	AT	5357	S IX	AT	4930
P IV	AT	5028	S X	AT	5044
	IP	5827		PT	4867
	SF	5827	S XIV	AT	5314
P XI	AT	5314		CL	5220, 5314
	CL	5314		EL	5314
	EL	5314	S XV	AT	5416, 5525
P XII	AT	5314		CL	4957, 5220, 5416, 5525, 5542
	CL	5314			5613
	EL	5314		EL	4957, 5416, 5525
				QF	5416
P XIII	AT	5314		SF	5453
	CL	5314, 5716		TA	5831, 5833
	EL	5314, 5716	S XVI	CL	5542
P XIV	CL	5627, 5716, 5800, 5943A		IP	5444
	EL	5627, 5716, 5943A		SF	5444
	SF	5453			
<b>Chlorine</b>					
P XV	IP	5444	Cl I	AT	5194, 5302, 5954
	QF	5757		CL	5681
	SF	5444		IS	5086A, 5654
<b>Sulfur</b>					
S I	AT	5058, 5194, 5302		TA	5764
	CL	5666		ZE	5194
	EL	5666	Cl II	IS	5135
	IP	5666		CL	5611
	IS	5086A		EL	5611
	ZE	5194	Cl IV	CL	5611
S II	AT	5816		EL	5611
	CL	5883	Cl V	CL	5611
	EL	5883		EL	5611
	IP	5883	Cl VI	AT	5028
	IS	5135		CL	5611
	PT	5883		EL	5611
S III	AT	5214, 5816, 5842		IP	5827
	CL	5737		SF	5827
S IV	AT	4876, 5258	Cl VII	AT	5538
	EL	5079		CL	5625, 5973
	PT	5079		EL	5625, 5973
			Cl VIII	PT	5625

**2.2. Reference Numbers for Individual Spectra – Continued**

Cl IX	AT	5515		Ar VIII	AT	5538	
	CL	5515			CL	5617	
	EL	5515		Ar IX	CL	5710, 5973	
Cl X	AT	5515			EL	5710, 5973	
	CL	5515			IP	5121	
	EL	5515			TA	5853	
Cl XI	AT	5579		Ar X	TA	5853	
	CL	5579		Ar XI	AT	4930	
	EL	5579			CL	5429	
Cl XII	CL	5600			TA	5853	
	EL	5600		Ar XII	AT	5044	
Cl XIII	CL	5601			CL	5429	
	EL	5601			TA	5853	
Cl XV	AT	5314		Ar XIII	CL	5429	
	CL	5314		Ar XIV	CL	5429	
	EL	5314					
Cl XVI	AT	5416		Ar XV	AT	5018, 5422	
	CL	4957, 5198, 5416, 5613			CL	5217, 5429	
	EL	4957, 5198, 5416			EL	5217	
	QF	5416		Ar XVI	AT	4863, 5314, 5901	
	SF	5453			CL	4863, 5217, 5901	
Cl XVII	TA	5831, 5833			EL	4863, 5217, 5314	
	IP	5444		Ar XVII	AT	5901	
	QF	5539			CL	5542, 5901, 5905	
	SF	5444			EL	5905	
					SF	5453	
					TA	5832	
<b>Argon</b>							
Ar I	AT	5523, 5661, 5759, 5903A		Ar XVIII	AT	5901	
	CL	5401, 5642			CL	5901	
	EL	5186, 5222, 5855			IP	5444	
	IP	5401			QF	5905, 5915	
	IS	5086A			SF	5444	
	SE	5128					
	ZE	5522, 5787					
<b>Potassium</b>							
Ar II	AT	5066, 5418, 5419, 5476, 5661 5954		K I	AT	5049, 5551	
	CL	5790, 5807			CL	5770, 5783	
	EL	5807			EL	5345, 5451, 5770, 5783	
	IS	5135			Hfs	5027, 5484, 5620, 5634, 5718 5768	
	SE	5240, 5431			IP	5451, 5770, 5783	
Ar III	AT	5661			IS	5179, 5484, 5634, 5768	
	EL	5859			SE	4976	
					SF	5451	
Ar IV	AT	5661		K II	EL	5061, 5209	
Ar VI	CL	5617		K III	AT	5954	
	EL	4989					
Ar VII	AT	5028		K VIII	IP	5827	
	CL	5283, 5617			SF	5827	
	IP	5827		K X	AT	5485	
	SF	5827			CL	5973	
					EL	5973	

**2.2. Reference Numbers for Individual Spectra—Continued**

K XI	AT	5515	Ca XII	AT	5515
	CL	5515		CL	5515
	EL	5515		EL	5515
K XII	AT	5515	Ca XIII	AT	5515
	CL	5515		CL	5515
	EL	5515		EL	5515
K XIII	AT	5579	Ca XIV	AT	5044, 5579, 5652
	CL	5217, 5579		CL	5217, 5316, 5579
	EL	5217, 5579		EL	5217, 5579
K XIV	CL	5217, 5600	Ca XV	CL	5217, 5316, 5600
	EL	5217, 5600		EL	5217, 5600
K XV	CL	5217, 5601	Ca XVI	CL	5217, 5601
	EL	5217, 5601		EL	5217, 5601
K XVI	AT	5961	Ca XVII	AT	5018, 5422, 5961
	CL	5217		CL	5217
	EL	5217		EL	5217
K XVII	AT	5314	Ca XVIII	AT	5314, 5660
	CL	5217, 5314		CL	5217, 5314
	EL	5217, 5314		EL	5217, 5314
K XIX	IP	5444	Ca XIX	CL	5542, 5943A
	SF	5444		EL	5943A
<b>Calcium</b>			Ca XX	IP	5444
Ca	W	5449		SF	5444
<b>Scandium</b>					
Ca I	AT	5134, 5181, 5365, 5486, 5633	Sc I	Hfs	5464
	CL	4910, 5134, 5301, 5463, 5486 5803, 5854, 5894			
	EL	4910, 5134, 5301, 5463, 5486 5578, 5894	Sc II	AT	5425
	Hfs	5348, 5479, 5518, 5695		CL	5141
	IP	5280		EL	5141
	IS	5483, 5695, 5817, 5894, 5926		Hfs	5568
	PT	4909, 4910, 5365, 5894		IP	5141
	SE	5894		PT	4991, 5425
	SF	5857	Sc X	CL	5562
	W	5391, 5392, 5463		EL	5562
				IP	5827
Ca II	AT	5907		SF	5827
	CL	5854	Sc XII	CL	5973
	PT	4991		EL	5973
Ca III	TA	5893	Sc XIII	AT	5515
Ca IV	CL	5511		CL	5389, 5515
Ca VIII	CL	5511		EL	5515
Ca IX	IP	5827	Sc XIV	AT	5515
	SF	5827		CL	5389, 5515
Ca XI	CL	5973		EL	5515
	EL	5973	Sc XV	AT	5579
Ca XII				CL	5217, 5579
				EL	5217, 5579
			Sc XVI	CL	5217, 5389, 5600
Ca XIII				EL	5217, 5600

**2.2. Reference Numbers for Individual Spectra – Continued**

Sc XVII	CL	5217, 5389, 5601	Ti XVIII	AT	5004
	EL	5217, 5601		CL	5217, 5291, 5317, 5370, 5560 5601
Sc XVIII	CL	5217, 5389	Ti XIX	EL	5217, 5601
	EL	5217		AT	5004, 5961
Sc XIX	AT	5314	Ti XX	CL	5217, 5317, 5560
	CL	5217, 5314, 5389		EL	5217
	EL	5217, 5314		AT	5004, 5314, 5802
<b>Titanium</b>					
Ti I	AT	5085, 5156, 5221, 5505, 5748	Ti XXI	CL	5217, 5314 5217, 5314
	Hfs	5435, 5464			
	PT	5013, 5572			
<b>Vanadium</b>					
Ti II	AT	5221, 5748	V I	AT	5748, 5791
	CL	5432		CL	5637, 5791
	EL	5432		EL	5637, 5791
	IP	5432		Hfs	4912, 5435, 5464
	PT	4991, 5432		PT	5013, 5791
Ti III	AT	5025, 5221, 5271, 5748	V II	W	5791
	PT	5025, 5271			
Ti IV	AT	5221, 5426, 5748, 5842	V III	AT	5748
Ti V	AT	5748	V IV	AT	5547, 5748
Ti X	CL	5962		PT	5547
	W	5962	V V	AT	5748, 5842
Ti XI	CL	5504, 5962		V VII	AT 5159
	IP	5827		PT	5159
	SF	5827	V VIII	AT	5159
	W	5962		PT	5159
Ti XII	CL	4862, 5962	V IX	AT	5159
	EL	4862		PT	5159
	W	5962			
Ti XIII	CL	5962, 5973	V X	AT	5159
	EL	5973		PT	5159
	W	5962			
Ti XIV	AT	5004, 5515	V XII	CL	5504
	CL	4971, 5291, 5317, 5370, 5515 5560		IP	5827
	EL	5515		SF	5827
				TE	4884
Ti XV	AT	5004, 5515	V XIV	CL	5973
	CL	4971, 5291, 5317, 5370, 5515 5560		EL	5973
	EL	5515			
Ti XVI	AT	5004, 5317, 5579	V XV	AT	5515
	CL	5217, 5560, 5579		CL	5515
	EL	5217, 5579		EL	5515
Ti XVII	AT	5004	V XVI	AT	5515
	CL	4971, 5217, 5291, 5317, 5370 5560, 5600		CL	5515
	EL	5217, 5600		EL	5515

**2.2. Reference Numbers for Individual Spectra—Continued**

V XVII	AT	5579		Cr XVIII	AT	5317, 5652
	CL	5217, 5579			CL	5067, 5205, 5513
	EL	5217, 5579			EL	5205
V XVIII	CL	5217, 5600		Cr XIX	AT	5007, 5317, 5477
	EL	5217, 5600			CL	5205, 5370, 5477, 5513
V XIX	CL	5217		Cr XX	AT	5317, 5477
	EL	5217			CL	4856, 5205, 5232, 5370, 5477
V XX	CL	5217			EL	5513
	EL	5217			EL	5205
V XXI	AT	5314		Cr XXI	AT	5268, 5477, 5921, 5961
	CL	5217			CL	5067, 5205, 5370, 5477
	EL	5217, 5314			EL	5205
V XXII	AT	5570		Cr XXII	AT	5314, 5477, 5921
	CL	5881			CL	5067, 5205, 5370, 5477
					EL	5205, 5314
<b>Chromium</b>				Cr XXIII	AT	5477, 5921
Cr I	AT	5413, 5748			CL	5067, 5477, 5707, 5847, 5881
	CL	5413, 5487				
	EL	5413, 5487		<b>Manganese</b>		
	Hfs	5464		Mn I	AT	4854
	IP	5413			CL	4854
	PT	5413			EL	4854
Cr II	AT	5748			Hfs	5435, 5464, 5904, 5963
	CL	5665			IP	4854
	EL	5487, 5665			PT	5013
Cr III	AT	5748			W	4854
Cr IV				Mn II	EL	5545
	AT	5025, 5748			Hfs	5931A
	CL	5498			ND	4991
	EL	5498			PT	4991
	IP	5498		Mn VI	CL	5143
Cr V	PT	5025, 5498			EL	5143
	AT	5748			IP	5143
Cr IX	CL	5316		Mn VII	CL	5223
Cr XIII					EL	5223
	CL	5504		Mn VIII	CL	5796
	IP	5827			EL	5796
	SF	5827			PT	5796
Cr XIV	TE	4884		Mn XIV	IP	5827
	CL	5205			SF	5827
Cr XV	CL	5973			TE	4884
	EL	5973		Mn XV	CL	5205
	IP	5121				
Cr XVI	CL	5067, 5205, 5513		Mn XVI	CL	5973
	EL	5205			EL	5973
					IP	5121
Cr XVII	AT	5007		Mn XVII	AT	5606
	CL	5205, 5513			CL	4904, 5205
	EL	5205			EL	5205

**2.2. Reference Numbers for Individual Spectra—Continued**

Mn XVIII	AT	5606		Fe XIII	CL	5808
	CL	4904, 5205		Fe XIV	AT	5118
	EL	5205			CL	5278, 5316
Mn XIX	AT	5606		Fe XV	AT	5005, 5175
	CL	4904, 5205			CL	5005, 5504
	EL	5205			IP	5827
Mn XX	AT	5606			PT	5043
	CL	4904, 5205, 5232			SF	5827
	EL	4904, 5205			W	4862
Mn XXI	AT	5606		Fe XVI	CL	5205
	CL	4904, 5205			W	4862
	EL	4904, 5205		Fe XVII	AT	5133, 5599
Mn XXII	AT	5606			CL	5067, 5090, 5133, 5213, 5278
	CL	4904, 5205				5973
	EL	4904, 5205			EL	5973
Mn XXIII	AT	5314, 5606			IP	5121
	CL	5205		Fe XVIII	AT	5133, 5411
	EL	5205, 5314			CL	5067, 5090, 5133, 5205, 5370
<b>Iron</b>						5513, 5531, 5947
Fe I	AT	5059			EL	4861, 5205
	CL	5571, 5815		Fe XIX	AT	4901, 5007, 5133, 5274, 5411
	Hfs	4935, 4987, 5435, 5464				5903A
	IP	5983A			CL	5067, 5090, 5133, 5205, 5370
	PT	5013				5513, 5531, 5784, 5947
	W	5571			EL	5205, 5784
Fe II	AT	5245		Fe XX	AT	5006, 5297, 5317, 5411, 5753
	CL	5972			CL	5205, 5300, 5370, 5513, 5531
	EL	5887			EL	5006, 5205, 5784
	PT	4991			ND	5006
Fe V	CL	5293		Fe XXI	AT	4911, 5007, 5297, 5317, 5364
Fe VI	CL	5293				5411, 5774
Fe VII	AT	5267, 5755			CL	5205, 5300, 5370, 5513, 5531
Fe VIII	CL	5267			EL	5784
	EL	5267		Fe XXII	AT	4943, 4944, 5178, 5297, 5317
	IP	5267				5364, 5411
	PT	5267			CL	5067, 5205, 5300, 5370, 5513
	CL	5223, 5808, 5923				5531, 5784
Fe IX	EL	5223			EL	5205, 5784
	CL	5796, 5808		Fe XXIII	AT	4871, 5018, 5229, 5268, 5297
	EL	5796				5364, 5368, 5408, 5411, 5422
Fe X	PT	5796				5731, 5961
	AT	5871			CL	4859, 4871, 5067, 5205, 5300
	CL	5808				5370, 5513, 5531
Fe XI	PT	4996			EL	4871, 5205
	CL	5808		Fe XXIV	AT	4871, 4901, 4925, 4926, 5314
Fe XII	CL	5808				5364, 5403, 5411, 5570
	EL	5808			CL	4859, 4871, 4885, 5067, 5205
	TA	4886, 5844				5643
	W	4871			EL	5205, 5314
					TA	4886, 5844
					W	4871

**2.2. Reference Numbers for Individual Spectra – Continued**

Fe xxv	AT	5184, 5298, 5403, 5616	Co xxiv	CL	5067, 5205
	CL	4859, 4885, 5320, 5616, 5844 5881, 5923		EL	5205
	EL	5136, 5320		Co xxv	5067, 5205
	TA	4886		EL	5205
Fe xxvi	CL	4859, 5466, 5844	Co xxvi	CL	5881
	EL	5136, 5466			
	QF	5706			<b>Nickel</b>
<b>Cobalt</b>			<b>Nickel</b>		
Co I	Hfs	5464, 5963	Ni I	AT	5126
				Hfs	5464
				IS	5126, 5941
Co II	EL	5887	Ni II	CL	5856
				EL	5856, 5887
Co VII	CL	5340		PT	4991, 5856
	EL	5340	Ni IV	CL	5624
	PT	5340			
Co VIII	CL	5016	Ni V	CL	5293, 5624
	EL	5016			
Co IX	CL	5223	Ni VI	AT	5124
	EL	5223		CL	5124, 5293, 5624
Co XI	CL	5015		EL	5124
Co XII	CL	5015		PT	5124
Co XIII	CL	5015	Ni X	CL	5102, 5223
Co XIV	CL	5015		EL	5223
Co XV	CL	5015		W	5102
Co XVI	CL	5015	Ni XI	W	5102
	IP	5827			
	SF	5827	Ni XII	AT	5159
	TE	4884		CL	5015
Co XVII	CL	5015, 5205		PT	5159
Co XVIII	CL	5067, 5090	Ni XIII	AT	5159
	IP	5121		CL	5015
Co XIX	CL	5067, 5090, 5205		PT	5159
	EL	4861, 5205	Ni XIV	AT	5159
Co XX	CL	5067, 5090, 5205		CL	5015
	EL	5205		PT	5159
Co XXI	AT	5317	Ni XVI	CL	5015
	CL	5205			
	EL	5205	Ni XVII	AT	5005
Co XXII	AT	5317		CL	5005, 5015, 5562
	CL	5205		EL	5562
	EL	5205		IP	5827
Co XXIII	AT	5317		PT	5043
	CL	5067, 5205		SF	5827
	EL	5205	Ni XVIII	CL	5015, 5205

**2.2. Reference Numbers for Individual Spectra—Continued**

Ni xix	CL	5067, 5090	Cu xi	CL	5223	
	IP	5121		EL	5223	
Ni xx	CL	4861, 5067, 5090, 5205, 5370 5513	Cu xiii	CL	5835	
	EL	4861, 5205	Cu xiv	CL	5835	
Ni xxI	AT	4901, 5007	Cu xv	CL	5835	
	CL	5067, 5090, 5205, 5370, 5513	Cu xvi	CL	5835	
	EL	5205				
Ni xxII	AT	5317	Cu xvii	CL	5835	
	CL	4856, 5205, 5513	Cu xviii	CL	5562, 5835	
	EL	5205		EL	5562	
Ni xxIII	AT	5007, 5317		IP	5827	
	CL	4856, 5205, 5232, 5370, 5513		SF	5827	
	EL	5205	Cu xx	CL	5090, 5122, 5243	
Ni xxIV	AT	5317		EL	5122	
	CL	4856, 5067, 5205, 5232, 5370 5513		IP	5121	
	EL	5205	Cu xxI	AT	4951	
Ni xxV	AT	4871, 5268		CL	4861, 5090, 5122, 5243, 5513	
	CL	4871, 5205		EL	4861, 5122	
	EL	4871, 5205		PT	4951	
Ni xxVI	AT	4871	Cu xxII	CL	5090, 5243, 5513	
	CL	4871, 5067, 5205	Cu xxIII	CL	5243, 5513	
	EL	5205	Cu xxIV	CL	5513	
	W	4871				
Ni xxVII	CL	5881	Cu xxV	CL	5513	
<b>Copper</b>			Cu xxVIII	CL	5881	
Cu	W	5048				
Cu I	AT	5577	Zn I	AT	5380	
	CL	4958		EL	5324	
	EL	4958		Hfs	5640	
	Hfs	4873, 5464		IS	5640	
	IP	4958		PT	5380	
	IS	4873				
Cu II	CL	5172	Zn II	EL	5324	
	EL	5708		PT	4991	
	PT	4991, 5775	Zn V	AT	5932	
Cu IV	AT	5144		CL	5535, 5932	
	CL	5144		EL	5535, 5932	
	EL	5144		PT	5932	
	IP	5144	Zn XIV	CL	5835	
	PT	5144		Zn XVIII	CL	5835
Cu VI	AT	5285		Zn XIX	CL	5835
	CL	5285		IP	5827	
	EL	5285		SF	5827	
	PT	5285				
Cu X	CL	5016	Zn XX	AT	5045, 5185	

**2.2. Reference Numbers for Individual Spectra—Continued**

Zn XXI	CL	5090, 5122	<b>Germanium</b>		
	EL	5122	Ge IV		
	IP	5121	PT      4867		
Zn XXII	AT	4951	Ge VI	AT	5038
	CL	5090, 5122		CL	5038
	EL	4861, 5122		EL	5038
	PT	4951	Ge VII	AT	5321
Zn XXIII	CL	5090		CL	5321
Zn XXIV	AT	5652	Ge XIV	CL	5797
Zn XXVII	AT	5961	Ge XV	CL	5797
Zn XXIX	CL	5881	Ge XVI	CL	5797, 5835
	PT	5208	Ge XVII	CL	5761, 5797, 5835
<b>Gallium</b>					
Ga	W	5378	Ge XVIII	CL	5797, 5835
Ga I	AT	4895, 5266, 5493, 5673	Ge XIX	CL	5797, 5835
	CL	5493, 5566, 5673	Ge XX	CL	5761, 5797, 5835
	EL	5493, 5566, 5673	Ge XXI	CL	5562, 5835
	Hfs	4960, 4966, 5639, 5641, 5809		EL	5562
	IP	5566		IP	5827
	IS	4960, 5566, 5639, 5641		SF	5827
	PT	5266	Ge XXII	CL	5090
	SE	4966		Ge XXIII	CL
	SF	5566			5090
Ga II	AT	5469	Ge XXIV	AT	4951
Ga VI	AT	5952		CL	5090
	CL	5952		IP	5121
	EL	5952	Ge XXV	AT	4951
	PT	5952		CL	5090, 5513
Ga XV	CL	5835		EL	4861
Ga XVI	CL	5761		PT	4951
Ga XIX	CL	5835	Ge XXVI	CL	5513
Ga XX	CL	5835	Ge XXVII	CL	5513
	IP	5827			
	SF	5827			
<b>Arsenic</b>					
Ga XXI	CL	5090	As I	AT	5030
Ga XXII	CL	5090, 5122		CL	5030
	EL	5122		EL	5030
	IP	5121		Hfs	4952, 5958
Ga XXIII	AT	4951		ND	5030
	CL	5090, 5122		PT	5030
	EL	5122		ZE	5030
	PT	4951	As IV	CL	5339
Ga XXIV	CL	5090	As V	CL	5339
Ga XXX	PT	5208		IP	5339
				ND	5629
				PT	4867

**2.2. Reference Numbers for Individual Spectra—Continued**

As VI	AT	5000		Se xxiii—Continued	
	CL	5000		IP 5827	
	EL	5000		SF 5827	
	IP	5000		Se xxiv CL 5090	
	PT	5000		Se xxv CL 5090	
As VII	AT	5000		IP 5121	
	CL	5000		Se xxvi CL 5090	
	EL	5000		EL 4861	
As XVII	CL	5835		Se xxvii CL 5090	
As XX	CL	5761		<b>Bromine</b>	
As XXI	CL	5761, 5835		Br I	AT 5194
As XXII	CL	5835			CL 5454, 5681, 5765
	IP	5827			EL 5454, 5765
	SF	5827			IS 5276
					ZE 5194
As XXIII	CL	5090		Br VII	CL 5242
As XXIV	CL	5090, 5122			EL 5242
	EL	5122			PT 4867
	IP	5121		Br VIII	CL 5343, 5472
As XXV	AT	4951		Br IX	AT 5472
	CL	5090, 5122			CL 5343, 5472
	EL	5122			EL 5343, 5472
	PT	4951			PT 5343
As XXVI	CL	5090		Br XXIV	IP 5827
					SF 5827
<b>Selenium</b>				Br XXV	CL 5090
Se I	AT	5058		Br XXVI	CL 5090, 5122
	CL	5688			EL 5122
	EL	5688		Br XXVII	CL 5090, 5122
	W	5688			EL 5122
Se V	CL	5556		Br XXVIII	CL 5090
	EL	5556			EL 5122
	ND	5629		Br XXXII	AT 5961
Se VI	PT	4867			
Se XVI	CL	5797	<b>Krypton</b>		
Se XVII	CL	5797		Kr I	CL 5132, 5497, 5685
Se XVIII	CL	5797, 5835			EL 5019, 5497, 5586, 5685, 5801
Se XIX	CL	5797, 5835			5855
Se XX	CL	5797, 5835		Hfs	4914
Se XXI	CL	5797, 5835			IP 5480, 5685, 5976
Se XXII	CL	5797, 5835			IS 5140, 5728
Se XXIII	CL	5562, 5835			PT 5480
	EL	5562			ZE 4879, 5522, 5787
				Kr II	AT 5066, 5418, 5419, 5954
				Kr III	AT 5575
					EL 5859

**2.2. Reference Numbers for Individual Spectra—Continued**

			<b>Rubidium</b>			
Kr IV	CL	5117	Rb I	AT	4894, 5049, 5284, 5450, 5551	
Kr V	CL	5117		CL	4970, 5783	
Kr VIII	AT	4956		EL	4889, 4970, 5150, 5783	
	CL	4956		Hfs	4970, 4972, 5021, 5027, 5390	
	EL	4956			5768, 5898, 5969, 5981	
	PT	4867		IP	4970, 5106, 5783	
Kr IX	TA	5917		IS	4889, 4970, 5021, 5390, 5768	
Kr X	TA	5917		SE	4892, 4976, 5021	
Kr XI	TA	5046, 5853, 5917	Rb II	SF	4970	
Kr XII	TA	5046, 5853, 5917		TA	4892	
Kr XIII	TA	5046, 5853	Rb IX	PT	4867	
Kr XIV	TA	5046, 5853	Rb XII	AT	5979	
Kr XX	CL	5835		CL	5979	
Kr XXI	CL	5761, 5835		EL	5979	
Kr XXIII	CL	5835		PT	5979	
Kr XXIV	CL	5835	Rb XXVI	IP	5827	
Kr XXV	CL	5562, 5835		SF	5827	
	EL	5562	Rb XXVIII	CL	5122	
	IP	5827		EL	5122	
	SF	5827	Rb XXIX	CL	5122	
				EL	5122	
Kr XXVI	AT	4863, 5045	Rb XXXVI	PT	5208	
	CL	4863, 5862A				
	EL	4863				
Kr XXVII	AT	4863, 5866	Sr I	AT	5134, 5181, 5284, 5365, 5452	
	CL	4863			5734	
	EL	4863		CL	5134, 5452, 5826	
Kr XXVIII	AT	4863		EL	5134, 5452, 5578, 5644, 5826	
	CL	4863, 5862A		Hfs	5356, 5702, 5721, 5734, 5849	
	EL	4863		IP	5280	
Kr XXIX	AT	4863		IS	5483, 5593, 5676, 5721, 5734	
	CL	4863, 5862A			5900, 5926	
	EL	4863		PT	4909, 5365, 5700	
Kr XXX	AT	5645		TA	5701	
Kr XXXI	AT	5645	Sr II	AT	5452	
Kr XXXII	AT	5645		IS	5593	
Kr XXXIII	AT	5169, 5645, 5731, 5961	Sr IX	W	5322	
	CL	5169	Sr X	AT	5322	
Kr XXXIV	AT	5169, 5645		CL	5322	
	CL	5169		EL	5322	
Kr XXXV	AT	5184		IP	5322	
			Sr XI	CL	5322	
				W	5322	
			Sr XII	AT	5521	
				CL	5521	
				EL	5521	
				PT	5521	
				W	5322	

**2.2. Reference Numbers for Individual Spectra—Continued**

Sr XIII	AT	5288, 5885, 5979		Y XIV—Continued	EL	5260, 5288, 5785, 5885
	CL	5288, 5885, 5979				PT 5288, 5785, 5885
	EL	5288, 5885, 5979				
	PT	5288, 5885, 5979				
Sr XIV	AT	5896		Y XV	AT	5896
Sr XXII	CL	5835			CL	5896
Sr XXIII	CL	5835			EL	5896
Sr XXVI	CL	5835			PT	5896
Sr XXVII	CL	5562, 5794, 5835		Y XXVIII	CL	5794
	EL	5562, 5794			EL	5794
	IP	5827			IP	5827
	SF	5827			SF	5827
Sr XXIX	CL	5122		Y XXX	IP	5121
	EL	5122		Y XXXI	AT	5598
Sr XXX	AT	5598			CL	5598
	CL	5122, 5598			EL	5598
	EL	5122, 5598		Y XXXVII	AT	5961
<b>Zirconium</b>						
<b>Yttrium</b>						
Y I	EL	5548		Zr I	ZE	5735
	Hfs	5618, 5968		Zr III	AT	5338
	IS	5618			CL	5338
					EL	5338
					IP	5338
Y IV	AT	5501		Zr IV	AT	5206
	CL	5501			CL	5042, 5206
	EL	5501			EL	5042, 5206
	IP	5501			IP	5042, 5206
Y V	EL	5318		Zr V	CL	5312
					EL	5312
Y VII	AT	5287		Zr VI	AT	5318
	CL	5287			CL	5042, 5318
	EL	5287			EL	5042, 5318
	IP	5287			IP	5318
Y X	CL	5296		Zr VII	AT	5744
Y XI	AT	4899, 5296, 5376			CL	5744
	CL	4899, 5296, 5376			EL	5744
	EL	4867, 4899, 5296		Zr VIII	AT	5277, 5287
	IP	4899			CL	5277, 5287
	PT	4867, 5296, 5376			EL	5277, 5287
					IP	5287
					PT	5287
Y XII	AT	5187		Zr IX	AT	5234
	CL	5187			CL	5234
	EL	5187			EL	5234
Y XIII	AT	5521		Zr XI	CL	5296
	CL	5521, 5581		Zr XII	AT	4917, 5296, 5376
	EL	5521, 5581			CL	4917, 5296, 5376
	PT	5521, 5581			EL	4867, 4917, 5296
Y XIV	AT	5260, 5288, 5885				
	CL	5260, 5288, 5785, 5885				

**2.2. Reference Numbers for Individual Spectra—Continued**

Zr XII—Continued				Nb V	CL	5437, 5524
IP 4917				EL	5437, 5524	
PT 4867, 5296, 5376				Hfs	5437	
TA 5557				IP	5437, 5524	
Zr XIII	AT	5187		Nb VI	CL	5527
CL	5187			EL	5527	
EL	5187			Nb VII	EL	5318
Zr XIV	AT	5521		Nb IX	AT	5287
CL	5521, 5581, 5821			CL	5287	
EL	5521, 5581			EL	5287	
PT	5521, 5581			IP	5287	
Zr XV	AT	5288, 5885			PT	5287
CL	5260, 5288, 5785, 5821, 5885			Nb XII	AT	5489
EL	5260, 5288, 5785, 5885			CL	5296, 5489	
PT	5288, 5785, 5885			EL	5489	
Zr XVI	AT	5896			PT	5489
CL	5896			Nb XIII	AT	4998, 5296, 5376, 5489
EL	5896			CL	4998, 5296, 5376, 5489	
PT	5896			EL	4867, 4998, 5296, 5489	
Zr XXI	CL	5821			IP	4998
Zr XXII	CL	5821			PT	4867, 5296, 5376, 5489
Zr XXIV	CL	5835		Nb XIV	AT	5187, 5489
Zr XXV	CL	5835		CL	5187, 5489	
Zr XXVI	CL	5835		EL	5187, 5489	
Zr XXVII	CL	5821, 5835			PT	5489
Zr XXVIII	CL	5835		Nb XV	AT	5489, 5521
Zr XXIX	CL	5562, 5794, 5835		CL	5489, 5521, 5581	
EL	5562, 5794			EL	5489, 5521, 5581	
IP	5827			PT	5489, 5521, 5581	
SF	5827			TA	5489	
Zr XXXI	CL	4850		Nb XVI	AT	5288, 5885
Zr XXXII	CL	4850		CL	5260, 5288, 5785, 5885	
W	4850			EL	5260, 5288, 5785, 5885	
Zr XXXIII	CL	4850		PT	5288, 5785, 5885	
W	4850			TA	5489	
<b>Niobium</b>						
Nb III	AT	5554		Nb XXIX	CL	5835
CL	5554			Nb XXX	CL	5794, 5835
EL	5554			EL	5794	
Nb IV	CL	5458		IP	5827	
EL	5458			SF	5827	
IP	5458			Nb XXXIII	W	4850
PT	5458			Nb XXXIV	W	4850
Nb XXXIX						
Nb XL						
Nb CL						

**2.2. Reference Numbers for Individual Spectra—Continued**

Molybdenum			Mo xxvii	CL	5835
Mo I	IS	5333	Mo xxviii	CL	5835
Mo VI	CL	5295	Mo xxix	AT	5830
Mo VIII	CL	5295		CL	5821, 5830, 5835
	EL	5318	Mo xxx	AT	5830
Mo X	AT	5287		CL	5830, 5835
	CL	5287	Mo xxxi	AT	5830
	EL	5287		CL	5562, 5794, 5830, 5835
	IP	5287		EL	5562, 5794
	PT	5287		IP	5827
				SF	5827
Mo XII	CL	5295	Mo xxxii	AT	5045, 5830
Mo XIII	CL	5083, 5295, 5296		CL	5830
Mo XIV	AT	5247, 5296, 5376, 5927	Mo xxxiii	AT	5599, 5830
	CL	5083, 5247, 5296, 5376		CL	5830
	EL	5247, 5296	Mo xxxiv	W	4850
	ND	5247		Mo xxxv	W
	PT	4867, 5296, 5376			4850
	TA	5093	Mo xxxix	AT	5731, 5961
Mo XV	AT	5187		<b>Technetium</b>	
	CL	5083, 5187	Tc I	AT	5848A
	EL	5187	Tc XV	PT	4867
	TA	5441	Tc xxxii	PT	5827
				SF	5827
Mo XVI	AT	4922, 5083, 5521, 5675		<b>Ruthenium</b>	
	CL	5083, 5396, 5521, 5581, 5675	Ru I	Hfs	5655
		5821		ZE	5655
	EL	5083, 5521, 5581, 5675	Ru XVI	AT	5376
	PT	5521, 5581		CL	5376, 5953
	TA	5441		EL	5953
				IP	5953
				PT	4867, 5376
Mo XVII	AT	5260, 5288, 5885, 5970	Ru XVII	AT	5187
	CL	5083, 5260, 5288, 5785, 5821		CL	5187
		5885		EL	5187
	EL	5260, 5288, 5785, 5885	Ru XVIII	CL	5581
	PT	5288, 5785, 5885		EL	5581
	TA	5441		PT	5581
Mo XVIII	AT	5896	Ru XIX	CL	5785
	CL	5083, 5896		EL	5785
	EL	5896		PT	5785
	PT	5896	Ru XX	AT	5896
	TA	5441		CL	5896
Mo XIX	TA	5441		EL	5896
Mo XX	TA	5441		PT	5896
Mo XXI	TA	5441			
Mo XXII	TA	5441			
Mo XXIII	CL	5821			
Mo XXIV	CL	5821			
Mo XXVI	CL	5835			

## **2.2. Reference Numbers for Individual Spectra – Continued**

Ru xxxiii	CL	5794	Pd xxii	AT	5896
	EL	5794		CL	5896
	PT	5827		EL	5896
	SF	5827		PT	5896
				TA	5441
Ru xli	AT	5961	Pd xxiii	TA	5441
	<b>Rhodium</b>				
Rh xvii	AT	5376	Pd xxiv	TA	5441
	CL	5376, 5953	Pd xxv	TA	5441
	EL	5953	Pd xxvi	TA	5441
	IP	5953	Pd xxvii	TA	5441
	PT	4867, 5376			
Rh xviii	AT	5187		<b>Silver</b>	
	CL	5187	Ag I	AT	4894, 5577, 5874
	EL	5187		CL	5874
Rh xix	CL	5581		EL	5874
	EL	5581	Ag II	EL	5070, 5204
	PT	5581	Ag IV	AT	5555, 5680
Rh xx	CL	5785		CL	5555, 5680
	EL	5785		EL	5555, 5680
	PT	5785		PT	5555
Rh xxi	AT	5896	Ag XVII	W	5440
	CL	5896	Ag XVIII	W	5440
	EL	5896	Ag XIX	AT	5376
	PT	5896		CL	5376, 5953
Rh xxxiv	CL	5794		EL	4867, 5953
	EL	5794		IP	5031, 5953
	PT	5827		PT	4867, 5376
	SF	5827		W	5440
	<b>Palladium</b>				
Pd i	Hfs	5400	Ag XX	AT	5187
Pd xviii	AT	5376		CL	5187
	CL	5376, 5953		EL	5187
	EL	4867, 5953	Ag XXI	CL	5581
	IP	5031, 5953		EL	5581
	PT	4867, 5376		PT	5581
Pd xix	AT	5187	Ag XXII	CL	5785
	CL	5187		EL	5785
	EL	5187		PT	5785
	TA	5441			
Pd xx	CL	5581	Ag XXIII	AT	5896
	EL	5581		CL	5896
	PT	5581		EL	5896
	TA	5441		PT	5896
Pd xxi	CL	5785	Ag XXXVIII	CL	5325
	EL	5785		<b>Cadmium</b>	
	PT	5785			
	TA	5441	Cd I	AT	4959
				CL	5308

**2.2. Reference Numbers for Individual Spectra—Continued**

<b>Cd I—Continued</b>			
EL	5308	In XXI	CL 5953
Hfs	5354		EL 4867, 5953
IS	5354		IP 5031, 5953
SE	4865		PT 4867
W	5308	In XL	CL 5325
ZE	5139A, 5632		
<b>Tin</b>			
Cd II	CL 5172	Sn I	Hfs 5529, 5843
	Hfs 4977		IS 5843
Cd III	CL 5192	Sn II	SE 5747
	EL 5192		ZE 4985
	IP 5192		
	PT 5192	Sn V	AT 5534
Cd IV	CL 5055		CL 5534
	EL 5055		EL 5534
	PT 5055		IP 5534
			PT 5534
Cd V	CL 5573, 5574	Sn XX	CL 5439
	EL 5573, 5574		W 5439
	PT 5574		
Cd XX	CL 5953	Sn XXI	CL 5439
	EL 4867, 5953		W 5439
	IP 5031, 5953		
	PT 4867	Sn XXII	AT 5692
Cd XXXIX	CL 5325		CL 5439, 5953
Cd XLV	AT 5961		EL 5953
			IP 5953
			PT 4867
			W 5439
<b>Indium</b>			
In I	AT 4895, 5266, 5384, 5433, 5493	Sn XLI	CL 5325
	CL 5024, 5384, 5433, 5462, 5493		
	5566		
	EL 5024, 5384, 5433, 5462, 5493	Sb I	CL 4893
	5566, 5861		EL 4893
	Hfs 4916, 4960, 5363, 5384, 5529		Hfs 5529
	5544, 5809		IP 4893
	IP 5384, 5462, 5566, 5717		ZE 5872
	IS 4960, 5363, 5566		
	PT 5266	Sb II	ND 5109A, 5119A
	SF 5566		PT 5109A, 5119A
	W 5024		SE 5747
In II	AT 5433	Sb VI	AT 4906
	CL 5433		CL 4883, 4906
	EL 5096, 5433		EL 4883, 4906, 5250
			PT 4883, 4906
In IV	AT 5534	Sb VII	AT 5107
	CL 5534		CL 5107
	EL 5534		EL 5107
	IP 5534		PT 5107
	PT 5534		
In VI	AT 5436, 5604	Sb XXIII	PT 4867
	CL 5436, 5604		
	EL 5436, 5604		
	PT 5436, 5604		
<b>Tellurium</b>			
		Te I	AT 5058
			CL 5346, 5704, 5789, 5813, 5880

**2.2. Reference Numbers for Individual Spectra—Continued**

Te I—Continued		Xe I—Continued	
EL	5704, 5789, 5813, 5880	TA	5154
IP	5789, 5880	W	4933, 5421
IS	4887	ZE	4879, 5522, 5705, 5787, 5825
PT	5760		
W	5346	Xe II	
		AT	5418, 5419
Te II	Hfs	Hfs	4851, 5326, 5614
	PT	IS	4851, 5326, 5614
Te VII	AT	PT	5115
	CL	SE	5745
	EL	W	5421, 5583
	PT		
Te VIII	AT	Xe III	
	CL	AT	5193, 5575
	EL	CL	5428, 5583, 5782
	PT	EL	5428, 5782
		IP	5938
Te XXIV	PT	PT	5428, 5760
		W	5421, 5583
<b>Iodine</b>		Xe VI	
I I	AT	AT	5623
	CL	CL	5117
	EL	ND	5623
	Hfs	Xe VII	
	IP	AT	5691, 5852
	IS	CL	4915, 5622, 5852
	PT	EL	4915, 5120, 5852
	W	IP	4915
	ZE	Xe VIII	
I II	PT	AT	5691, 5852
		CL	4900, 5120, 5256, 5438, 5852
		EL	4900, 5120, 5256, 5438, 5852
		IP	4900, 5438, 5532
		PT	5256
I VI	CL	Xe IX	
	EL	AT	5691, 5852
	IP	CL	5678, 5852
		EL	5678, 5852
I VII	CL	Xe X	
	EL	AT	5841
	IP	CL	5841
		EL	5841
I VIII	CL	PT	5841
	EL	Xe XVII	
		AT	5691
I IX	CL	Xe XXV	
	EL	AT	5100
	PT	Xe XXVI	
		AT	5100
I XXV	PT	PT	4867
	W	Xe XXVIII	
		AT	5675
		CL	5675
		EL	5675
Xe I	AT	Xe XLIV	
	CL	AT	5415
	EL	CL	5415
		Xe XLV	
		AT	5415
		CL	5415
	Hfs	Xe XLVI	
	IP	AT	5415
	IS	CL	5415
	SF		
<b>Xenon</b>			

**2.2. Reference Numbers for Individual Spectra—Continued**

Xe XLVII	AT	5415	Ba I—Continued	
	CL	5415	Hfs	5011, 5022, 5510, 5512, 5517 5543, 5550, 5594, 5595, 5609 5721, 5722, 5781
Xe LI	AT	5961	IP	5401
		<b>Cesium</b>	IS	5011, 5022, 5104, 5483, 5510 5512, 5520, 5609, 5721, 5781
Cs I	AT	5289, 5551, 5792, 5919	PT	4909, 5011, 5328, 5352, 5584 5587, 5594, 5694, 5696, 5711 5722, 5727, 5957, 5977
	CL	4891, 5289, 5605, 5726, 5733 5756, 5919	SE	5040, 5328, 5957
	EL	4891, 4940, 5103A, 5177, 5224 5226, 5228, 5289, 5726, 5733 5756, 5919	SF	5590
	Hfs	4940, 5023, 5027, 5382, 5474 5533, 5580, 5662, 5726, 5733 5768	TA	4909, 5010, 5064, 5248, 5771
	IP	4891, 5177, 5289, 5580, 5750 5756, 5783	ZE	5239, 5630
	IS	5533, 5768	Ba II	AT 5039, 5212, 5516, 5714, 5858 5868
	SE	4976, 5371, 5564, 5773, 5840	CL	5516
	SF	5495, 5733	EL	4965, 5062, 5286, 5516
	TA	4897, 5762	Hfs	5105, 5478, 5647, 5698, 5699
Cs II	AT	4978, 5605, 5739	IS	5105, 5766, 5772
	CL	5173, 5605	PT	5977
	EL	5056, 5173, 5209, 5605	ZE	5332
	Hfs	4853, 4927, 4978, 5605	Ba III	AT 5414, 5516, 5739, 5858
	IP	5605	CL	5516
	ND	5173	EL	5516
	PT	5605	PT	5977
			TA	5154
Cs III	AT	5605	Ba V	CL 5760
	CL	5605		EL 5760
	EL	5605		PT 5760
	Hfs	5605	Ba X	CL 5438
	PT	5605		EL 5438
				IP 5438, 5532
Cs IV	CL	5760	Ba XI	CL 5678
	EL	5760		EL 5678
	PT	5760		
Cs IX	CL	5438	Ba XII	AT 5820
	EL	5438		CL 5820
	IP	5438, 5532		EL 5820
				PT 5820
Cs X	CL	5678	Ba XXVII	AT 5100
	EL	5678		CL 5100
Cs XI	AT	5250	Ba XXVIII	CL 5473
	CL	5250		EL 5473
	EL	5250		IP 5473
	PT	5250		
		<b>Barium</b>	Ba XXX	AT 5675
Ba I	AT	5039, 5181, 5516, 5858, 5868 5910, 5946		CL 5675
	CL	5063, 5167, 5249, 5516, 5694 5711, 5723, 5929, 5978		EL 5675
	EL	4864, 4965, 5249, 5286, 5328 5516, 5584, 5587, 5590, 5694 5711, 5722, 5723, 5727, 5913 5978		<b>Lanthanum</b>
			La I	Hfs 4932, 5963
				IS 4932
			La II	Hfs 5020, 5138A, 5482, 5514

**2.2. Reference Numbers for Individual Spectra—Continued**

La VI	CL	5760	Pr XIII	CL	5532
	EL	5760		EL	5532
	PT	5760		IP	5532
La XI	CL	5438	Pr XIV	CL	5678
	EL	5438		EL	5678
	IP	5438, 5532			
					<b>Neodymium</b>
La XII	CL	5678	Nd I	Hfs	5393
	EL	5678		IS	4918, 5252, 5393, 5911
La XXVIII	AT	5100		ND	4918
	CL	5100		W	5252
La XXXI	AT	5675	Nd II	IS	5252, 5395, 5911
	CL	5675		W	5252
	EL	5675			
La XXXIX	CL	5473	Nd IV	AT	5025
	EL	5473		PT	5025
	IP	5473	Nd XIV	CL	5532
				EL	5532
				IP	5532
					<b>Cerium</b>
Ce III	AT	5025	Nd XV	CL	5678
	PT	5025		EL	5678
Ce VIII	TA	5359	Nd XXXI	AT	5100
				CL	5100
Ce IX	TA	5359	Nd XXXII	AT	5100
Ce X	TA	5359		CL	5100, 5473
Ce XI	TA	5359		EL	5473
				IP	5473
Ce XII	CL	5532	Nd XXXIV	AT	5675
	EL	5532		CL	5675
	IP	5532		EL	5675
	TA	5359			
Ce XIII	CL	5678			<b>Promethium</b>
	EL	5678	Pm XVI	CL	5678
	TA	5359		EL	5678
Ce XIV	TA	5359			<b>Samarium</b>
Ce XV	TA	5359	Sm I	AT	5863
Ce XVI	TA	5359		EL	5863
			Sm I	IS	5158, 5369, 5385, 5687, 5818
					5877
					<b>Praseodymium</b>
Pr I	CL	5336, 5360	Sm II	Hfs	5658
	EL	5336, 5360		IS	5047
	Hfs	5336, 5360		PT	5251
	PT	5336	Sm XVI	CL	5532
	ZE	5336		EL	5532
				IP	5532
Pr IV	AT	5025, 5434	Sm XVII	CL	5678
	Hfs	5819		EL	5678
	PT	5025	Sm XXXIII	AT	5100
				CL	5100

**2.2. Reference Numbers for Individual Spectra—Continued**

Sm xxxiv	CL	5473	<b>Terbium</b>		
	EL	5473	Tb III		
	IP	5473	PT    5251		
Sm xxxv	ND    4974		Tb xix	CL    5532	
	CL    5675			EL    5532	
Sm xxxvi	AT	5675	Tb xx	CL    5678	
	CL	5675		EL    5678	
	EL	5675			
<b>Europium</b>			<b>Dysprosium</b>		
Eu I	CL	5889	Dy I	Hfs	5116, 5712, 5713
	EL	5077, 5889		IS	5130, 5567, 5582, 5713, 5799 5877
	Hfs	4954, 5215, 5362, 5442, 5499 5653, 5864, 5963		ND	5582, 5799
	IS	4954, 5442, 5499, 5628, 5864 5877, 5959, 5963		W	5567
Eu II	Hfs	5397	Dy II	IS	5850
	IS	4954		PT	5850
Eu III	CL	5137	Dy XX	CL	5532
	IS	4954		EL	5532
	PT	5251		Dy XI	CL    5678 EL    5678
Eu XVII	CL	5532	Dy XXXVII	AT	5100
	EL	5532		CL	5100
	IP	5532			
Eu XVIII	CL	5678	Dy XXXVIII	CL	5473
	EL	5678		IP	5473
<b>Gadolinium</b>			Dy XXXIX	ND	4974
Gd I	IS	5636		Dy XL	AT    5675 CL    5675 EL    5675
Gd II	PT	5251			
Gd XII	AT	5838			
Gd XVIII	CL	5532	<b>Holmium</b>		
	EL	5532	Ho I	CL	5657
Gd XIX	CL	5678		EL	5657
	EL	5678		Hfs	5488, 5657
Gd XXXV	AT	5100		ZE	5488
	CL	5100	Ho XI	CL	5532
Gd XXXVI	AT	5100, 5927		EL	5532
	CL	5100, 5473, 5927	Ho XII	CL	5678
	EL	5473, 5927		EL	5678
	IP	5473	Ho XXXIX	CL	5980A
Gd XXXVII	ND	4974			
<b>Erbium</b>					
Gd XXXVIII	AT	5675	Er I	CL	5246
	CL	5675		EL	5246
	EL	5675		Hfs	5712, 5908
Gd LXI	AT	5961		IS	5884
				PT	5884
				W	5246
			Er III	AT	5026

**2.2. Reference Numbers for Individual Spectra—Continued**

<b>Er IV</b>	<b>EL</b>	<b>5870</b>	<b>Yb II—Continued</b>			
	<b>PT</b>	<b>5251</b>				
<b>Er XXXIX</b>	<b>AT</b>	<b>5100</b>				
	<b>CL</b>	<b>5100</b>				
<b>Er XL</b>	<b>AT</b>	<b>5100</b>	<b>Yb XLI</b>			
	<b>CL</b>	<b>5100, 5473</b>				
	<b>EL</b>	<b>5473</b>				
	<b>IP</b>	<b>5473</b>				
<b>Er XLII</b>	<b>AT</b>	<b>5675</b>	<b>Yb XLII</b>			
	<b>CL</b>	<b>5675</b>				
	<b>EL</b>	<b>5675</b>				
<b>Thulium</b>						
<b>Tm I</b>	<b>AT</b>	<b>5823</b>	<b>Yb XLIII</b>			
	<b>Hfs</b>	<b>5108</b>				
<b>Tm IV</b>	<b>AT</b>	<b>5025, 5026</b>	<b>Yb XLIV</b>			
	<b>EL</b>	<b>5306</b>				
	<b>PT</b>	<b>5025, 5251, 5306</b>	<b>Lutetium</b>			
<b>Tm XL</b>	<b>AT</b>	<b>5692</b>	<b>Lu I</b>			
	<b>CL</b>	<b>5692</b>				
	<b>EL</b>	<b>5692</b>				
<b>Tm XLI</b>	<b>AT</b>	<b>5375, 5692, 5927</b>	<b>Lu II</b>			
	<b>CL</b>	<b>5375, 5692, 5927</b>				
	<b>EL</b>	<b>5692, 5927</b>	<b>Lu III</b>			
	<b>W</b>	<b>5375</b>				
<b>Tm XLII</b>	<b>AT</b>	<b>5374</b>	<b>Lu IV</b>			
	<b>CL</b>	<b>5374</b>				
<b>Tm XLIII</b>	<b>AT</b>	<b>5375, 5692</b>	<b>Hafnium</b>			
	<b>CL</b>	<b>5375, 5692</b>				
	<b>EL</b>	<b>5692</b>	<b>Hf I</b>			
	<b>W</b>	<b>5375</b>				
<b>Tm XLIV</b>	<b>AT</b>	<b>5692</b>	<b>Hf IV</b>			
	<b>CL</b>	<b>5692</b>				
	<b>EL</b>	<b>5692</b>	<b>Hf V</b>			
<b>Ytterbium</b>						
<b>Yb I</b>	<b>AT</b>	<b>4907, 5257, 5334, 5537, 5823</b> <b>5851</b>				
	<b>CL</b>	<b>4907, 5410, 5461</b>	<b>Hf XLIII</b>			
	<b>EL</b>	<b>4907, 4965, 5231, 5253, 5257</b> <b>5410, 5461, 5920</b>				
	<b>Hfs</b>	<b>4866, 4947, 5157, 5448</b>	<b>Hf XLIV</b>			
	<b>IS</b>	<b>4866, 4947, 5076, 5097, 5157</b> <b>5743, 5963</b>				
	<b>ND</b>	<b>4980, 5076, 5410</b>	<b>Hf XLV</b>			
	<b>PT</b>	<b>4907, 4980, 5157, 5410</b>				
	<b>SE</b>	<b>5147</b>	<b>Hf XLVI</b>			
	<b>TA</b>	<b>5010</b>				
	<b>ZE</b>	<b>4907, 5399</b>				
<b>Yb II</b>	<b>AT</b>	<b>4907, 4997, 5671, 5823</b>				
	<b>CL</b>	<b>4907</b>				

**2.2. Reference Numbers for Individual Spectra—Continued**

<b>Tantalum</b>				<b>Rhenium</b>			
Ta I	Hfs	5233, 5937		Re I	Hfs	4954, 5082, 5656	
	ZE	5233			IS	4954, 5082	
Ta VI	AT	5341			PT	5656	
	CL	5341			ZE	5656	
	EL	5341		Re XLVI	AT	5692	
	PT	5341			CL	5692	
Ta XLIV	AT	5692			EL	5692	
	CL	5100, 5692		Re XLVII	AT	5692, 5927	
	EL	5692			CL	5692, 5927	
Ta XLV	AT	5692			EL	5692, 5927	
	CL	5473, 5692		Re XLVIII	AT	4974	
	EL	5473, 5692			CL	4974	
	IP	5473		Re XLIX	AT	5692	
	PT	4867			CL	5692	
Ta XLVI	AT	4974, 5374, 5927			EL	5692	
	CL	4974, 5374, 5927					
	EL	5927					
Ta XLVII	AT	5692					
	CL	5692		Os XLVIII	PT	4867	
	EL	5692					
<b>Tungsten</b>				<b>Osmium</b>			
W VII	AT	5341					
	CL	5341					
	EL	5341					
	PT	5341					
W XIII	AT	5621					
W XIV	AT	5235, 5891					
W XXVIII	CL	5227, 5532		Pt I	IS	4945	
	EL	5532			PT	4945	
W XLV	AT	5692			ZE	5810	
	CL	5100, 5692		Pt XLIX	AT	5692	
	EL	5692			CL	5692	
W XLVI	AT	5375, 5692			EL	5692	
	CL	5100, 5375, 5473, 5692			PT	4867	
	EL	5473, 5692		Pt LI	AT	5692	
	IP	5473			CL	5692	
	PT	4867			EL	5692	
	W	5375			PT	4867	
W XLVII	AT	4974, 5374		Pt LII	CL	4975	
	CL	4974, 5374					
W XLVIII	AT	5375, 5675, 5692		Pt LII	AT	5692	
	CL	5375, 5675, 5692			CL	5692	
	EL	5675, 5692			EL	5692	
	W	5375					
W LXXI	AT	5731, 5961					
				Au I	CL	4880	
					EL	4880	
					IS	5668, 5933A	
					W	4880	
				Au II	CL	5172	

**2.2. Reference Numbers for Individual Spectra—Continued**

Au XIX	AT	5235, 5621, 5891	Bi I—Continued		
Au LI	PT	4867	IS 5975A W 5196		
		<b>Mercury</b>	Bi II		
Hg I	AT	5697		AT	4920
	CL	5697		Hfs	4920
	EL	5361, 5697		SE	5747
	Hfs	5427	Bi III		
	IP	5697	PT 5266		
	IS	5292, 5349, 5788	<b>Francium</b>		
	ND	5956	Fr AT 5719		
	ZE	5427	Fr I CL 5281		
Hg II	CL	5190		Hfs 5738, 5768	
	EL	5190		IS 5281, 5768	
Hg LII	PT	4867	<b>Radium</b>		
Hg LXXIII	AT	5274	Ra I CL 4979		
				EL 4979	
		<b>Thallium</b>		IP 4979	
Tl	W	5378		PT 4909, 4979	
<b>Thorium</b>					
Tl I	AT	4895, 5266, 5493, 5836	Th I CL 5951		
	CL	5461, 5493, 5836		EL 5342, 5951	
	EL	5461, 5493, 5836		IS 5724	
	ND	5266	Th II CL 5951		
	PT	5266		EL 5951	
Tl II	CL	5190	Th III CL 5541, 5951		
	EL	5069, 5096, 5190		EL 5541, 5951	
Tl LIII	PT	4867		IP 5541	
		<b>Lead</b>		PT 5541	
Pb I	CL	5196, 5519	Th VIII TA 5359		
	EL	5196, 5519, 5948	Th IX TA 5359		
	Hfs	5394A, 5822	Th X TA 5359		
	IS	5191, 5394A, 5459, 5561, 5672 5822, 5925A	Th XI TA 5359		
	PT	5942	Th XII TA 5359		
	W	5196	Th XIII TA 5359		
Pb II	CL	5190, 5519	Th XIV TA 5359		
	EL	5190, 5207, 5519	Th XV TA 5359		
	SE	5747	Th XVI TA 5359		
Pb XXI	AT	5621	<b>Uranium</b>		
Pb XXII	AT	5235, 5891	U I CL 5037, 5145, 5471, 5494, 5674		
Pb LIV	PT	4867		EL 5342, 5494, 5965	
Pb LXXIX	AT	5961		Hfs 5002, 5967A	
		<b>Bismuth</b>		IP 5494	
Bi I	CL	5196, 5507, 5909A		IS 4938	
	EL	5196		PT 5763	
	Hfs	4948, 5715, 5975A		W 5145	
	IP	5196			

**2.2. Reference Numbers for Individual Spectra—Continued**

<b>U II</b>	AT	<b>5928</b>		<b>Pu II</b>	IP	<b>4919</b>
	CL	<b>5145, 5471</b>			PT	<b>5081</b>
	Hfs	<b>5928</b>		<b>Pu III</b>	IP	<b>4919</b>
	IP	<b>4919</b>		<b>Pu IV</b>	IP	<b>4919</b>
	PT	<b>5081</b>		<b>Pu V</b>	IP	<b>4919</b>
	W	<b>5145</b>		<b>Pu VI</b>	IP	<b>4919</b>
<b>U III</b>	IP	<b>4919</b>				
	W	<b>5003, 5888</b>				
<b>U IV</b>	IP	<b>4919</b>				
	W	<b>5003, 5888</b>				
						<b>Curium</b>
<b>U V</b>	AT	<b>5129, 5729</b>		<b>Cm I</b>	IS	<b>4890</b>
	CL	<b>5129</b>			PT	<b>5081</b>
	EL	<b>5129</b>			W	<b>4995</b>
	IP	<b>4919</b>		<b>Cm II</b>	ND	<b>5902A</b>
	PT	<b>5129</b>			PT	<b>5081</b>
<b>U VI</b>	IP	<b>4919</b>			W	<b>4995</b>
<b>U XXXII</b>	AT	<b>5235, 5621, 5891</b>				<b>Berkelium</b>
<b>U LXIV</b>	PT	<b>4867</b>		<b>Bk I</b>	EL	<b>5113A</b>
<b>U LXXXIX</b>	AT	<b>5961</b>			PT	<b>5081</b>
			<b>Neptunium</b>	<b>Bk II</b>	EL	<b>5113A</b>
<b>Np I</b>	PT	<b>5081</b>			PT	<b>5081</b>
<b>Np II</b>	IP	<b>4919</b>		<b>Cf I</b>	PT	<b>5081</b>
	PT	<b>5081</b>		<b>Cf II</b>	PT	<b>5081</b>
<b>Np III</b>	IP	<b>4919</b>				<b>Einsteinium</b>
<b>Np IV</b>	IP	<b>4919</b>		<b>Es I</b>	PT	<b>5081</b>
<b>Np V</b>	IP	<b>4919</b>		<b>Es II</b>	PT	<b>5081</b>
<b>Np VI</b>	IP	<b>4919</b>				<b>Lawrencium</b>
			<b>Plutonium</b>	<b>Lr I</b>	AT	<b>5168</b>
<b>Pu I</b>	CL	<b>5798</b>				
	EL	<b>5798</b>				
	PT	<b>5081</b>				

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Sb XXIII, Te XXIV, I XXV, Xe XXVI, Ta XLV: PT  
W XLVI, Re XLVII, Os XLVIII, Ir XLIX, Pt L: PT  
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Ni XVII, Cu XVIII, Zn XIX, Ga XX, Ge XXI: SF IP  
As XXII, Se XXIII, Br XXIV, Kr XXV, Rb XXVI: SF IP  
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#### 4. Author Index

Aashamar, K. 5786	Ando, K. 5396
Abdel-Raouf, M. A. 6050T	Andra, H. J. 4973 5319 5347 5869
Abjean, R. 4948	Andrew, K. L. 5030 5228 5289
Abramov, V. A. 5921	Andriessen, J. 4972 5478 5981
Abt, K. H. 4977	Andrillat, Y. 5709
Abu-Safia, H. 5787	Aniola, M. 5275
Acquista, N. 4899 4917 4998 5042 5247 5287 5322 5953	Anisimova, G. P. 5211
Adam, A. G. 5092	Anselment, M. 5822
Adam, M. Y. 5207	Antonucci, E. 5466 5660
Adams, B. G. 4902	Apicella, M. L. 5847
Adeney, P. D. 5304	Arcimowicz, B. 4920 5715
Aepfelbach, G. 5111	Arimondo, E. 5170
Agentoft, M. 5846	Armour, I. A. 4852 4881 5112 5319 5530
Aggarwal, K. M. 5635	Armstrong, J. A. 4909 4979 5181
Aglitskii, E. V. 4850 5325	Armstrong, L., Jr. 6067T
Ahmad, S. 5478	Arnesen, A. 4851 4853 4927 4978 5397 5568
Ahmad, S. A. 4918 5076 5252 5395 5567 5582 5636 5799 5850 5911	Arnold, M. 5348
Aleksakhin, I. S. 5077 5253	Arteca, G. A. 5610
Aleksandrov, E. B. 5210 5898	Artru, M. C. 5131 5142 5307 5355
Alkhazov, G. D. 5864 5959	Ashizawa, Y. 5391 5392
Allam, S. H. 5661	Astner, G. 5244
Alvarez, E. 4851 4853 4927 4978	Augustyniak, L. 5335 5398
Alvarez-Herrero, C. 5048	Avril, R. 5494
Amin, S. R. 5960A	Aydin, R. 5479
Amusia, M. Ya. 5684	Aymar, M. 4980 5480 5584 5630 5696 5711
Andersen, N. 4983	Bachtijarov, A. S. 5848A
Andersen, T. 5078 5405 5406 5471 5703 5846	Bacis, R. 4929
Anderson, E. K. 5961	Back, C. G. 5324 5519 5836
Anderson, E. M. 5961	Bahr, J. L. 5120 5339 5556 5629
Andl, A. 5695	Baig, M. A. 4854 5134 5266 5413 5493 5697

**4. Author Index—Continued**

Baird, P. E. G. 5817 5843	Beigang, R. 5301 5356 5402 5483 5578 5644 5700 5701 5702 5849 5900 5964
Baluja, K. L. 4921 5254 5255 5635	Bekk, K. 5561 5695 5822
Bandzaitis, A. 4981	Bekov, G. I. 5231 5257 5851
Barbier, L. 5157	Belfrage, C. 5769
Barrat, J. P. 4985 5447	Bell, F. 5525
Bartiromo, R. 5847	Bell, K. L. 5523
Bartoe, J. D. F. 5203	Bell, R. E. 5295 5504
Barut, A. O. 5481	Belrhmi-Belhassan, A. 5306
Barwick, J. T. F. 5934	Bely-Dubau, F. 4924 4925 4926 5068 5403 5404 5660 5802
Barzakh, A. E. 5959	Ben Ahmed, Z. 5482 5138A
Bar-Shalom, A. 4974 4975 5187 5374 5375 5376 5692 5927	Bendali, N. 5484
Bashkin, S. 4881 5256 5626 5679 5962	Bengtson, A. 4851 4853 4927 4978 5397
Basov, N. G. 5800	Benincasa, M. 5048
Batson, C. H. 5346	Bentzen, S. M. 5078 5405 5406 5471 5703
Bauche, J. 4922 4945 5135 5350 5441 5482 5838 5941 5138A 5916A	Berg, J. O. 5003
Bauche-Arnoult, C. 4922 5251 5441 5838	Bergmann, E. 5348
Baudinet-Robinet, Y. 5611	Berkowitz, J. 4963 5346 5764
Baumann, M. 5399 5400	Berlovich, E. 5864 5959
Bauschlicher, C. W., Jr. 5156	Bernheim, R. A. 4928
Bava, E. 5899 5914	Beroff, K. 4857
Baxter, J. A. 5222 5801	Berry, H. G. 4929 4956 4957 5160 5171 5198 5407 5416 5612 5613 5615 5624 5741
Bayer, R. 4923 5351	Berry, R. S. 4949 5940
Baylis, W. E. 4894 4895 6060T 6069T	Betz, H. D. 5525
Beatham, N. 5212	Beverini, N. 5803
Beattie, W. H. 5746	Beyer, H. F. 5626 5901
Becker, W. 5698 5699	Beyer, H. J. 5552 5553
Begemann, M. H. 5401	Bhadra, K. 5258
Behrens, H. O. 5963	Bhalla, C. P. 5603
Beier, R. 4855	

#### 4. Author Index—Continued

Bhatia, A. K.		Bokor, J.
4858   4884   4930   4982   5004   5005   5006		5132
5043   5044   5079   5080   5146   5153   5175		Bombarda, F.
5195   5268   5295   5408   5420   5606   5645		5847
5753   5866		Bonnelle, C.
Bhatia, K. S.		5306   5677
5704   5813		Booth, A. J.
Bhatti, S. A.		5904
5352		Bopp, P.
Bideau-Mehu, A.		5348
4948		Borghs, G.
Biemont, E.		5105   5326   5766   5772
5646   6054T   6082T   6085T		Borovik, A. A.
Binet, G.		5077   5253   5486   5854
5705   5825		Borozdin, V. S.
Bingham, C. R.		5008
5614		Boruta, I. I.
Bionducci, G.		5026   5903A
5803		Botch, B. H.
Biraben, F.		5085
4857   4875   5089   5259   5350   5546   5558		Bottcher, C.
5793   5840   5966		5426   5469
Bisgaard, P.		Boulay, M.
4964   4983		5586
Bitter, M.		Bouma, J.
4859   5643   5802		4952
Bjorklund, G. C.		Boxman, R. L.
4860		5775
Blackburn, J.		Bradford, C. M.
5852		5381
Blaha, M.		Brand, H.
5045		5158   5653
Blaich, T.		Brand, K.
5933A		5962
Blaise, J.		Brandenberger, J. R.
5081   5113A   5902A		4931
Blancard, P.		Brandt, H. W.
5494		5047
Blatt, R.		Brault, J. W.
5647   5698   5804   5839		5856
Bleach, R. D.		Braun, V. R.
5046   5853		5654
Bloemen, E.		Breton, C.
4989		4856   5232
Blok, J.		Breuckmann, B.
4952   5116   5130		5209
Bloomfield, L. A.		Brevard, C.
5349   5585   5648   5649   5650   5651   5693		5655
5788		Briand, J. P.
Blundell, S. A.		5706   5905
5843		Brillet, A.
Bobashev, S. V.		5793
5800		Brillet, L.
Bobulescu, R. C.		6062T
5037		Brion, C. E.
Bogdanovich, P. O.		5273
5007   5599   5652   5848A   5903A   6051T		Briotta, D. A., Jr.
Bogdanovichene, M. I.		5737
5007   5260   5485   5575   6051T		Briyunas, V. E.
Boiko, V. A.		5490
4861		

**4. Author Index—Continued**

Broglia, M. 5965	Buttlar, H. v. 5072 5073 5962
Bromage, G. E. 4951 5117 5122 5159 6085T	Bylicki, M. 5776
Brooks, R. L. 4896 5160 5161 5283 5407 5416 5612 5613 5615	Caesar, T. 5935
Brown, B. A. 5822	Cage, M. E. 4866
Brown, C. G. 5002	Cagnac, B. 5089
Brown, C. M. 4910 4958 5162 5826	Camhy-Val, C. 5802
Brown, R. M. 5180	Campos, J. 4978
Bruch, R. 4964 5388	Camus, P. 4864 4907 5010 5410 5584 5587 5696 5711
Brueckner, G. E. 5203	Can, C. 5603
Bruhn, R. 5487 5545 5708	Cantu, A. M. 4880 5263 5455 5491 5688 5789 5880
Bryzgunov, V. A. 5707	Cao, W. 5243
Brzezowska, J. 5357	Carillon, A. 5052
Buchet, J. P. 5213 5320 5616 5617 5710	Carlson, T. A. 5948
Buchet-Poulizac, M. C. 5213 5320 5616 5617 5710	Caroli, S. 5048
Buchinger, F. 5354 5618	Carre, M. 5332
Buckman, S. J. 5855	Carroll, P. K. 5359 5852
Bukow, H. H. 5261	Carter, H. K. 5614
Bunge, A. V. 5163	Carter, S. L. 5184
Bunge, C. F. 5163 5164 5165 5262 5358 5367 5373	Castro, E. A. 5610
Bureeva, L. A. 6052T	Catoni, F. 5965
Burger, K. H. 5082 5233 5906A	Ceausescu, N. 5037
Burgess, D. D. 5009	Cecchi, J. L. 5093 5330 5389 5557
Burghardt, B. 5082 5488	Cederquist, H. 5607 5751
Burke, P. G. 4921 5229 5254 5523 5907	Cerrina, F. 5948
Burkhalter, P. G. 4862 4863 5083 5489 5853	Ceyzeriat, P. 5617
Burrows, G. 5843	Chaghtai, M. S. Z. 5206 5234 5277 5312 5318 5338 5524 5527 5554 5744
Bushaw, B. A. 5409	Champeau, R. J. 5010 5157
Butscher, W. 5388	Chan, K. K. 5225
Buttgenbach, S. 5082 5233 5281 5390 5488 5533 5569 5634 5656 5718 5768 5151A 5906A	Chang, E. S. 5327 5857

**4. Author Index—Continued**

Chang, T. N. 5049	Cohen, S. 5389 5513 5562 5797 5821 5835
Chantepie, M. 4865	Cok, D. R. 5344 5657
Chao, T. S. 5155	Cole, B. E. 4933
Chardonnet, C. 5840	Cole, J. D. 5614
Chartier, A. 5918	Collins, G. J. 4873
Chase, L. F. 5133	Comaskey, B. 5983A
Chatelet, J. 5494	Comer, J. 5222 5801
Cheglokov, E. I. 5230	Connerade, J. P. 4854 5039 5134 5167 5266 5413 5414 5450 5493 5674 5714 5858
Cheng, C. C. 5268	Conturie, Y. 5415
Cheng, K. T. 4911 5160 5407 5411 5506 5739	Conway, J. G. 5003 5081 5437 5113A 5902A 5983A
Chetioui, A. 5905	Cooke, L. 5122
Chevallier, P. 5905	Cooke, R. L. 4951
Chien, R. L. 4949	Cooke, W. E. 5352
Childs, W. J. 4932 5360 5657 5712 5884 5908	Cooper, D. 5515 5579 5600 5601 5953
Chirkov, V. A. 5875	Cooper, J. W. 4933
Christensen, T. E. 5003	Coste, A. 5494
Chung, K. T. 5199 5200 5264 5492 5588 5805 5828 5860 6055T	Costello, J. 5852
Chung, S. 5412	Couillaud, B. 5333 5349 5585 5788
Churilov, S. S. 5260 5947	Cowan, R. D. 4862 4863 4984 5083 5297 5302 5364 5415 5489 5784 5830
Chuvatin, S. A. 5707	Cremer, C. 5909A
Cizek, J. 4902	Crifo-Magnant, F. 5316
Clark, B. O. 4937	Crocker, A. 5690
Clark, C. W. 5919 5936 5977	Cromer, C. L. 5352
Clark, D. L. 4866 5713	Crossley, R. 5829
Clark, R. E. H. 6064T 6089T	Crosswhite, H. 5928
Clyne, M. A. A. 5166	Crosswhite, H. M. 5239
Cocke, C. L. 5619	Cuk, M. 5564
Coffey, M. T. 5381	Culhane, J. L. 5466
Cohen, L. 4862 5489	Curl, R. F., Jr. 5276
Cohen, M. 5265 5456 5457	

**4. Author Index—Continued**

Curnutt, B. 5619	Delsart, C. 4934 5497 5685
Curtis, L. J. 4867 4869 4956 5031 5114 5160 5235 5309 5495 5496 5621 5827 5910 6065T 6070T	Delwiche, J. 5186
Dabkiewicz, P. 5354 5585	Dembczynski, J. 4920 4935 4987 5013 5435 5637 5715
Dalby, F. W. 5361	Denis, A. 5213 5320 5616
Dalgarno, A. 5208	Denisov, V. P. 5864 5959
Damaschini, R. 5741	Denne, B. 4869 5114 5236 5237 5752 5835
Daniele, R. 5012 5050	Densberger, J. 5983A
Das, T. P. 4972 5478 5981	Dernyatin, A. G. 5959
Dassen, H. W. 5859	Derouard, J. 5084 5201
David, D. 4985	Deschepper, P. 5716
Davies, P. B. 5790	Desclaux, J. P. 4911 5168 5207 5905
Davis, B. F. 5199 5588 5860	Desesquelles, J. 5213 5320 5616
Davis, D. S. 5791	Dezenberg, G. J. 5173
Davis, J. 5045	Dhez, P. 5725
De Bisschop, P. 5326 5772	Di Rocco, H. O. 5782
de Clercq, E. 4875 5089 5259 5350	Dicke, R. 5233 5656 5906A
de Heer, F. J. 4989	Dickow, H. 5236
De Lange, C. A. 5315	Diebold, G. J. 5417
De Leeuw, D. M. 5315	Dietrich, D. D. 5169 5862A
De Marchi, A. 5914	Dieulin, M. 4864 5587 5711
De Michelis, C. 4856	Dobryshin, V. E. 5863
de Saint Simon, M. 5281 5390 5533 5569 5634 5718 5768 5151A	Donnelly, K. E. 4896 5120
de Vlieger, G. J. N. E. 5861	Donszelmann, A. 4916 4960 5717 5861
DeMarchi, A. 5899	Doreste Suarez, L. 4903
DeMichelis, C. 5232	Dorsch, C. 5348
DeSerio, R. 4957 5198 5416 5613	Dorschel, K. 5658 5864
Debarre, A. 4980 5410	Doschek, G. A. 4858 4930 5364 5415 5420 5784
Delande, D. 4897 5840	Doughty, D. K. 5937
Delgado-Barrio, G. 4986	Doyle, J. G. 5255

**4. Author Index—Continued**

Drake, G. W. F. 4868	Eissner, W. 4988
Driker, M. N. 6080T	Ekberg, J. O. 4869 5016 5114 5267 5330 5498 5752
Drouin, R. 5171	Ekstrom, C. 5618
Druetta, M. 5213 5320 5616 5624 5659	El Himdy, A. 5584 5587 5696 5711
Druhl, K. 5638	El Masri, Y. 5757
Druzick, J. 5865A	El Sherbini, T. M. 4989 5115 5500 5661 5720
Dubau, J. 4924 4936 4996 5298 5403 5404 5477 5660 5802	Elbel, M. 5020 5135 5086A
Dubois, R. D. 5619	Eliel, E. R. 5011 5108 5116 5130 5215 5248 5362 5363 5393 5499 5721 5722 5723
Ducas, T. W. 5014	Ellis, D. G. 5235 5621 6083T
Dufton, P. L. 5214	Endert, H. 5800
Dukart, R. J. 5862A	Engleman, R., Jr. 4938 5087 5145 5724 5951
Duley, W. W. 5041 5196 5461	Engstrom, L. 4869 5114 5498 5752
Dumont, G. 5105	Epstein, G. L. 5501
Dumont, P. D. 5611	Eriksson, K. B. S. 5939
Duncanson, J. A., Jr., 4949	Erkoc, S. 5767
Dunn, M. H. 5292	Ermolaev, A. M. 5912
Dunning, F. B. 5313	Ertmer, W. 4912 4987 5435 5479
Dunning, T. H., Jr. 5085	Esteva, J. M. 5689 5725
Duong, H. T. 5281 5390 5484 5533 5569 5620 5634 5718 5741 5768 5151A .	Evenson, K. M. 4969 5125
Duquette, D. W. 5937	Ezra, G. S. 5940
Dutil, R. 5938	Fabre, C. 4946 5216 5726
Duval, B. P. 5626	Faenov, A. Ya. 4861
Dyall, K. G. 5304 5418 5419	Fahlman, A. 5948
Dzuba, V. A. 5719 5792	Fairbank, W. M., Jr. 5740
Ederer, D. L. 4933	Faisal, F. H. M. 5075
Efthimion, P. C. 4859	Falcone, R. W. 5001
Ehret, G. 5909A	Falkenburg, B. 4913
Eichhorn, A. 5135 5086A	Fan, B. 4870
Eidelsberg, M. 5316	Farley, J. W. 4939 5502
	Faucher, P. 5068 5403 5404 5660 5802

**4. Author Index—Continued**

Fawcett, B. C.		Fry, R. C.
4871 4905 5015 5016 5112 5117 5217		5180
5314 5602		Fujimoto, T.
Fedoseev, V. N.		5249
5959		Fujita, J.
Fedotov, S. I.		5844
5800		Fukuda, K.
Feldman, U.		5150 5249 5391 5392 5429 5463 5559
4858 4862 4930 5004 5079 5268 5297		5808
5300 5364 5415 5420 5645 5866		Gabriel, A. H.
Feneuille, S.		4925 4926 5298 5403 5466 5660
5010 5503		Gaillard, M. L.
Ferguson, A. I.		5332 5614
4877		Gaily, T. D.
Fernandez, F. M.		5092
5610		Galan, M.
Finkenthal, M.		5367
4856 5187 5232 5295 5504 5562 5797		Gallagher, T. F.
5821		5017 5064 5224 5226 5328 5590 5694
Fischer, C. F.		5727 5771 5913 5103A
5051 5118 5365 5411 5412 5505 5506		Gallardo, M.
5589 5846 5867 6056T 6074T 6075T 6084T		5421 5583
Fisher, A.		Galli, M.
4863		5803
Flaks, I. P.		Gammelgaard, P.
5882		5238
Flambaum, V. V.		Ganas, P. S.
5719 5792		4941 5329 6057T
Folkmann, F.		Garavaglia, M.
5626 5901		5583
Fonck, R.		Garnir, H. P.
4971 5291 5389		5611
Fonseca, A. L. A.		Garrett, W. R.
5941		5470
Foot, C. J.		Garton, W. R. S.
5843		5134 5239 5704
Forster, E.		Gaspar, R.
5800		4872
Fortner, R. J.		Gauthé, B.
5136 5862A		5725
Fraenkel, B. S.		Gawlik, W.
5187		5383
Fraga, S.		Gay, J. C.
4968		4897 5840
Fredriksson, K.		Gazit, Y.
4940		5980A
Freed, K. F.		Gebauer, H.
5221 5748 6061T		5233
Freeman, R. R.		Geisler, M.
4860 4962 5202 5377 5465 5099A		5399
Freund, R. S.		George, S.
5201		4942 5507
Fricke, B.		Georgescu, S.
5168 5868		5870
Frieze, W. E.		Gerber, G.
5088 5366		5909A
Frohling, R.		Gerhardt, H.
5869		5585 5648 5649 5650 5651 5693 5728
Frolich, D.		5806
5561 5644		Gerstenberger, D. C.
		4873

#### 4. Author Index—Continued

Giacobino, E.		Goodman, G. L.	
4857   4875   5089   5259   5350   5546   5558		5346	
5793   5966		Goodman, L. S.	
Giannella, R.		4932   5360   5657   5712   5884   5908	
5847		Goodship, S. J.	
Gil, T.		5967A	
5942		Gorbett, M. J.	
Gilbert, S. L.		5507	
5662   5773		Gordon, H.	
Giles, K.		5090	
4874		Goring, S.	
Ginibre, A.		5695   5822	
5336		Gornik, W.	
Ginter, M. L.		5509	
4910   4958   5826		Gotz, K.	
Girard-Vernhet, D.		5800	
5905		Gough, D. S.	
Giusfredi, G.		5968	
5899   5914		Gould, H.	
Glab, W.		5169   5706   5915	
5663		Gounand, F.	
Glab, W. L.		5694   5727	
5780		Goy, P.	
Glaeser, N.		4946   5216   5580   5733	
5488		Grafstrom, P.	
Glass, R.		5510   5630   5769	
4876   4943   4944   5018   5269   5270   5299		Grandin, J. P.	
5368   5422   5423   5424   5508   5563   5730		4879   4914   5272   5522   5705   5825   5976	
5731   5732   5871   6078T		Grant, I. P.	
Glembokis, J.		5039   5212   5570   6071T	
5577		Grasdalen, G. L.	
Godefroid, M.		5511	
6054T   6058T   6075T		Greenland, P. T.	
Godone, A.		5967A	
5899   5914		Greenlees, G. W.	
Goett, S. J.		4866   5713	
6089T		Gregory, D. C.	
Golden, L. B.		5330   5557	
6064T		Grethen, H.	
Goldman, A.		4945	
5381		Griffin, D. C.	
Goldman, M.		5426   5469	
4859		Griffin, P. M.	
Goldman, S. P.		5330   5614	
4868		Griffith, J. A. R.	
Goldovskii, V. L.		5369   5385	
5137		Grischkowsky, D.	
Goldschmidt, Z. B.		4870	
5271   5425   5547   5729		Grisendi, T.	
Goldsmith, J. E. M.		4880	
4877		Gross, M.	
Goldsmith, S.		4946	
5775		Grudzinskas, I. I.	
Golts, E. Ya.		5921	
4850   4886   5325		Grundevik, P.	
Golz, G.		4878   4947   5512   5630   5734   5781   5868	
5656   5906A		Gruzdev, P. F.	
Gomez, R.		5032   5749	
5859		Grynnberg, G.	
Gong, W.		4857   4875   5089   5259   5350	
5243			

#### 4. Author Index—Continued

Guennou, H. 5052	Hasama, T. 5429 5808
Guern, Y. 4948	Hashimoto, S. 5240 5430 5431
Guidara, K. 5482 5138A	Hashizume, A. 5308
Guimbal, P. 5569 5634 5718 5768 5151A	Hata, J. 5570 6071T
Gull, G. E. 5737	Hatter, A. T. 5015 5217
Gupta, R. 5027	Hayes, M. A. 5736
Gustavsson, M. 4947 5734 5781	Heckmann, P. H. 5071 5072 5073 5679 5837 5892 5962
Guthohrlein, G. H. 5963	Heddrich, W. 5864
Gutii, A. I. 5077	Heine, G. 5261
Hall, J. L. 5342	Held, S. 5246
Hallin, R. 4851 4853 4927 4978 5237 5256 5397 5568 5622	Heldt, J. 5872 5942
Halstead, J. A. 5427	Hellmann, H. 5679 5892
Hamel, J. 4985 5447	Helms, H. A. 4952
Hamilton, P. A. 5790	Henke, L. 5347
Hamilton, W. H. 5014	Henry, R. J. W. 5258 5536
Hammond, P. 5855	Herman, M. F. 6061T
Hannaford, P. 5548 5735 5968	Herman, R. 5876
Hansch, T. W. 5127 5170 5333 5349 5585 5648 5649 5650 5651 5693 5788 5806	Hermann, G. 4977
Hansen, J. C. 4949	Herrick, D. R. 4990
Hansen, J. E. 5019 5293 5302 5365 5428 5476 5782 5807 5954 6076T	Herter, T. 5737
Hanser, A. 5561 5695 5822	Heully, J. L. 5738 5935 5969
Happer, W. 5027	Hibbert, A. 5053 5091 5623 5842
Hardis, J. E. 5160 5407 5416 5612	Hicks, P. J. 5222
Harley, R. T. 5819	Hildum, E. A. 5788
Harmon, J. 5918	Hill, K. W. 4859 5643 5802
Haroche, S. 4946 5216 5580 5733	Hill, W. T., III 5739 5919 5977
Harris, S. E. 5001 5345	Hinds, E. A. 5088 5366 5795
Harrison, J. F. 5085	Hinnov, E. 4971 5291 5370 5389 5513 5531 5562 5821 5835
Harzer, R. 5082 5488	Hinterlong, S. J. 4957 5242 5379 5416 5627 5943A
	Hippelein, H. 5323

#### 4. Author Index—Continued

Hirota, E. 5460	Hutcheon, R. J. 4951   5121   5122
Hitchcock, A. P. 5273	Indelicato, P. 5706   5905
Hlousek, L. 5740	Inguscio, M. 5803
Ho, Y. K. 4950   5591   6072T	Irwin, D. J. G. 5283   5339   5629
Hobby, M. G. 5090	Isaak, G. R. 5369   5385
Hodge, W. L. 5797	Ishii, K. 5114   5970
Hoeffgen, H. 5082	Isolde Collaboration 5533   5618
Hoffnagle, J. 5371	Itano, W. M. 5372
Hofmann, H. 5944	Ivanov, L. N. 5257   5334   5537   5823   5851   6080T
Hofsaess, D. 5664	Ivanov, V. S. 5959
Hogervorst, W. 4952   5011   5040   5108   5116   5130   5215 5248   5362   5363   5393   5499   5721   5722	Ivanova, E. P. 5537   6080T
Hohle, C. 5020   5514   5138A	Jackel, S. 5374   5375
Holt, R. A. 5092	Jackson, A. R. G. 4874
Horback, S. 5873	Jackson, D. A. 5140   5809
Horton, R. 4859   5643	Jackson, D. J. 5170
Houck, J. R. 5737	Jacques, C. 5171   5624   5659
Hovis, F. E. 5282	Jacquinot, P. 5021   5281   5390   5533   5768   5151A
Howell, R. H. 5136	Jaffe, S. 5166
Huber, G. 5281   5390   5533   5768	Jain, K. 5172
Hubin-Franskin, M. J. 5186	Jamar, C. 5307   5355
Huddle, J. R. 5034	Jamelot, G. 5052
Huet, M. 5632   5139A	James, G. K. 5433   5874
Hughes, T. P. 4871	Jankowski, K. 5434
Hughes, V. W. 5088   5353   5366	Jannitti, E. 4880   5971
Huhnermann, H. 5020   5514   5658   5864   5138A   5916A	Jaskolska, B. 5776
Huldt, S. 4869   5114   5237   5432   5752	Jauregui, R. 5373
Hults, M. 5872	Jelenkovic, B. 5311   5378   5387   5449   5568
Humphrey, L. M. 5202   5377	Jolley, N. A. 4881   5319
Husson, X. 4879   4914   5272   5522   5705   5825   5976	Jeschonnek, F. 5728
	Jeys, T. H. 5313

#### 4. Author Index—Continued

Jha, S. S. 5181	Kagan, D. T. 5437
Jiang, Z. K. 5510 5544 5592 5682	Kagawa, T. 5274
Jitschin, W. 5022	Kalashnikov, M. P. 5800
Joelsson, I. 4882 5337	Kallne, E. 5830 5831 5832 5833 5917
Johann, U. 4912 4987 5435 5479	Kallne, J. 5830 5831 5832 5833
Johannin-Gilles, A. 4948	Kamke, W. 5135 5086A
Johansson, B. 5284	Karazija, R. 5575
Johansson, S. 4991 5141 5432 5665 5972	Karnatak, R. C. 5306 5725
Johnson, B. M. 5093 5330 5557	Karpov, N. A. 5743 5863
Johnson, C. E. 5054 5353	Karwowski, J. 5275
Johnson, D. 5643	Kash, M. M. 4976
Johnson, W. R. 4953 5739	Kaslahn, E. 5759
Johnston, R. R. 5133	Kasper, J. V. V. 5276
Jones, D. W. 5173	Kastner, S. O. 4884 5005 5043 5175 5278 5945 5973
Jones, K. W. 5093 5330 5557	Kato, H. 5810
Jones, L. A. 5917	Kaufman, V. 5129 5131 5142 5227 5341 5438 5515
Jonsson, G. 5510 5639 5682	5532 5541 5579 5600 5601 5666 5678 5761 5820 5841 5919
Jordan, C. 5203	Kawamura, M. 5810
Jordan, W. C. 5133	Kazakov, S. M. 5920
Jorgensen, P. 5074	Keller, J. C. 4934 5497 5685
Joshi, Y. N. 4883 4893 4906 5000 5055 5107 5174 5192 5218 5250 5343 5436 5534 5535 5555 5573 5574 5604 5680 5688 5765 5789 5880 5886 5932	Keller, R. A. 5087 5145 5342
Jost, R. 5084 5201	Kellman, M. E. 4990
Joyce, R. R. 5511	Kelly, F. M. 5382
Julien, L. 5219	Kernahan, J. A. 5120 5283 5339 5556 5623 5629
Juncar, P. 5281 5390 5533 5569 5634 5718 5741 5768 5918 5151A	Key, M. H. 4951 5122
Jungen, M. 5742	Khan, M. A. 5439 5440
Jupen, C. 5625 5752	Khan, Z. A. 5206 5234 5277 5312 5318 5338 5744
Kachru, R. 5590 5694 5727 5771 5913	Khawaja, E. 4993
	Khrustoforov, O. V. 5920
	Khvostenko, G. I. 5023

#### 4. Author Index—Continued

Kickin, I. S. 5599	Kononov, E. Ya. 4885 4886 5260 5875 5947
Kidd, P. W. 5003	Koos, I. 4872
Kim, Y. K. 4911 5411	Korneev, V. V. 4885 4886
Kimman, J. 5745	Kotlikov, E. N. 5331
Kindt, S. 5509	Kotochigova, S. A. 5863 5946
King, G. C. 5855 5859	Kotz, U. 5094
King, R. F. 5667	Kovalev, V. I. 5947
King, W. H. 5687	Kowalski, F. V. 5342
Kingston, A. E. 4921 5214 5254 5842 5907	Kowalski, J. 4923 5094 5095 5348 5351 5876 5922A
Kisielius, R. S. 5921	Kozlov, M. G. 5024
Kisielinski, M. 5244 5387 5449 5568	Kponou, A. 5353
Kittrell, C. 4928	Kramida, A. E. 5875
Klapisch, M. 4922 4974 4975 5187 5374 5375 5376 5441 5581 5692 5785 5838 5896 5927	Krasnoperov, L. N. 5654
Klapisch, R. 5281 5390 5533 5569 5634 5718 5768 5151A	Kraus, J. 5481
Klar, H. 4992	Krause, M. O. 5204 5948
Klar, M. 4992	Kremmling, H. 5668 5933A
Klein, H. A. 5319 5626 5679	Kreplin, R. W. 5300
Kleinpoppen, H. 5552 5553	Kroll, S. 5510 5769
Klemp, W. 5618	Kronfeldt, H. D. 4954 5442 5877
Kleppner, D. 4976 5014	Kropp, J. R. 5442 5877
Kloch, R. 5640	Kruit, P. 5745
Kluge, H. J. 5354 5668 5933A	Kruse, T. H. 5093 5330 5557
Knight, R. E. 6059T 6081T	Krutov, V. V. 4885 4886
Knobl, E. 5658	Krylov, B. E. 5024
Knystautas, E. J. 4900 4915 5171 5616 5624 5659 5923	Krynetskii, B. B. 5743 5863
Koenig, E. L. 5503	Kucal, H. 4914 5976
Koike, F. 4961	Kuchiev, M. Ju. 5684
Kolb, C. E. 5189	Kugel, H. W. 5539
Kompanets, O. N. 5959	Kuhnen, R. 5233
	Kuhnert, A. 5111 5974

#### 4. Author Index—Continued

Kulagin, N. A.		Lax, B.	
5025   5026		5101   5182   5446	
Kupliauskiene, A. V.		Le Dourneuf, M.	
4981   5241   5486   5490   5576   5669   5854		4953   5197	
5878   5882   5921   5949		Le, H.	
Kupliauskis, Z. I.		5101   5446	
4981   5241   5443   5490   5576   5669   5878		Leavitt, J. A.	
5882   5949		5169   5256   5622	
Kuske, P.		Lebrun, P.	
5319		5716	
LaVilla, R. E.		Lecler, D.	
5029   5279		4967   5616	
Labastie, P.		Lecordier, R.	
5558   5966		4887	
Labozin, V. P.		Lee, E. P. F.	
4890		5056   5061   5062   5096   5280	
Laguna, G. A.		Lee, E. T. P.	
5746		5412	
Lakicevic, I. S.		Lee, S. A.	
5564   5747   5924		5740	
Laloe, F.		Lee, S. T.	
5219		4965	
Lam, L. K.		Lee, Y. S.	
5027		5221   5748	
Lambert, D.		Legre, J.	
5494		5494	
Lamontagne, J. J.		Leibacher, J. W.	
5975A		5784	
Lan, V. K.		Lemen, J. R.	
5197		5784	
Lang, P. F.		Lemery, H.	
5444		5447	
Langenberg, A.		Lemoigne, J. P.	
5220		4967   5976	
Langlois, J.		Les, Z.	
4955   5176		5640	
Laporte, D.		Lesage, A.	
5689		5924	
Larijani, F.		Letokhov, V. S.	
5049		5097   5231   5257   5334   5823   5851   5959	
Larkins, F. P.		Leuchs, G.	
5304   5418   5419		4888   4993   4994	
Larsson, S.		Leventhal, M.	
5829		5539	
Larzilliere, M.		Levinson, C.	
5332		5510   5630   5639	
Lasnitschka, G.		Levykin, Yu. A.	
4977		4850   5325	
Latimer, C. J.		Lewis, C. L. S.	
5667		4951   5122	
Latush, E. L.		Lewis, D. A.	
4873		4866	
Lauenstein, M.		Lewis, S. A.	
5400		5353	
Laughlin, C.		Li, H. H.	
5028   5445   5565   5950		5030	
Lawler, J. E.		Liao, P. F.	
4877   5170   5333   5349   5937		5202   5377   5099A	
Lawson, K. D.		Liberman, S.	
5205   5317		4889   4892   5010   5021   5281   5390   5494	
		5503   5533   5569   5634   5718   5768   5151A	

#### 4. Author Index—Continued

Liening, H. 5399 5400 5448	Lundberg, H. 4878 4940 5510 5512 5544 5592 5630 5682
Lilenfeld, H. V. 5282	Lundeen, S. R. 4937 5098 5225 5344
Lin, C. C. 5412	Lundin, L. 5568
Lin, C. D. 5686	Lunney, J. G. 5879
Lin, F. C. 5681 5897	Lurio, A. 4870
Lindel, H. 5399	Luther, G. 5100 5247 5473
Lindgard, A. 5031 5378 5622	Lutz, O. 5655
Lindgren, I. 5734 5868 5925A	MacAdam, K. B. 4939
Lindroth, E. 5670	Macfarlane, R. M. 5819
Lisitsa, V. S. 5921	Machado, I. J. 5076
Littman, M. G. 4976	Magnusson, C. E. 4882 5337 5779
Litzen, U. 4991 5141 5256 5432 5752 5856	Mahon, R. 5956
Liu, J. B. 5681	Majewski, U. 5929
Livingston, A. E. 4956 4957 5198 5242 5283 5379 5416 5627	Makat, W. 5728 5849
Livshits, A. M. 4850 5325	Makdisi, Y. 5704 5813
Lobikov, E. A. 4890 4995	Malinovsky, M. 4996
Loginov, A. V. 5032 5749	Malvezzi, A. M. 5834
Lombardi, M. 5084 5201	Mandelbaum, P. 5187 5374 5375 5376 5441 5692 5785 5896 5927
Longmire, M. S. 4958 5826	Mandelstam, S. L. 4850 4885 4886
Lorenzen, C. J. 4891 5177 5451 5593 5750 5783 5811 5926	Mankin, W. G. 5381
Loulergue, M. 4936 5298 5466 5477 5660	Mann, R. 5901
Lu, R. 5243	Mannervik, S. 5244 5311 5378 5387 5449 5568 5607 5608 5751 5752
Lu, X. 5243	Mansfield, M. W. D. 5380 5414 5450 5452
Luc, P. 5113A	Marafi, M. 5704
Lucatorto, T. B. 5154 5516 5739 5977	Marchand, P. 5586
Lucke, K. 5578 5644	Marek, J. 5474
Luc-Koenig, E. 4892 5632 5838 6063T	Margerie, J. 5787
Luke, T. M. 5786 5812	Mariella, R., Jr. 5033
Lukyanov, S. Yu. 5707	Marketos, P. 5551

#### 4. Author Index—Continued

Marmar, E. S. 5295	Meijer, F. G. 5458 5782
Marmet, P. 5938	Meinders, E. 5144 5437 5458
Marrus, R. 5169 5706 5915	Meisel, G. 4912 5022 5082 5488 5561 5822 5843
Martensson, A. M. 4878	Meissner, E. 5047
Martensson, N. 5284	Mendoza, C. 5816
Martensson-Pendrill, A. M. 5670 5738 5873	Menzel, W. 5209
Martin, M. A. P. 5167 5858	Merkelis, G. V. 5260
Martin, W. C. 5057 5453 5814	Meroz, E. 5441
Martinis, M. 5549	Mescherkin, A. P. 5800
Martinson, I. 4869 5031 5114 5311 5752	Meservey, E. 4859
Mason, H. E. 5006 5044 5178 5408 5753	Mies, F. H. 4959
Mathias, L. E. S. 5690	Migdalek, J. 4894 4895 4997 5671 5754 6060T 6069T 6079T
Matthews, D. L. 5136	Mikhailov, Yu. A. 5800
Matthias, E. 5356 5509 5520 5728 5900 5925A 5930A	Mikushkin, V. M. 5882
Mattioli, M. 4856 5232	Milazzo, G. 5048
Mayer, F. 5922A	Miller, T. A. 5101 5182 5201 5446 5465
Mayige, C. 4851 4853	Mirza, M. Y. 5041 5196 5461
Mazzoni, M. 4893 5055 5263 5303 5454 5455 5688 5789 5880	Mishin, V. I. 5097 5231 5257 5743 5851 5863 5959
McAllister, H. C. 5571 5815	Mitchell, P. 5222 5801
McCabe, M. K. 5571 5815	Mizui, J. 4908
McConkey, J. W. 5859	Mlekodaj, R. L. 5614
McCullen, J. D. 5173	Mohr, P. J. 6087T
McEachran, R. P. 5456 5457	Mokler, P. H. 5901
McFadden, D. L. 5417	Moore, C. E. 5035
McGuire, E. J. 5058	Moores, D. L. 4988
McIlrath, T. J. 5154 5516 5739 5977	Moos, H. W. 5295 5504 5797
McKenzie, B. J. 5212	Morgenstern, R. 5305
Mehlhorn, W. 5207 5209	Morillon, C. 4864 5010 5410
Mehlman, G. 4933 5279	Morita, S. 5844 5881
Meier, T. 5658	Morris, K. 5036 5183

#### 4. Author Index—Continued

Moscardo, F.		New, R.	
4986		5369	5385
Moscatelli, F. A.		Newsom, G. H.	
5459	5626	4854	5134
5672		5413	5452
Mosse, J. P.		Nicol, J. L.	
5905		5817	
Mowat, J. R.		Nicolosi, P.	
5034		5971	
Mueller, A. C.		Niehaus, A.	
5354	5618	5305	
Muller, H. G.		Nielsen, S. E.	
5745		5031	
Muller, H. R.		Nielsen, U.	
5837		5471	5928
Munch, G.		Niemax, K.	
5323		4891	5177
Murakawa, K.		5179	5451
5845		5593	5750
Murcray, D. G.		5811	5926
5381		Nikitin, A. A.	
Murcray, F. H.		5848A	
5381		Nilsson, L.	
Murcray, F. J.		5512	5630
5381		Nishimura, F.	
Murnick, D. E.		4961	
5539		Niv, Y.	
Mushtaq, A.		5539	
5524	5527	Noehte, S.	
5554		4923	5094
Myers, E. G.		5351	5876
4852	4881	5922A	
5319		Nomura, T.	
Nagai, K.		5633	
5460		Nordling, C.	
Nagel, D. J.		4851	4853
5853		4927	4978
Nahon, J.		5397	5568
5265		Noreland, T.	
Nakayama, S.		4851	4853
5382	5383	4978	
Naqvi, A. S.		Northway, S. J.	
5461		5180	
Naumann, R. A.		Nowicki, G.	
5672		5695	
Nayfeh, M. H.		Nunnemann, A.	
5663	5780	5974	
Neijzen, J. H. M.		Nuroh, K.	
4916	4960	5059	
5717		Nussbaumer, H.	
5642		5060	5245
Neil, G. R.		5294	5386
5003		5755	
Nelson, E. T.		Nystrom, K.	
5539		4878	
Nestor, J. R.		Oda, N.	
5642		4961	
Neugart, R.		Odintsova, N. K.	
5618		4890	4995
Neukammer, J.		Ogurtsov, G. N.	
5517	5520	5882	
5929	5978	Okasaka, R.	
5609		5463	5559
Neumann, R.		Olsen, J. O.	
4923	5094	4983	
5095	5351	Olsson, G.	
5876	5922A	5464	5512
		5518	5734
		5781	5868
		Onishi, Y.	
		5808	

#### 4. Author Index—Continued

Orihara, H.		Pellegrin, P.						
5240		5716	5757					
Orihara, S.		Pendrill, L. R.						
5431		4897	5179	5451	5721	5926		
Osterberg, U.		Penent, F.						
5873		5840						
Otten, E. W.		Perdrix, M.						
5354		5597						
Otto, P.		Perez, J. D.						
4902		5133						
Outred, M.		Perschmann, W. D.						
5782		5758						
O'Brien, R.		Persson, W.						
4881		5019	5428	5782	5807			
O'Neill, J. A.	4896	Pesnelle, A.						
	5120	5281	5390	5533	5597	5768		
O'Sullivan, G.	5359	Petkevicius, J.						
	5691	5577						
O'Sullivan, M. S.	5756	Petley, B. W.						
	5770	5036	5183					
Paisner, J. A.	5983A	Petrini, D.						
		4924	4988	5307	5355	5467	5468	5759
Pakhomov, M. T.	5707	Pettersson, J. E.						
		5883						
Palfy, L.	5716	Pettersson, S. G.						
	5757	5596						
Palmer, B. A.	4938	Pettini, M.						
	5087	4880	5263	5303	5454	5455		
Palmer, C. W. P.	5145	Pfeufer, V.						
5817	5342	5628	5653	5712	5884	5908		
Pandey, K. C.	5724	Phillips, K. J. H.						
5181	5951	5784						
Panfilov, V. N.		Pichanick, F. M. J.						
5654		5088	5353	5366	5795			
Panock, R.		Pihl, J.						
4962	5101	5237						
Panteleev, V. N.	5182	Pikuz, S. A.						
5864	5202	4861						
Pantelouris, M.	5377	Pilkuhn, H.						
5674	5465	5549						
Parkinson, J. H.	5099A	Pillet, P.						
5542		5281	5390	5533	5727	5768		
Parlag, A. M.		Piltch, N. D.						
5077		5502						
Parmar, A. N.		Pinard, J.						
5466		4889	4892	5010	5021	5281	5390	5494
Parmer D. R.								
5528		5503	5533	5569	5634	5718	5768	5918
Patel, C. K. N.								
5539		5151A						
Payne, M. G.		Pinard, M.						
5470		5219						
Peacock, N. J.		Pindzola, M. S.						
5090	5205	5146	5184	5426	5469	5470		
Peau, E. W.	5317	Pinnington, E. H.						
5864	5530	4896	5120	5161	5283	5339	5556	5623
Pegg, D. J.	5560							
5330	5614	5629						
Pejcev, V.		Pipin, J.						
5123	5324	5776						
	5519	Pipkin, F. M.						
	5836	4937	5098	5225				
		Pittman, T. L.						
		5761						

**4. Author Index—Continued**

Playford, C. St. Q. 5009	Rahimullah, K. 5206   5234   5277   5312   5318   5338   5744
Plohn, H. J. 5347	Rahman, A. A. 5720
Plumbe, R. D. 5002	Raimond, J. M. 5580   5733
Podobedova, L. I. 5321   5535   5875   5952	Ralls, M. P. 5369   5385
Pogrebnyak, P. S. 5193	Ramanujam, P. S. 5387   5495   5496   5827   5910   6070T
Poirier, J. A. 4957	Ramonas, A. A. 5038   5223   5260   5321   5340   5472   5952
Pollock, C. R. 5276	Ramos, M. T. 5905
Polyakov, A. G. 5864	Rand, S. C. 5651
Pomytkin, V. F. 4890	Rapley, C. G. 5466   5660
Popescu, D. 5037	Rashid, K. 5185   5440
Popescu, I. I. 5037	Rassi, D. 5123   5286   5433
Post, B. H. 5363   5393   5499   5957	Rathmann, P. W. 5622
Postoi, E. N. 5152	Rathore, B. A. 5924
Potapov, A. M. 5707	Ray, S. N. 4972   5981
Potts, A. W. 5056   5061   5062   5096   5280	Ray, W. 5160   5407   5612
Poulin, A. 5186	Read, F. H. 5855
Poulsen, O. 5078   5236   5405   5406   5471   5703   5928	Reader, J. 4899   4917   4998   5042   5083   5100   5247
Praderie, F. 5307   5355	5287   5288   5296   5322   5473   5501   5521
Pradhan, A. K. 4874   4898   5831   5832	5598   5675   5760   5794   5885   5953
Prestage, J. D. 5795	Rebel, H. 5695   5822
Prieels, R. 5757	Redi, O. 5459   5672
Prilipko, V. K. 5210	Reese, J. M. 5528
Puric, J. 5564   5747   5924	Reeves, R. R. 5427
Pyper, N. C. 5551	Reimche, A. 5628
Quad, R. 5135	Remijn, L. 5458
Raassen, A. J. J. 5124   5285   5293   6076T	Reyna Almandos, J. G. 5421   5583
Radler, K. 4963	Rhodes, C. K. 5132
Raftopoulos, V. 5891	Rice, J. E. 5295
Raghunathan, K. 5478	Richardson, R. J. 5282
Ragozin, E. N. 5875	Ridgeley, A. 4871   5016   5217   5314
	Rinkleff, R. H. 5147

**4. Author Index—Continued**

Rinneberg, H.								Ryabtsev, A. N.						
5517	5520	5543	5550	5594	5595	5609		5038	5102	5143	5223	5260	5288	5296
5676	5728	5929	5978					5321	5340	5472	5521	5535	5885	5952
Robaux, O.								5979						
4980	5480							Rydberg, S.						
Roberts, J. R.								4947						
4900	4915	5761						Ryschka, M.						
Robinson, H. G.								5474						
5054								Sadziuviene, S.						
Rodbro, M.								5652						
4964								Safia, H. A.						
Rode, A. V.								5522						
5800								Safinya, K. A.						
Roesch, L. P.								5064	5224	5225	5226	5328	5694	5103A
5371	5762							Safranova, A. S.						
Roney, W.								4850	4861	6062T				
4859	5643							Safranova, U. I.						
Rose, S. J.								4901	5475	6052T	6062T	6068T	6073T	6086T
5039	5212							6088T						
Rosen, A.								Sage, F.						
4947	5464	5734	5868					4967						
Rosenberg, R. A.								Saha, H. P.						
4965	5063							5944	6084T					
Rosenbluh, M.								Sahal-Brechot, S.						
5101	5182	5446						4996						
Rosenthal, S. J.								Sakai, H.						
4966								5327						
Roski, B.								Saksena, G. D.						
5488								4918	5076	5252	5395	5567	5582	5636
Rosner, S. D.								5799	5850	5911				
5092								Salman-Zade, R. C.						
Ross, K. J.								5848A						
5123	5286	5324	5433	5519	5836	5874		Saloman, E. B.						
Roth, C.								4933	5279					
5572	5763							Salomonson, S.						
Rothenberg, J. E.								5518	5873	5969				
5345								Salop, A.						
Rothermel, J.								4989						
5525								Sampson, D. H.						
Rovera, G. D.								6064T	6089T					
5899	5914							Samson, J. A. R.						
Rowan, W. L.								5540						
5761								Samsonov, B. F.						
Roxey, T. E.								5230						
5888								Sanchez-Fernandez, M. J.						
Roy, D.								4903						
5186								Sanders, F. C.						
Rudkjobing, M.								6059T						
5238								Sanders, J. H.						
Rudnicka-Szuba, H.								5361						
5637	5715							Sandner, N.						
Rudzikas, Z. B.								5207						
5599	5652	5921	5848A	5903A				Sandner, W.						
Ruff, G. A.								5226	5328	5694	5103A			
5224	5103A							Sansonetti, C. J.						
Runge, S.								5228	5289	5605	5814			
5597								Sarma, V. N.						
Ruscic, B.								5765	5886					
5764								Sato, K.						
								5513	5821					

#### 4. Author Index—Continued

Sauthoff, N. R. 4859 5643	Semenov, R. I. 5211
Saxena, K. M. S. 4968	Semple, D. J. 5461
Saykally, R. J. 4969 5125 5401	Sen, K. D. 5066 6053T
Schaaf, H. 5933A	Senashenko, V. S. 5475 6086T
Scharmann, A. 4977	Series, G. W. 5382 5383 5548 5735 5968
Schatz, G. 5104 5695 5822	Serrao, J. M. P. 5526
Schawlow, A. L. 4877	Serre, J. M. 5569 5634 5718 5768 5151A
Schechtman, R. M. 4956	Sevin, D. 5597
Schinzler, B. 5618	Shallis, M. J. 5904
Schlagheck, W. 5072	Shawyer, R. E. 5183
Schleicher, M. 4977	Shelby, R. M. 5819
Schleinkofer, L. 5525	Sheppard, M. G. 5221
Schmidt, D. 5402 5509 5578 5700 5701 5964	Shestakov, A. F. 6080T
Schmidt, E. 5487 5545 5708 5887	Shiloh, J. 4863
Schmidt, V. 5207	Shimon, L. L. 5137
Schnatz, H. 5804 5839	Shirley, D. A. 4965 5063
Schneider, D. 5388	Shlyaptsev, V. N. 6088T
Schneider, F. 5728 5930A	Shlyaptseva, A. S. 6088T
Schneider, R. L. 5853	Shorer, P. 5208
Schneider, R. T. 5888	Shujauddin, Q. 5524 5527 5554
Schonberger, P. 5459	Shure, M. A. 5737
Schonhense, G. 5929	Shustryakov, V. M. 5863
Schroder, H. 5487 5545 5708 5887	Sichel, J. M. 4955 5176
Schuessler, H. A. 5668 5933A	Sidelnikov, Y. V. 4886
Schwarz, W. H. E. 5388	Siegel, A. 5333 5349
Schwebel, S. L. 5065	Siese, M. 5931A
Schweitzer, N. 5187 5376 5581 5785	Silver, E. 5643
Schwob, J. L. 4974 4975 5067 5187 5374 5375 5376 5581 5692 5785 5797 5896 5927	Silver, J. D. 4852 4881 5112 5319 5530 5602 5626 5679
Scott, N. S. 5229 5523	Silverans, R. E. 5105 5326 5766 5772
Seibert, B. 5158	Silverman, M. P. 5188

#### 4. Author Index—Continued

Silverstone, H. J.		Stachowska, E.
4902		5715
Simpson, F. R.		Stamp, M. F.
5623		5317   5530   5560
Sims, J. S.		Stanton, A. C.
5528		5189
Simsek, M.		Stebbins, R. F.
5767		5313
Simsek, S.		Steenman-Clark, L.
5767		4936   5068   5298   5404   5660   5802
Sinzelle, J.		Stehlin, T.
4991		5348
Sivtsev, V. I.		Stelmakh, O. M.
5599		5743   5863
Sklizkov, G. V.		Steudel, A.
5800		5047   5126   5158   5628   5653   5931A
Skovpen, Yu. I.		Stewart, R. E.
5529		5862A
Smentek-Mielczarek, L.		Stinner, P.
5846   5867		4987
Smeyers, Y. G.		Stodiek, W.
4903		4859   5643
Smid, H.		Stoeckel, F.
5476   5954		5332
Smirnov, Yu. M.		Stoicheff, B. P.
5008		4970   5106   5756   5770
Smith, B. C.		Stoll, H.
5444		5538
Smith, G.		Storey, P. J.
5889		5060   5178   5245   5294   5386   5755
Smith, K. A.		Storz, R. H.
5313		4860   4962
Smith, S. J.		Stratton, B. C.
4993   4994		5797
Smitt, R.		Streib, J.
5796		5668   5933A
Sokolov, Yu. L.		Streif, V. F.
5955		5615
Sokolowski, A.		Striganov, A. R.
5434		4890   4995   5798
Solomon, A. M.		Stroke, H. H.
5137		5459   5672
Sonntag, B.		Strumia, F.
5487   5545   5708   5887		5803
Souw, E. K.		Sucher, J.
5890		5080
Spector, N.		Suckewer, S.
4974   4975   5067   5246   5306   5398   5491		4971   5291   5370   5389   5513   5531   5562
		5797   5821   5835   5866
Spence, D.		Sugar, J.
5290		4900   4915   5129   5227   5341   5438   5515
Spencer, W. P.		5516   5532   5579   5600   5601   5678   5739
5014		5761   5820   5841   5919
Srivastava, R. P.		Suhr, H.
5574		4923   5094   5351   5876   5922A
Staaf, O.		Sun, H.
4851   4853   4927   4978   5397   5568		5221   6061T
Stacey, D. N.		Sureau, A.
5640   5817   5818   5843   5916A		5052
Stacey, V.		Suremeian, A.
5640   5916A		5037

#### 4. Author Index—Continued

Sushkov, O. P. 5719   5792	Thibault, C. 5281   5390   5533   5569   5634   5718   5768 5151A
Suzer, S. 5069   5070   5190   5209	Thomas, C. 5480   5497   5685
Svanberg, S. 4878   4940   5510   5544   5592   5630   5639	Thompson, A. 5907
Svendenius, N. 5148   5149   5779	Thompson, D. C. 5770
Svensson, L. A. 5796	Thompson, R. C. 5561   5695   5822
Swainson, R. A. 5912	Thornton, G. 5063
Sweeney, B. V. 5489	Thorsen, P. 5928
Sylwester, B. 4885	Timmermann, A. 5191   5356   5483   5578   5644   5701   5702 5728   5849   5900   5925A
Sylwester, J. 4885	Tittel, F. K. 5276
Szostak, D. 5758	Tiwary, S. N. 5842
TFR Group 4904   5477   5504	Tokarev, V. I. 5331
Tahira, S. 4961	Tomiyama, T. 5810
Taleb, A. 5503	Tomkins, F. S. 4979   5239   5889   5956
Talman, J. D. 5786	Tondello, G. 5971
Tam, A. C. 4999	Ton-That, D. 6067T
Tanaka, K. 5460	Torbohm, G. 5868
Tao, S. Y. 5155	Touchard, F. 5281   5390   5533   5569   5634   5718   5768 5151A
Tarng, S. S. 5502	Tozzi, G. P. 4880   5263   5303   5455   5491
Tatewaki, H. 5633	Traber, F. 5082   5233   5488   5656   5906A
Tauheed, A. 5527	Trabert, E. 4852   4905   5071   5072   5073   5112   5319 5602   5679   5683   5837   5892   5962
Tavernier, M. 5706	Trager, F. 5095   5348
Taylor, K. T. 5523	Tran, N. H. 5590   5727   5771   5913
Tech, J. L. 5820   5841	Trefftz, E. 5944
Telegdi, V. L. 5371	Triebel, U. 5126
Temkin, A. 4982   5146   5153   5195	Trigueiros, A. 5752
Tepehan, G. G. 5552   5553	Trollmann, G. 5525
Terry, J. L. 5295	Tropper, A. C. 5819
Thakur, A. K. 4919	Tsika, M. 4865
Thakur, L. 4919	
Theodosiou, C. E. 5209   5891   5910	

#### 4. Author Index—Continued

Tuilier, M. H. 5677 5689	Verhaegen, G. 6058T
Tunitsyn, I. I. 5946	Verkhovtseva, E. T. 5193
Tunnell, T. W. 5603	Veseth, L. 5194 5310
Turbiner, A. V. 5631	Vialle, J. L. 5281 5390 5484 5533 5569 5634 5718 5768 5151A
Tutlis, V. I. 4981 5921 5949 5903A	Victor, G. A. 5028
Uchiike, M. 5808	Vidolova-Angelova, E. P. 5231 5257 5334 5537 5823 5851
Ueda, K. 5150 5249 5391 5392	Vitrant, G. 5580 5733
Ugrin, S. Y. 5893	Voelker, M. 4942
Uhlenbusch, J. 5890	Volonte, S. 4925 4926 5298 5660
Uijlings, P. 5144 5192	Vol'dman, M. L. 5253
Urnov, A. M. 4885 4886 4901	von Goeler, S. 4859 5643 5802
Vach, H. 5622	von Oppen, G. 5758
Vaidyanathan, A. G. 5014	Voss, H. 5887
Vainshtein, L. A. 6073T	Voss, M. 5958 5109A 5119A
Vajed-Samii, M. 4972 5981 6067T	Vukstich, V. S. 5152 5778 5824
Vakula, V. V. 5253	Wagner, H. 5514 5658
Van Baak, D. A. 4937	Wagner, W. 5864
Van den Cruyce, J. M. 5105 5326 5766	Wagstaff, C. E. 5292
Van der Wiel, M. J. 5745	Wahlstrom, C. G. 5639
Van Hove, M. 5326 5772	Wakid, S. 5153 5195
van Kleef, T. A. M. 4883 4906 5000 5055 5107 5174 5192 5218 5250 5285 5343 5436 5534 5535 5555 5573 5574 5604 5680 5932	Walker, D. 5256
van Leeuwen, K. A. H. 5040 5108 5116 5130 5215 5363 5393 5499 5894 5957	Wallmeroth, K. 5668 5933A
van Linden van de Heuvell, H. B. 5913	Walther, H. 4888 4993 4994
van Wijngaarden, A. 4868	Wang, J. C. 5001
van Wyngaarden, W. L. 5536	Wangler, J. 5347
Veck, N. J. 5542	Ward, L. 5397 5568
Veje, E. 4869 5114 5378 5622	Wasada, N. 5308
Venugopalan, A. 5567 5582 5636 5799 5850	Watel, G. 5597
Verges, J. 5149 5289 5113A 5902A	Watson, R. L. 5220

**4. Author Index—Continued**

Watts, R. N. 5662 5773	Windholz, L. 5128
Weber, K. H. 5177	Wing, W. H. 4939 5502
Wedig, U. 5538	Winkler, K. 4923 5094 5351 5922A
Weinberger, D. A. 5502	Winkler, R. 4945 5442 5877 5958 5109A 5119A
Weinberger, E. 4970 5106	Winter, H. 4973
Weis, A. 5371	Wittmann, W. 5347
Weiss, A. W. 5774	Wohrer-Beroff, K. 4875
Weiss, W. 5958 5109A 5119A	Wolffer, N. 5597
Wells, M. 5904	Wong, W. S. 5155
Wendlandt, D. 5126	Wood, O. R., III 5539
Wendt, K. 5618	Woodgate, G. K. 5817 5843
Wenz, R. 5728 5930A	Woodruff, P. R. 5540
Werel, K. 5335 5398	Worden, E. F. 5081 5113A 5902A 5983A
Werner, A. 5110	Wort, D. J. H. 5002 5967A
Werth, G. 5647 5698 5699 5804 5839	Woznicki, W. 5776
West, P. J. 5578 5644 5728 5849 5964 5930A	Wuilleumier, F. 5207
Wetzel, H. E. 5887	Wyart, J. F. 4907 4991 5081 5129 5251 5296 5341
Whineland, D. J. 5372	5432 5482 5541 5581 5785 5838 5896
Whitaker, T. J. 5409	5113A 5138A 5902A
White, J. C. 4962	Wynne, J. J. 4909 4979 5301
White, J. R. 5220	Xu, G. X. 5770
White, M. D. 5324	Yaakobi, B. 5415
White, M. G. 5063	Yakhontov, V. L. 5684
Whitefield, P. D. 5166	Yakobson, N. N. 5898
Wieman, C. 5127 5662 5773	Yakovlev, V. P. 5955
Wiggins, R. L. 5459 5672 5394A	Yamaguchi, N. 4908
Wijnen, H. 5861	Yeager, D. L. 5074 6061T
Willison, J. R. 5001 5982A	Yin, G. 5243
Wills, M. S. 5690	Young, J. F. 5001 5345
Wilson, M. 5433 5519 5836 5874 5895 5916A	Young, W. A. 5041 5196
	Younger, S. M. 5516 6066T

**4. Author Index—Continued**

Yurtsever, E. 5075	Zhitnik, I. A. 4885   4886
Zaal, G. J. 4952   5116   5130	Zhmenyak, Yu. V. 5152   5777   5778   5824
Zampetti, P. 5965	Zhu, X. H. 5681   5897
Zapesochnyi, I. P. 5137   5778   5824	Zigler, A. 4974   4975   5067   5374   5375   5441   5692 5927
Zavelovich, J. 5132	Zimmerman, M. L. 4976
Zegarski, B. R. 5465	Zimmermann, D. 5110   5111   5974
Zehnder, A. 5371	Zimmermann, G. 5305
Zeippen, C. J. 5197   5316   6077T	Zimmermann, P. 4913   5111
Zelichenko, V. M. 5230	Zmora, H. 4974   4975   5067   5374
Zetterberg, P. O. 4882   5337   5779	zu Putlitz, G. 4923   5094   5095   5348   5351   5876   5922A
Zhang, W. 5243	
Zherikhin, A. N. 5959	

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