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Supplementary Tables for

A Systematic Analysis of the Spectra of the Lanthanides Doped into Single Crystal LaF_3

by

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Supplementary tables to which we refer in our article of the same title in the Journal of Chemical Physics are reproduced here. These tables along with certain supplementary figures and an expanded discussion of the experimental data are also contained in an unpublished report, ANL-88-8. This report is available from the NTIS Distribution Service, P. O. Box 1300, Oak Ridge, TN 37831 (telephone number: (615) 576-1301).

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Appendix I.

Experimental and Computed Energy Level Structure of $Nd^{3+}:LaF_3$

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O–C	Caspers et al.[d] (cm^{-1})	Wong et al.[e] (cm^{-1})	Voron'ko et al.[f] (cm^{-1})
$^4I_{9/2}$	0	5	-5	0		0
	45	48	-3	45		44
	136	153	-17	136		140
	296	304	-8	296		297
	500	513	-13	500		502
$^4I_{11/2}$	1978	1965	13	1978		1980
	2037	2027	10	2037		2039
	2068	2070	-2	2068		2069
	2091	2089	2	2091		2093
	2187	2193	-6	2187		2190
	2223	2226	-3	2223		2225
$^4I_{13/2}$	3918	3902	16	3919		3919
	3978	3970	8	3979		3973
	4038	4033	5	4039		4039
	4076	4087	-11	4078		4077
	4118	4115	3	4120		4119
	4208	4205	3	4213		4213
	4278	4267	11	4278		4277
$^4I_{15/2}$	5816	5804	12	5815		5817
	5874	5871	3	5877		5876
	5986	5999	-13	5988		5989
	6141	6163	-22			6142
	6167	6185	-18			6173

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Appendix I. (cont.)

SLJ^a State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O–C	Caspers et al.[d] (cm^{-1})	Wong et al.[e] (cm^{-1})	Voron'ko et al.[f] (cm^{-1})
$^4I_{15/2}$	6323	6113	10			6320
	6454	6445	9			6448
	6556	6538	18			6551
$^4F_{3/2}$	11592	11596	-4	11592	11591.6	11594
	634	638	-4	634	633.6	637
$^2H_{9/2}$,	12596	12576	20	12596	12595.6	
$^4F_{5/2}$	614	595	19	613	612.9	
	622	633	-11	621	620.7	
	676	680	-4	675	674.6	
	694	704	-10	693	692.6	
	754	761	-7	755	755.3	
	843	847	-4	-	-	
	902	874	27	-	-	
$^4F_{7/2}$	13514	13521	-7	13515	13514.8	
	590	591	-1	591	590.8	
$^4S_{3/2}$	671	670	1	671	670.9	
	676	678	-2	677	676.7	
$^4F_{7/2}$	711	690	21	710	710.1	
	715	725	-10	714	714.2	
$^4F_{9/2}$	14834	14840	-6	14835	14834.7	
	861	860	1	860	861.8	
	892	891	1	891	890.6	

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Appendix I. (cont.)

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C	Caspers et al.[d] (cm^{-1})	Wong et al.[e] (cm^{-1})
$^4F_{9/2}$	14926	14925	1	14927	
	959	955	4	958	14959.4
$^2H_{11/2}$	15997	16025	-28	15998	15998.1
	16033	043	-10	16033	-
	046	049	-3	045	16046.4
	060	067	-7	059	-
	100	093	7	103	-
	165	136	29	-	-
$^4G_{5/2}$, $^4G_{7/2}$	17306	17301	5	17304	17304.6
	316	318	-2	315	316.0
	363	360	3	364	362.9
	511	492	19	512	509.2
	518	512	6	520	520.3
	571	567	4	570	
	605	607	-2	601	603.2
$^4G_{7/2}$	19147	19134	13	19147	19147.4
	235	243	-8	235	236.2
	252	266	-14	251	252.1
	324	322	2	323	325.4
$^2K_{13/2}$, $^4G_{9/2}$	19567	19570	-3	19568	19568.2
	615	622	-7	617	
	651	638	13	651	650.9
	686	681	5	685	686.2

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Appendix I. (cont.)

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O–C	Caspers et al.[d] (cm^{-1})	Wong et al.[e] (cm^{-1})
$^2K_{13/2}$,	19704	19696	8	19702	19704.0
$^4G_{9/2}$	–	727		–	–
	741	741	0	739	739.4
	799	786	13	801	
	835	834	1	839	
	–	892		–	
	–	946		–	
	960	970	-10	–	
$^2G_{9/2}$	21155	21151	4	21158	
	176	180	-4	176	
	198	202	-4	201	
	232	242	-10	234	
	252	271	-19	254	
$^2D_{3/2}$	21338	21337	1	21339	
	353	355	-2	351	
$^4G_{11/2}$,	21542	21535	7		
$^2K_{15/2}$	–	618			
	633	630	3		
	718	704	14		
	–	754			
	768	767	1		
	–	783			
	807	810	-3		
	–	821			
	846	861	-15		
	–	884			

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Appendix I. (cont.)

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O–C	Caspers et al.[d] (cm^{-1})
$^4G_{11/2}$,	–	21929		
$^2K_{15/2}$	–	957		
	21992	989	3	
$^2P_{1/2}$	23473	23463	10	23468
$^2D_{5/2}$	23991	23985	6	23991
	24033	24035	−2	
	080	075	5	
$^2P_{3/2}$	26378	26389	−11	
	426	424	2	
$^4D_{3/2}$	28341	28342	−1	
	374	371	3	
$^4D_{5/2}$	28501	28500	1	
	525	526	−1	
	676	672	4	
$^4D_{1/2}$	28962	28943	19	
$^2I_{11/2}$	29463	29467	−4	
	489	476	13	
	568	558	10	
	644	646	−2	
	–	648		
	773	777	−4	

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Appendix I. (cont.)

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O–C
$^2L_{15/2}$,	30275	30270	5
$^4D_{7/2}$	318	317	1
	-	363	
	-	471	
	517	523	-6
	-	536	
	576	593	-17
	-	600	
	631	644	-13
	682	691	-9
	719	722	-3
	807	796	11
$^2I_{13/2}$	-	30860	
	30893	898	-5
	933	948	-15
	994	31010	-16
	31030	31029	1
	068	054	14
	-	118	
$^2L_{17/2}$	31781	31768	13
	-	817	
	859	851	8
	-	983	

SLJ[a]	Obsd.[b] (vac cm^{-1})	Calc.[c] (cm^{-1})	O–C
$^2L_{17/2}$	-	31987	
	-	32008	
	-	030	
	-	074	
	-	172	
$^2H_{9/2}$	33030	33036	-6
	107	117	-10
	181	178	3
	228	226	2
	255	255	0
$^2D_{3/2}$	33619	33616	3
	649	647	2
$^2H_{11/2}$,	34292	34264	28
$^2D_{5/2}$	380	368	12
	419	443	-24
	-	501	
	521	534	-13
	-	578	
	678	659	19
	706	723	-17
	-	811	

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Appendix I. (cont.)

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O–C
$^2F_{5/2}$	38690	38708	-18
	735	764	-29
	841	811	30
$^2F_{7/2}$	40103	40104	-1
	-	120	
	155	176	-21
	288	247	41
$^2G_{9/2}$	-	47867	
	47894	887	7
	937	954	-17
	999	48021	-22
	48043	056	-13

SLJ[a]	Obsd.[b] (vac cm^{-1})	Calc.[c] (cm^{-1})	O–C
$^2G_{7/2}$	48839	48852	-13
	908	868	40
	977	979	-2
	49088	49071	17
$^2F_{7/2}$	-	66565	
	-	716	
	-	772	
	-	916	
$^2F_{5/2}$	-	67856	
	-	900	
	-	68126	

[a]The principal component of the eigenvector is given.

[b](cm^{-1} vac). Components of $^4I_{9/2}$ and $^4I_{11/2}$ taken from ref. 32.

[c]Energy level parameters are given in Table 1.

[d]Ref. 32.

[e]Ref. 6.

[f]Ref. 34.

Appendix II.

Experimental and Computed Energy Level Structure for $Pr^{3+}:LaF_3$

SLJ State	Model[a] (cm^{-1})	Expt.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C	SLJ State	Model[a] (cm^{-1})	Expt.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C
$^3H_4$	0	0	0.2	0	$^3H_5$	2281	2272	2284	−12
	90	57	71	−14		2289	2299	2290	9
	95	71	95	−24		2294	2304	2295	9
	124	136	138	−2		2327	2354	2318	36
	144	195	183	12		2363	2412	2399	13
	226	204[d]	221	−17		2441	2431	2412	19
	305	322[d]	333	−11		2442	2457	2438	19
	386	–	444			2538	2567	2540	27
	479	(508)[e]	463						
					$^3H_6$	4220	–	4179	
$^3H_5$	2160	–	2126			4230	4223	4200	23
	2184	–	2158			4319	4268	4283	−15
	2188	2179	2191	−12		4381	4305	4321	−16

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Appendix II. (Cont.)

SLJ State	Model[a] (cm^{-1})	Expt.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C	SLJ State	Model[a] (cm^{-1})	Expt.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C
$^3H_6$	4414	4388	4384	4	$^3F_2$	5263	5280[d]	5276	4
	4473	4440[d]	4467	-27					
	4494	–	4478		$^3F_3$	6420	6453	6456	-3
	4507	4508	4496	12		6481	6495	6490	5
	4545	4529	4508	21		6489	6499	6508	-9
	4621	4581	4590	-9		6562	6587	6579	8
	4713	4673	4693	-20		6576	6602	6600	2
	4715	–	4712			6602	6622	6628	-6
	4821	4785	4814	-29		6701	6722	6740	-18
$^3F_2$	5130	5137	5145	-8	$^3F_4$	6907	6927	6918	9
	5153	5182	5182	0		6920	–	6936	
	5180	5201	5185	16		6944	6946	6950	-4
	5245	5275	5270	5		6956	–	6952	

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Appendix II (Cont.)

SLJ State	Model[a] (cm^{-1})	Expt.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C	SLJ State	Model[a] (cm^{-1})	Expt.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C
$^3F_4$	6958	6946	6953	−7	$^1G_4$	10477	10499	10516	−17
	6996	6980	6983	−3					
	7000	7029	7034	−5	$^1D_2$	16879	16873	16887	−14
	7084	7104	7096	8		925	893	895	−2
	7129	7165	7152	13		17072	17083	17082	1
						095	–	117	
$^1G_4$	9720	9716	9721	−5		149	183	170	13
	9761	9751	9762	−11					
	9840	9876	9860	16	$^3P_0$	20942	20927	20911	16
	9936	9912	9927	−15					
	9937	–	9958		$^1I_6$	21276	21279	21284	−5
	9979	10005	9996	9		21313	–	304	
	10031	042	10030	12		320	331	340	−9
$^1G_4$	10154	10163	10150	13		398	404	390	14

Appendix II (Cont.)

SLJ State	Model[a] (cm^{-1})	Expt.[b] (cm^{-1})	Calc.[c] (cm^{-1})	0-C	SLJ State	Model[a] (cm^{-1})	Expt.[b] (cm^{-1})	Calc.[c] (cm^{-1})	0-C
$^1I_6$	21440	21418	21406	12	$^1I_6$	21852	21897	21889	8
	447	–	481			905	942	958	−16
$^3P_1$	21472	21475	21487	−12					
	532	522	519	3	$^3P_2$	22607	22691	22668	23
$^1I_6$	21541	–	21570			664	714	704	10
$^3P_1$	21556	21567	21592	−25		673	734	738	−4
$^1I_6$	598	585	588	−3		725	772	787	−15
	619	–	637			767	819	817	2
	650	668	666	2					
	738	–	804		$^1S_0$	46961	46965[f]	46965	0

[a]Ref. 13. Values for the $^1I_6$ components (but not the $^3P_1$) were reduced by 100 cm^{-1} to correspond to present assignments.
[b]Ref. 36 and 39 except as indicated; cm^{-1} vac.
[c]Energy level parameters are given in Table 1.
[d]Ref. 38.
[e]Not used in fitting parameters.
[f]Ref. 42.

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Appendix III.

Computed Energy Level Structure for $Pm^{3+}:LaF_3$

SLJ[a] State	Calc.[b] (cm^{-1})	SLJ[a] State	Calc.[b] (cm^{-1})	SLJ[a] State	Calc.[b] (cm^{-1})	SLJ[a] State	Calc.[b] (cm^{-1})
$^5I_4$	0	$^5I_6$	3376	$^5I_8$	6556	$^5F_2$	13156
	135		3389		6605		170
	189		3392		6621		
	233		3413		6653	$^5F_3$	13853
	266		3413		6672		900
	294		3416		6746		918
	332		3439		6763		952
	437		3462		6824		965
	474		3470		6827		998
					6857		14020
$^5I_5$	1667	$^5I_7$	5042		6959		
	1710		5045		6977	$^5S_2$	14525
	1717		5059		7060		529
	1769		5060		7063		529
	1769		5066		7129		529
	1810		5074		7131		530
	1812		5078		7152		
	1821		5084			$^5F_4$	14804
	1828		5086	$^5F_1$	12650		837
	1829		5090		671		892
	1845		5110		684		894
			5114				895
$^5I_6$	3285		5116	$^5F_2$	13031		898
	3322		5143		076		926
	3326		5149		091		965
	3369						998

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Appendix III. (cont.)

SLJ[a] State	Calc.[b] (cm^{-1})	SLJ[a] State	Calc.[b] (cm^{-1})	SLJ[a] State	Calc.[b] (cm^{-1})	SLJ[a] State	Calc.[b] (cm^{-1})
$^5F_5$	16145	$^5G_4$,	18045	$^5G_3$	18679	$^5G_5$,	20471
	148	$^5G_3$,	066	$^3K_7$	689	$^5G_4$	492
	149	$^3K_7$	068				532
	151		076	$^3K_8$	19854		541
	212		079		859		579
	226		104		870		592
	249		104		872		611
	250		126		885		664
	273		147		890		700
	307		252		928		713
	322		316		951		
			364		973	$^3G_3$	21968
$^3K_6$	17071		381		974		974
	088		408		20005		22020
	088				012		040
	091	$^5G_3$,	18426		035		062
	092	$^3K_7$	426		036		070
	093		444		107		117
	104		461		111		
	106		500		136	$^5G_5$,	22424
	109		508			$^5G_6$	429
	115		510	$^5G_5$,	20243		433
	123		535	$^5G_4$	260		461
	123		536		294		469
	137		545		303		480
			557		20361		500
$^5G_2$	17904		559		365		503
	932		611		366		512
	949		657		387		539
	18007		665		445		563
	017				463		575

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Appendix III. (cont.)

SLJ[a] State	Calc.[b] (cm^{-1})	SLJ[a] State	Calc.[b] (cm^{-1})	SLJ[a] State	Calc.[b] (cm^{-1})
$^5G_5$,	22663	$^3L_7$	24028	$^3H_6$,	24992
$^5G_6$	683		043	$^3G_4$,	25014
	696		046	$^3L_8$	018
	696				023
	754	$^3P_1$	24289		038
	769		299		068
	779		306		071
	827				073
	831	$^3H_6$,	24635		122
	895	$^3G_4$,	661		136
	909	$^3L_8$	664		156
	942		678		157
			695		171
$^3D_2$	23189		708		172
	253		762		224
	288		772		263
	327		780		
	327		785		(25816-50000[c])
			810		
$^3L_7$	23699		817		
	701		834		
	828		849		
	840		869		
	841		874		
	887		893		
	889		24905		
	954		917		
	956		918		
	965		924		
	968		945		
	24022		950		

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Appendix III. (cont.)

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[a]The leading component of the state eigenvector is indicated.

[b]The energy level parameters (interpolated) used to compute these level energies are given in Table 1.

[c]Since there are no experimental data available, the tabulation has been arbitrarily stopped at 25263 cm^{-1}. At higher energies, starting with the next level at 25816 cm^{-1}, the computed density of states is relatively high. Some additional results are given for Pm^{3+}:$LaCl_3$ in Ref. 45. Figure 7 indicates the larger gaps in energy where no crystal-field components are computed to occur.

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Appendix IV.

Experimental and Computed Energy Level Structure of $Sm^{3+}:LaF_3$

SLJ[a] State	Expt.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O–C	Rast[d] et al. (cm^{-1})	Dieke[e] (cm^{-1})
$^6H_{5/2}$	0	-6	6	0	0
	44	53	-9	48	44
	159	135	24	115	159
$^6H_{7/2}$	1000	990	10	1000	1003
	1044	1027	17	044	046
	1185	1205	-20	185	100
	1280	1262	18	280	187
$^6H_{9/2}$	2209	2193	16	2209	2213
	244	233	11	244	247
	342	332	10	342	344
	409	408	1	409	404
	473	468	5	473	493
$^6H_{11/2}$	3520	3510	10	3517	
	568	553	15	567	
	651	628	23	647	
	671	667	4	670	
	727	739	-12	726	
	791[d]	793	-2	791	
$^6H_{13/2}$	4972	4947	25	4971	4969
	982	975	7	982	
	5007	5004	3	5007	5005
	046	042	4	047	044
	057	059	-2	057	
	122	114	8	122	
	160	170	-10	160	

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Appendix IV. (cont.)

SLJ[a] State	Expt.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C	Rast[d] et al. (cm^{-1})	Dieke[e] (cm^{-1})
$^6H_{15/2}$,	6309	6300	9	–	
$^6F_{1/2}$	341	334	7	6346	
	406	417	-11	408	6404
	460	465	-5	454	
	–	472		462	
	–	553		492	
	568	578	-10	538	
	609	605	4	571	
	–	666			
$^6F_{3/2}$	6707	6724	-17	6707	
	–	738		–	
$^6F_{5/2}$	7177	7177	0	7174	7173
	184	190	-6	184	180
	223	239	-16	225	
$^6F_{7/2}$	7992	8008	-16	7993	7987
	8041	026	15	8042	8034
	060	059	1	059	054
	092	108	-16	092	086
$^6F_{9/2}$	9170	9173	-3	9170	9162
	178	189	-11	180	173
	228	223	5	231	222
	252	243	9	254	247
	268	281	-13	270	262
$^6F_{11/2}$	10561	10567	-6	10559	
	584	583	1	581	
	592	590	2	590	
	603	621	-18	602	
	613	633	-20		
	644	656	-12		

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Appendix IV. (cont.)

SLJ[a] State	Expt.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C	Rast[d] et al. (cm^{-1})	Dieke[e] (cm^{-1})
$^4G_{5/2}$	17858	17863	-5		17858
	949	960	-11		949
	(18045)	18087			18046
$^4F_{3/2}$	18924	18933	-9		18924
	942	951	-9		942
$^4G_{7/2}$	20037	20041	-4		20037
	093	094	-1		093
	112	123	-11		111
	164	168	-4		
$^4I_{9/2}$	20416	20406	10		20417
	472	472	0		471
	499	505	-6		497
	522	531	-9		523
	570	551	19		
$^4M_{15/2}$,	-	20685			
$^4I_{11/2}$	-	770			
	-	808			
	-	858			
	-	892			
	-	904			
	-	922			20944
	-	974			
	-	21004			
	-	071			
	-	164			
	-	179			
	-	248			
	-	265			

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Appendix IV. (cont.)

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O–C	Dieke[e] (cm^{-1})
$^4I_{13/2}$	21520	21541	−21	21520
	602	602	0	
	636	616	20	637
	665	649	16	647
	–	652		
	674	666	8	
	706	684	22	709
$^4F_{3/2}$	22164	22178	−14	22164
	207	213	−6	207
	240	254	−14	241
$^4M_{17/2}$,	22501	22500	1	22501
$^4G_{9/2}$,	531	539	−8	532
$^4I_{15/2}$	542	552	−10	
	–	573		
	579	581	−2	
	628	630	−2	
	695	693	2	
	–	738		
	–	770		
	808	801	7	
	829	834	−5	
	–	867		
	–	912		
	942	943	−1	
	–	982		
	–	23020		
	–	023		
	–	036		
	–	054		
	–	083		

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O–C	Dieke[e] (cm^{-1})
$^4M_{17/2}$,	–	23116		
$^4G_{9/2}$,	–	158		
$^4I_{15/2}$				
$^4M_{19/2}$,	23988	23989	−1	
$^6P_{5/2}$	24022	24035	−13	
	031	068	−37	
	064	080	−16	
	084	101	−17	24084
	119	126	−7	119
	135	134	1	
	153	162	−9	153
	–	169		
	–	181		
	–	186		
	–	207		
	–	218		
$^4L_{13/2}$	24608	24616	−8	24607
	629	632	−3	628
	631	642	−11	631
	644	658	−14	643
	679	689	−10	678
	683	695	−12	683
	710	720	−10	709
$^4F_{7/2}$	24911	24900	11	24911
	993	987	6	993
	25007	25002	5	25007
	064	071	−7	064
$^6P_{3/2}$	081	088	−7	
	–	106		

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Appendix IV. (cont.)

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C	Dieke[e] (cm^{-1})
$^4G_{11/2}$, $^4M_{21/2}$, $^4M_{15/2}$, $^4H_{11/2}$	25166	25169	-3	
	182	177	5	
	204	203	1	
	216	217	-1	
	-	220		
	-	243		
	248	259	-11	
	282	285	-3	
	-	308		
	-	343		
	-	398		
	-	439		
	-	476		
	-	543		
	-	565		
	611	603	8	25614
	636	621	15	632
	650	645	5	649
	672	654	18	666
	684	682	2	681
	-	698		
	711	708	3	
	718	713	5	
	771	762	9	767
	789	782	7	787
	801	795	6	798
	826	823	3	
	832	845	-13	
	866	866	0	
	904	882	22	
	-	921		
$^4D_{1/2}$.	26495	26472	23	26495

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C	Dieke[e] (cm^{-1})
$^4L_{17/2}$, $^6P_{7/2}$	26702	26694	8	26699
	712	705	7	709
	717	718	-1	712
	743	751	-8	758
	776	763	13	776
	792	777	15	791
	797	800	-3	796
	-	803		
	812	812	0	810
	822	826	-4	822
	859	849	10	857
	-	862		
	874	868	6	
$^4K_{13/2}$	26942	26931	11	
	962	955	7	
	27003	991	12	
	018	27014	4	
	031	026	5	
	061	073	-12	
	120	109	11	
$^4F_{9/2}$	27417	27381	36	27419
	432	443	-11	434
	448	467	-19	448
	508	510	-2	
	-	552		
$^4D_{3/2}$	27648	27646	2	27649
	658	654	4	659

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Appendix IV. (cont.)

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	0–C	Dieke[e] (cm^{-1})
$^4P_{5/2}$	27691	27714	-23	27692
	734	763	-29	735
	758	787	-29	759
$^4H_{7/2}$	28247	28242	5	28247
	261	252	9	262
	344	359	-15	
	409	393	16	410
$^4K_{15/2}$	28722	28735	-13	
	732	743	-11	28732
	760	757	3	
	–	770		
	784	783	1	
	797	793	4	
	–	804		
	817	823	-6	
$^4H_{9/2}$	28938	28925	13	28938
	–	929		
	981	989	-8	980
	29035	29045	-10	036
	055	070	-15	052
$^4D_{7/2}$	29086	29098	-12	29083
	094	108	-14	092
	112	115	-3	111
	–	122		
$(^4K,^4L)_{17/2}$	–	137		
	–	140		
	29154	154	0	29154
	–	156		

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	0–C	Dieke[e] (cm^{-1})
$(^4K,^4L)_{17/2}$	29166	29169	-3	
	–	183		
	195	191	4	
	–	219		
	–	238		
$^4L_{19/2}$,	29268	29270	-2	
$^4H_{11/2}$,	304	298	6	
$^4H_{13/2}$	–	315		
	–	325		
	–	335		
	–	347		
	–	356		
	–	363		
	–	397		
	–	416		
	–	457		
	–	478		
	–	505		
	–	514		
	–	555		
	–	558		
	–	562		
	–	607		
	–	615		
	–	650		
	709	681	28	
	723	693	30	
	738	738	0	
$^4G_{7/2}$,	30027	30031	-4	30028
$^4G_{9/2}$	120	118	2	120
	136	159	-23	136

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Appendix IV. (cont.)

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O–C	Dieke[e] (cm^{-1})
$^4G_{7/2}$,	–	30193		
$^4G_{9/2}$	30216	210	6	213
	235	212	23	
	–	260		
	293	289	4	
	332	347	-15	
$^4G_{5/2}$	–	30438		
	–	508		
	–	549		
$^4P_{1/2}$	–	31226		
$^2L_{15/2}$,	–	31337		
$^4G_{11/2}$,	–	352		
$^4P_{3/2}$	31410	394	16	31412
	433	445	-12	435
	463	476	-13	465
	488	495	-7	489
	511	504	7	511
	523	513	10	524
	532	530	2	533
	543	558	-15	538
	583	604	-21	582
	624	623	1	627
	–	630		
	–	682		
	–	707		
	759	734	25	
$^4P_{5/2}$	32800	32797	3	32799
	823	824	-1	823
	857	856	1	858
$^2F_{5/2}$,	–	33548		
$^2K_{13/2}$,	33615	642	-27	
$^4F_{9/2}$	–	708		
	777	787	-10	
	–	813		
	–	865		
	–	900		
	–	955		
	–	962		
	–	977		
	–	34007		
	–	028		
	–	049		
	–	081		
	–	095		
$^2L_{17/2}$,	–	34341		
$^4I_{9/2}$	–	358		
	–	386		
	–	426		
	–	434		
	34454	467	-13	
	468	468	0	
	481	488	-7	34484
	497	495	2	499
	519	536	-17	
	–	552		
	–	590		

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C
$^2L_{17/2}$,	-	34612	
$^4I_{9/2}$	-	654	
$^4F_{7/2}$,		(35612-35823)[f]	
$^2N_{19/2}$			
$^2P_{1/2}$	-	35846	
$^4I_{11/2}$	35890	35892	-2
	905	905	0
	-	932	
	954	945	9
	996	987	9
	36007	999	8
	055	36054	1
		(36315-37273)[f] (39 levels)	
$^4H_{9/2}$	37623	37607	16
	-	618	
	634	638	-4
	657	654	3
	679	667	12
$^2F_{7/2}$,	-	38175	
$^2P_{3/2}$	-	219	
	-	300	
	38467	461	6
	492	485	7
	-	512	

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C
		(38906-41774)[f,g] 46 levels	
$^2G_{9/2}$	-	42039	
	42066	072	-6
	124	104	20
	135	137	-2
	176	183	-7
$^2O_{23/2}$,	42227	42215	12
$^4G_{5/2}$,	378	400	-22
$^4G_{7/2}$	-	456	
	462	472	-10
	486	480	6
	-	506	
	-	514	
	-	546	
	-	574	
	-	594	
	-	612	
	616	614	2
	-	642	
	-	643	
	658	661	-3
	-	668	
	-	699	
	711	720	-9
	-	744	
$^2O_{21/2}$,	-	809	
$^4K_{15/2}$	-	914	
	-	951	
	959	963	-4

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Appendix IV. (cont.)

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C
$^2O_{21/2}$, $^4K_{15/2}$	-	42976	
	42990	996	-6
	-	43022	
	43040	041	-1
	-	056	
	074	080	-6
	(43088-43658)[f] 27 levels		
$^2H_{11/2}$	43769	43760	9
	-	762	
	-	808	
	844	855	-11
	-	869	
	-	921	
$^2G_{7/2}$	43991	43975	16
	-	44005	
	-	033	
	-	041	

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C
	(44491-47029)[f] 54 levels		
$^2H_{11/2}$	47336	47306	30
	374	363	11
	-	430	
	-	523	
	-	536	
	-	675	
	(47812-48909)[f] 45 levels		
$^4P_{1/2}$, $^2H_{9/2}$, $^2F_{5/2}$	(49581-49865)[f]		

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[a]Largest or two largest eigenvector components are indicated.

[b]Experimental results for the $^6H_{5/2}$ state taken from Ref. 1 based on correlation with model calculation. Observed data for the $^6H_{9/12}$ and $^6H_{9/2}$ states in the ground multiplet from Ref. 46. Values in parentheses were not included in the parameter fitting process. All entries in cm^{-1} vac.

[c]Energy level parameters are given in Table 1.

[d]Ref. 46.

[e]Ref. 1.

[f]In certain regions of the spectrum where no structure was observed and computations indicated a high density of levels, only the initial and final energies of the group are indicated. In some cases one or two very weak bands were observed consistent with calculation, but not included.

[g]There is an energy gap, 39500-40340 cm^{-1}, in which no levels are computed to occur.

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Appendix V.

Experimental and Computed Energy Level Structure for $Er^{3+}:LaF_3$

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O–C
$^4I_{15/2}$	0	−22	22
	51.2	27	24
	121.2	92	30
	199.7	176	24
	219.4	193	26
	313.8	289	25
	400.3	375	25
	442.9	420	23
$^4I_{13/2}$	6604	6612	−8
	630	637	−7
	670	686	−16
	700	699	1
	723	732	−9
	754	771	−17
	823	830	−7
$^4I_{11/2}$	10301	10300	1
	311	314	−3
	330	336	−6
	344	351	−7
	358	364	−6
	395	405	−10
$^4I_{9/2}$	12419	12392	27
	518	512	6
	615	596	19
	701	681	20
	730	720	10
$^4F_{9/2}$	15391	15406	−15
	432	443	−11
	443	462	−19
	474	488	−14
	527	538	−11
$^4S_{3/2}$	18557	18577	−20
	588	610	−22
$^2H_{11/2}$	19266	19299	−33
	307	324	−17
	314	344	−30
	363	371	−8
	367	379	−12
	419	430	−11
$^4F_{7/2}$	20656	20654	2
	703	697	6
	734	735	−1
	786	790	−4
$^4F_{5/2}$	22370	22380	−10
	374	389	−15
	407	414	−7
$^4F_{3/2}$	22684	22692	−8
	751	748	3

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Appendix V. (cont.)

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O–C
$^2G_{9/2}$	24602	24587	15
	680	698	−18
	754	755	−1
	840	831	9
	862	864	−2
$^4G_{11/2}$	26526	26534	−8
	554	559	−5
	582	586	−4
	(621)[d]	637	
	647	640	7
	707	700	7
$^4G_{9/2}$	27602	27608	−6
	616	615	1
	628	625	3
	641	637	4
	668	660	8
$^2K_{15/2}$	27817	27826	−9
	827	838	−11
	872	877	−5
	898	893	5
	933	932	1
	–	978	
	–	28014	
	28125	132	−7

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O–C
$^2G_{7/2}$	28239	28233	16
	255	237	18
	–	246	
	264	250	14
$^2P_{3/2}$	31695	31723	−28
	752	786	−34
$^2K_{13/2}$	33107	33086	21
	116	106	10
	141	154	−13
	163	161	2
	186	196	−10
	–	228	
$^2P_{1/2}$	33346	33350	−4
$^2K_{13/2}$	397	405	−8
$^4G_{5/2}$	–	33510	
	–	522	
	–	628	
$^4G_{7/2}$	34159	34154	5
	197	182	15
	222	215	7
	280	271	9

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Appendix V. (cont.)

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O–C
$^2D_{5/2}$	35026	35043	-17
	052	052	0
	085	091	-6
$^2H_{9/2}$	36520	36526	-6
	556	549	7
	623	637	-14
	720	729	-9
	804	796	8
$^4D_{5/2}$	38807	38815	-8
	837	858	-21
	844	863	-19
$^4F_{7/2}$	39454	39460	-6
	537	540	-3
	603	605	-2
	634	630	4
$^2I_{11/2}$	41237	41211	26
	294	269	25
	313	304	9
	380	352	28
	395	375	20
	493	466	27
$^2L_{17/2}$	41680	41720	-40
	-	801	
	783	822	-39

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O–C
$^2L_{17/2}$	41802	41832	-30
	-	861	
	-	922	
	934	957	-23
	42002	42045	-43
	-	054	
$^4D_{3/2}$	42499	42484	15
	529	517	12
$^2D_{3/2}$	43090	43108	-18
	127	138	-11
$^2I_{13/2}$	43686	43672	14
	742	725	17
	759	750	9
	770	769	1
	833	815	18
	914	898	16
	-	956	
$^4D_{1/2}$	-	47347	
$^2L_{15/2}$	47891	47891	0
	951	922	29
	-	990	
	-	48007	
	48071	066	5
		083	

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Appendix V. (cont.)

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O–C
$^2L_{15/2}$	-	48168	
	-	199	
$^2H_{9/2}$	-	48306	
	-	349	
	-	394	
	-	438	
	-	461	
$^2D_{5/2}$	49223	49178	45
	272	248	24
	357	321	36

[a]The principal SLJ-component of the state is indicated.

[b]All energies are corrected to vacuum cm^{-1}. The energies of the ground $^4I_{15/2}$ state are taken from Ref. 47.

[c]Energy level parameters are given in Table 1.

[d]Not included in the energy level parameter fitting.

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Appendix VI.

Experimental and Computed Energy Level Structure for $Tm^{3+}:LaF_3$

SLJ State	Model[a] (cm^{-1})	Expt.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C
$^3H_6$	0	0	-4	4
	67	67	66	1
	74	-	76	
	156	118	131	-13
	204	-	197	
	235	-	198	
	272	-	254	
	274	-	273	
	349	-	339	
	354	-	346	
	400	-	386	
	418	-	399	
	441	-	420	

SLJ State	Model[a] (cm^{-1})	Expt.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C
$^3F_4$	5585	5615	5613	2
	5689	5706	5703	3
	5790	5814	5820	-6
	5813	5826	5838	-12
	5836	5859	5857	2
	5851	5866	5863	3
	5903	-	5905	
	5916	5918	5924	-6
	5929	5958	5941	17
$^3H_5$	8306	8305	8293	12
	8354	8332	8331	1

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Appendix VI. (cont.)

SLJ State	Model[a] (cm^{-1})	Expt.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C
$^3H_5$	8365	8338	8337	1
	8395	8366	8368	-2
	8451	8400	8415	-15
	8460	–	8442	
	8470	–	8446	
	8481	–	8464	
	8522	–	8499	
	8581	8550	8562	-12
	8589	–	8568	
$^3H_4$	12547	12561	12553	8
	597	570	578	-8
	678	700	690	10
	734	727	719	8

SLJ State	Model[a] (cm^{-1})	Expt.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C
$^3H_4$	12784	–	12770	
	826	12825	819	6
	832	–	824	
	880	868	863	5
	909	–	890	
$^3F_3$	14514	14508	14522	-14
	530	–	537	
	534	539	538	1
	550	554	556	-2
	582	588	588	0
	590	596	593	3
	622	–	627	

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Appendix VI. (cont.)

SLJ State	Model[a] (cm^{-1})	Expt.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C
$^3F_2$	15153	15138	15144	−6
	180	169	171	−2
	200	207	193	14
	254	240	240	0
	266	–	264	
$^1G_4$	21016	21037	21041	−4
	193	196	198	−2
	300	309	319	−10
	335	349	339	10
	362	366	372	−6
	364	380	382	−2
	425	–	406	
	508	–	511	

SLJ State	Model[a] (cm^{-1})	Expt.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C
$^1G_4$	21511	21519	21512	7
$^1D_2$	28022	28021	28024	−3
	023	034	024	10
	041	057	049	8
	074	088	088	0
	100	106	114	−8
$^1I_6$	34781	34769	34772	−3
	808	–	795	
	906	896	906	−10
	35000	–	997	
	022	–	35015	
	078	–	106	

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Appendix VI. (cont.)

SLJ State	Model[a] (cm^{-1})	Expt.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C
$^1I_6$	35079	35107	35109	−2
	149	160	143	17
	201	–	184	
	216	–	226	
	217	–	234	
	257	–	253	
	272	–	270	
$^3P_0$	35588	35604	35624	−20
$^3P_1$	36502	36531	36525	6

SLJ State	Model[a] (cm^{-1})	Expt.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C
$^3P_1$	36549	36587	36575	12
	588	–	624	
$^3P_2$	38225	38250	38244	6
	266	291	290	1
	296	336	326	10
	415	414	427	−13
	426	451	464	−13
$^1S_0$	75158	–	75025	

[a]Ref. 13.

[b]Ref. 49 (cm^{-1} vac).

[c]Energy level parameters are given in Table 1.

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Appendix VII.

Experimental and Computed Energy Level Structure for $Ho^{3+}:LaF_3$

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O–C
$^5I_8$	0	-2	2
	4.5	3	1
	42	29	13
	50	54	-4
	69	67	2
	122	130	-8
	145	151	-6
	201	221	-20
	215	222	-7
	227	232	-5
	(261)[d]	298	
	307	307	-0
	322	324	-2
	349	339	10
	387	388	-1
	398	391	7
	409	410	-1
$^5I_7$	–	5182	
	5192	182	10
	–	242	
	–	243	
	–	244	
	246	248	-2
	250	250	0
	–	256	
	264	268	-4
	273	276	-3
	280	276	4
$^5I_7$	5287	5291	-4
	296	293	3
	309	300	9
	314	303	11
$^5I_6$	8726	8722	4
	730	723	7
	733	732	1
	735	735	0
	747	740	7
	753	754	-1
	761	767	-6
	773	776	-3
	783	778	5
	786	791	-5
	814	812	2
	–	817	
	834	839	-5
$^5I_5$	11304	11298	6
	306	303	3
	308	303	5
	311	314	-3
	–	315	
	321	319	2
	332	333	-1
	–	338	
	363	360	3

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Appendix VII. (cont.)

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C
$^5I_5$	-	11369	
	11386	392	-6
$^5I_4$	-	13260	
	13286	285	1
	362	382	-20
	380	388	-8
	-	394	
	-	419	
	-	455	
	-	477	
	-	607	
$^5F_5$	15576	15587	-11
	593	603	-10
	608	615	-7
	625	629	-4
	641	637	4
	659	661	-2
	-	681	
	-	712	
	-	714	
	708	717	-9
	730	734	-4
$^5S_2$	18590	18597	-7
	600	598	2
	603	601	2

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C
$^5S_2$	18603	18602	1
	620	620	0
$^5F_4$	18677	18677	0
	688	683	5
	709	719	-10
	720	728	-8
	737	749	-12
	753	760	-7
	-	767	
	776	793	-17
	814	812	2
$^5F_3$	20744	20725	19
	754	750	4
	796	789	7
	799	791	8
	826	821	5
	832	823	9
	866	861	5
$^5F_2$	21238	21228	10
	249	232	17
	265	260	5
	275	281	-6
	286	287	-1
$^3K_8$	21411	21405	6
	419	424	-5

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Appendix VII. (cont.)

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C
$^3K_8$	21423	21427	-4
	432	426	6
	440	449	-9
	451	457	-6
	461	458	3
	-	468	
	481	479	2
	495	480	15
	514	507	7
	527	514	13
	532	546	-14
	550	552	-2
	566	564	2
	-	573	
	579	574	5
$^5G_6$	22220	22238	-18
	235	250	-15
	263	260	3
	283	303	-20
	328	331	-3
	346	342	4
	361	348	13
	374	360	14
	389	380	9
	407	395	12
	424	423	1
	438	429	9
	454	479	-25

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C
$^5F_1$	-	22504	
	22508	504	4
	-	535	
$^5G_5$	24112	24123	-11
	116	130	-14
	125	136	-11
	146	165	-19
	-	167	
	170	173	-3
	182	180	2
	-	185	
	196	194	2
	-	222	
	247	222	25
$^5G_4$	25985	25982	3
	26008	980	28
	037	26051	-14
	054	057	-3
	-	058	
	084	059	25
	096	096	0
	-	155	
	161	169	-8
$^3K_7$	26255	26261	-6
	-	262	
	-	266	

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Appendix VII. (cont.)

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O–C
$^3K_7$	26266	26267	−1
	277	282	−5
	–	287	
	288	287	1
	293	298	−5
	–	299	
	298	299	−1
	312	312	0
	320	314	6
	–	324	
	328	331	−3
	328	332	−4
$^5G_5,{}^3H_6$	27749	27746	3
	758	751	7
	804	788	16
	–	814	
	815	814	1
	–	819	
	–	820	
	825	826	−1
	839	840	−1
	–	846	
	854	851	3
	869	859	10
	879	882	−3
	–	926	
	–	927	
	932	928	4

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O–C
$^5G_5,{}^3H_6$	27945	27948	−3
	–	973	
	–	984	
	–	991	
	997	28000	−3
	–	020	
	–	076	
	28092	077	15
$^5F_2$	28426	28433	−7
	–	450	
	–	479	
	–	492	
	–	506	
$^5G_3,{}^3L_9$	–	28956	
	28981	996	−15
	29011	29017	−6
	020	019	1
	032	020	12
	035	028	7
	039	036	3
	–	049	
	–	051	
	068	052	16
	–	094	
	–	094	4
	–	095	
	102	100	2

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Appendix VII. (cont.)

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O–C
$^5G_3, ^3L_9$	29122	29125	-3
	–	127	
	–	128	
	–	146	
	161	160	1
	–	164	
	–	166	
	187	174	13
	–	220	
	230	220	10
	–	303	
	292	303	-11
$^3F_4, ^3K_6$	–	30023	
	–	027	
	30058	058	0
	078	072	6
	094	101	-7
	101	105	-4
	–	114	
	116	122	-6
	–	140	
	157	155	2
	186	187	-1
	–	197	
	197	198	-1
	213	218	-5
	–	228	
	234	231	3
$^3F_4, ^3K_6$	–	30267	
	–	288	
	30292	306	-14
	–	322	
	–	325	
	330	331	-1
$^5G_2$	–	30997	
	31002	31006	-4
	020	008	12
	–	026	
	062	072	-10
$^3D_3$	–	33313	
	–	330	
	–	346	
	–	360	
	–	382	
	–	412	
	–	437	
$^3P_1$	–	33554	
	–	560	
	–	564	
$^3M_{10}, ^3L_8$	34022	34033	-11
	–	040	
	–	048	
	061	057	4

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Appendix VII. (cont.)

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O–C
$^3M_{10}, ^3L_8$	–	34105	
	34116	122	-6
	–	138	
	–	166	
	–	191	
	205	205	0
	–	212	
	–	221	
		(34234-34542)[e]	
$^5G_4$	–	34967	
	–	978	
	–	978	
	34994	984	10
	–	998	
	35003	35002	1
	023	024	-1
	–	024	
	049	032	17
$^3F_3$	35335	35327	8
	–	343	
	369	368	1
	424	415	9
	–	435	
	489	491	-2
	–	530	
$^5D_4$	36058	36040	18
	070	071	-1
	086	085	1
	100	090	10
	111	140	-29
	–	221	
	–	251	
	244	252	-8
	–	270	
$^3P_0$	–	36318	
		(36450-36703)[f]	
$^3H_5$	36852	36868	-16
	869	875	-6
	894	909	-15
	–	935	
	–	965	
	37001	990	11
	–	37021	
	034	032	2
	–	032	
	–	045	
	–	066	
		(37975-38237)[g]	

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Appendix VII. (cont.)

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C
$^3I_7$	-	38560	
	-	568	
	38570	571	-1
	-	585	
	-	590	
	-	590	
	599	597	2
	-	612	
	-	614	
	-	620	
	-	621	
	-	624	
	38638[h]	646	
	-	647	
	-	652	

[a]The principal SLJ-component of the state is given.

[b]The energies quoted as observed are primarily from ref. 52 as confirmed in the present study. In some instances the band energies reported are those found in the present work where no corresponding observations were quoted in (52); there were also cases in which more crystal-field components than would be allowed for a given J-value were quoted in (52). The present model crystal-field calculations were used as the basis for excluding the extra levels. Units of cm^{-1} vac.

[c]Energy level parameters are given in Table 1.

[d]Not included in the energy level parameter fitting.

Appendix VII. (cont.)

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[e]There are 24 crystal-field components belonging principally to the $^3M_{10}$ and $^3L_8$ states computed in the energy range between 34234 and 34542 cm^{-1}. No structure was observed in this range.

[f]There are 22 crystal-field components belonging principally to the $^3F_2$ and $^1L_8$ states computed in the energy range 36450–36703 cm^{-1}. No structure was observed.

[g]There are 20 crystal-field components belonging principally to the $^3P_2$ and $^3L_7$ states computed in the energy range 37975–38237 cm^{-1}. No structure was observed.

[h]No structure attributable to $f \rightarrow f$ transitions was observed at energies >36638 cm^{-1}.

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Appendix VIII.

Experimental and Computed Energy Level Structure of $Dy^{3+}:LaF_4$

SLJ^a State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C	Fry et al.[d] Obs. (cm^{-1})
$^6H_{15/2}$	0	0	0	0
	17	28	−11	17
	69	76	−7	69
	124	126	−2	124
	184	188	−4	184
	208	209	−1	208
	–	296		
	307	316	−9	307
$^6H_{13/2}$	3503	3502	1	3502
	575	568	7	576
	621	602	19	618
	628	624	4	630

SLJ^a State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C	Fry et al.[d] Obs. (cm^{-1})
$^6H_{13/2}$	3645	3639	6	3645
	–	678		–
	701	681	20	695
$^6H_{11/2}$	5883	5875	8	5882
	908	912	−4	909
	924	918	6	925
	945	934	11	945
	976	973	3	977
	6021	6024	−3	6024
$^6H_{9/2}$,	7632	7630	2	7633
$^6F_{11/2}$	664	673	−9	665

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Appendix VIII. (cont.)

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C	Fry et al.[d] Obs. (cm^{-1})
$^6H_{9/2}$,	7726	7728	−2	7727
$^6F_{11/2}$	756	776	−20	758
	812	828	−16	803
	837	832	5	813
	840	841	−1	842
	854	862	−8	887
	930	927	3	933
	996	998	−2	8019
	8075	8065	10	075
$^6H_{7/2}$,	8992	8996	−4	8990
$^6F_{9/2}$	9074	9085	−11	9071
	087	091	−4	085
	144	139	5	141

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C	Fry et al.[d] Obs. (cm^{-1})
$^6H_{7/2}$,	9181	9185	−4	9179
$^6F_{9/2}$	234	238	−4	235
	282	265	17	279
	343	330	13	343
	435	435	0	438
$^6H_{5/2}$	10222	10220	2	10222
	285	284	1	284
	345	346	−1	344
$^6F_{7/2}$	11037	11038	−1	11044
	108	099	9	116
	138	138	0	159
	152	142	10	206

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Appendix VIII. (cont.)

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C	Fry et al.[d] Obs. (cm^{-1})
$^6F_{5/2}$	12456	12466	−10	12456
	502	501	1	501
	514	517	−3	520
$^6F_{3/2}$	13271	13288	−17	13271
	285	296	−11	284
$^6F_{1/2}$	–	13839		–
$^4F_{9/2}$	21057	21058	−1	21059
	142	131	11	141
	159	147	12	159
	205	190	15	175
	–	358		218

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C	Fry et al.[d] Obs. (cm^{-1})
$^4I_{15/2}$	22022	21996	26	22020
	132	121	11	126
	175	168	7	169
	189	185	4	190
	213	211	2	214
	292	297	−5	290
	342	328	14	342
	379	352	27	380
$^4G_{11/2}$	23468	23460	8	23468
	497	504	−7	501
	513	525	−12	513
	537	542	−5	534
	551	555	−4	550

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Appendix VIII. (cont.)

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C
$^4G_{11/2}$	–	23611	
$^4M_{21/2}$	24984	24971	13
	25001	998	3
	067	25070	–3
	090	092	–2
	–	172	
	187	185	2
	–	186	
	226	223	3
	–	273	
	303	307	–4
	341	333	8

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C
$^4I_{13/2}$,	–	25626	
$^4F_{7/2}$,	25661	674	–13
$^4K_{17/2}$	691	722	–31
	740	742	–2
	748	759	–11
	778	814	–36
	–	829	
	824	837	–13
	–	845	
	849	861	–12
	867	892	–25
	–	894	
	–	912	
	903	919	–16

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Appendix VIII. (cont.)

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C
$^4I_{13/2}$,	25918	25929	−11
$^4F_{7/2}$,	–	935	
$^4K_{17/2}$	940	952	−12
	953	962	−9
	–	981	
	990	982	8
$^4M_{19/2}$	–	26242	
	–	251	
	26260	257	3
	–	291	
	–	397	
	448	445	3
	–	475	

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C
$^4M_{19/2}$	26509	26528	−19
	571	552	19
	583	563	20
$^6P_{3/2}$	27476	27493	−17
	529	545	−16
$^6P_{5/2}$	27574	27580	−6
	616	611	5
	658	660	−2
$^4I_{11/2}$	27912	27903	9
	–	984	
	982	991	−9

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Appendix VIII. (cont.)

SLJ^a State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C
$^4I_{11/2}$	–	28036	
	28030	046	–16
	068	072	–4
$^4M_{15/2}$,	–	28492	
$^6P_{7/2}$	536	523	13
	572	575	–3
	605	607	–2
	630	634	–4
	651	641	10
	666	673	–7
	–	676	
	703	698	5
	726	727	–1

SLJ^a State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C
$^4M_{15/2}$,	28819	28808	11
$^6P_{7/2}$	834	835	–1
$^4F_{5/2}$,	29527	29517	10
$^4I_{9/2}$	630	614	16
	660	658	2
	676	683	–7
	746	725	21
	780	783	–3
	851	842	9
	884	883	1
$^4G_{9/2}$,	–	29960	
$^4M_{17/2}$	29980	986	–6

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Appendix VIII. (cont.)

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C
$^4G_{9/2}$,	–	29997	
$^4M_{17/2}$	–	30020	
	–	025	
	–	041	
	30073	081	-8
	–	092	
	–	106	
	139	151	-12
	–	194	
	241	224	17
	–	263	
	301	296	5

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C
$^6P_{3/2}$	30879	30862	17
	914	898	16
$^4K_{15/2}$,	31119	31105	14
$^4L_{19/2}$	134	148	-14
	170	169	1
	195	190	5
	214	218	-4
	226	245	-19
	262	266	-4
	282	285	-3
	294	298	-4
	–	316	
	–	350	

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Appendix VIII. (cont.)

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C
$^4K_{15/2}$,	–	31356	
$^4L_{19/2}$	31369	370	-1
	–	375	
	–	389	
	–	415	
	443	456	-13
	–	462	
$^4G_{7/2}$	31571	31565	6
	651	648	3
	–	698	
	707	710	-3
$^4D_{5/2}$	–	32062	
$^4D_{5/2}$	–	32087	
$^4D_{1/2}$	–	152	
$^4D_{5/2}$	–	168	
$^4K_{13/2}$	–	33148	
	–	180	
	33185	185	0
	–	197	
	205	203	2
	221	206	15
	239	219	20
$^4H_{13/2}$	–	33485	

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Appendix VIII. (cont.)

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C
$^4H_{13/2}$	–	33497	
	33500	500	0
	508	506	2
	537	518	19
	552	553	-1
	600	566	34
$^4F_{3/2}$	33628	33632	-4
	642	639	3
$^4D_{7/2}$	34009	34021	-12
	020	030	-10
	031	041	-10
	070	069	1

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C
$^4H_{11/2}$,	34227	34237	-10
$^4L_{17/2}$,	240	241	-1
$^4F_{5/2}$,	–	260	
$^4H_{9/2}$	278	274	4
	293	285	8
	–	292	
	–	298	
	–	324	
	–	338	
	346	348	-2
	–	355	
	–	358	
	–	370	
	373	381	-8

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Appendix VIII. (cont.)

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C
$^4H_{11/2}$,	34398	34383	15
$^4L_{17/2}$,	406	400	6
$^4F_{5/2}$,	–	420	
$^4H_{9/2}$	430	436	–6
	445	448	–3
	–	457	
	–	470	
	–	472	
	505	493	12
$^4H_{11/2}$	34847	34846	1
	869	874	–5
	902	891	11
	910	910	0

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C
$^4H_{11/2}$	34933	34934	–1
	969	990	–21
$^4K_{11/2}$,	–	35776	
$^4G_{7/2}$	–	818	
	–	902	
	35936	948	–12
	961	971	–10
	36002	36005	–3
	022	014	8
	051	056	–5
	077	100	–23
	–	153	

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Appendix VIII. (cont.)

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C
$^4L_{13/2}$,	36484	36480	4
$^4G_{5/2}$,	498	500	-2
$^4L_{15/2}$	-	505	
	522	533	-11
	-	553	
	-	558	
	-	574	
	-	579	
	590	588	2
	-	597	
	-	606	
	614	611	3
	-	624	
	633	627	6

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C
$^4L_{13/2}$,	-	36645	
$^4G_{5/2}$,	36653	660	-7
$^4L_{15/2}$	672	664	8
	686	692	-6
$^4G_{9/2}$	36752	36746	6
	780	781	-1
	-	803	
	-	833	
	-	846	
$^4G_{7/2}$	-	37649	
$^4P_{1/2}$	-	674	
$^4G_{7/2}$	-	682	

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Appendix VIII. (cont.)

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C
$^4G_{7/2}$	-	37775	
	-	789	
$^4F_{3/2}$	37933	37921	12
	962	952	10
$^2L_{15/2}$	-	38047	
	-	084	
	-	170	
	-	264	
	-	274	

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C
$^2L_{15/2}$	-	38366	
	-	451	
	-	502	
$^4P_{5/2}$	38926	38911	15
	997	989	8
	39085	39077	8
$^4P_{3/2}$	39159	39163	-4
	182	185	3
		(39185-50000)[e]	

[a]The leading component of the eigenvector is given.
[b]The components of the ground state are from Ref. 54. All values in cm^{-1} vac.
[c]Energy level parameters are given in Table 1.
[d]Ref. 54.
[e]At >39185 cm^{-1}, a large number of crystal-field components is computed over the energy range to 50000 cm^{-1}; however, there are five intervals of > 650 cm^{-1} in which no energy levels are computed. These are 39185-40531 (Δ = 1346) cm^{-1}, 43977-44798 (Δ = 821) cm^{-1}, 45073-46225 (Δ = 1152) cm^{-1}, 46471-47462 (Δ = 991) cm^{-1}, and 48618-49406 (Δ = 788) cm^{-1}.

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Appendix IX.

Experimental and Computed Energy Level Structure of $Tb^{3+}:LaF_3$

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O–C
$^7F_6$	0	-6	6
	6	0	-6
	-	13	
	-	20	
	44	26	18
	49	58	-9
	80	86	-6
	-	88	
	-	108	
	-	119	
	-	162	
	-	233	
	-	244	
$^7F_5$	-	2035	
	-	043	
	-	063	
	-	076	
	-	082	
	-	131	
	-	133	
	-	167	
	-	261	
	-	263	
	-	313	
$^7F_4$	-	3281	
	-	293	
	-	383	
	-	396	
	-	397	
	-	441	
	-	446	
	-	506	
	-	506	
	-	685	
$^7F_3$	4329	4331	-2
	413	407	6
	421	415	6
	429	425	4
	440	442	-2
	461	448	13
	487	473	14
$^7F_2$	5016	5041	-25
	038	045	-7
	-	161	
	166	164	2
	197	200	-3
$^7F_1$	5502	5522	-20
	568	586	-18
	617	632	-15

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Appendix IX. (cont.)

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O–C
$^7F_0$	5819	5806	13
$^5D_4$	-	20504	
	20507	506	1
	534	533	1
	534	534	0
	-	539	
	-	548	
	555	560	-5
	569	568	1
	580	588	-8
$^5D_3$	26270	26263	7
	274	266	8
	-	281	
	-	285	
	296	302	-6
	325	318	7
	346	344	2
$^5G_6$	26405	26410	-5
	415	423	-8
	454	462	-8
	482	494	-12
	493	503	-10
	-	536	
	532	537	-5
	549	556	-7
	-	564	
$^5G_6$	-	26578	
	-	609	
	26631	634	-3
	-	680	
$^5L_{10}$	-	26946	
	26962	949	13
	-	966	
	-	966	
	981	972	9
	994	981	13
	-	27012	
	27029	015	14
	048	041	7
	078	075	3
	142	152	-10
	161	154	7
	183	166	17
	-	201	
	225	215	10
	-	234	
	251	249	2
	-	274	
	-	278	
	-	286	
	322	306	16
$^5G_5$	-	27829	
	-	833	

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Appendix IX. (cont.)

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C
$^5G_5$	27833	27833	0
	839	837	2
	856	872	-16
	882	883	-1
	-	891	
	903	905	-2
	910	916	-6
	930	926	4
	989	972	17
$^5D_2$	28197	28215	-18
	206	222	-16
	-	240	
	233	241	-8
	262	260	2
$^5G_4$,	-	28316	
$^5L_9$	28336	344	-8
	-	345	
	-	350	
	348	351	-3
	364	367	-3
	-	375	
	378	376	2
	392	392	0
	428	411	17
	-	459	
	460	460	0
	-	479	

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C
$^5G_4$,	28480	28483	-3
$^5L_9$	491	496	-5
	514	510	4
	540	542	-2
	-	552	
	-	563	
	-	581	
	604	598	6
	618	614	4
	-	626	
	-	633	
	-	663	
	-	665	
	-	671	
	-	678	
$^5G_3$	29030	29019	11
	032	029	3
	037	038	-1
	045	039	6
	-	050	
	068	051	17
	090	087	3
$^5L_8$,	-	29183	
$^5L_7$,	29216	220	-4
$^5G_2$,	234	230	4
$^5L_6$	-	246	
	-	249	

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Appendix IX. (cont.)

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C
$^5L_8$,	29274	29279	-5
$^5L_7$,	-	284	
$^5G_2$,	-	291	
$^5L_6$	295	295	0
	336	329	7
	-	348	
	360	354	6
	-	370	
	392	399	-7
	-	406	
	-	412	
	-	413	
	430	426	4
	-	434	
	465	447	18
	-	481	
	503	502	1
	-	504	
	520	521	-1
	552	542	10
	-	565	
	-	572	
	-	592	
	(29598-30057)[d]		
$^5D_1$	30765	30755	10
	774	770	4
	800	788	12

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C
$^5D_0$	-	31391	
$^5H_7$	-	31399	
	31402	402	0
	-	403	
	-	452	
	-	459	
	494	496	-2
	-	506	
	509	506	3
	-	522	
	-	528	
	533	535	-2
	-	545	
	-	592	
	613	608	5
	637	628	9
$^5H_6$	32889	32894	-5
	918	929	-11
	941	942	-1
	982	992	-10
	-	998	
	999	999	0
	-	33025	
	33027	028	-1
	-	031	
	047	038	9
	-	102	

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Appendix IX. (cont.)

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O–C
$^5H_5$	33114	33104	10
	146	119	27
	–	817	
	–	838	
	–	850	
	–	878	
	–	882	
	887	885	2
	909	919	-10
	–	923	
	–	924	
	–	927	
	939	937	2
$^5H_4$	–	34435	
	–	442	
	–	452	
	34452	455	-3
	–	461	
	–	462	
	–	482	
	–	485	
	488	489	-1
$^5F_5$, $^5H_3$, $^5I_8$	–	34958	
	–	960	
	–	986	
	34980	987	-7
	35005	990	15

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O–C
$^5F_5$, $^5H_3$, $^5I_8$	35021	35030	-9
	044	053	-9
	–	060	
	072	062	10
	–	068	
	–	085	
	–	090	
	–	094	
	–	102	
	–	117	
	139	137	2
	167	168	-1
	–	176	
	179	178	1
	–	183	
	203	214	-11
	211	228	-17
	–	229	
	237	235	2
	–	243	
	–	246	
	256	250	6
	274	261	13
	–	309	
	–	313	
	–	315	
	316	316	0
	–	323	
	–	327	
	348	330	18

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Appendix IX. (cont.)

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C
$^5F_4$	35479	35474	5
	-	505	
	-	510	
	-	510	
	-	523	
	-	533	
	555	546	9
	-	581	
	588	588	0
$^5F_3$,	-	36587	
$^5I_7$	-	588	
	36619	599	20
	-	635	
	-	663	
	-	670	
	679	682	-3
	-	723	
	-	729	
	731	735	-4
	731	736	-5
	348	330	18

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O-C
$^5F_3$,	-	36737	
$^5I_7$	-	739	
	36741	748	-7
	-	750	
	-	764	
	-	766	
	-	766	
	773	774	-1
	-	783	
	786	787	-1
	-	796	
$^5F_2$	-	37226	
	-	230	
	-	256	
	-	278	
	-	280	
$^5F_1$	-	37527	
	-	555	
	-	579	

(37652-38193)[e]

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Appendix IX. (cont.)

SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O–C	SLJ[a] State	Obsd.[b] (cm^{-1})	Calc.[c] (cm^{-1})	O–C
$^5K_9$, $^5D_2$	39210	39221	-11		-	410	
	-	224			-	450	
	-	226	11		-	454	
	-	233			-	475	
	-	246			-	480	
	-	269			-	489	
	265	280	-15		-	502	
	-	303			-	503	
	-	305			-	513	
	356	374	-18		-	521	
	-	378			-	521	
	383	399	-16				
	-	405				(39522-50000)[f]	

[a]The leading component of the eigenvector is given.

[b]Units of cm^{-1} vac.

[c]The energy level parameters are given in Table 1.

[d]There are 22 levels belonging principally to the $^5L_7$, $^5D_2$, and $^5L_6$ states in the interval 29598-30059 cm^{-1}.

[e]There are 33 levels belonging principally to the $^5I_6$, $^5I_4$, and $^5I_5$ states in the interval 37657-38193 cm^{-1}. No structure was observed.

[f]At >39521 cm^{-1} the density of computed levels is high. Energy gaps in the range 39522-50000 cm^{-1}, i.e., regions of >650 cm^{-1} where no crystal-field components are computed, are as follows: 39522-40253 (Δ=731) cm^{-1}, 43645-44415 (Δ=770) cm^{-1}, 44568-45281 (Δ=713) cm^{-1}, and 48392-49112 (Δ=720) cm^{-1}.

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Appendix X.

Experimental and Computed Energy Level Structure for $Gd^{3+}:LaF_3$

SLJ State	Expt.[a] (cm^{-1})	Calc.[b] (cm^{-1})	O–C	SLJ State	Expt.[a] (cm^{-1})	Calc.[b] (cm^{-1})	O–C
$^8S_{7/2}$	0	19.6	-20	$^6I_{17/2}$	36340	36351	-11
		19.7			342	351	-9
		19.8			346	352	-6
		19.9			351	354	-3
					354	355	-1
$^6P_{7/2}$	32176	32169	7		363	357	6
	185	177	8		370	360	10
	199	194	5		377	362	15
	226	224	2		384	364	20
$^6P_{5/2}$	32771	32774	-3	$^6I_{11/2}$	36549	36554	-5
	791	780	11		561	563	-2
	808	802	6		571	572	-1
					584	585	-1
$^6P_{3/2}$	33352	33368	-16		592	590	2
	370	386	-16		611	606	5
$^6I_{7/2}$	35923	35934	-11	$^6I_{15/2}$,	36659	36671	-12
	945	945	0	$^6I_{13/2}$	668	680	-12
	968	964	4		677	683	-6
	996	979	17		687	696	-9
					698	699	-1
$^6I_{9/2}$	36274	36277	-3		701	707	-6
	285	286	-1		710	713	-3
	305	303	2		712	714	-2
	313	311	2		717	715	2
	332	323	9		722	724	-2

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Appendix X. (cont.)

SLJ State	Expt.[a] (cm^{-1})	Calc.[b] (cm^{-1})	O-C
$^6I_{15/2}$, $^6I_{13/2}$	36731	36725	6
	736	729	7
	749	747	2
	760	753	7
	769	760	9
$^6D_{9/2}$	39667	39647	20
	686	681	5
	719	709	10
	742	731	11
	758	747	11
$^6D_{1/2}$	-	40620	
$^6D_{7/2}$	40734	40734	0
	740	737	3
	744	741	3
	751	753	-2
$^6D_{3/2}$	-	40876	
	-	905	
$^6D_{5/2}$	-	41003	
	-	045	
	-	059	
$^6G_{7/2}$	49170	49160	10
	49221	49225	-4

SLJ State	Expt.[a] (cm^{-1})	Calc.[b] (cm^{-1})	O-C
$^6G_{7/2}$	240	243	3
	298	284	14
$^6G_{11/2}$, $^6G_{9/2}$, $^6G_{5/2}$	49533	49545	-12
	560	556	4
	604	623	-19
	638	654	-16
	651	661	-10
	680	688	-8
	-	696	
	-	711	
	-	731	
	740	741	-1
	-	757	
	-	810	
	824	823	1
	-	860	
$^6G_{3/2}$	-	50486	
	-	568	
$^6G_{13/2}$	-	51310	
	-	357	
	-	382	
	-	402	
	-	414	
	-	436	
	-	483	

[a]Experimental results from Refs. 68 and 69, cm^{-1} vac.
[b]The parameter values used in this calculation are given in Table 1.