Supporting Information

Dinuclear Zinc Synergistic Catalytic Asymmetric Phospha-Michael/Michael Cascade Reaction: Synthesis of 1,2,3-Trisubstituted Indanes Bearing Phosphoryl Group

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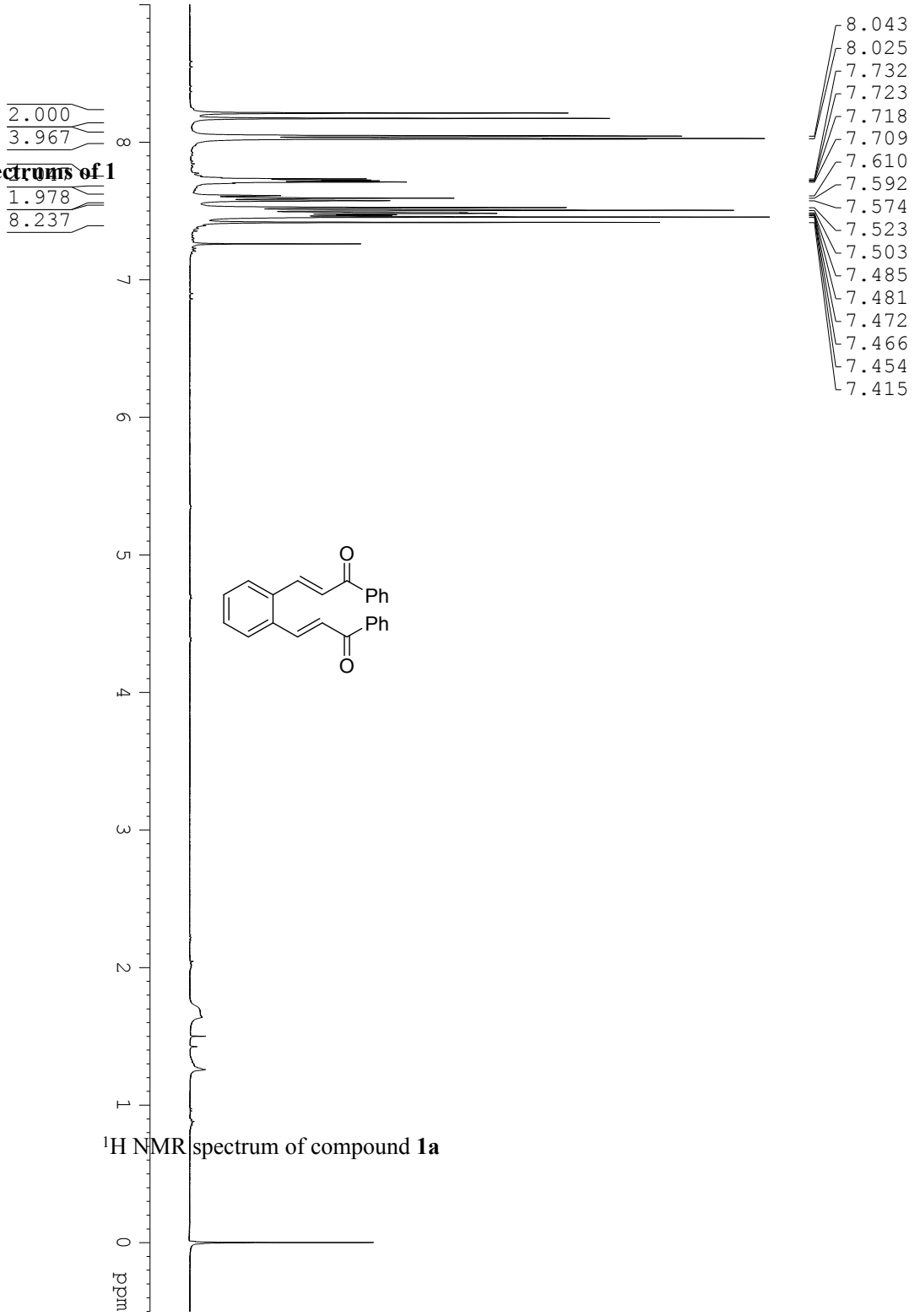
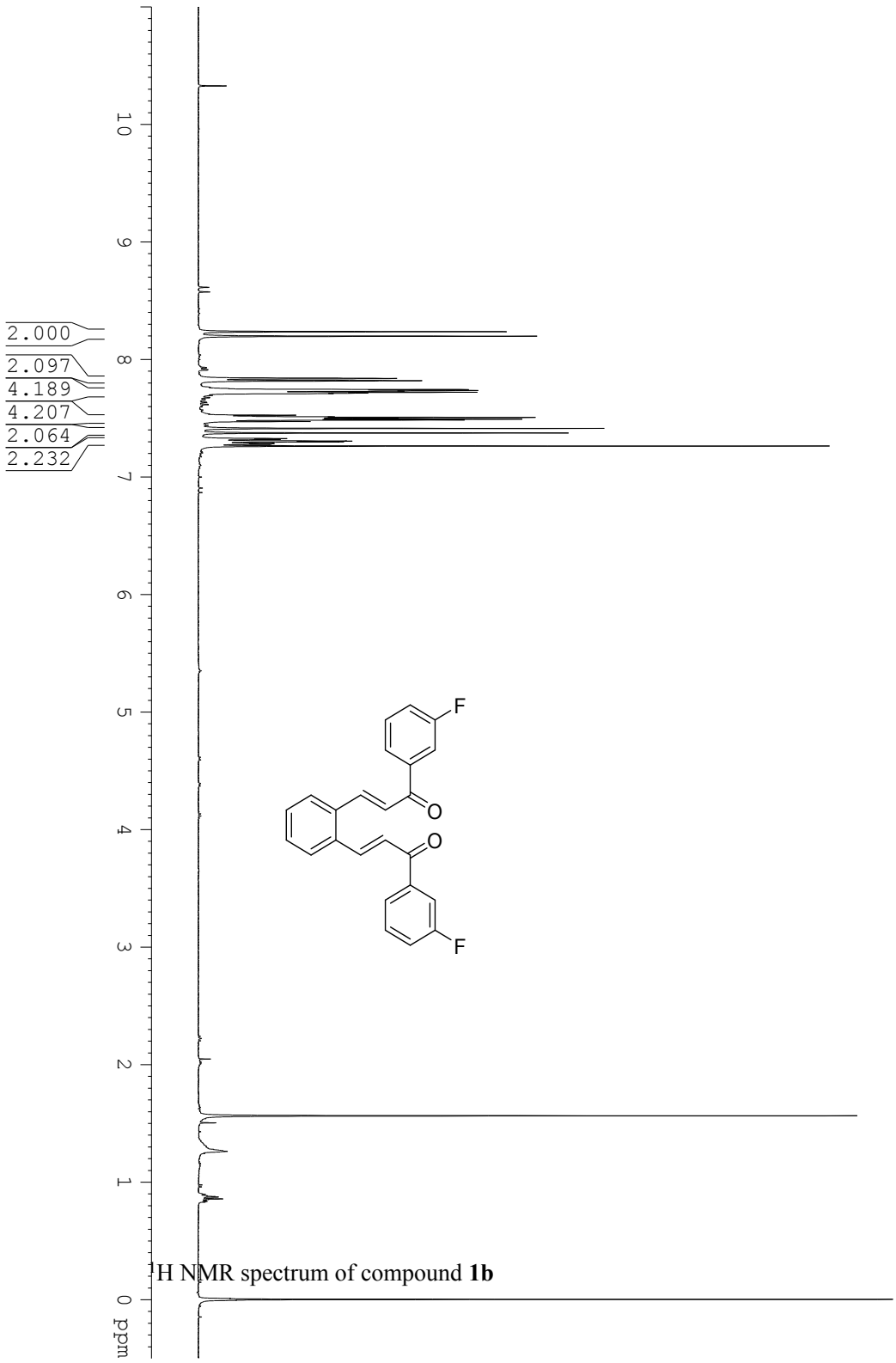


^{1}H NMR spectrum of compound **1a**



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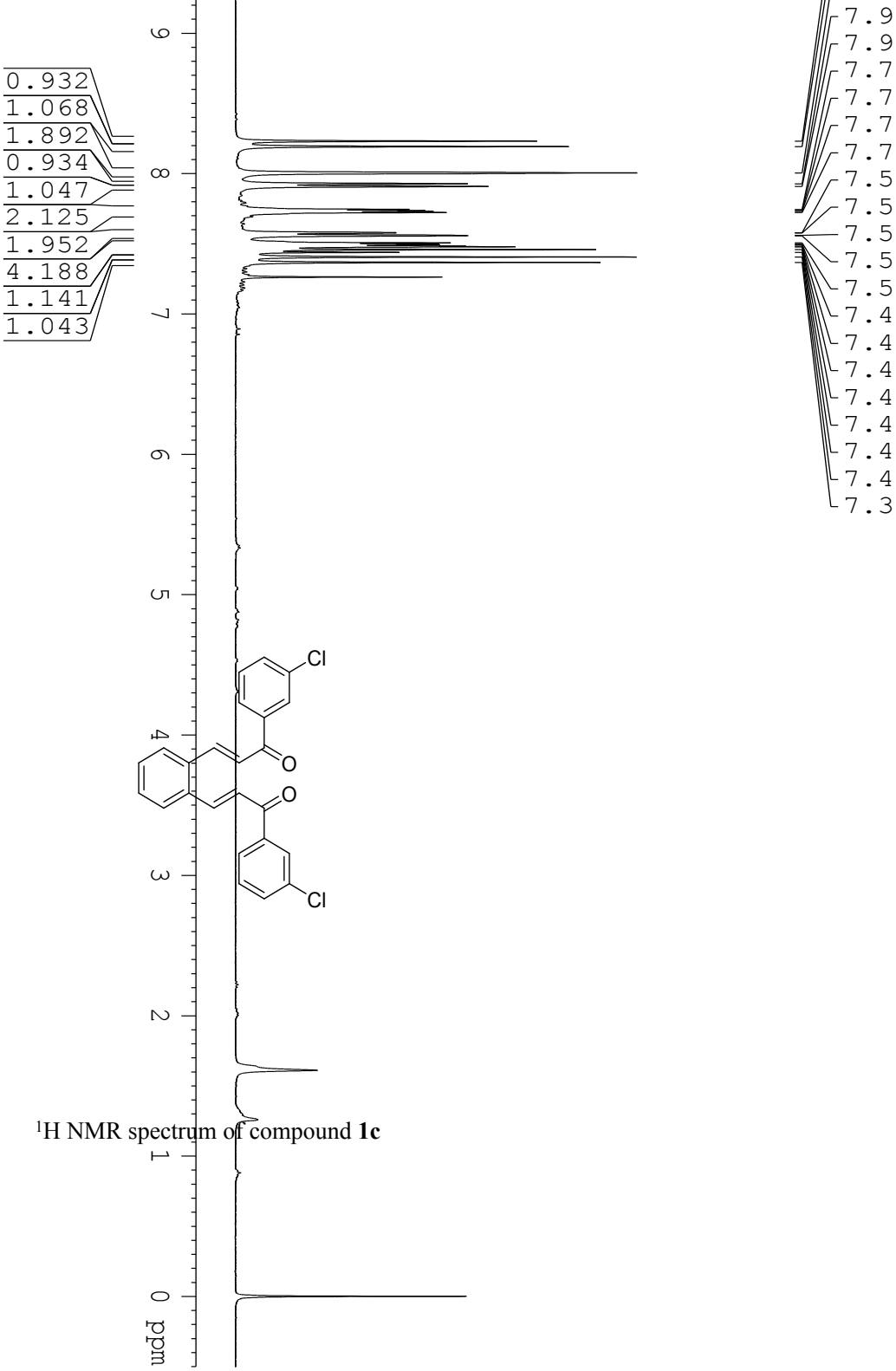

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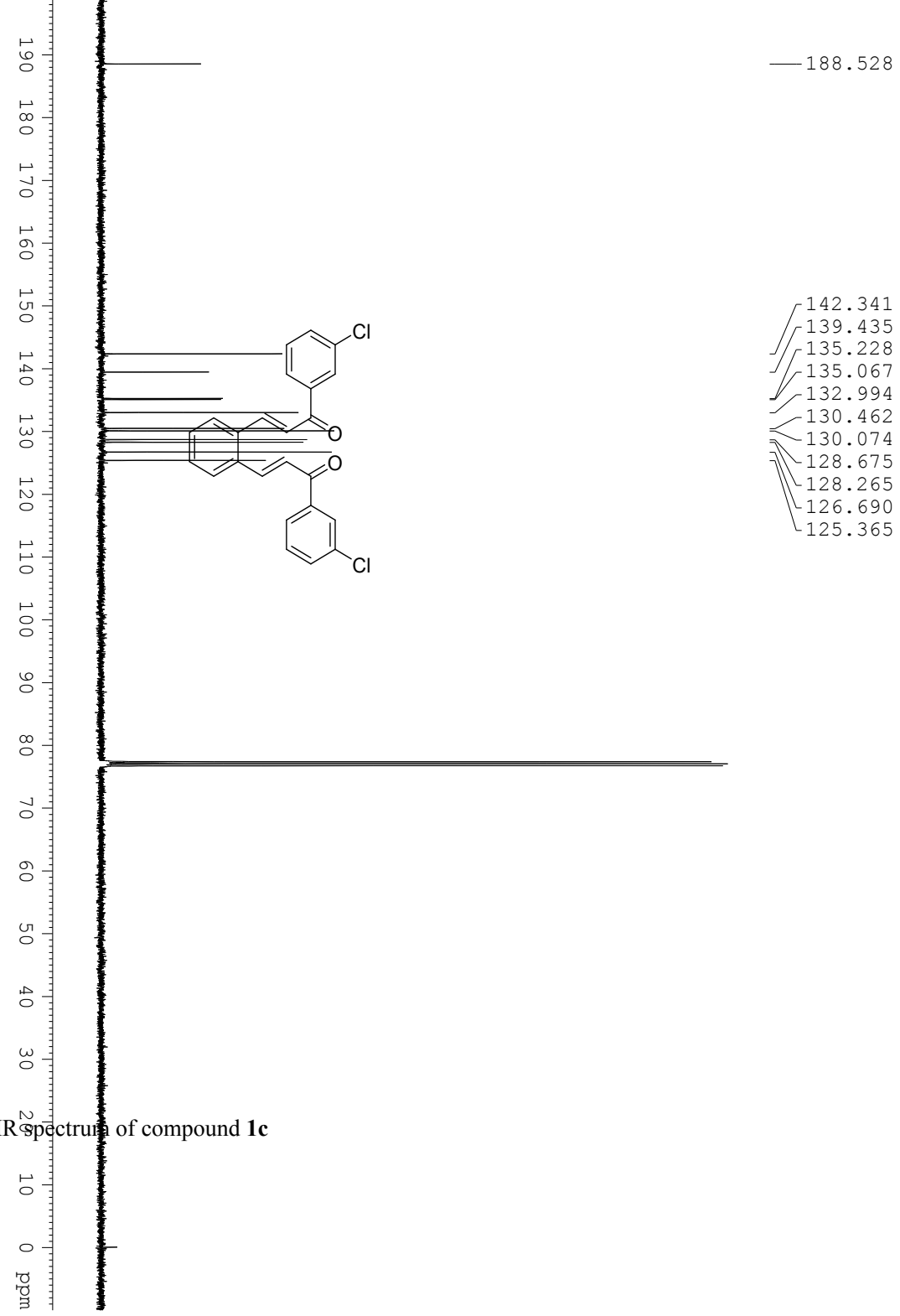

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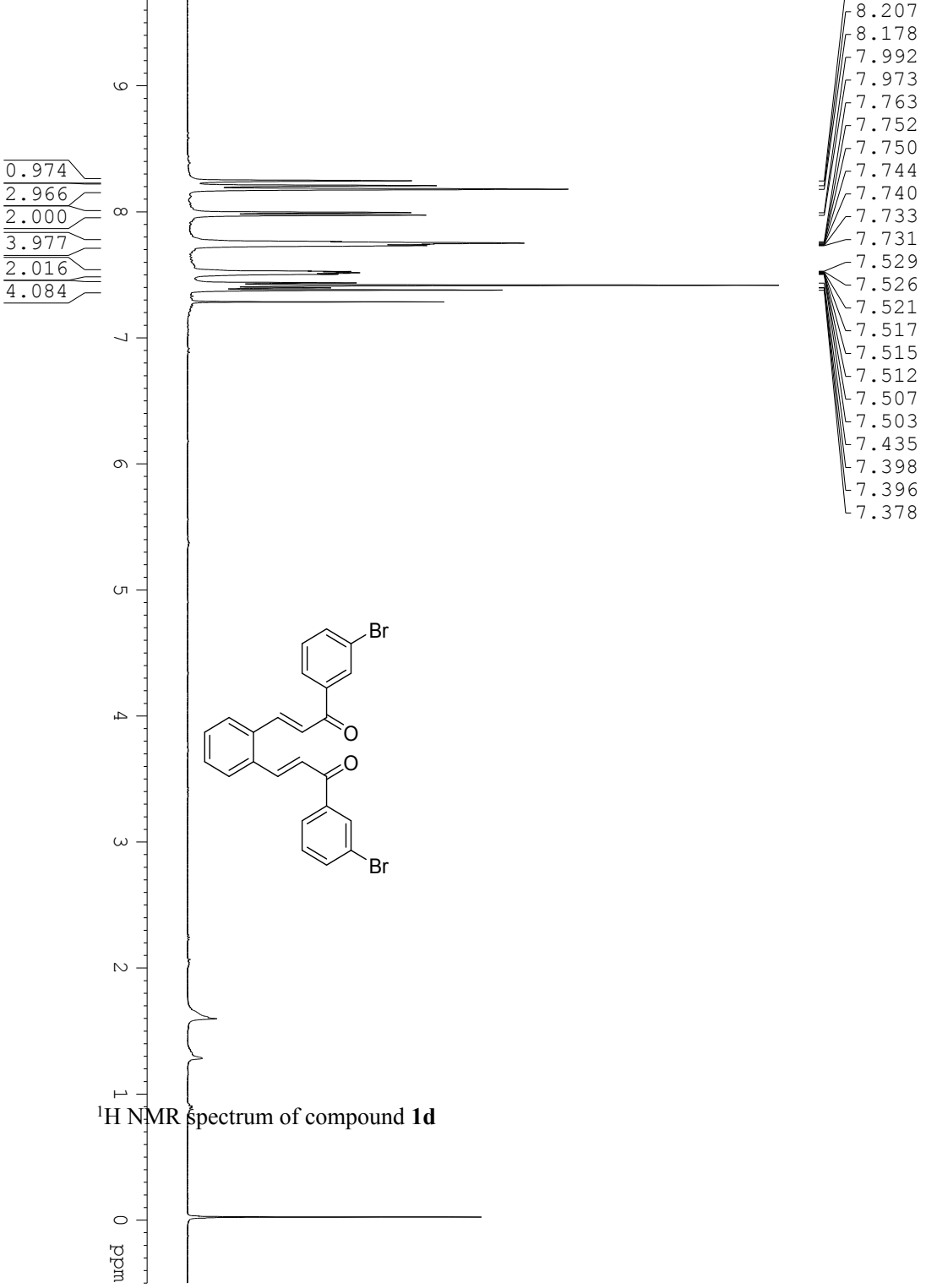

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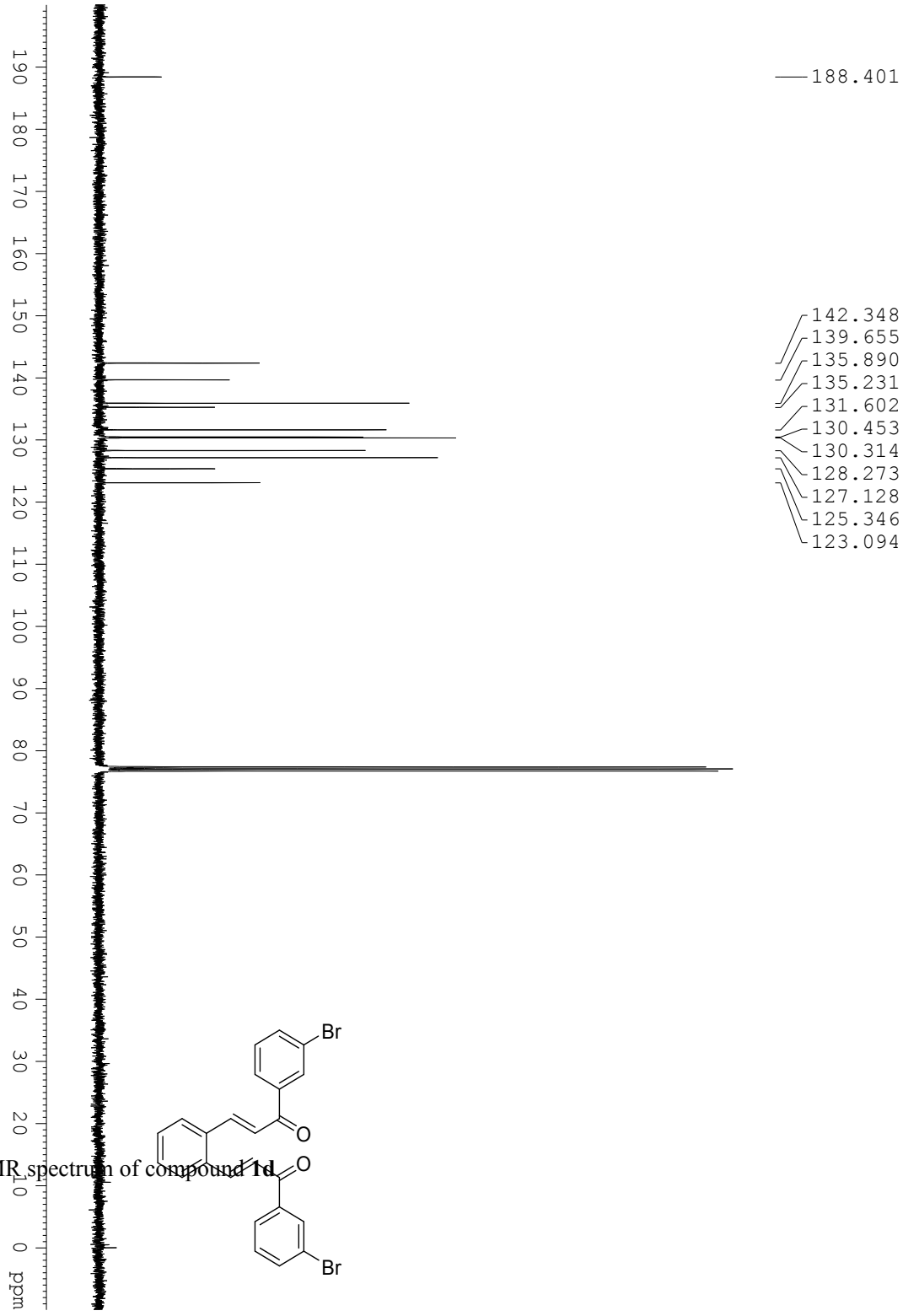

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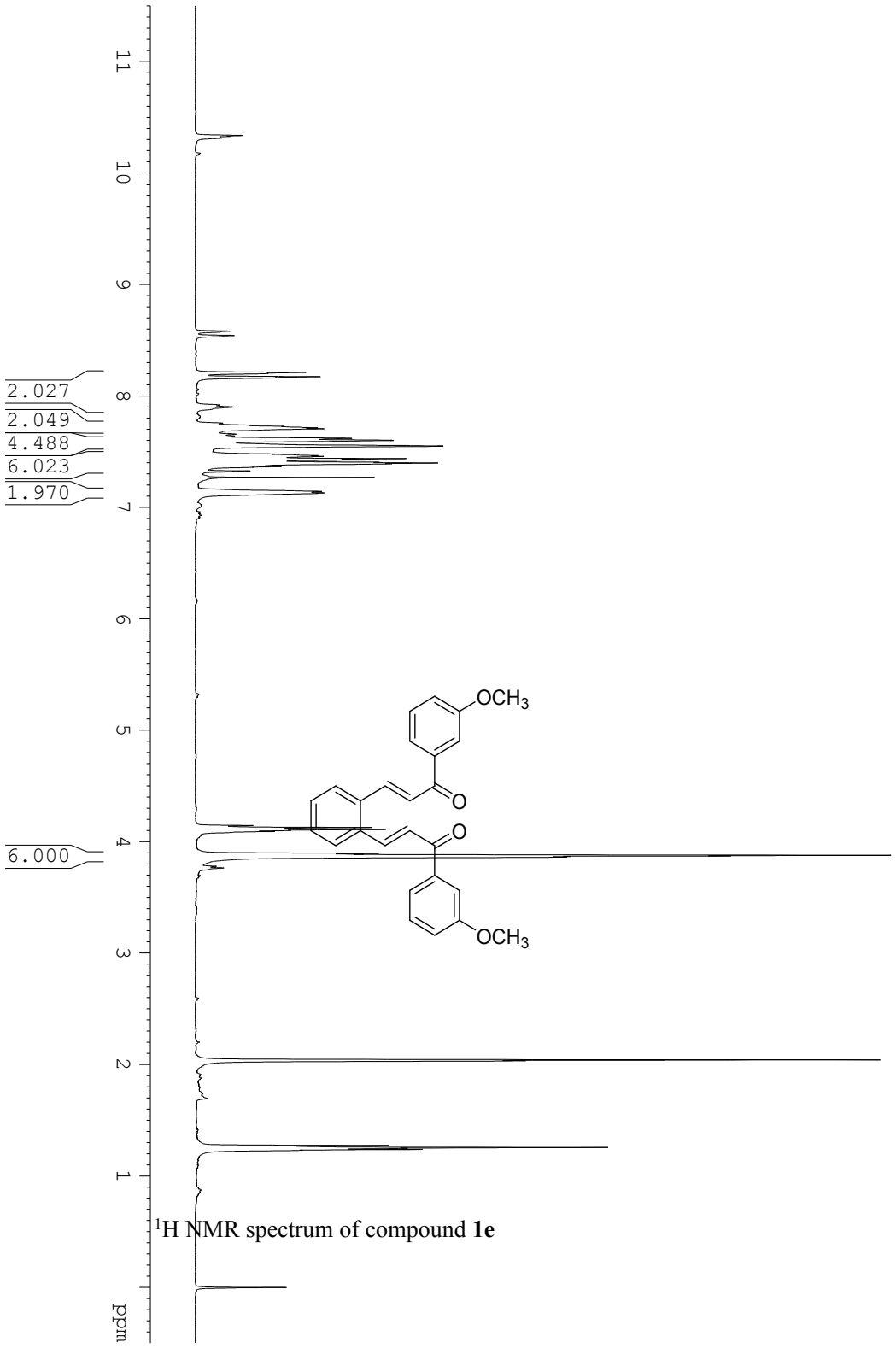

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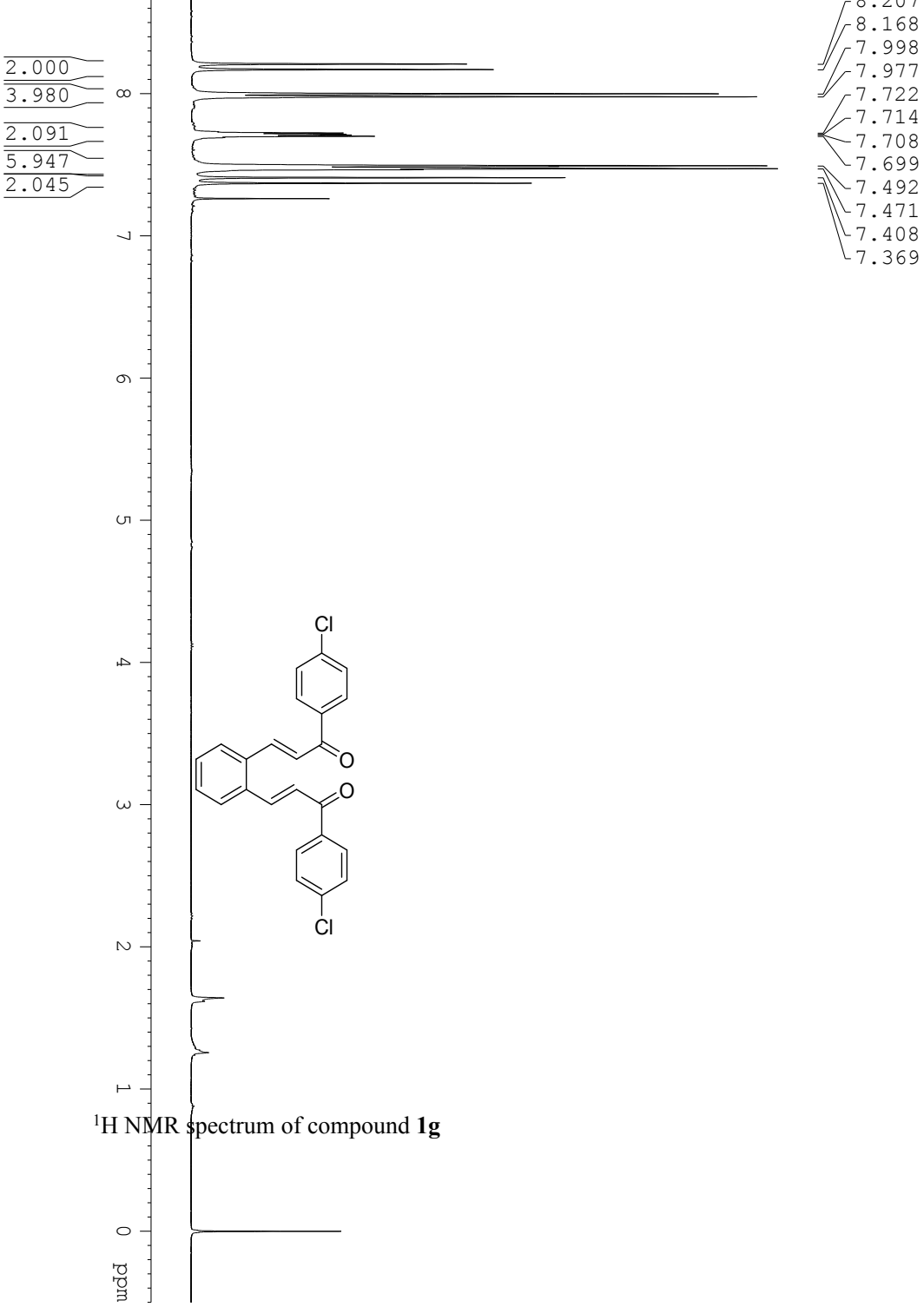

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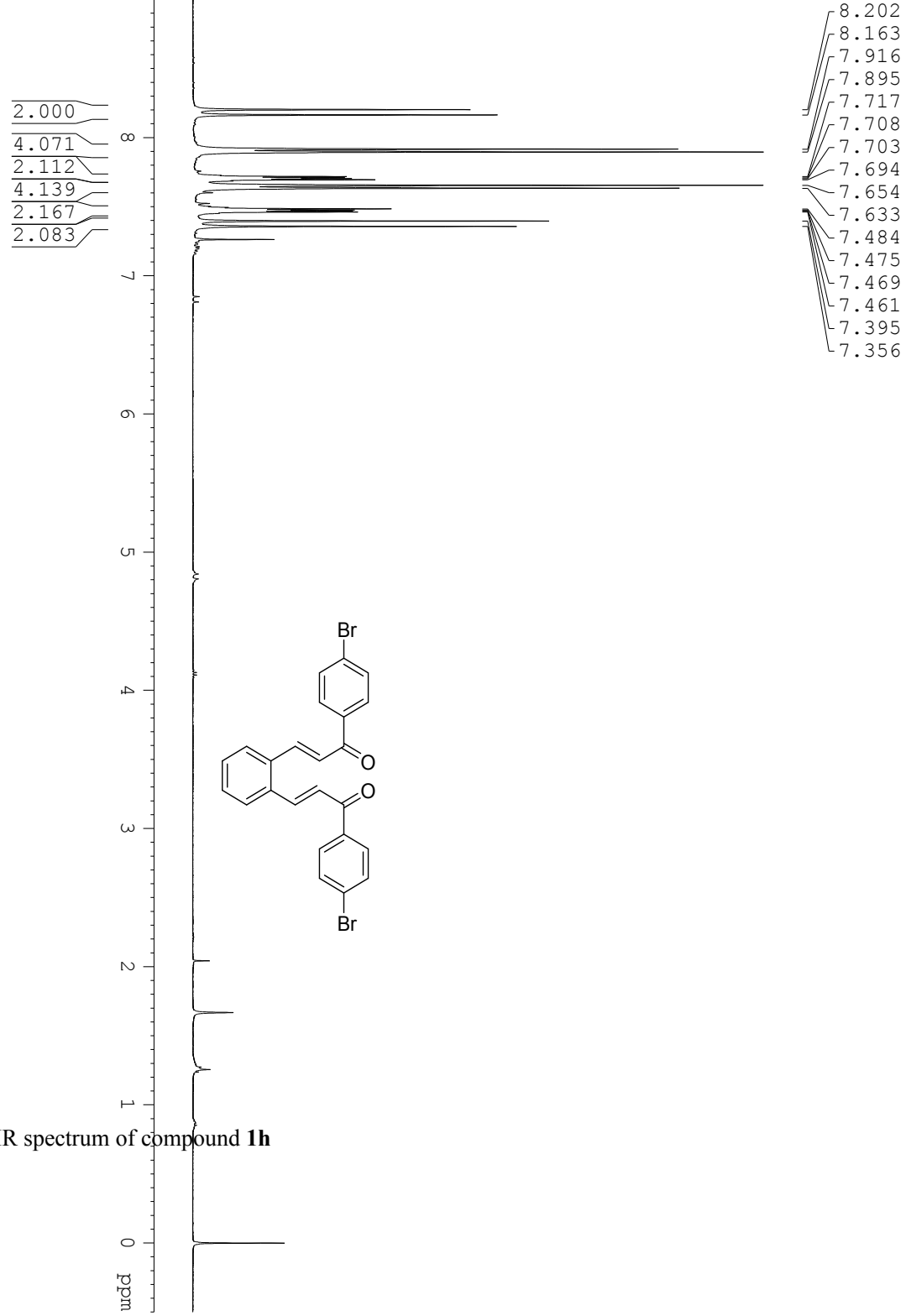

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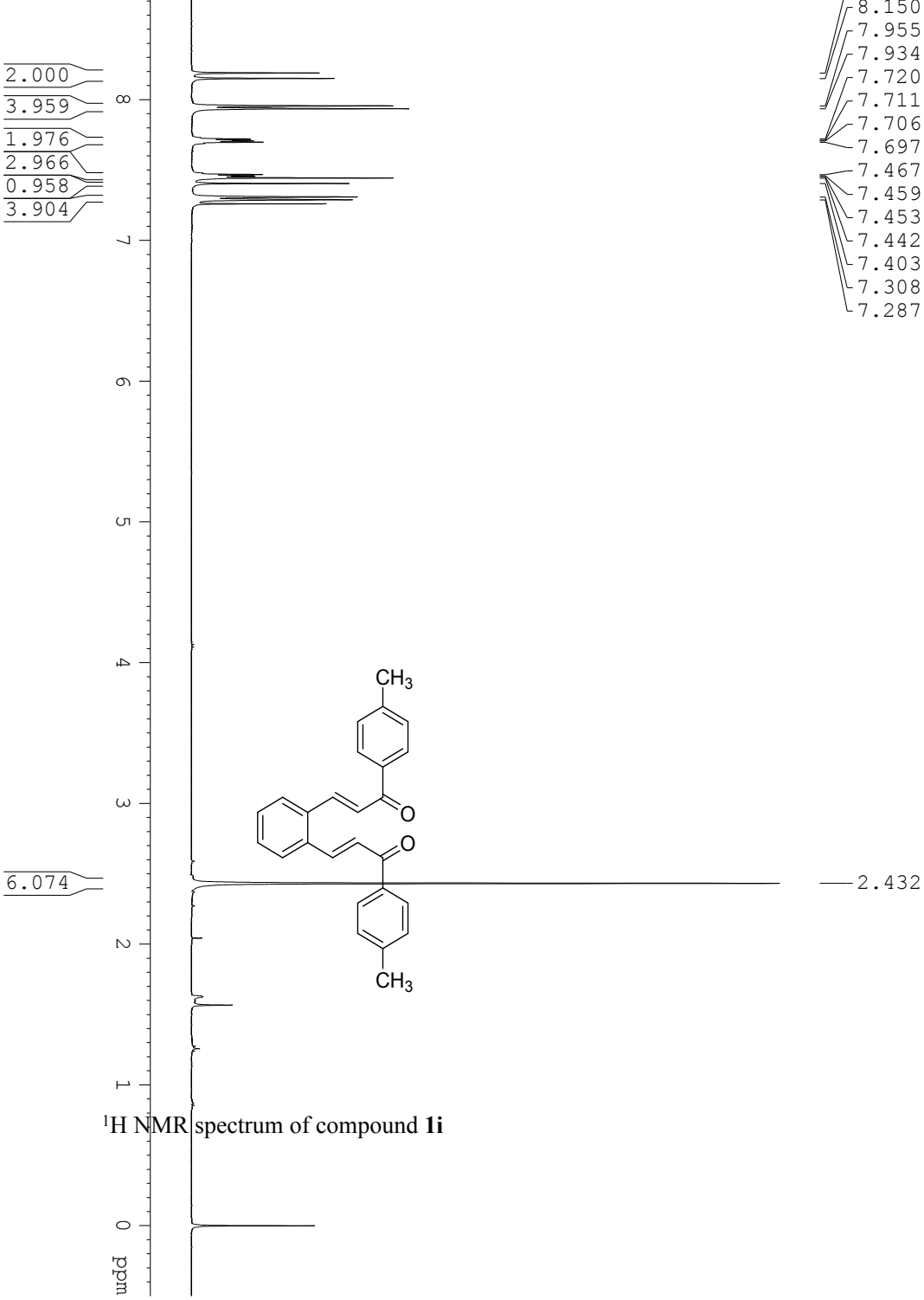

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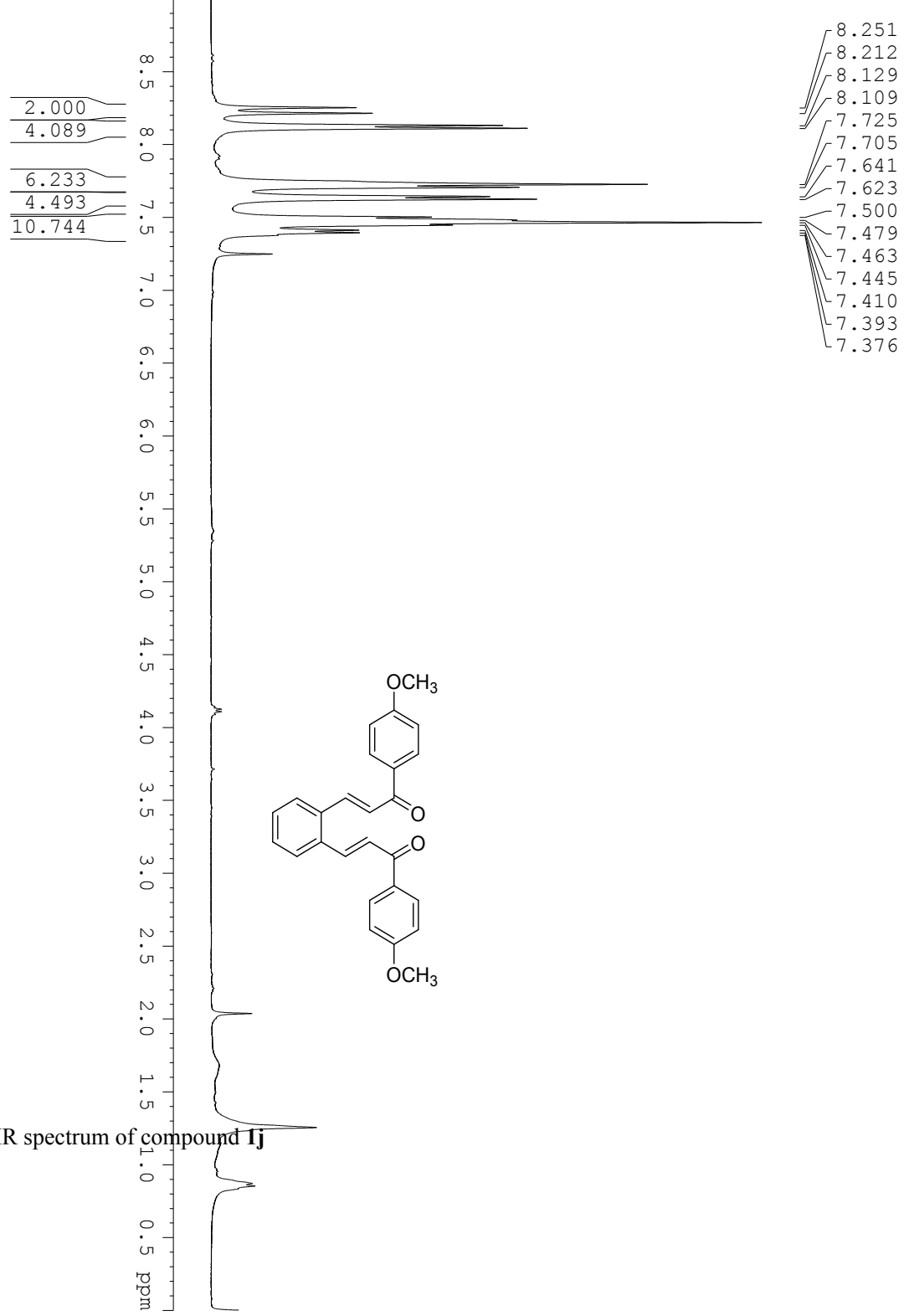

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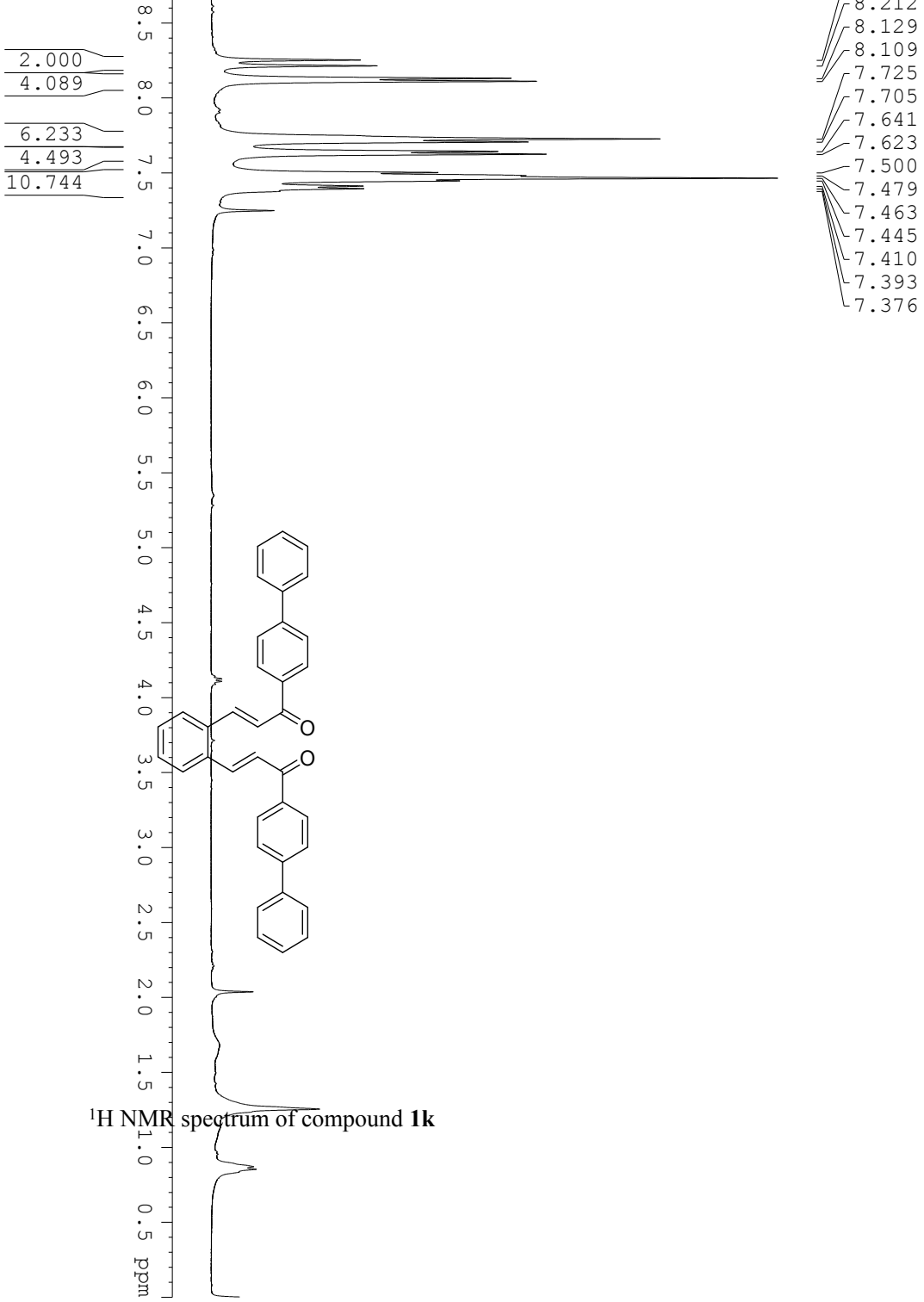

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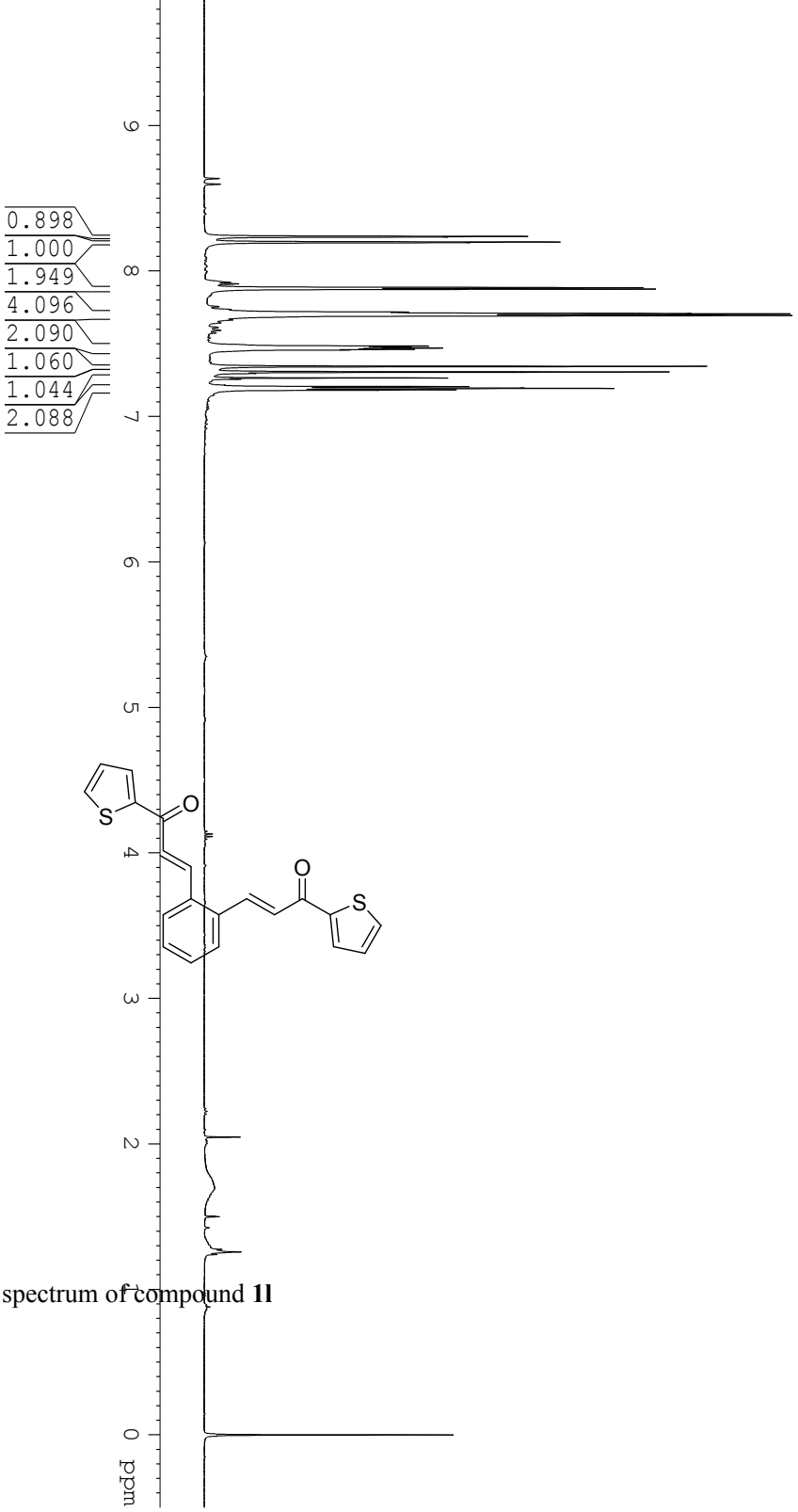

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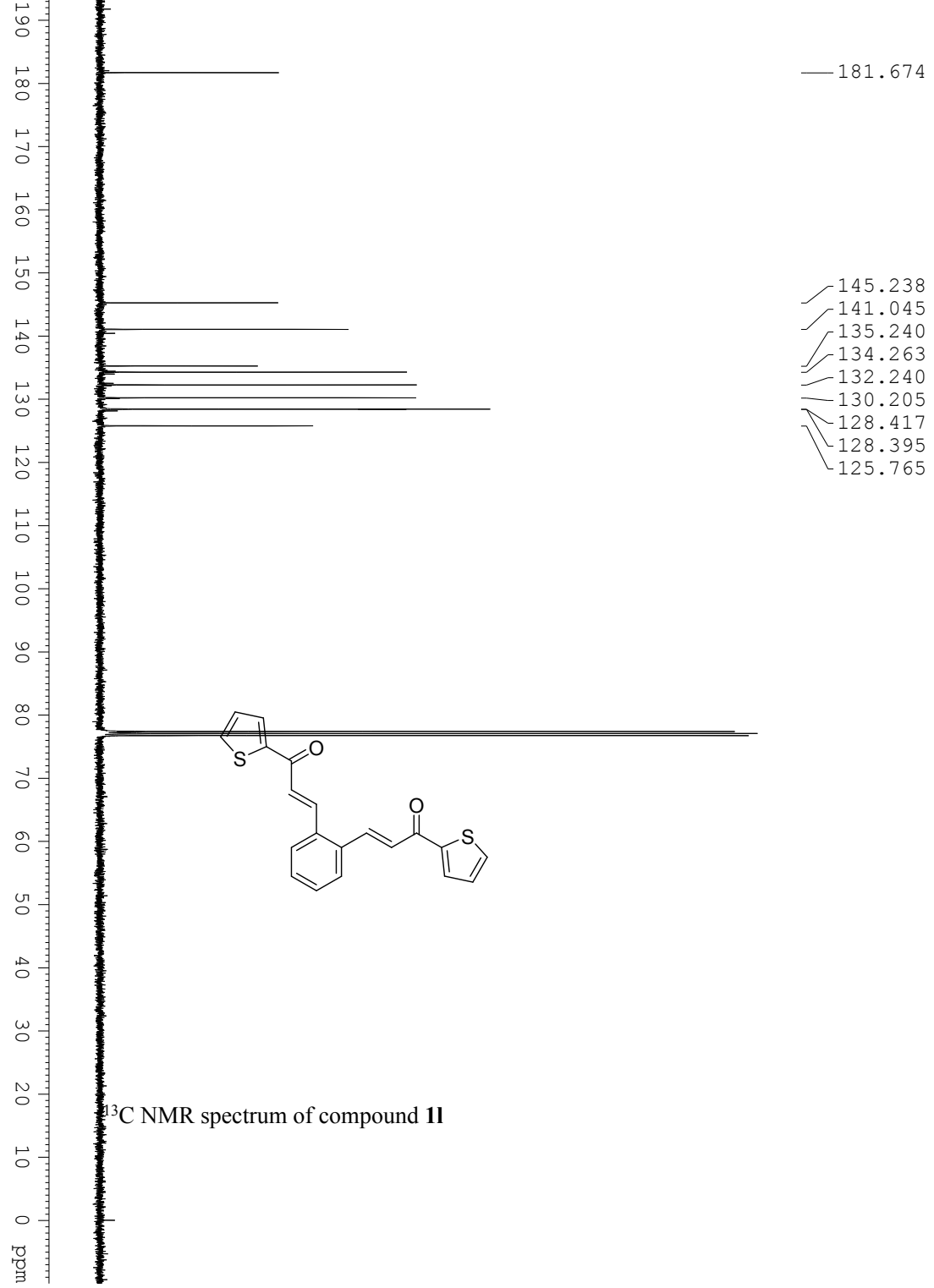

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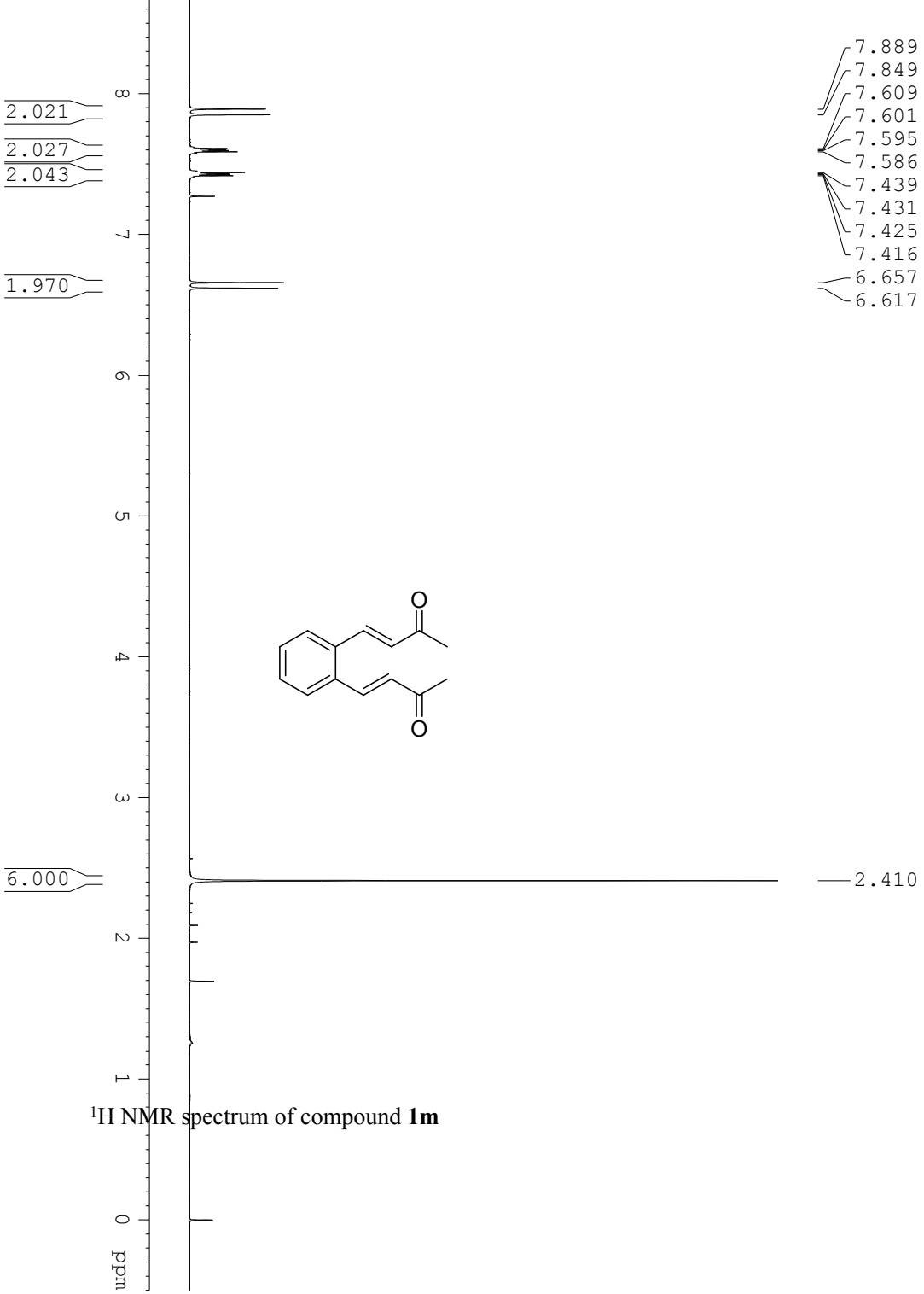

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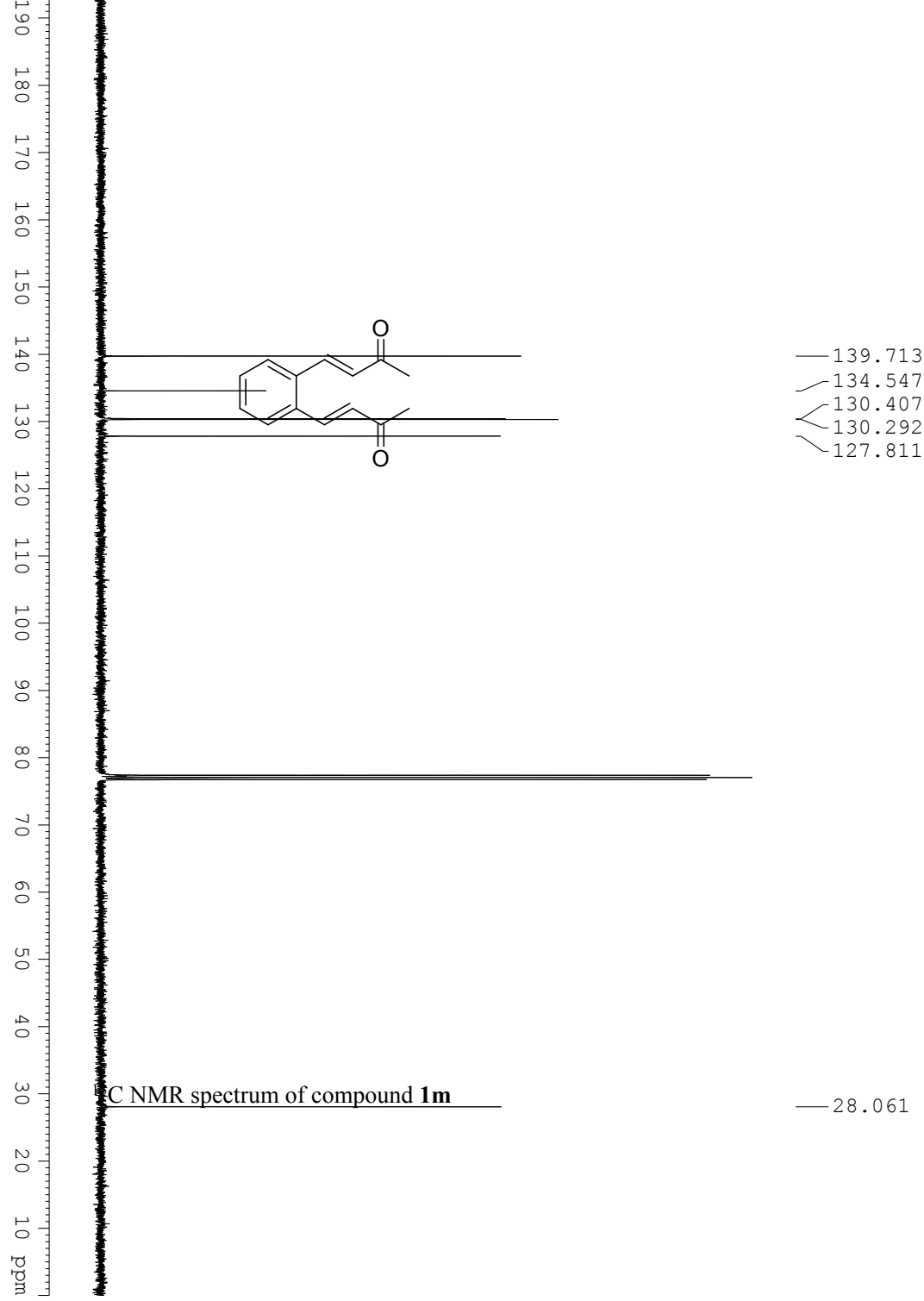
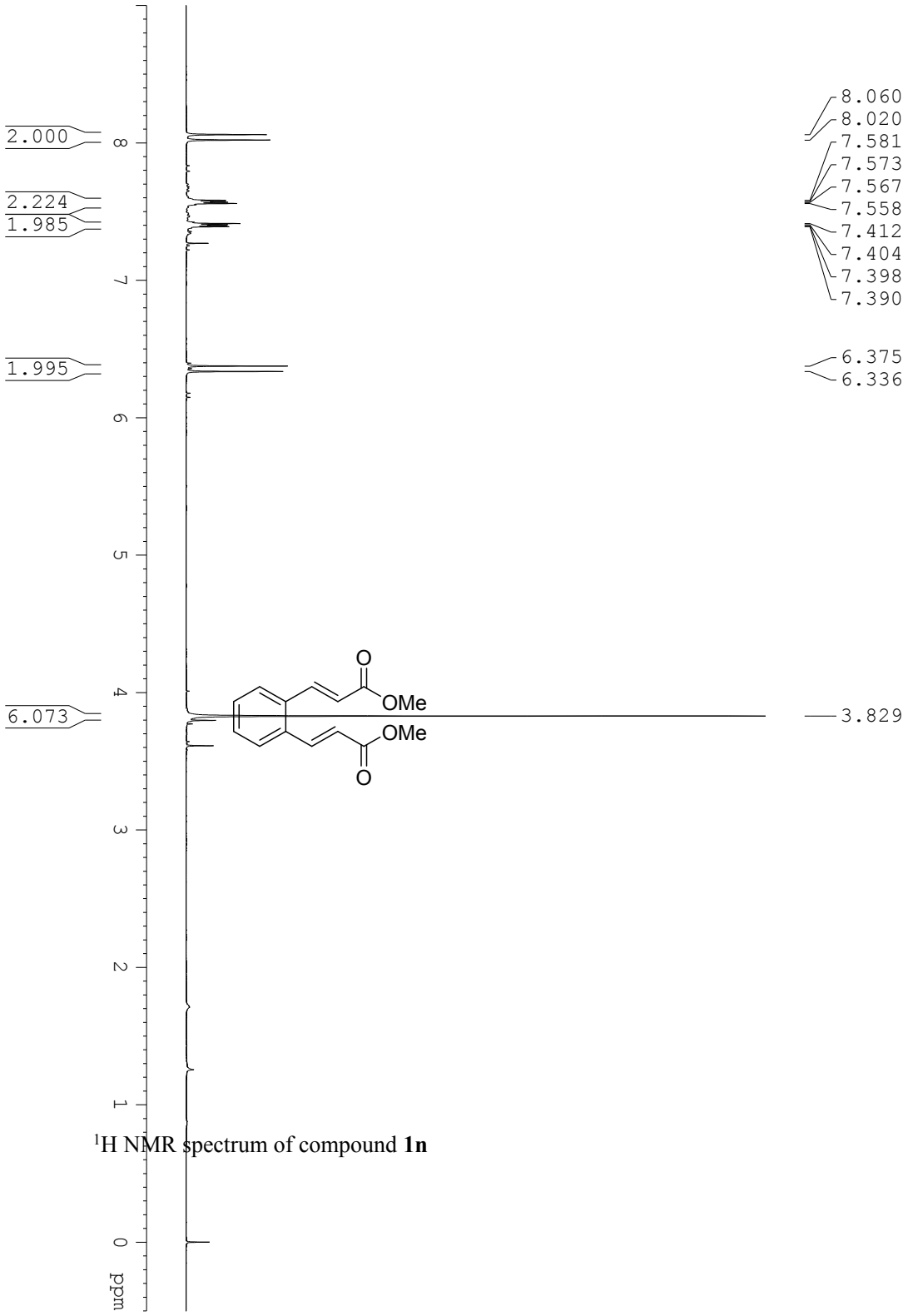


^{13}C NMR spectrum of compound **1m**



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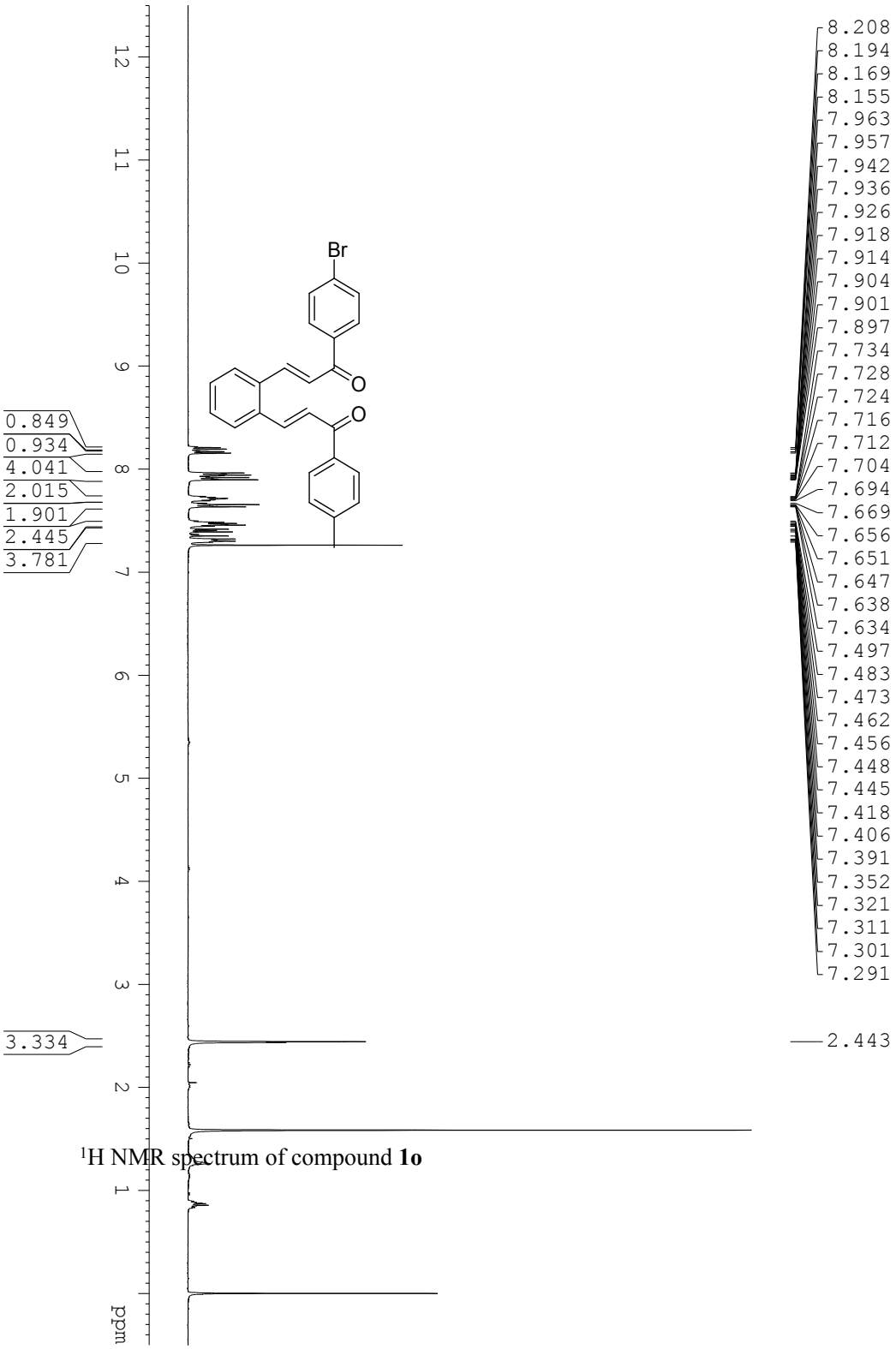
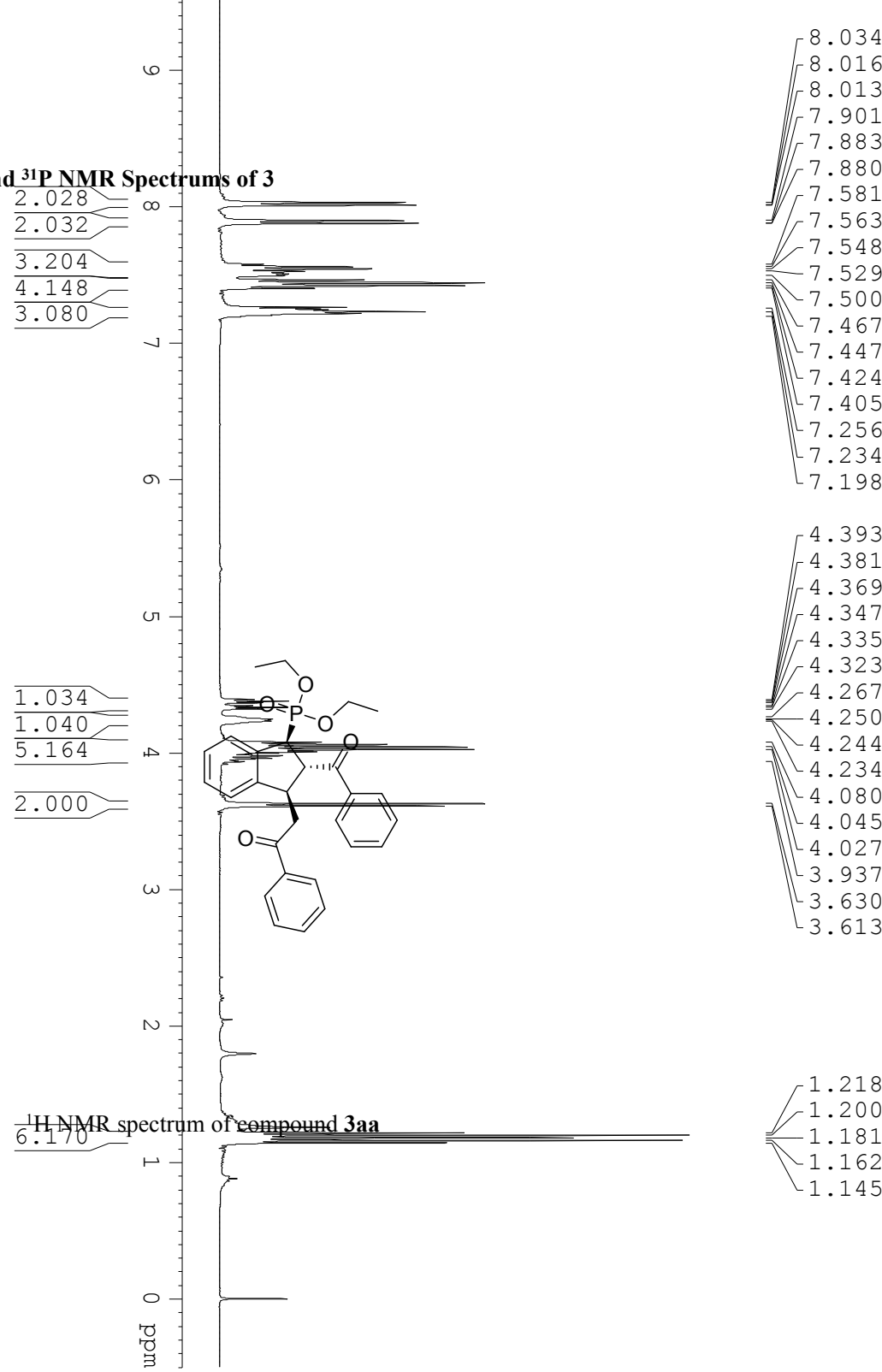


^{1}H NMR spectrum of compound **1o**

Copies of ^{1}H NMR, ^{13}C, and ^{31}P NMR Spectrums of 3



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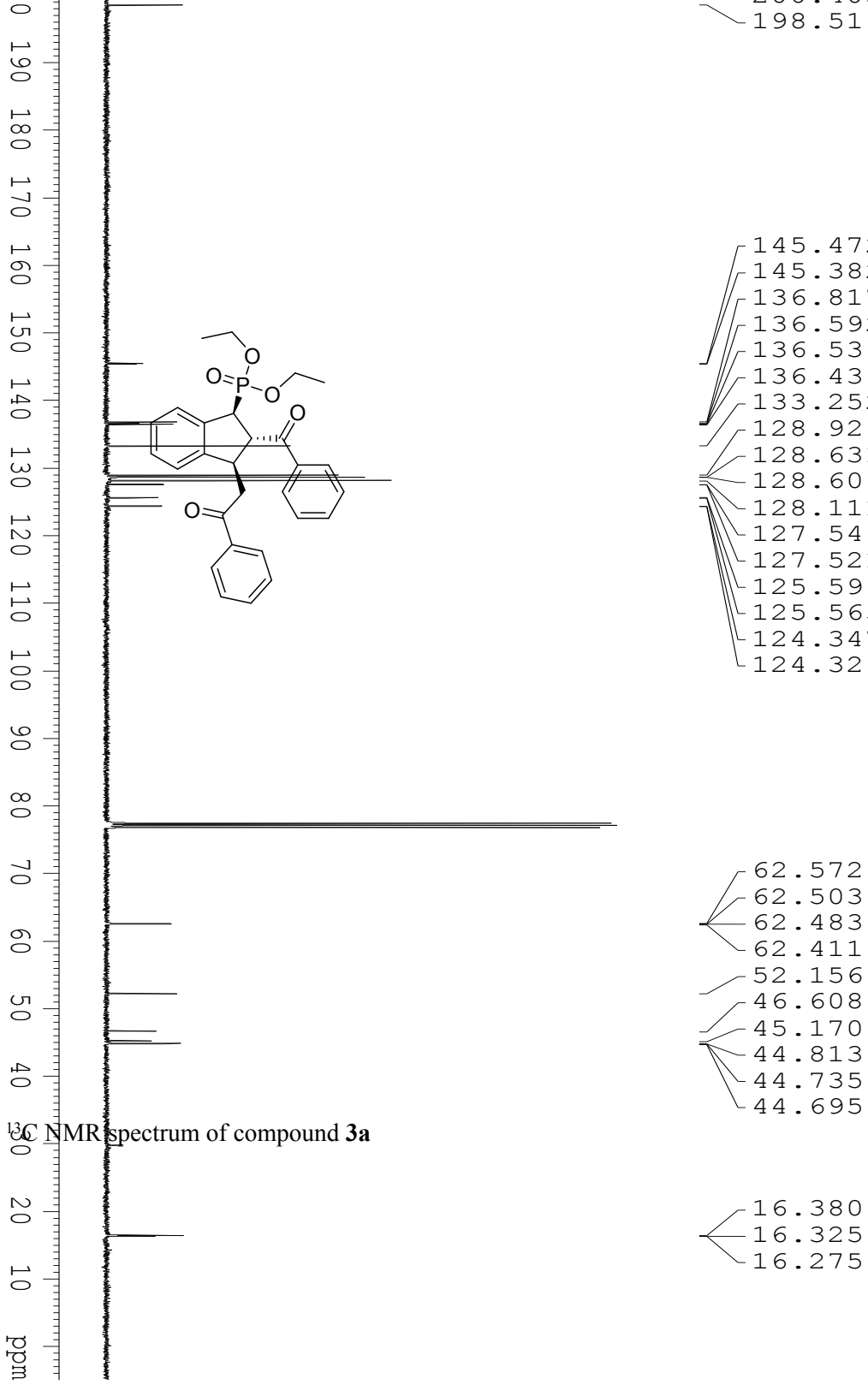

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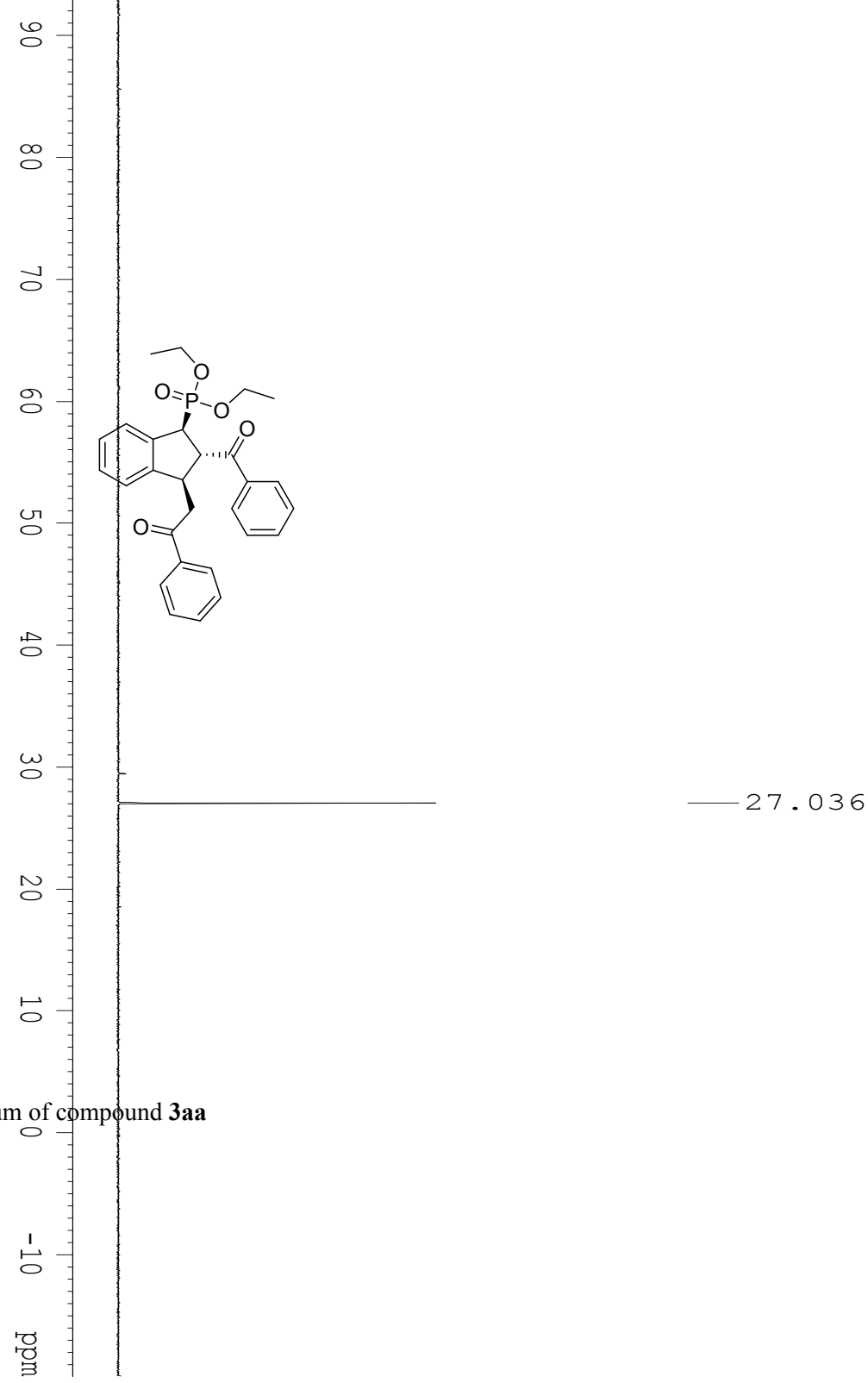

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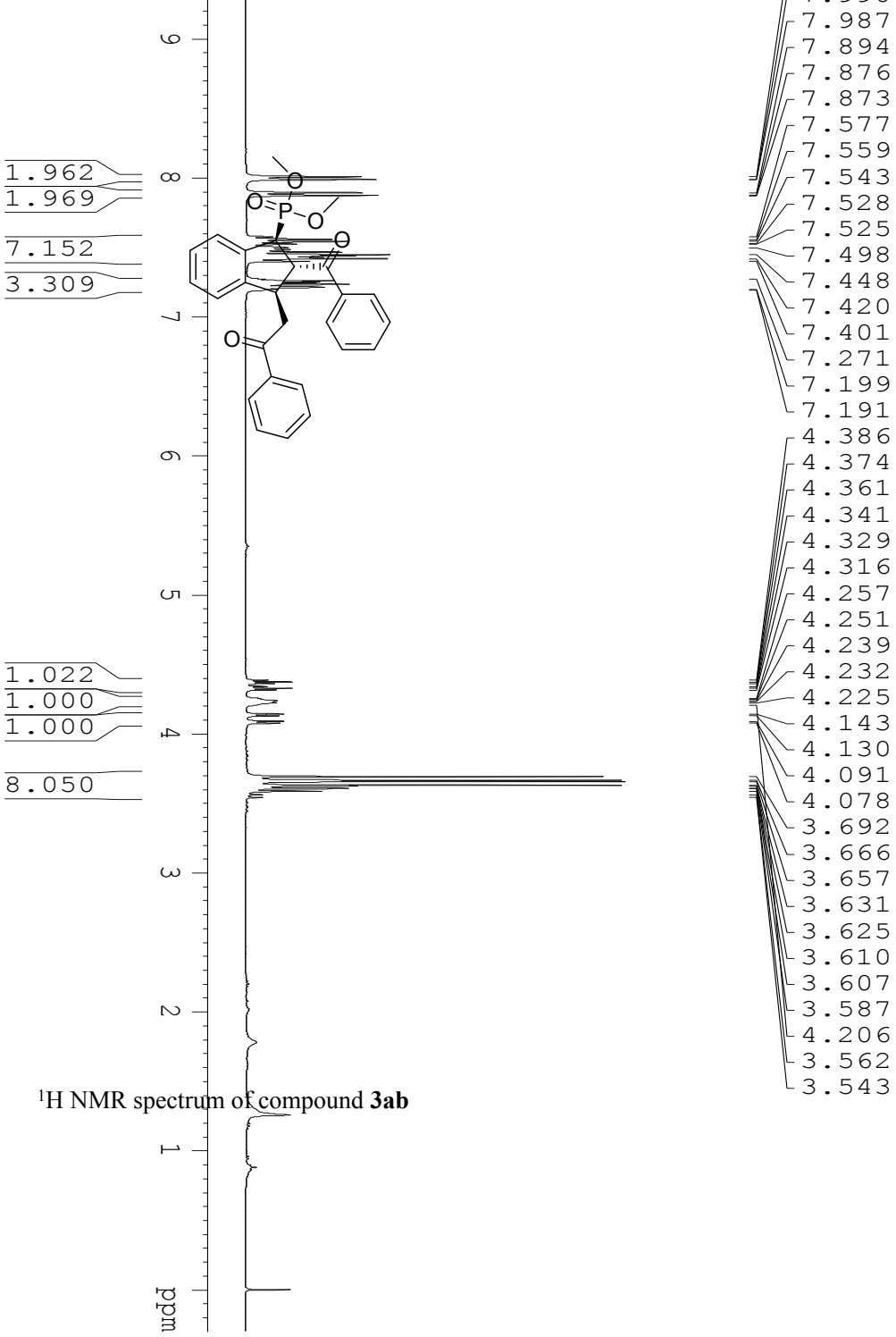

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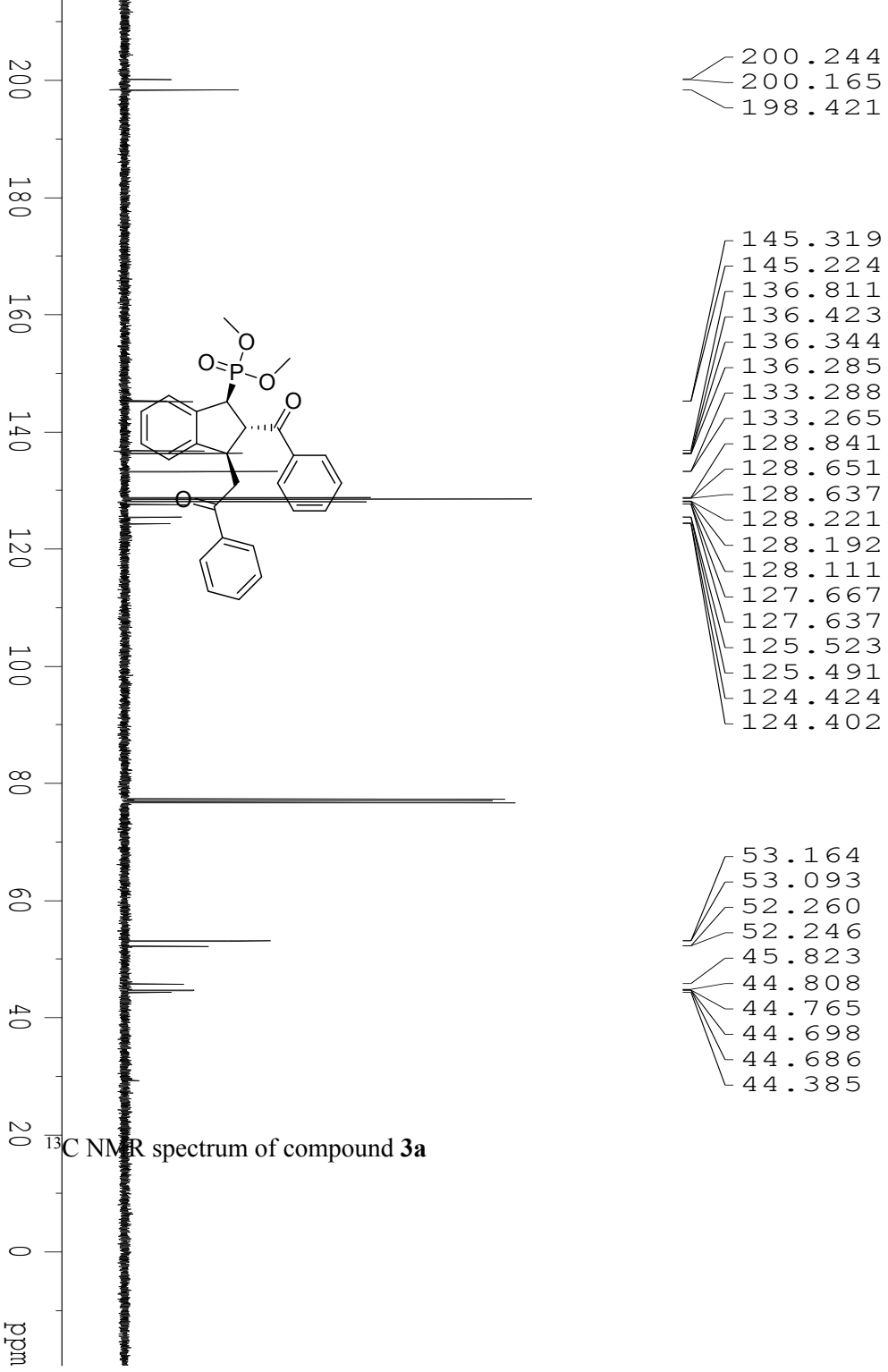

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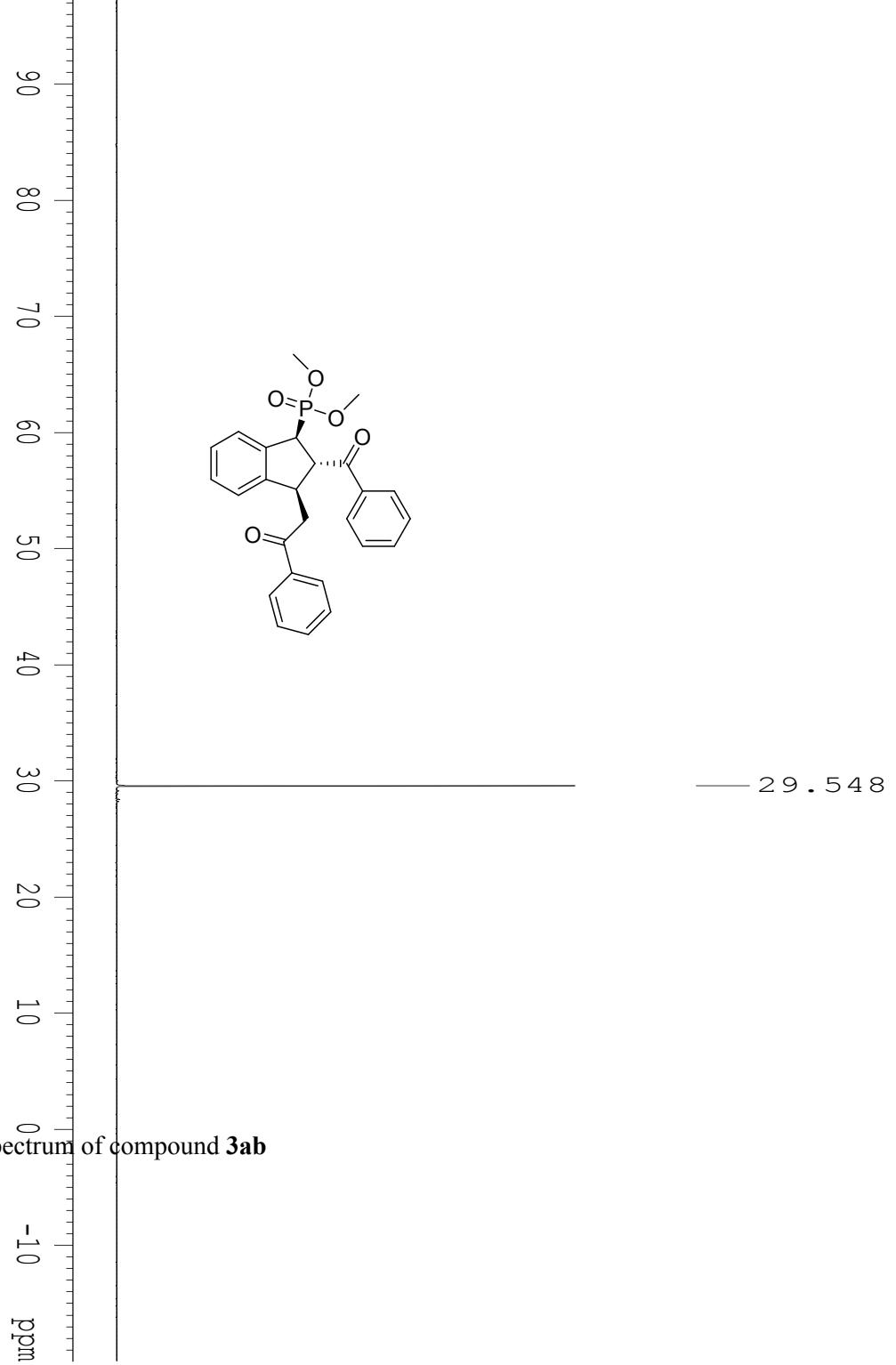

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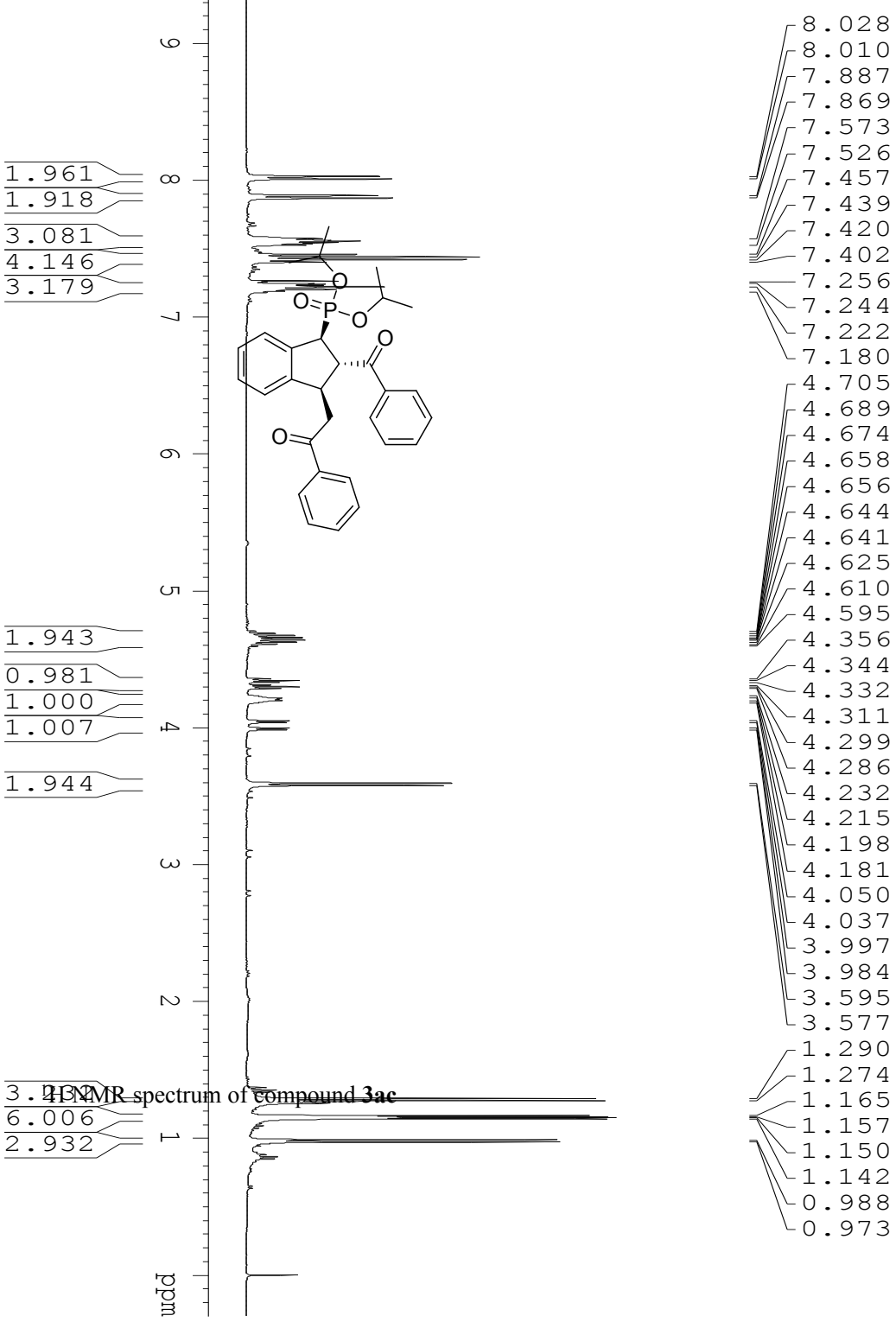

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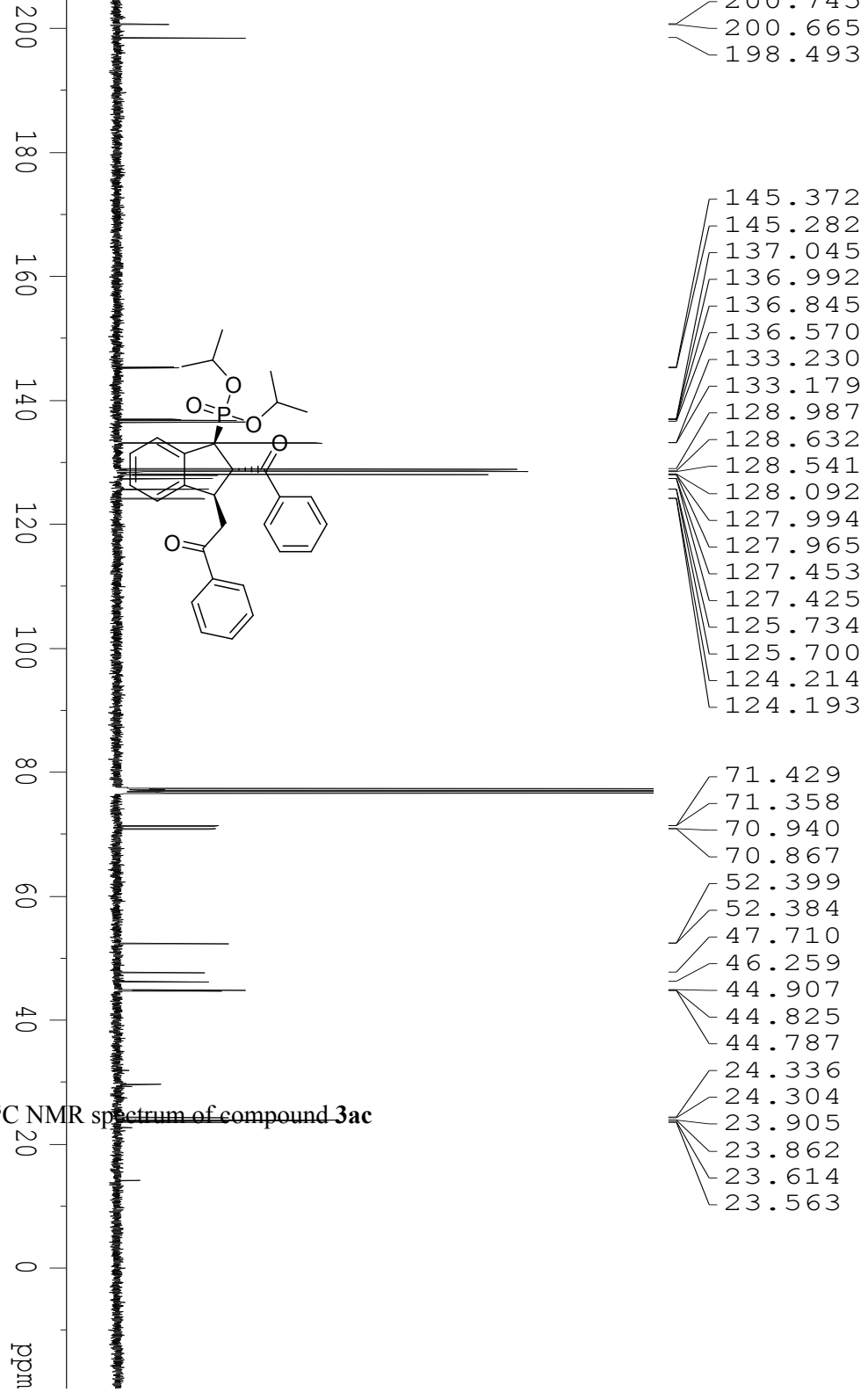

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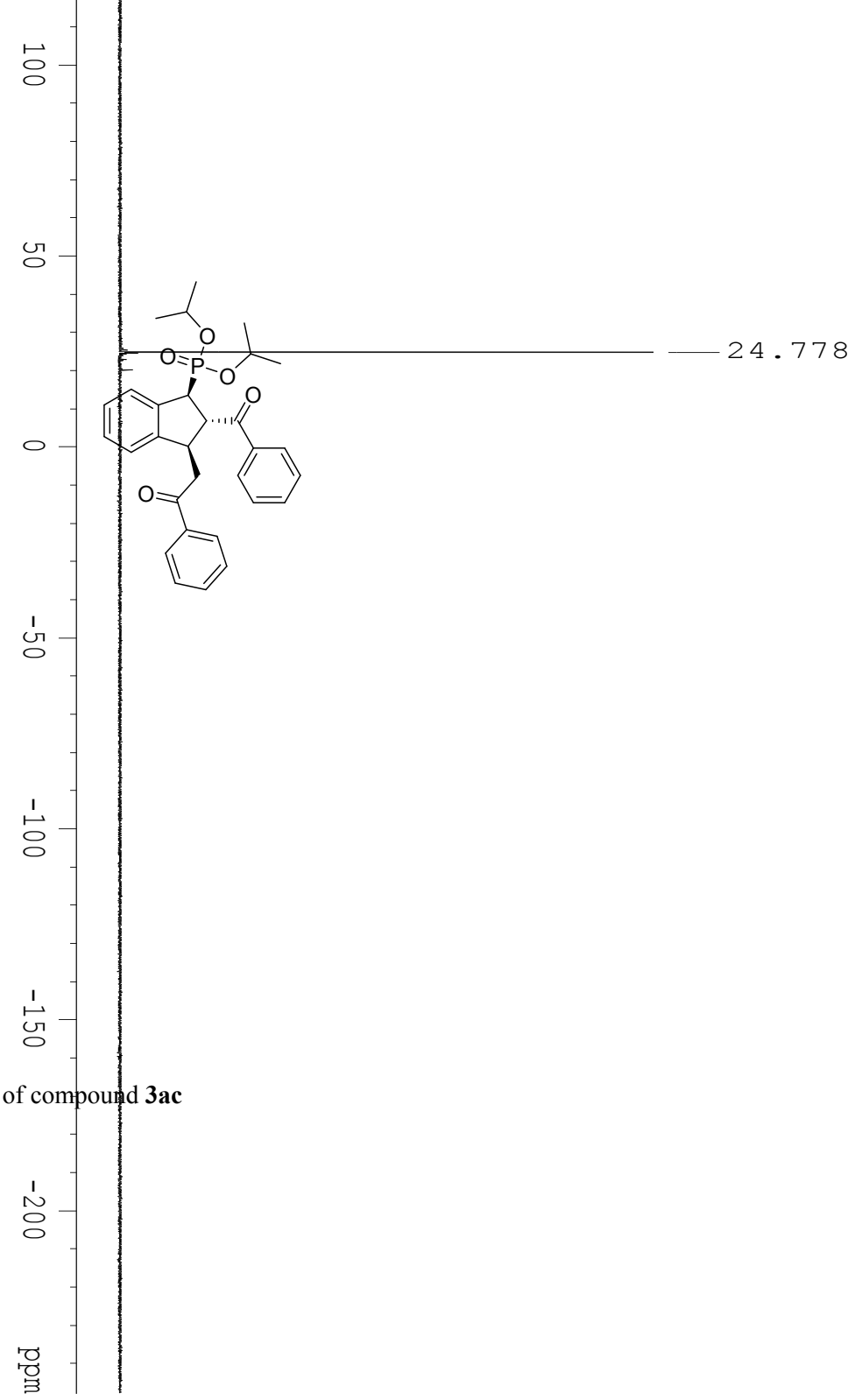

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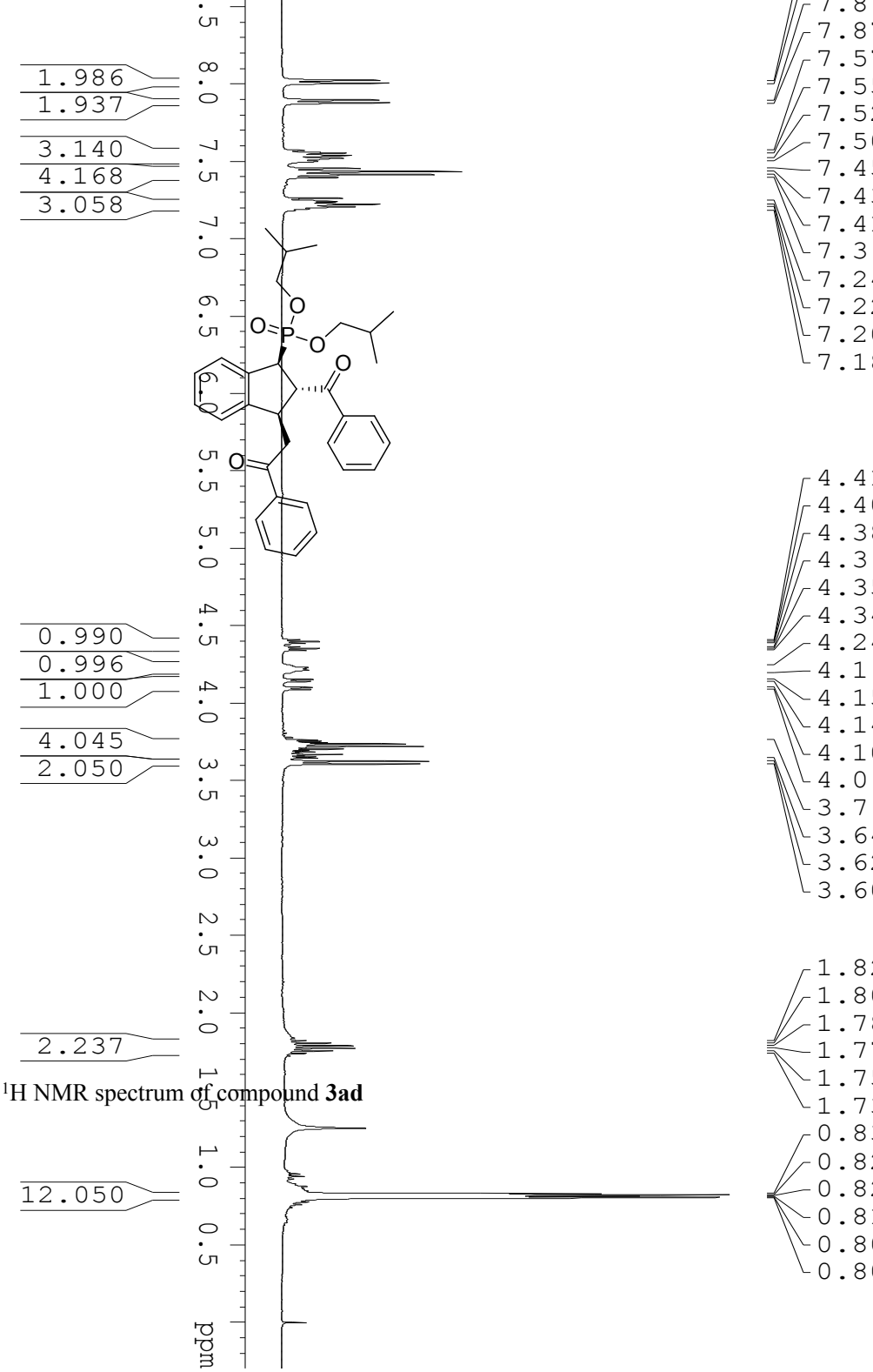

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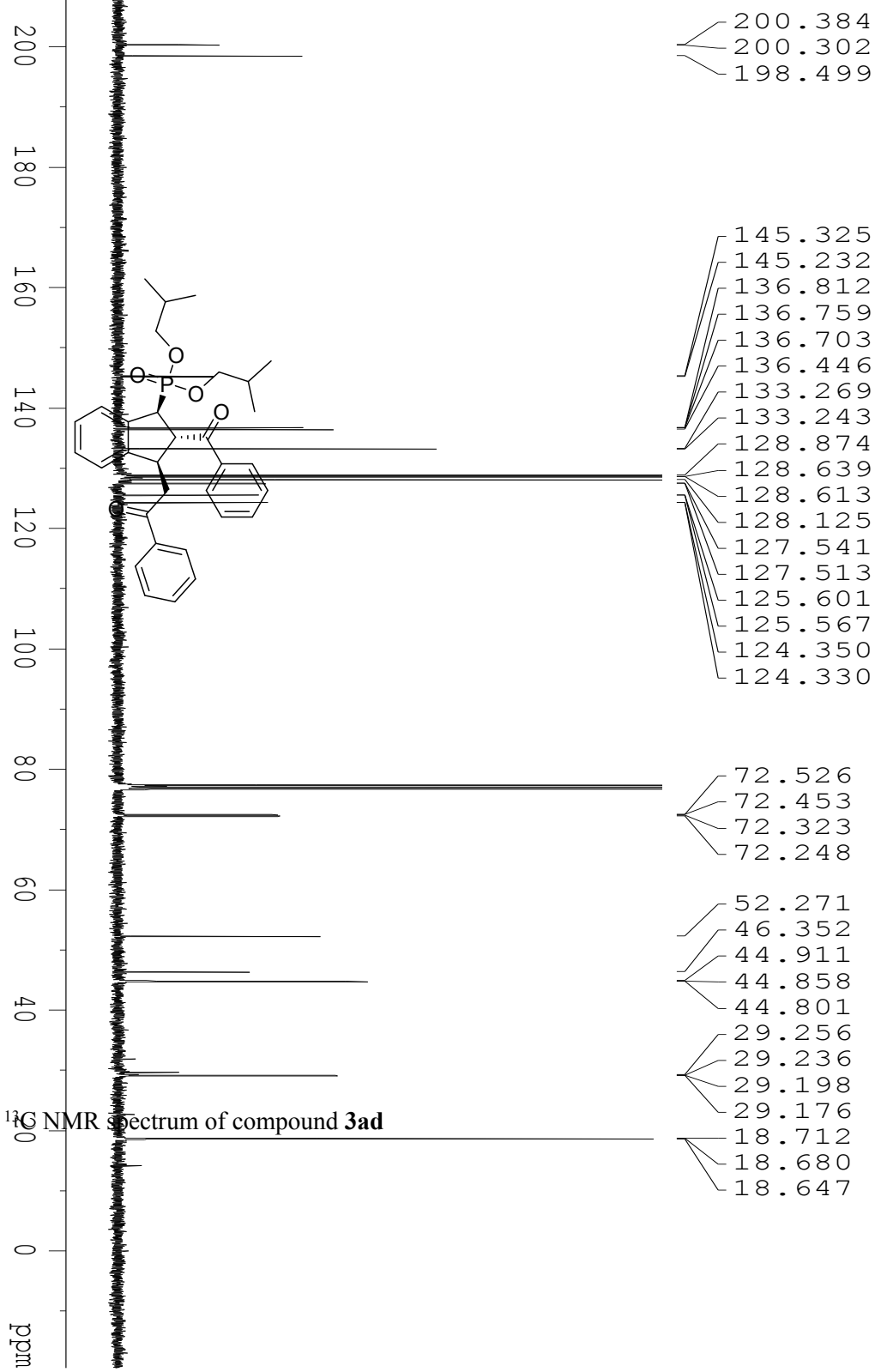

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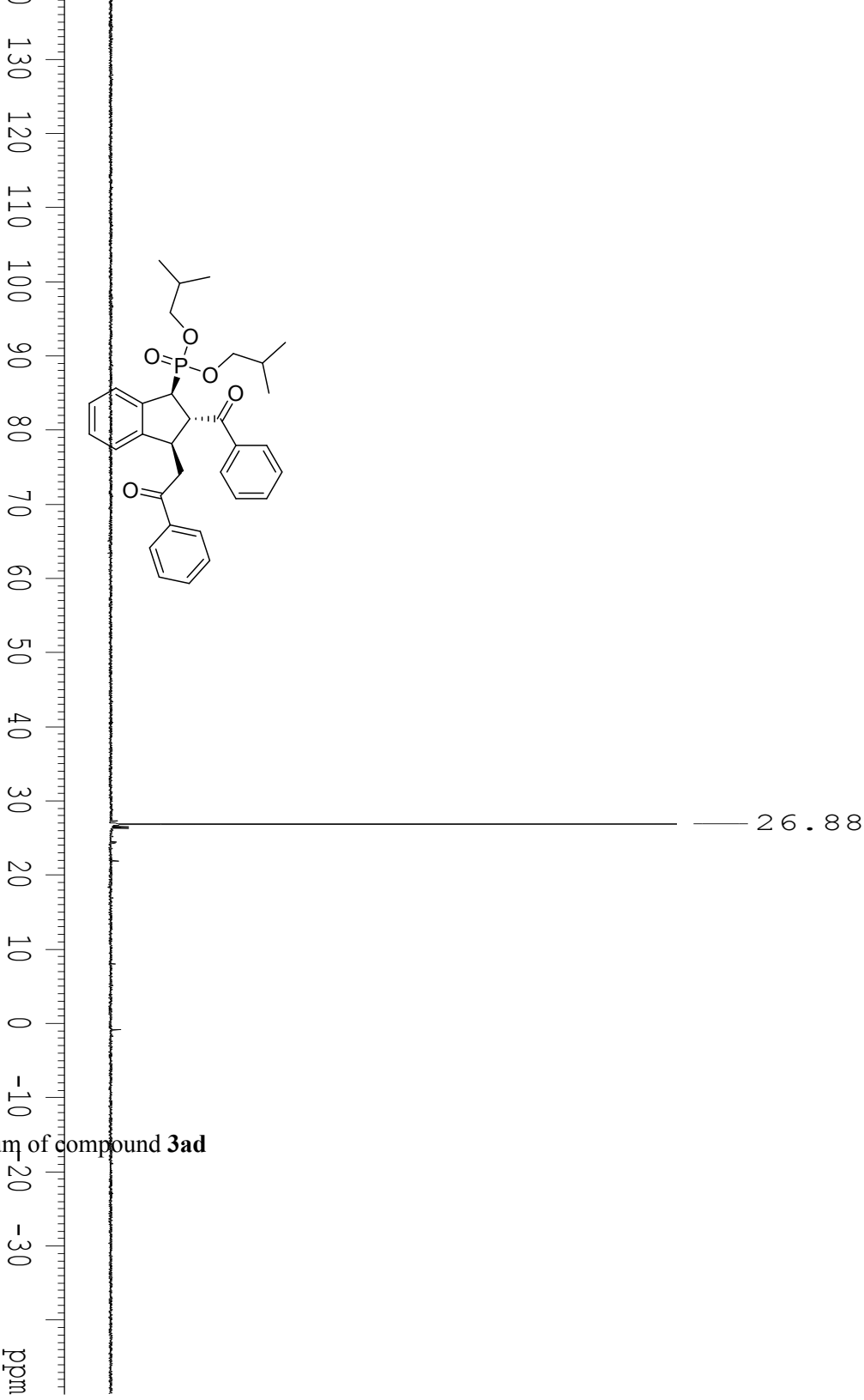

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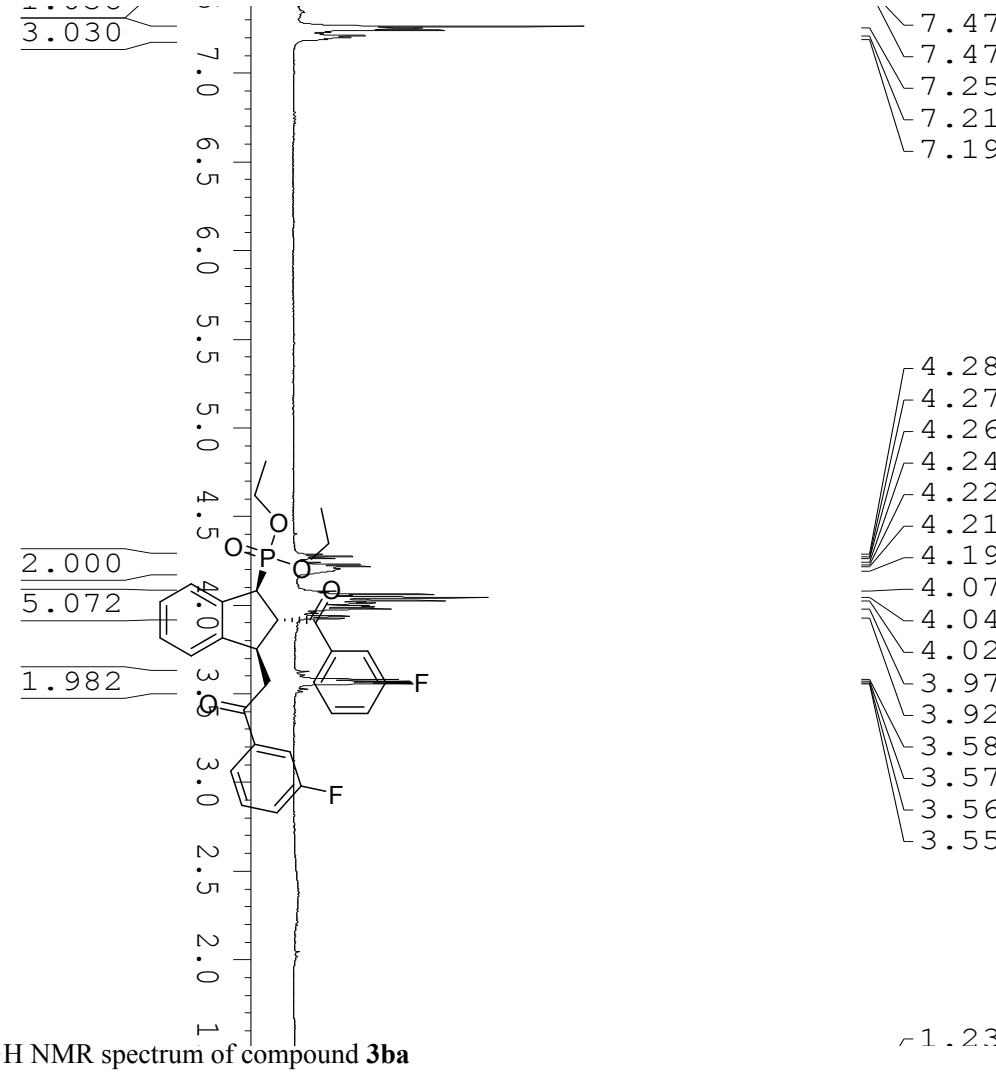

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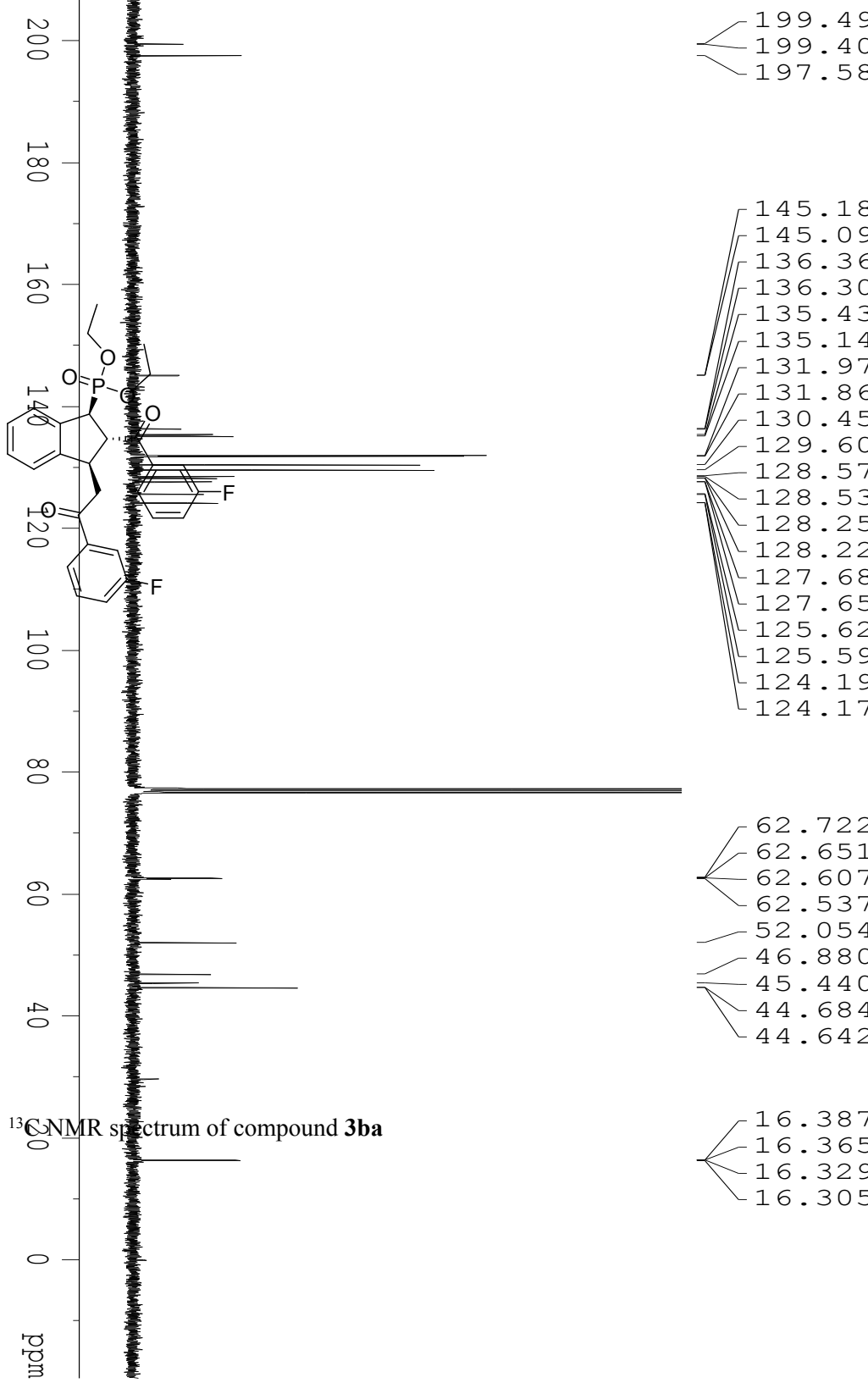

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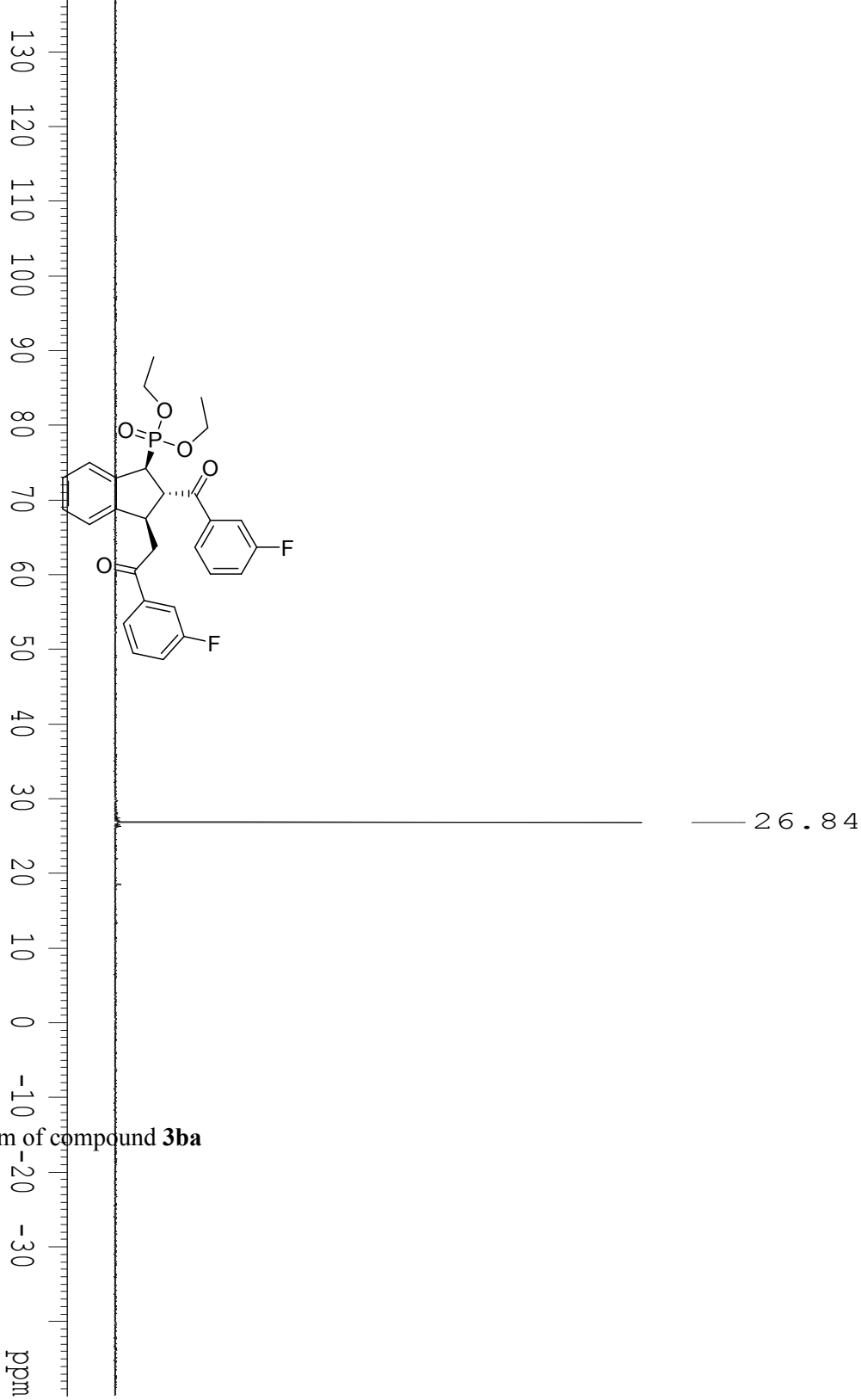

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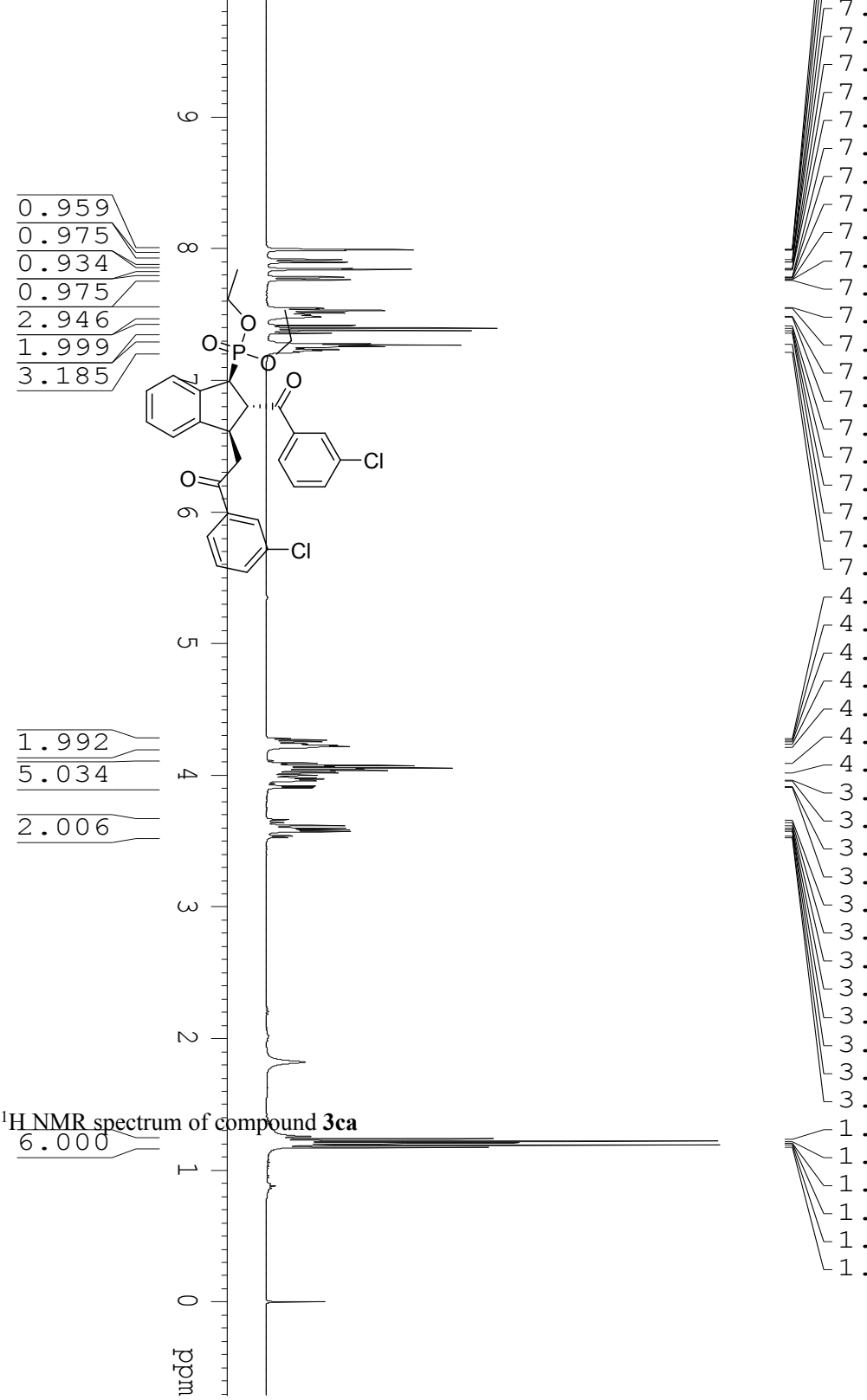

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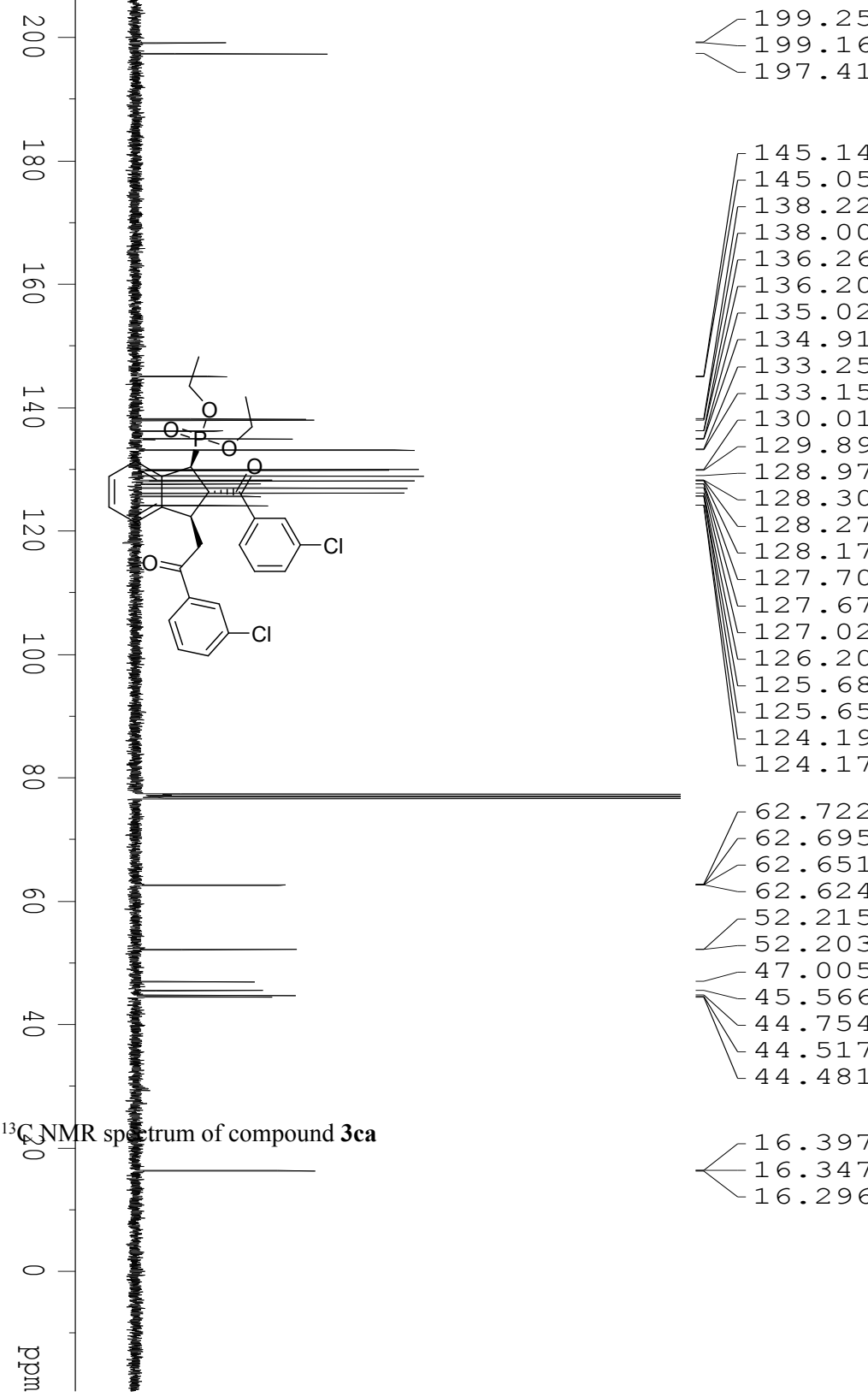

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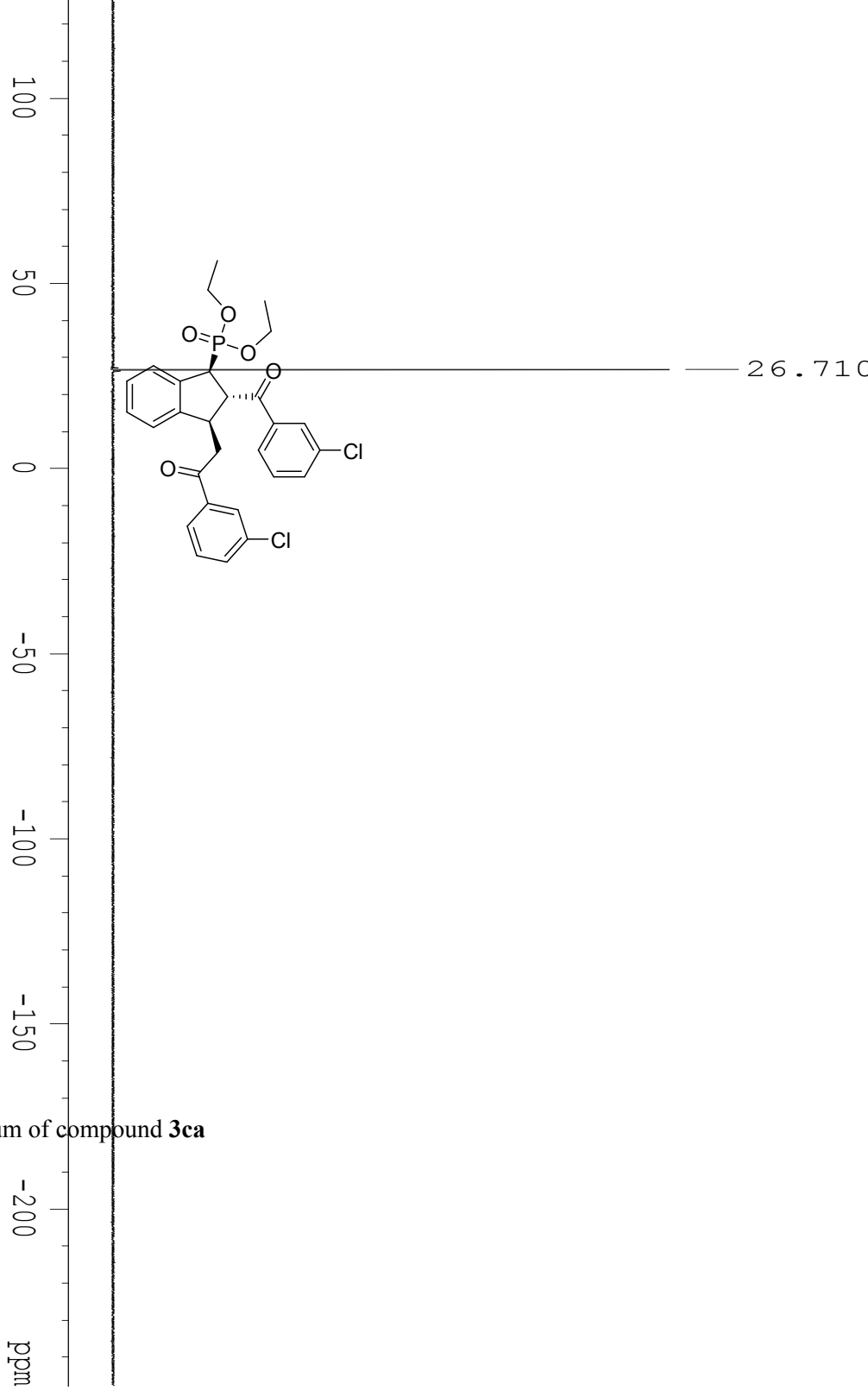

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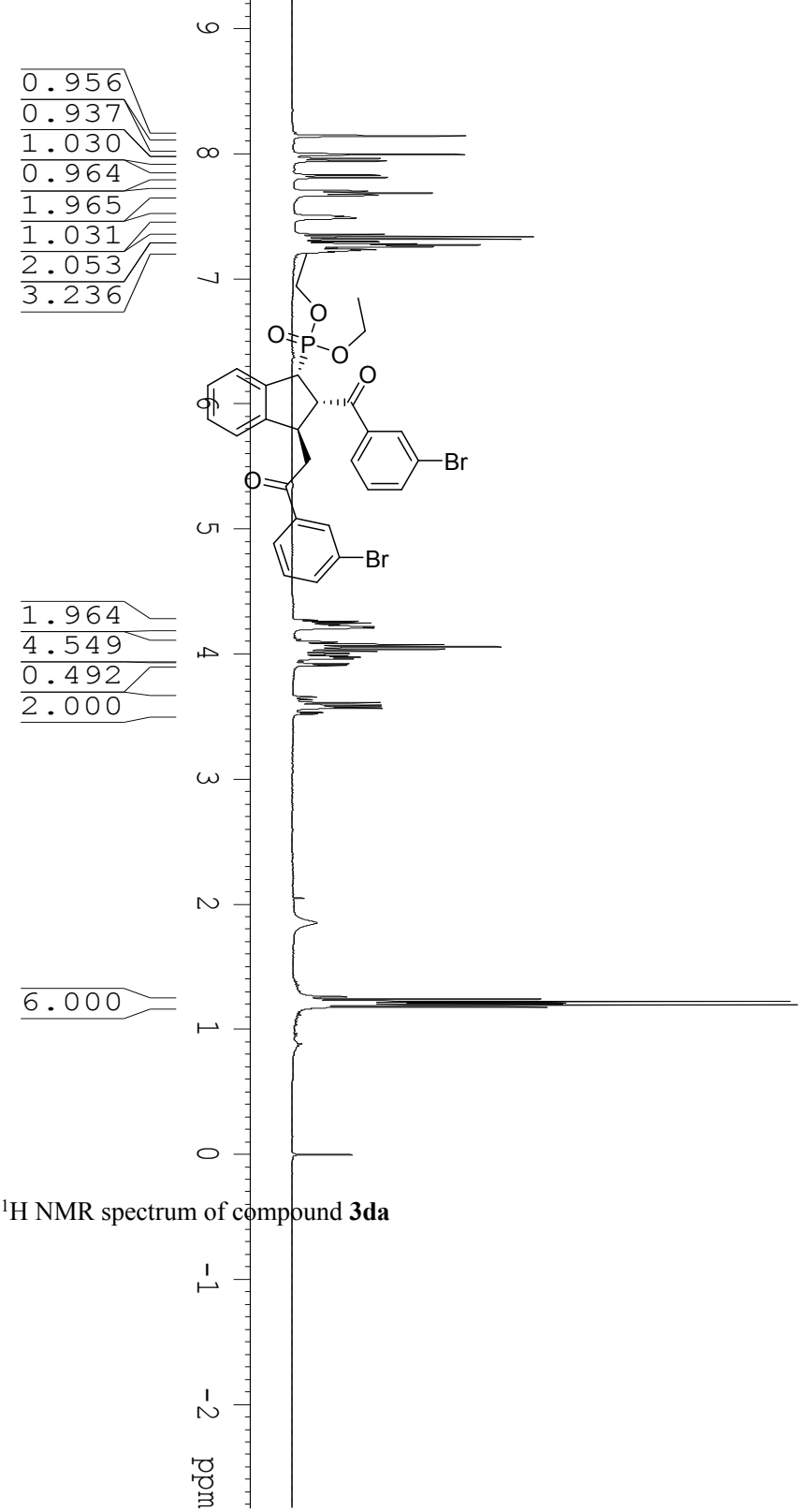

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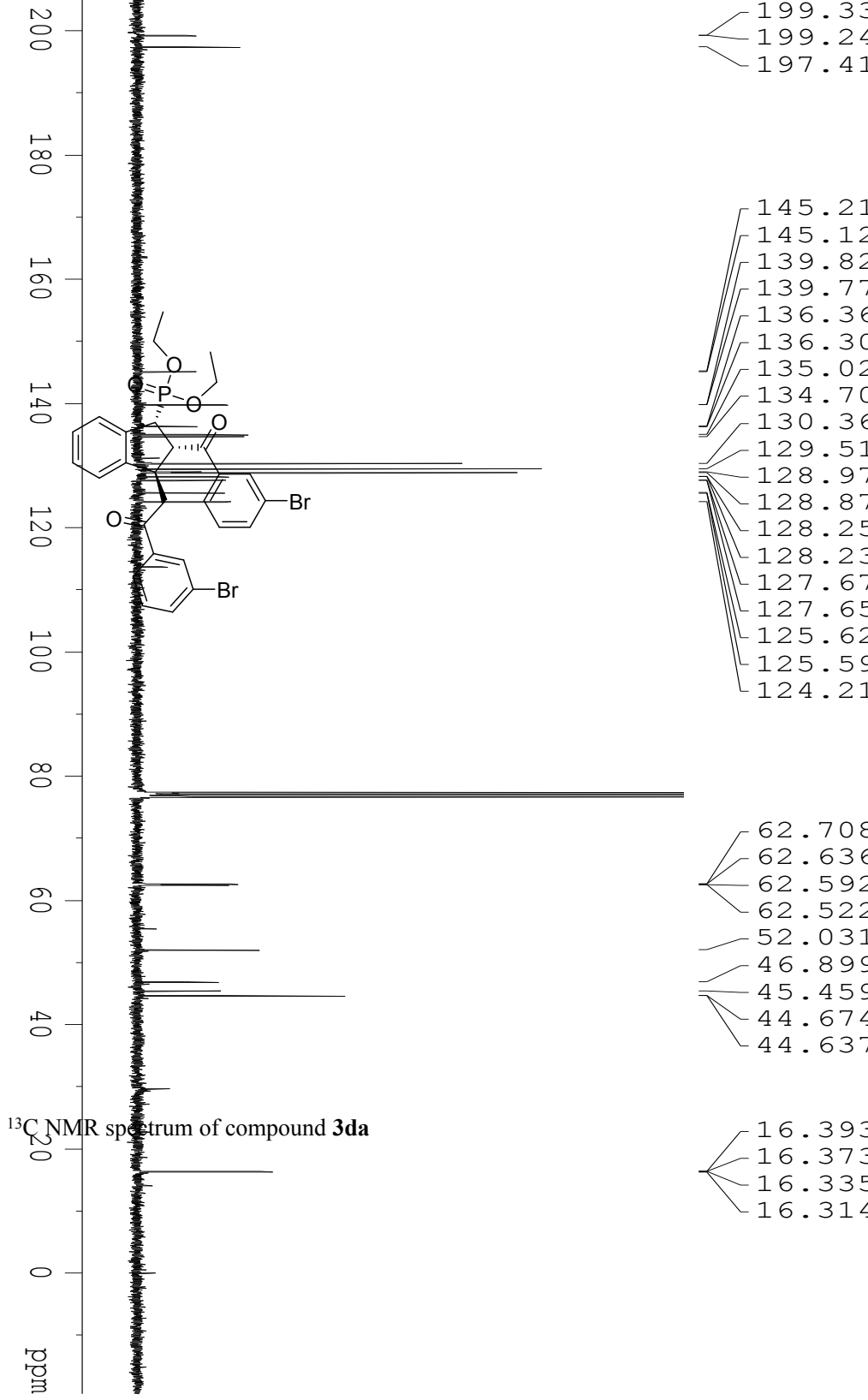

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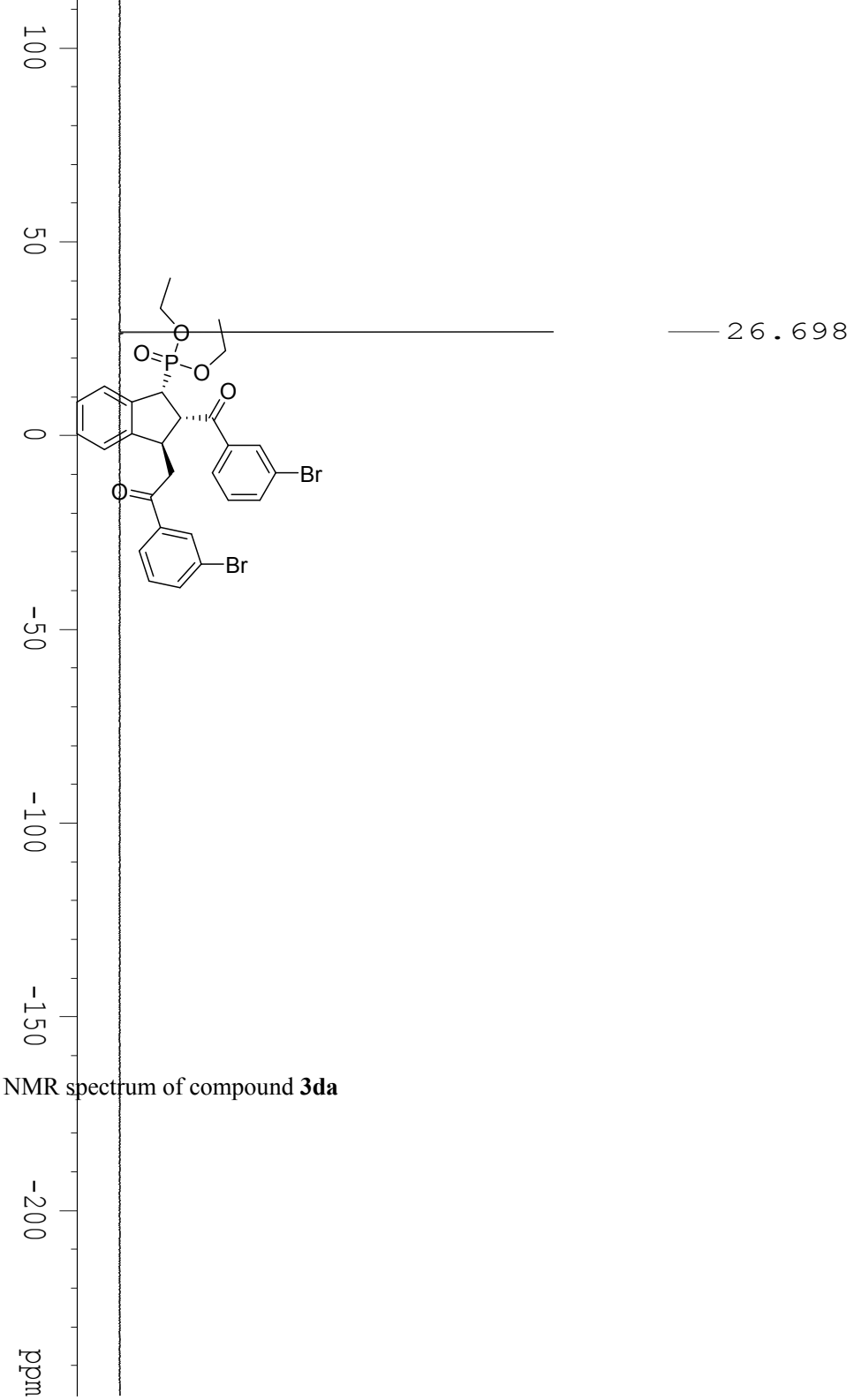

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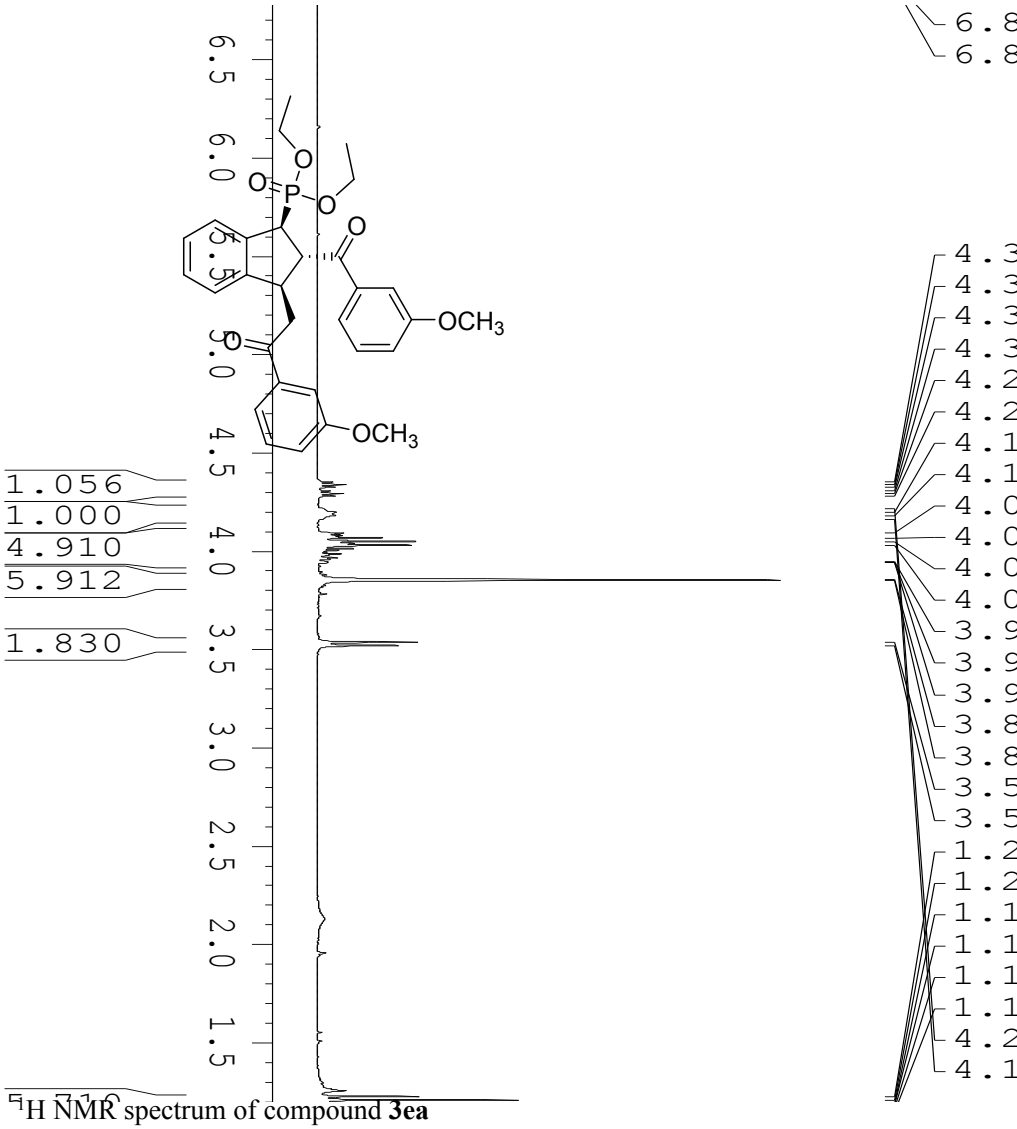

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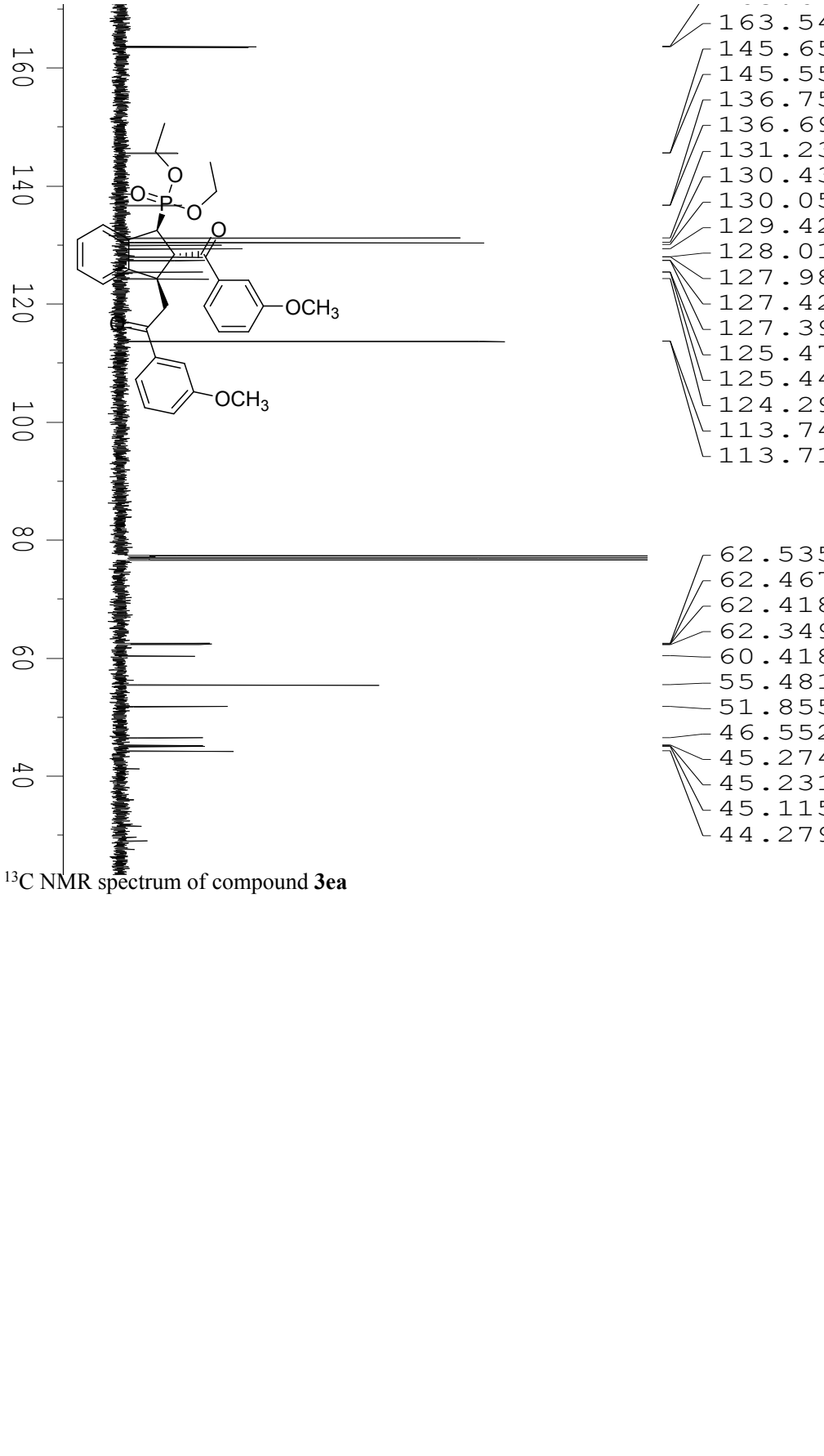

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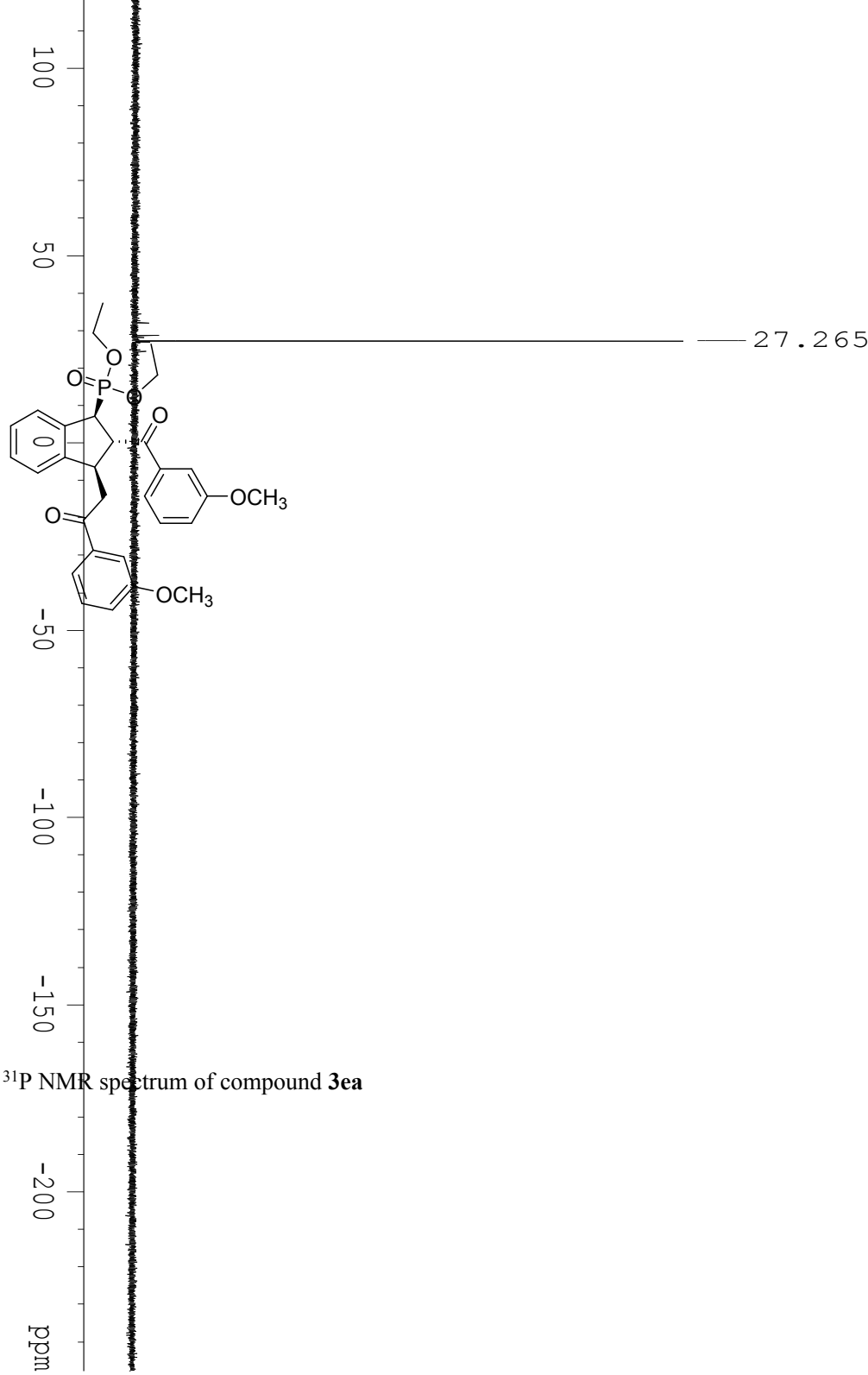

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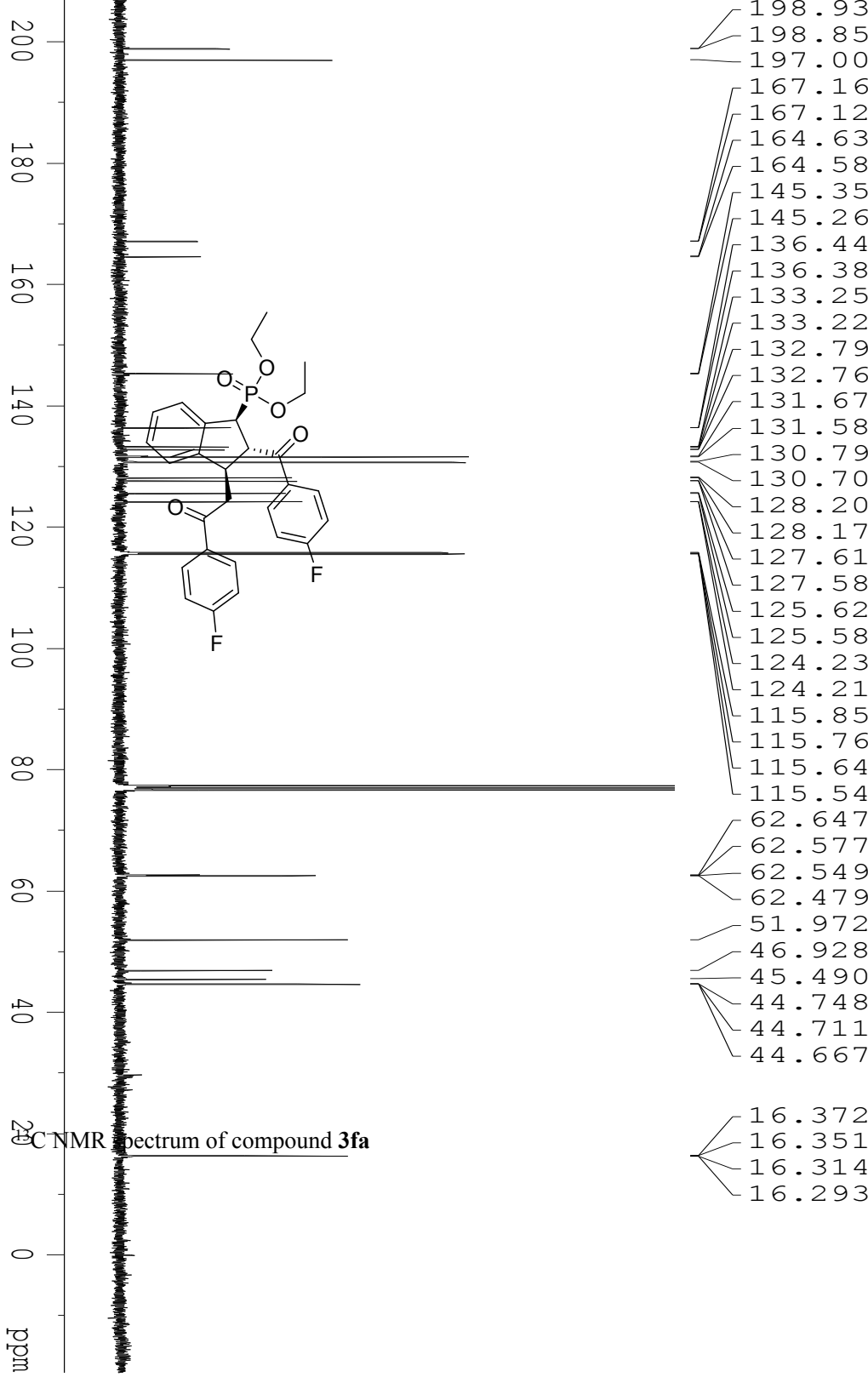

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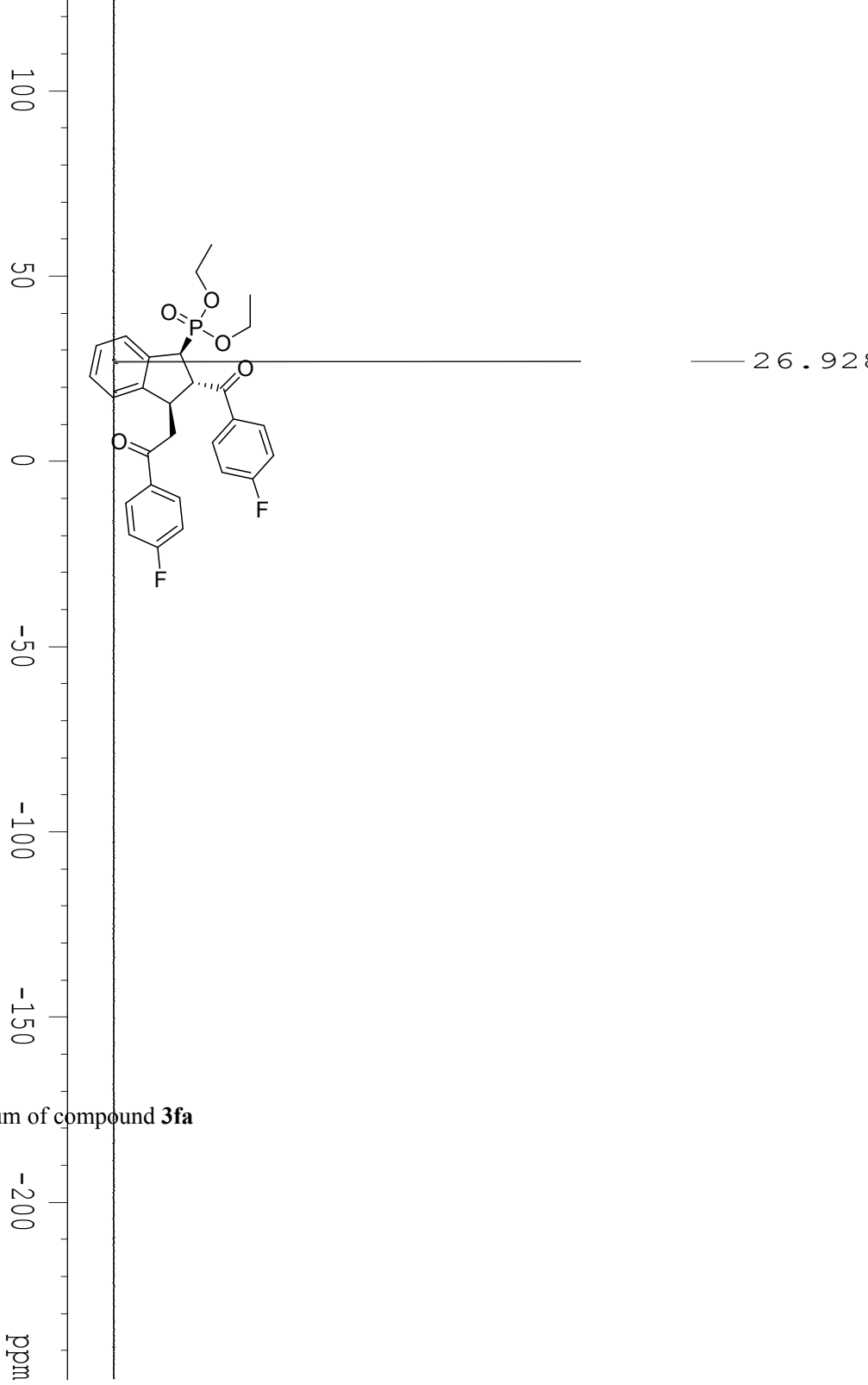

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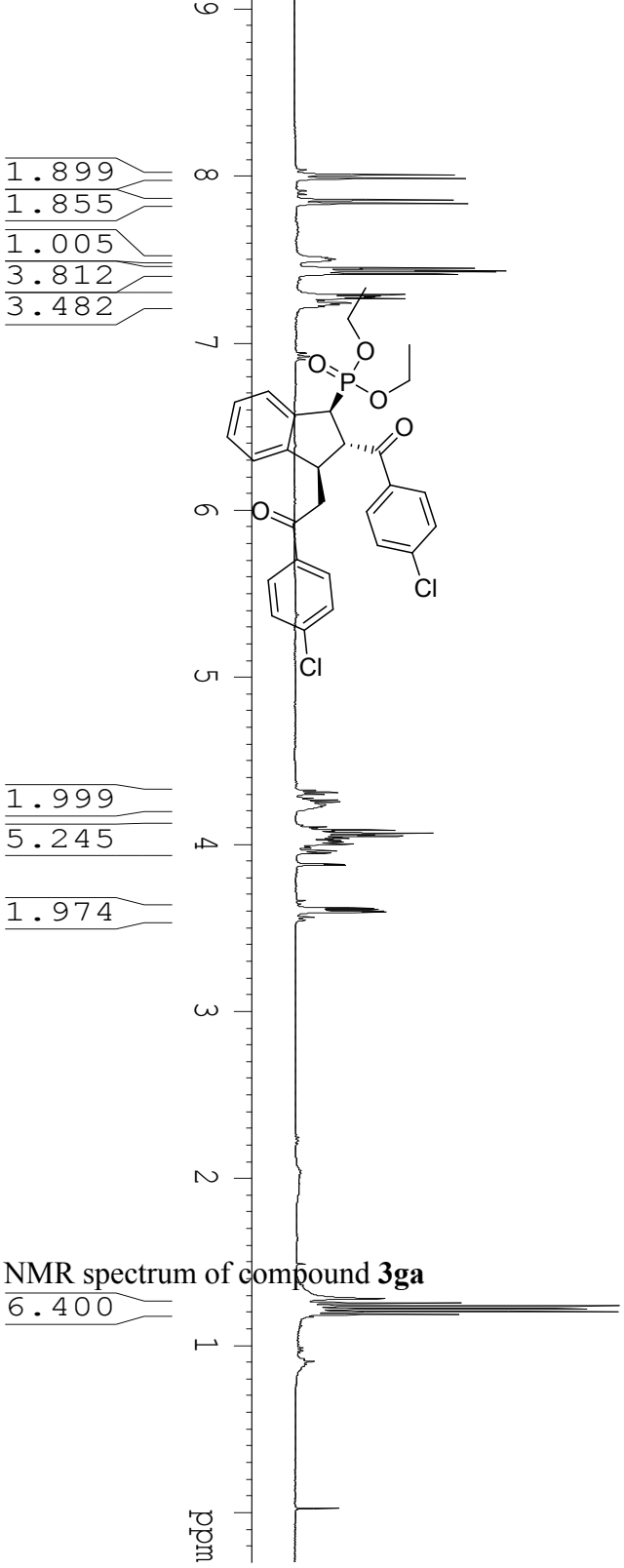

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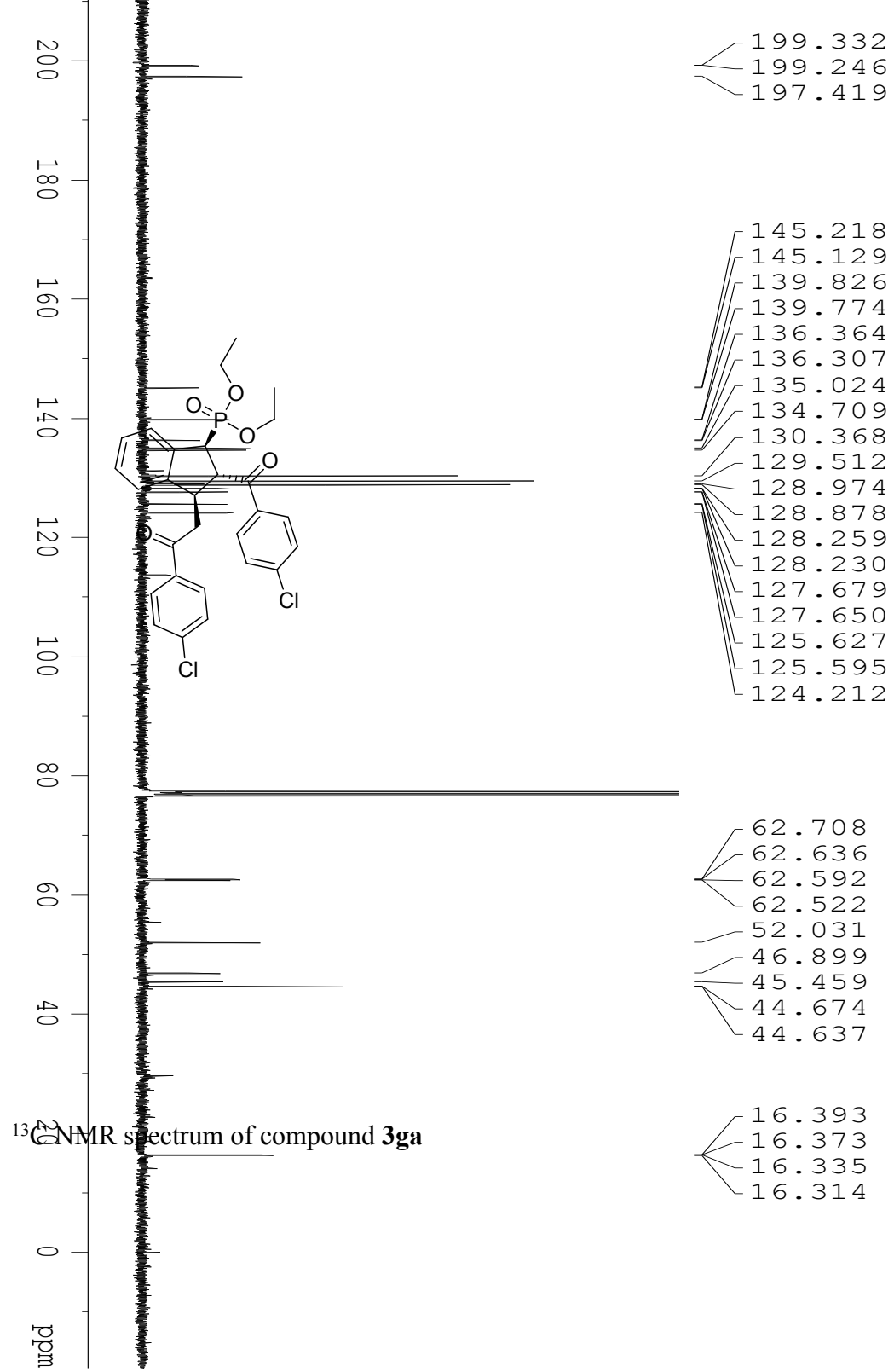

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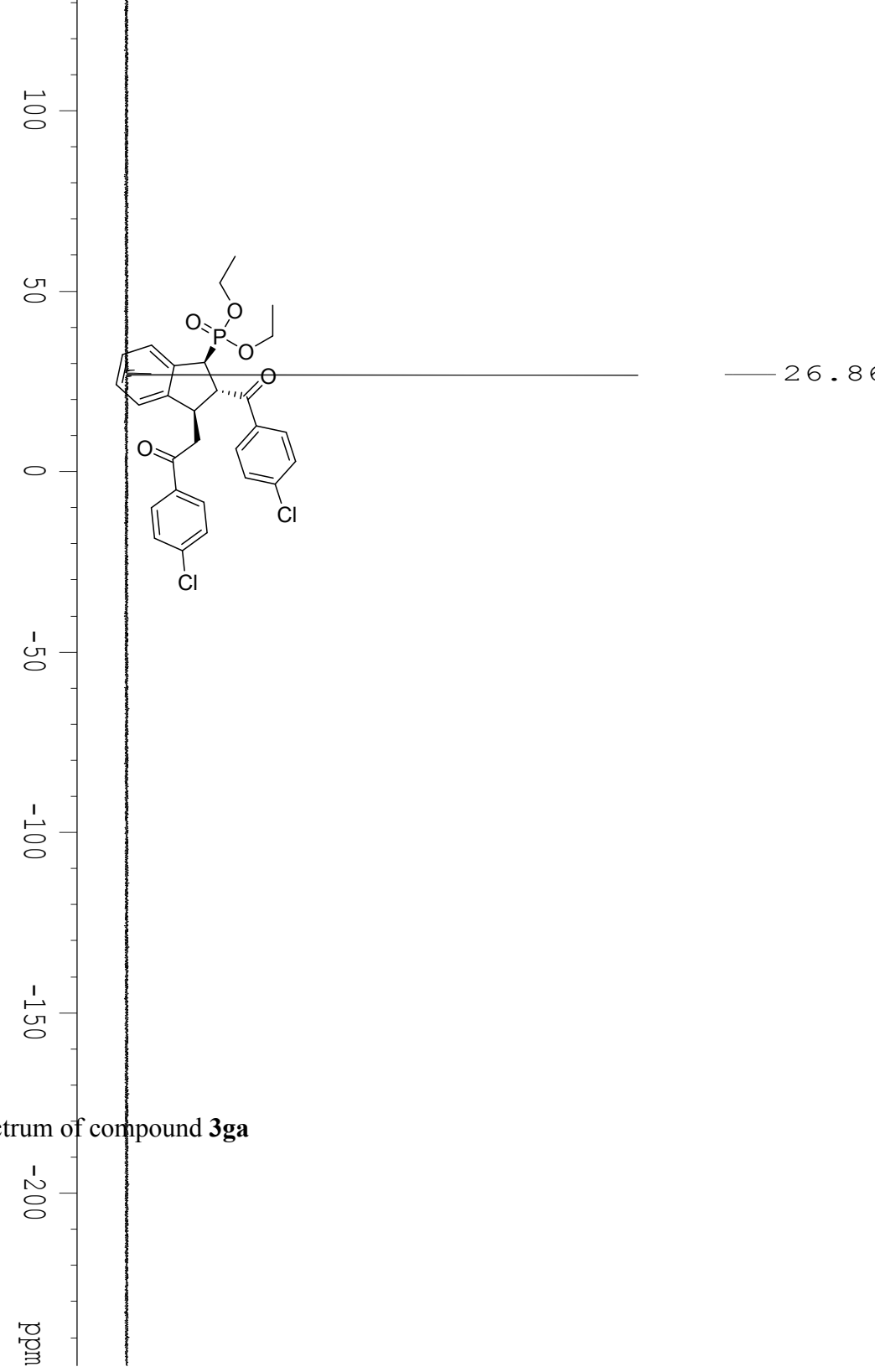

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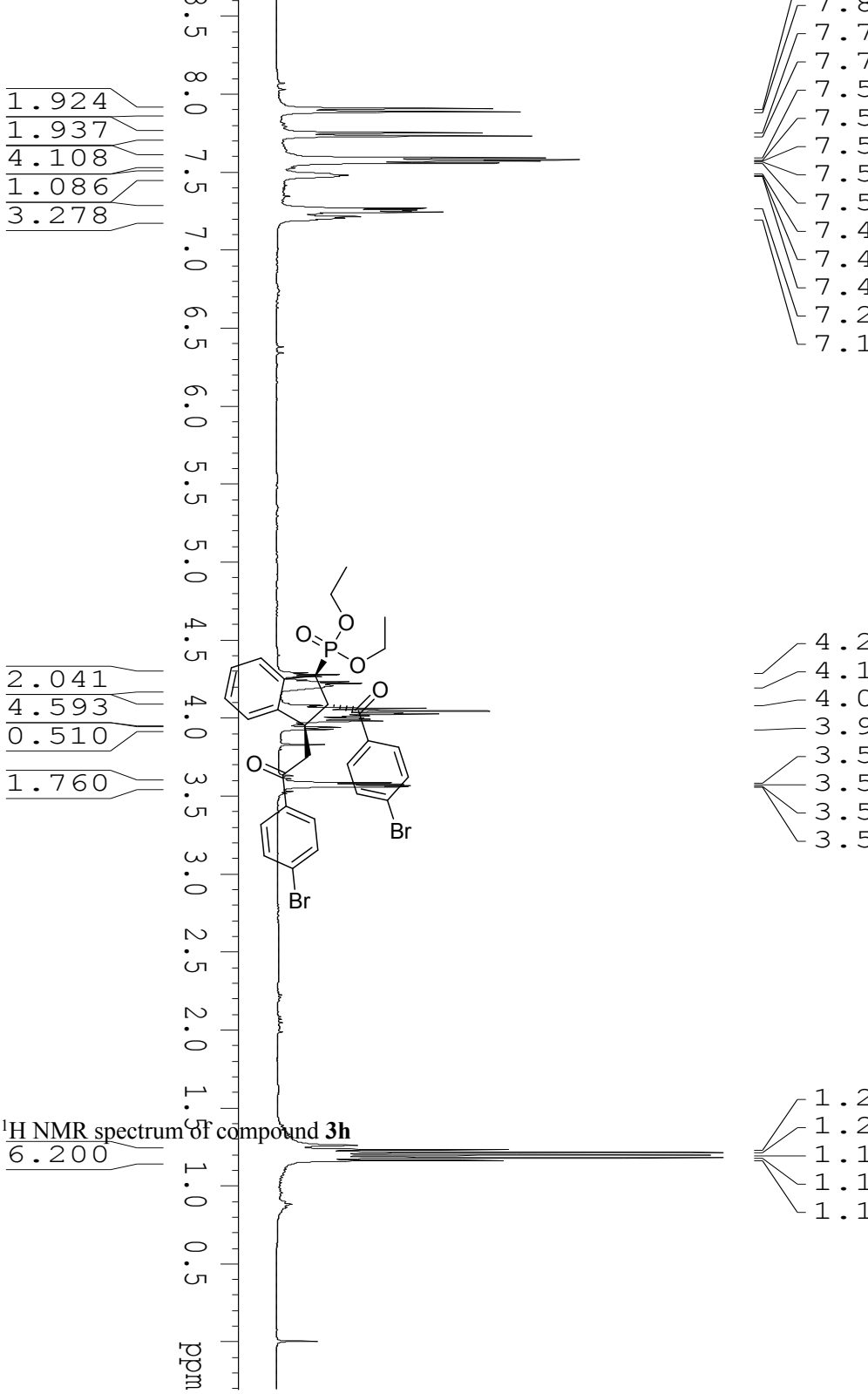

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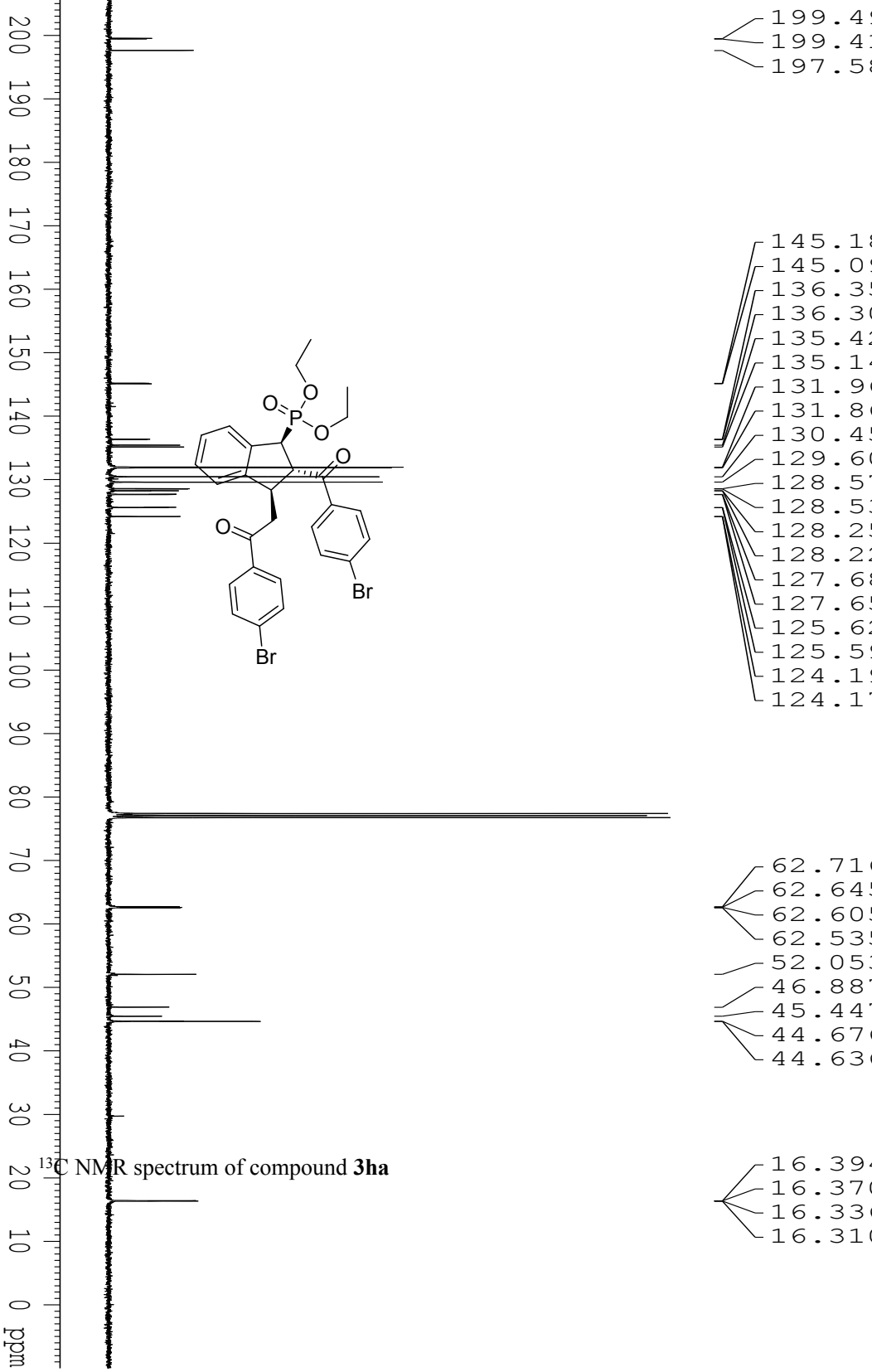

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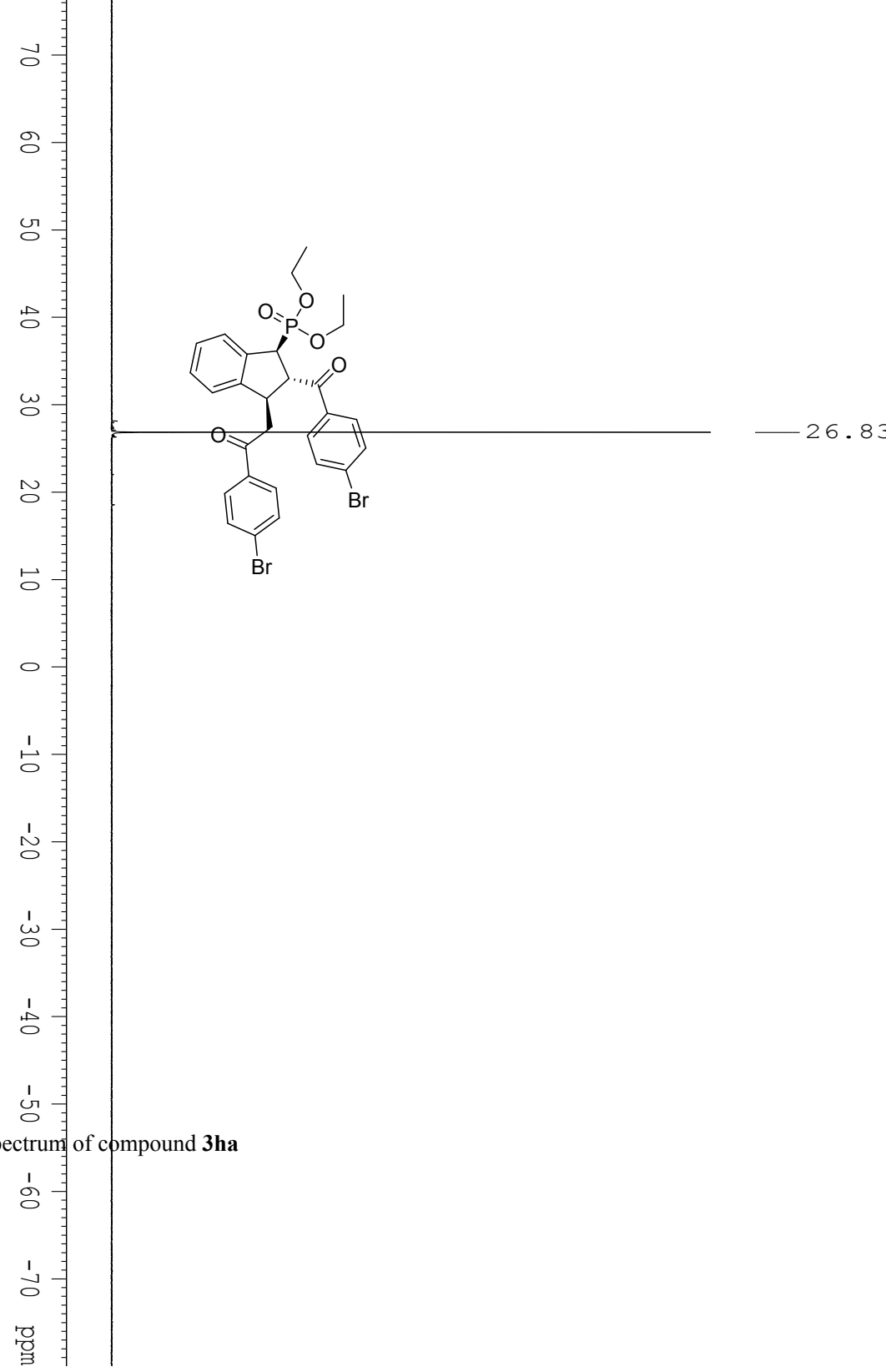

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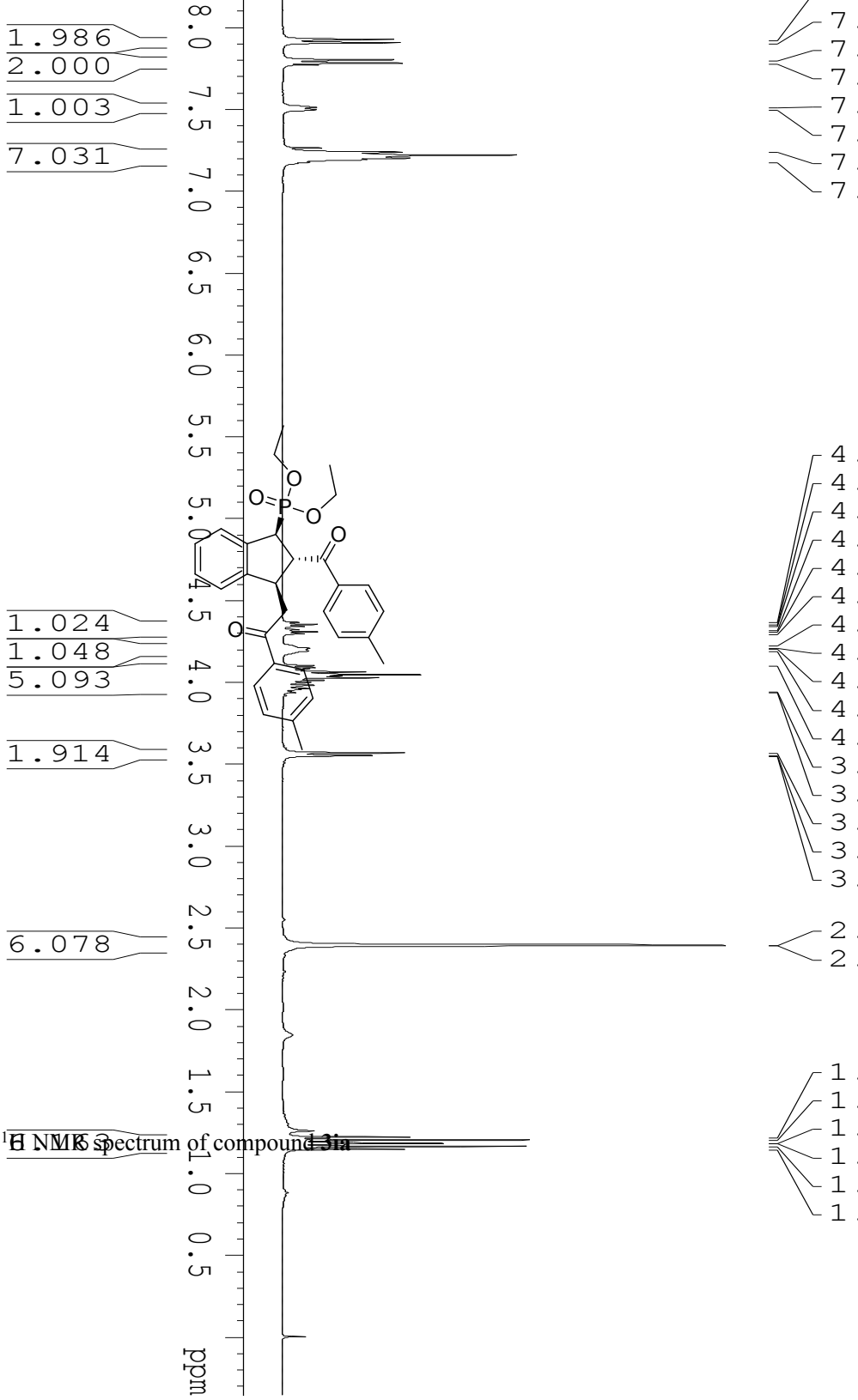

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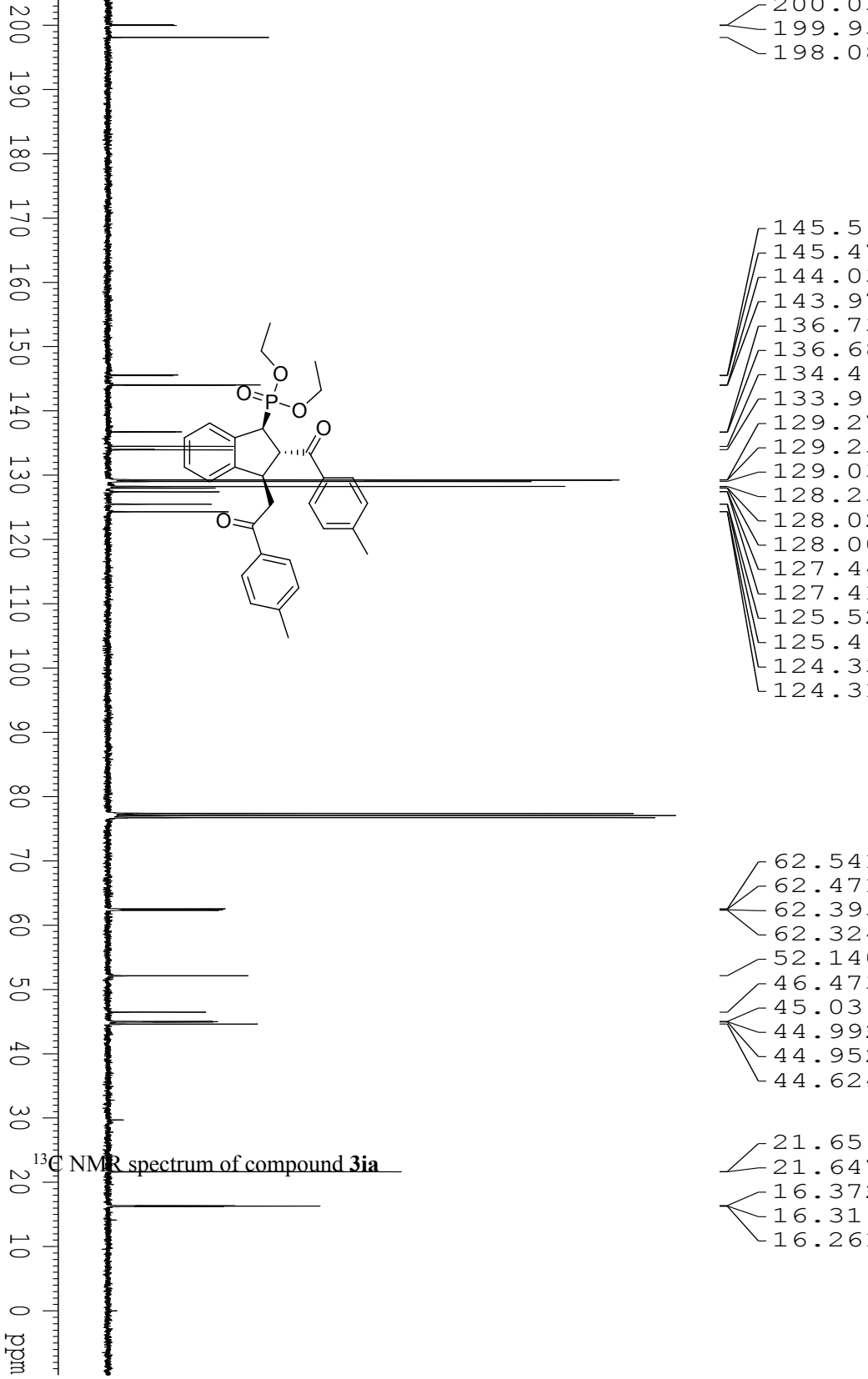
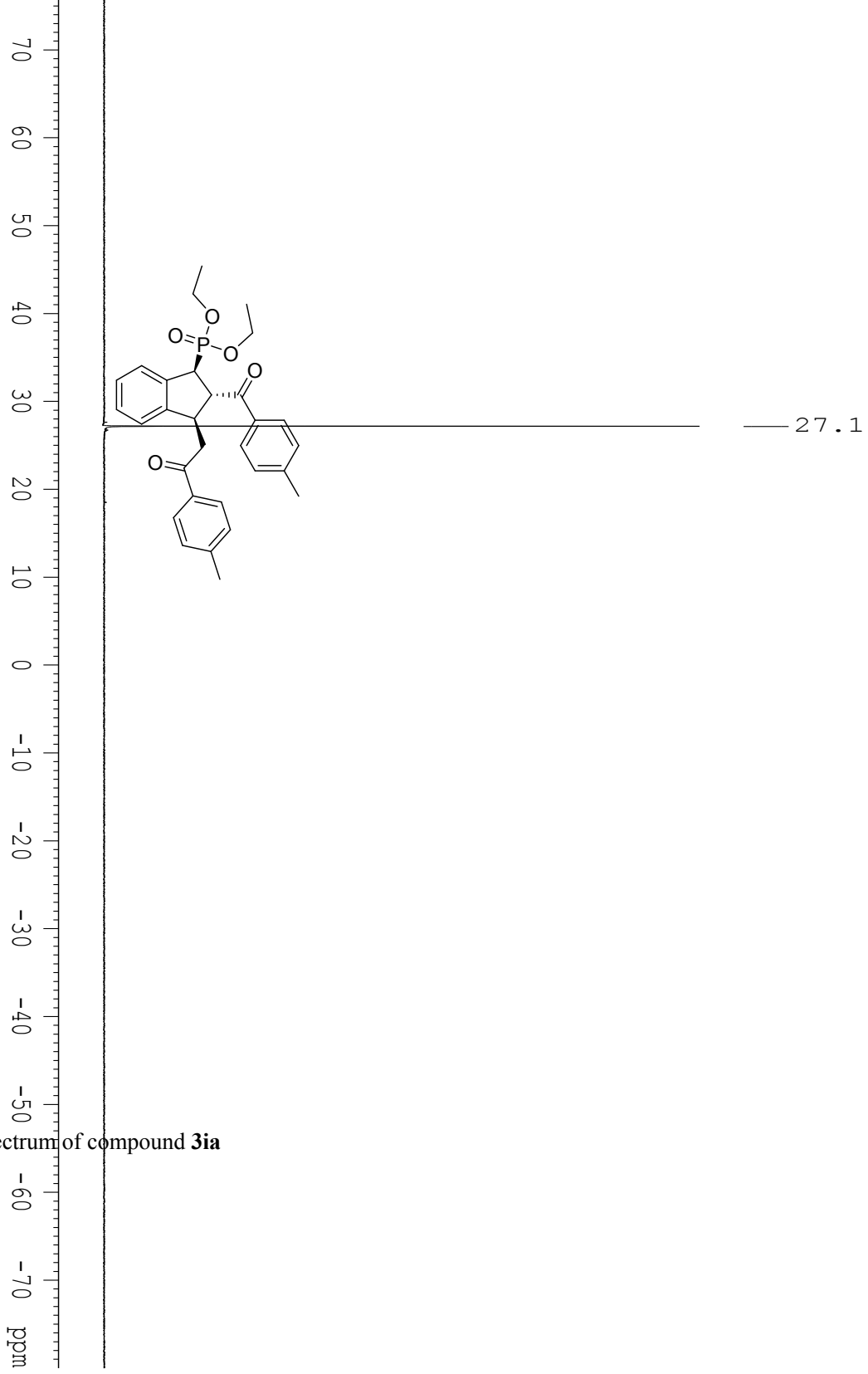
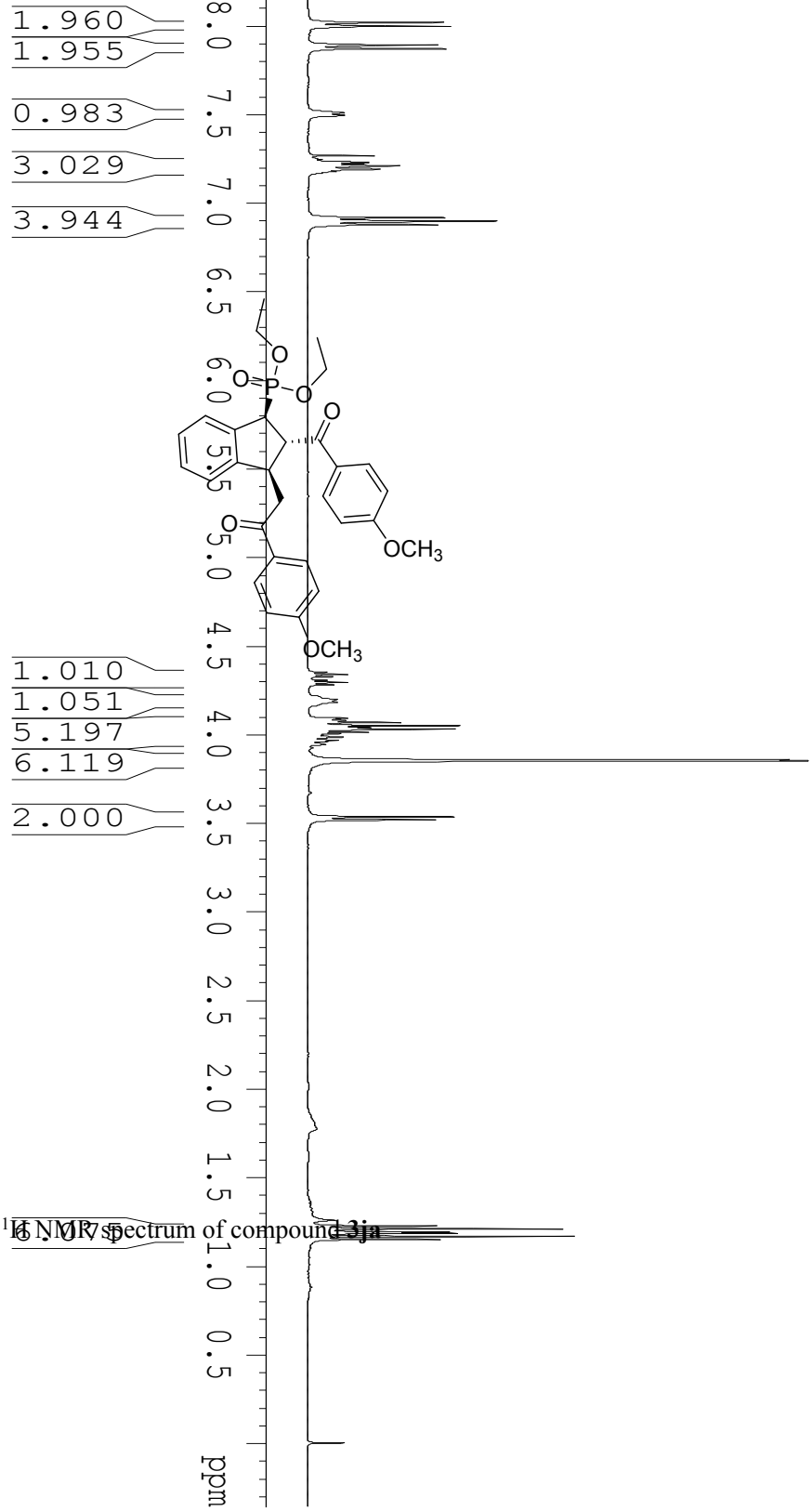


^{13}C NMR spectrum of compound **3ia**



^{31}P NMR spectrum of compound **3ia**



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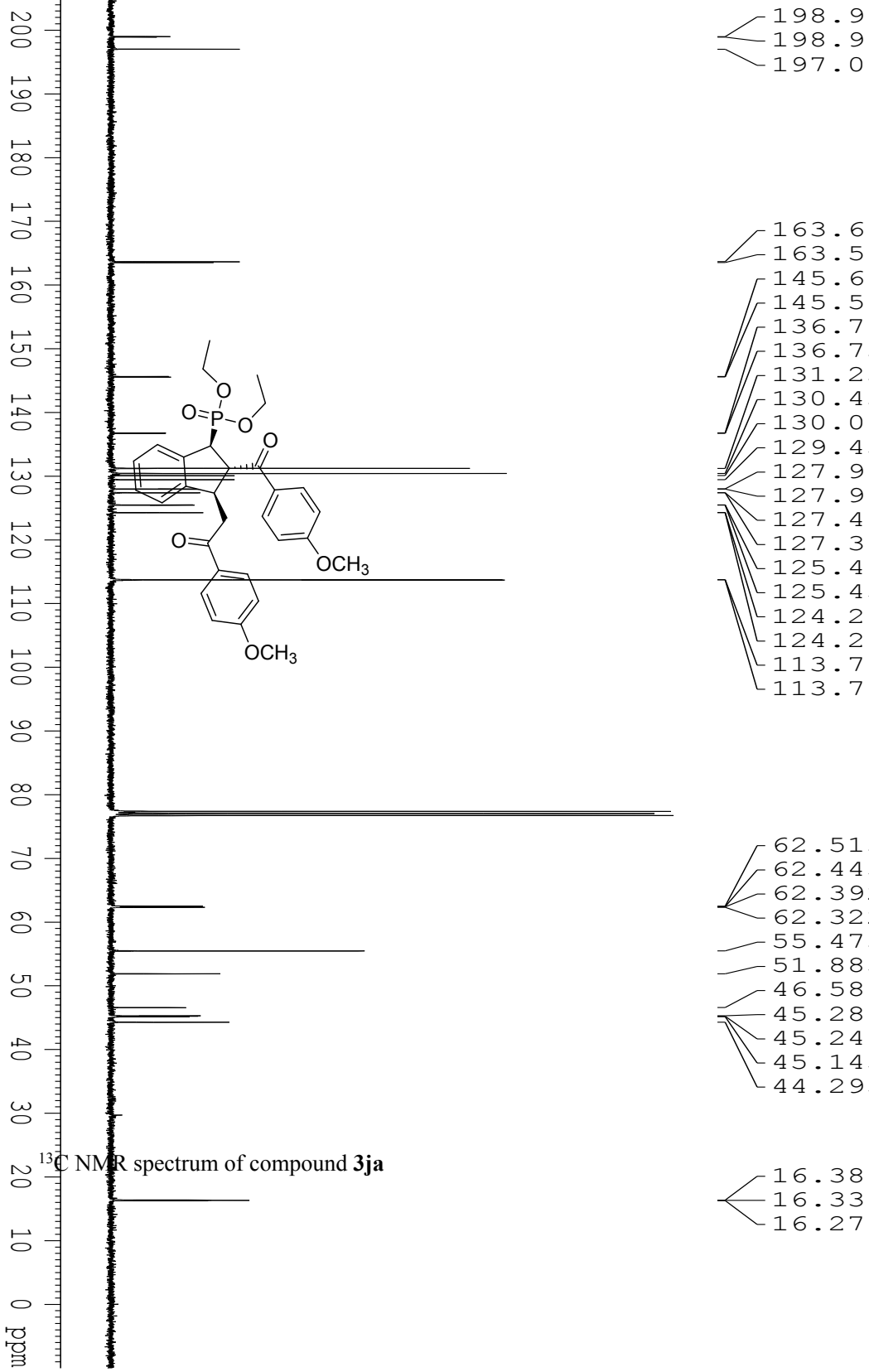
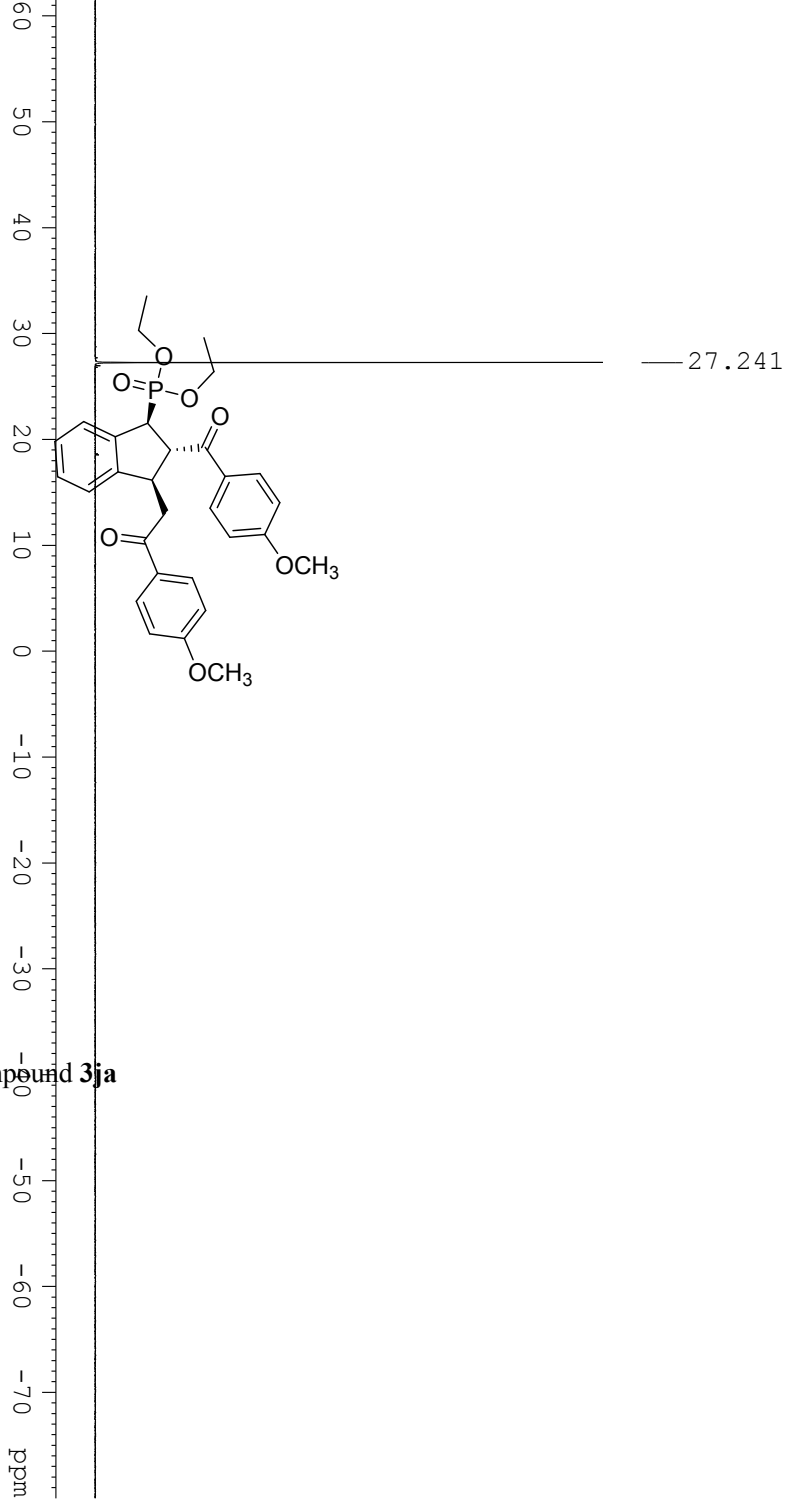
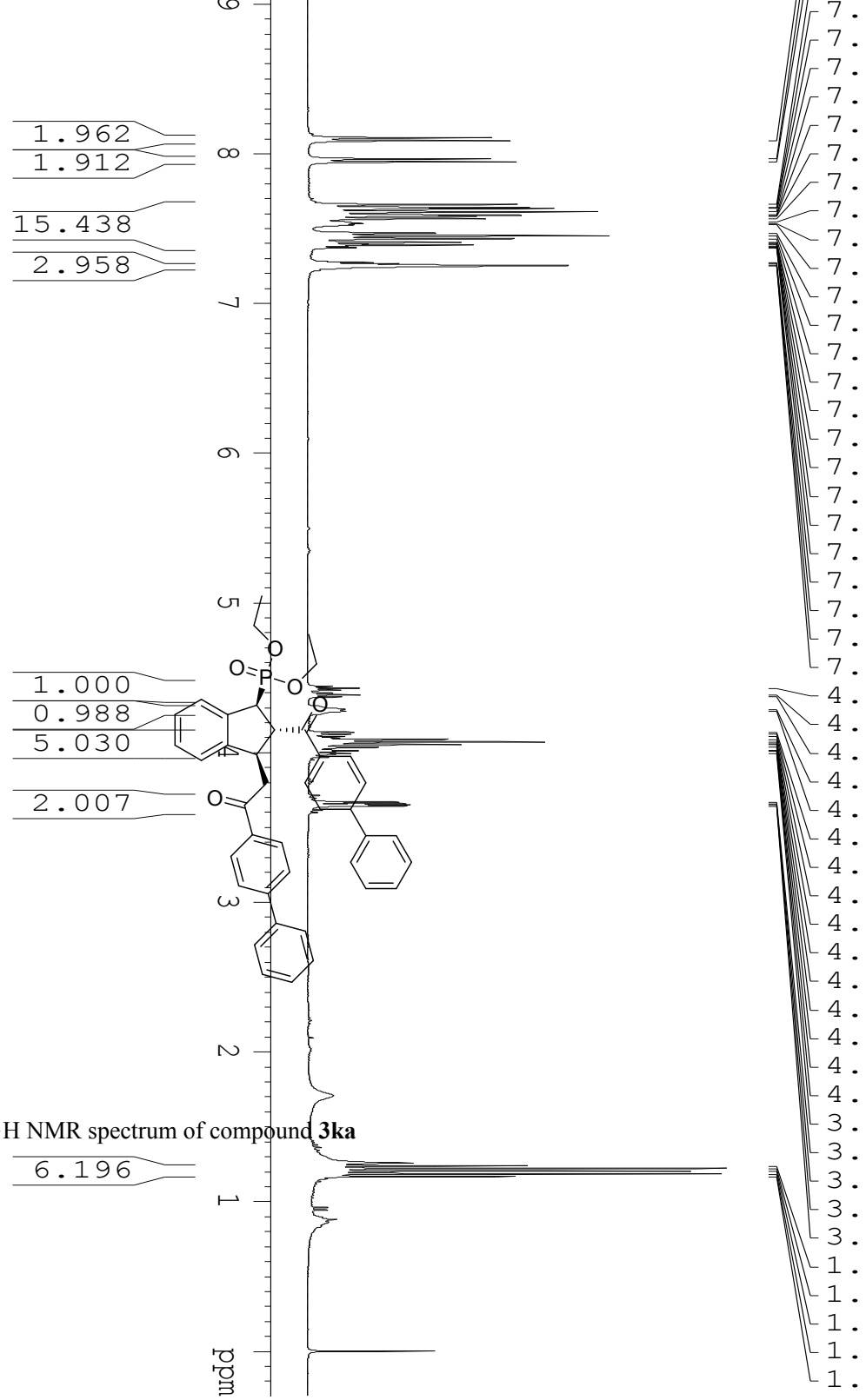


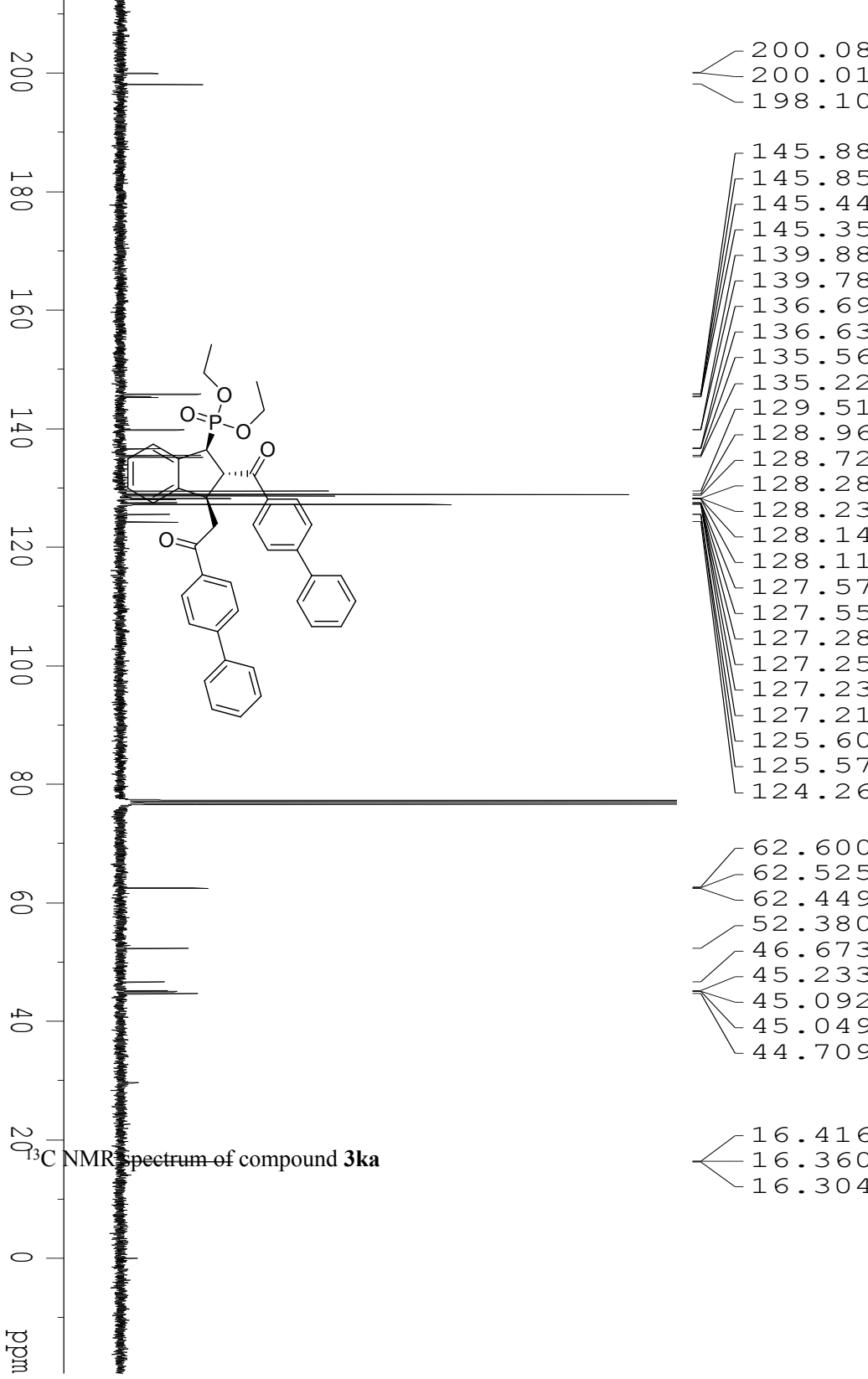
^{13}C NMR spectrum of compound **3ja**



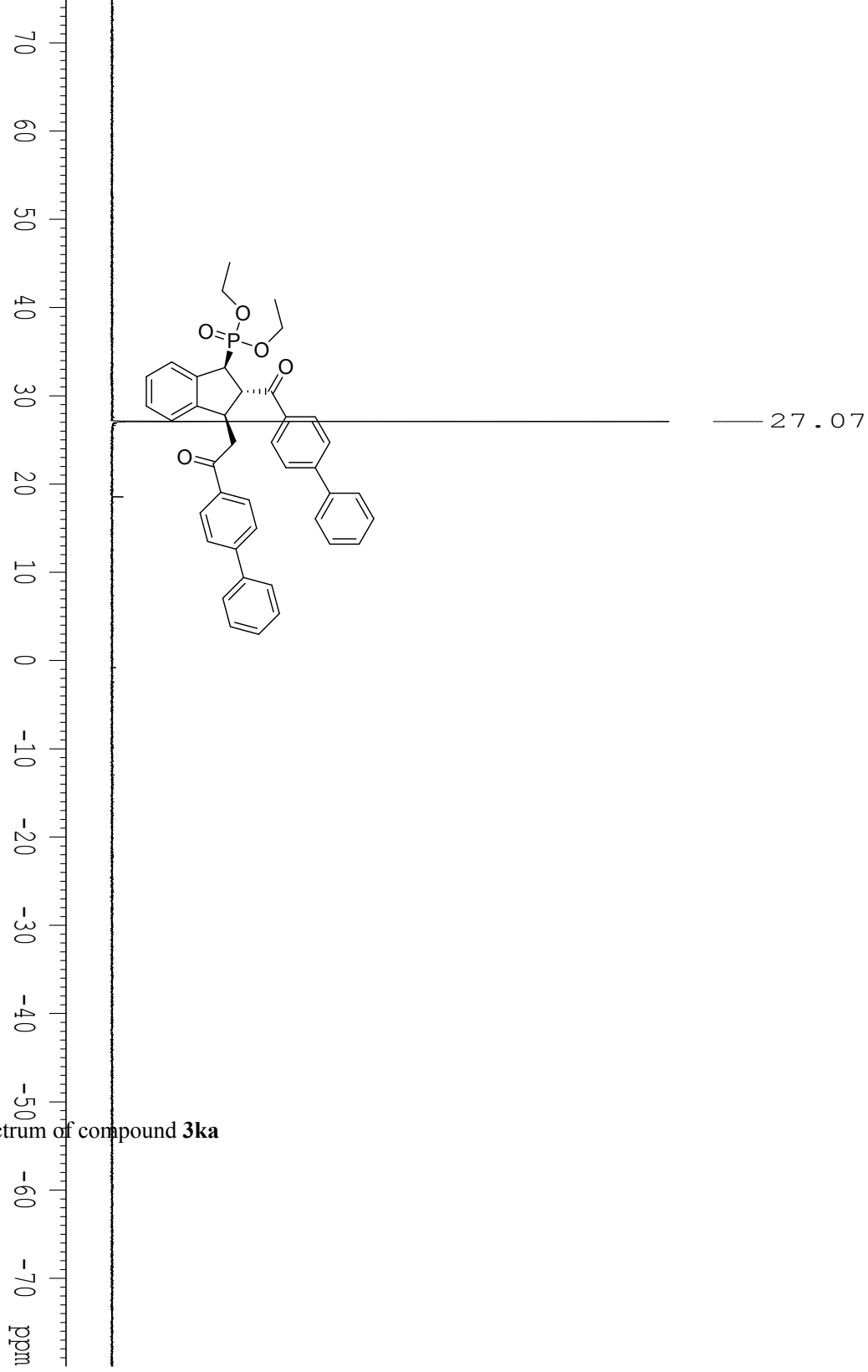
^{31}P NMR spectrum of compound **3ja**



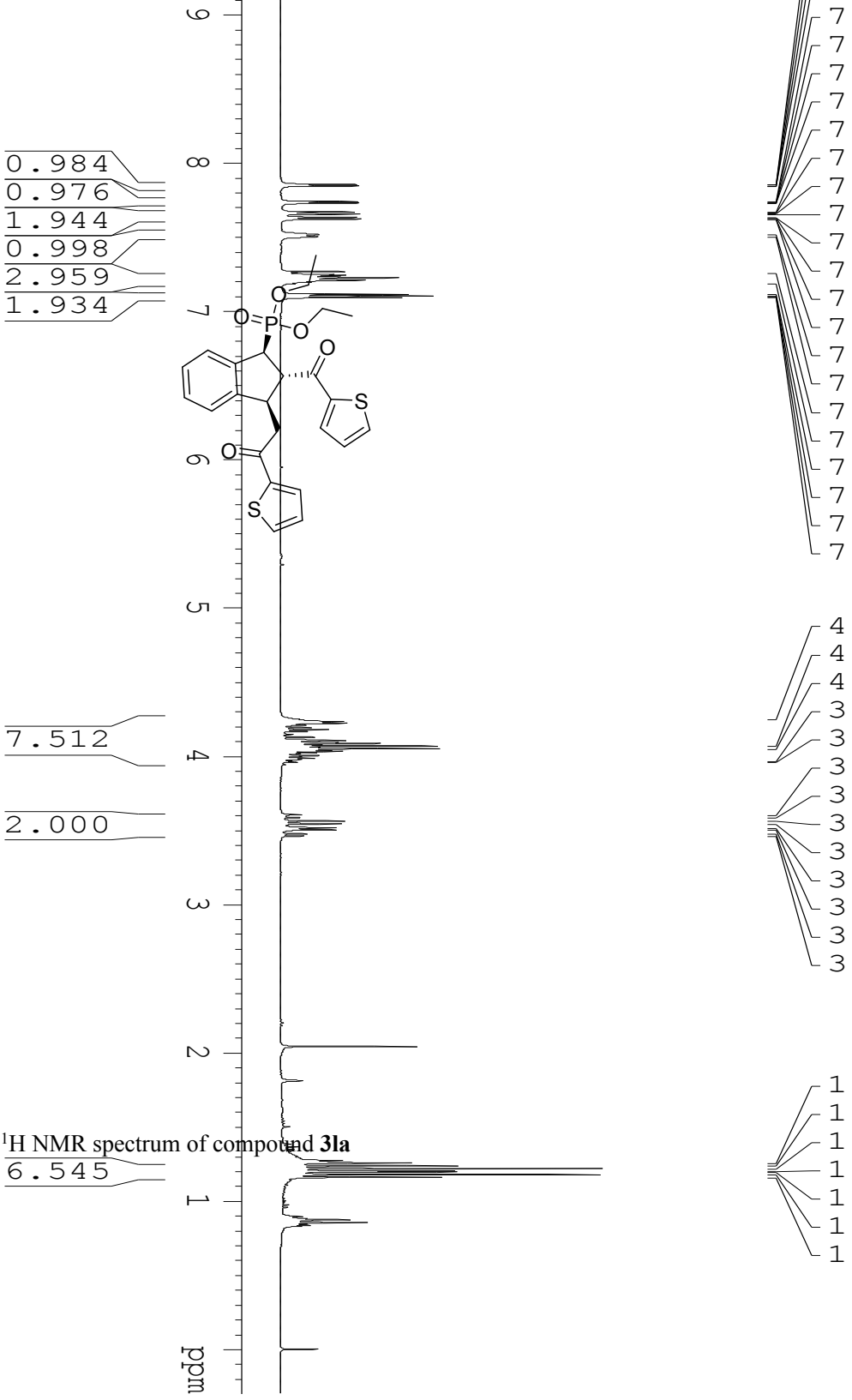
^{1}H NMR spectrum of compound **3ka**



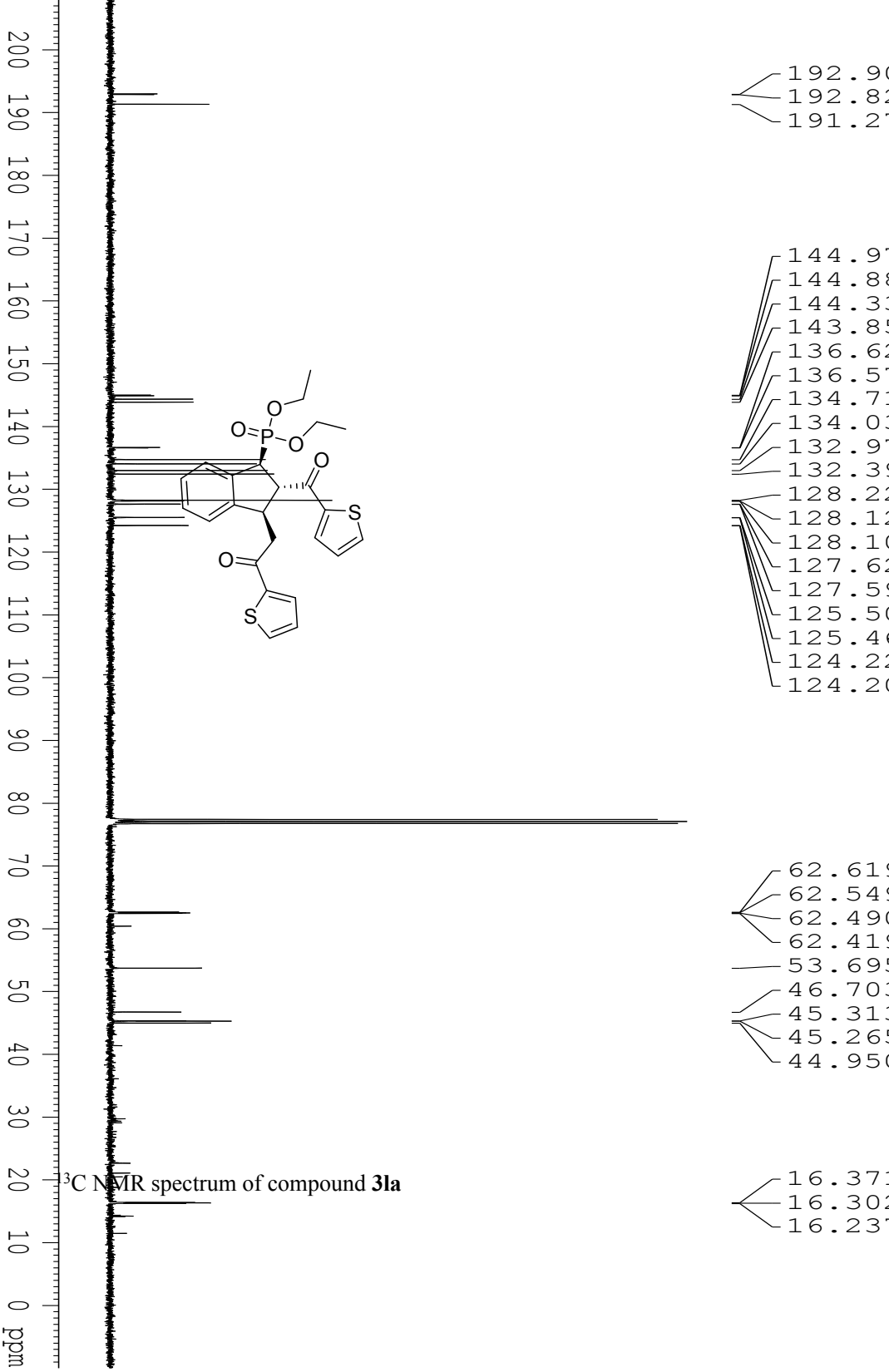
^{13}C NMR ~~spectrum of~~ compound **3ka**



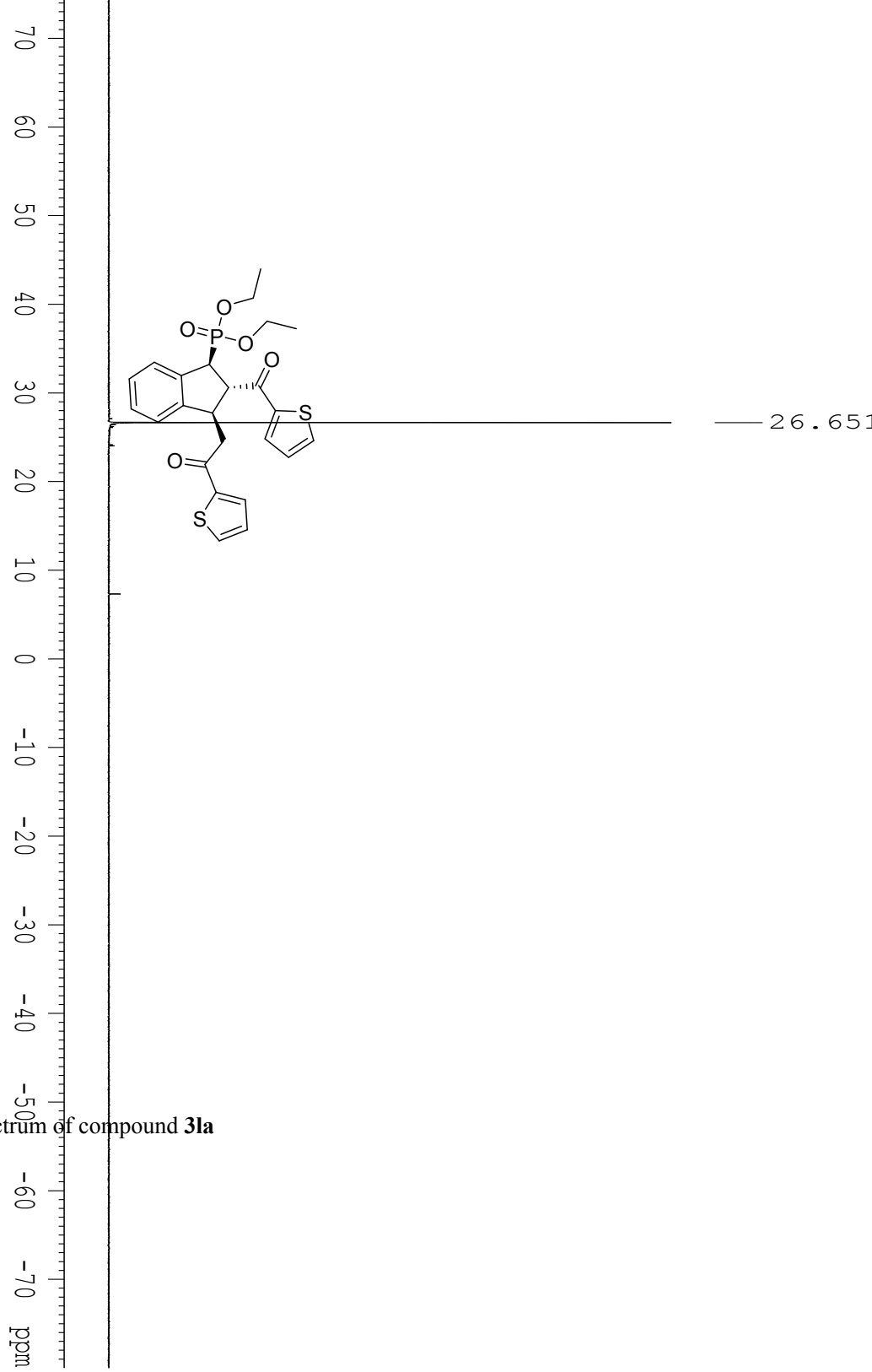
^{31}P NMR spectrum of compound **3ka**



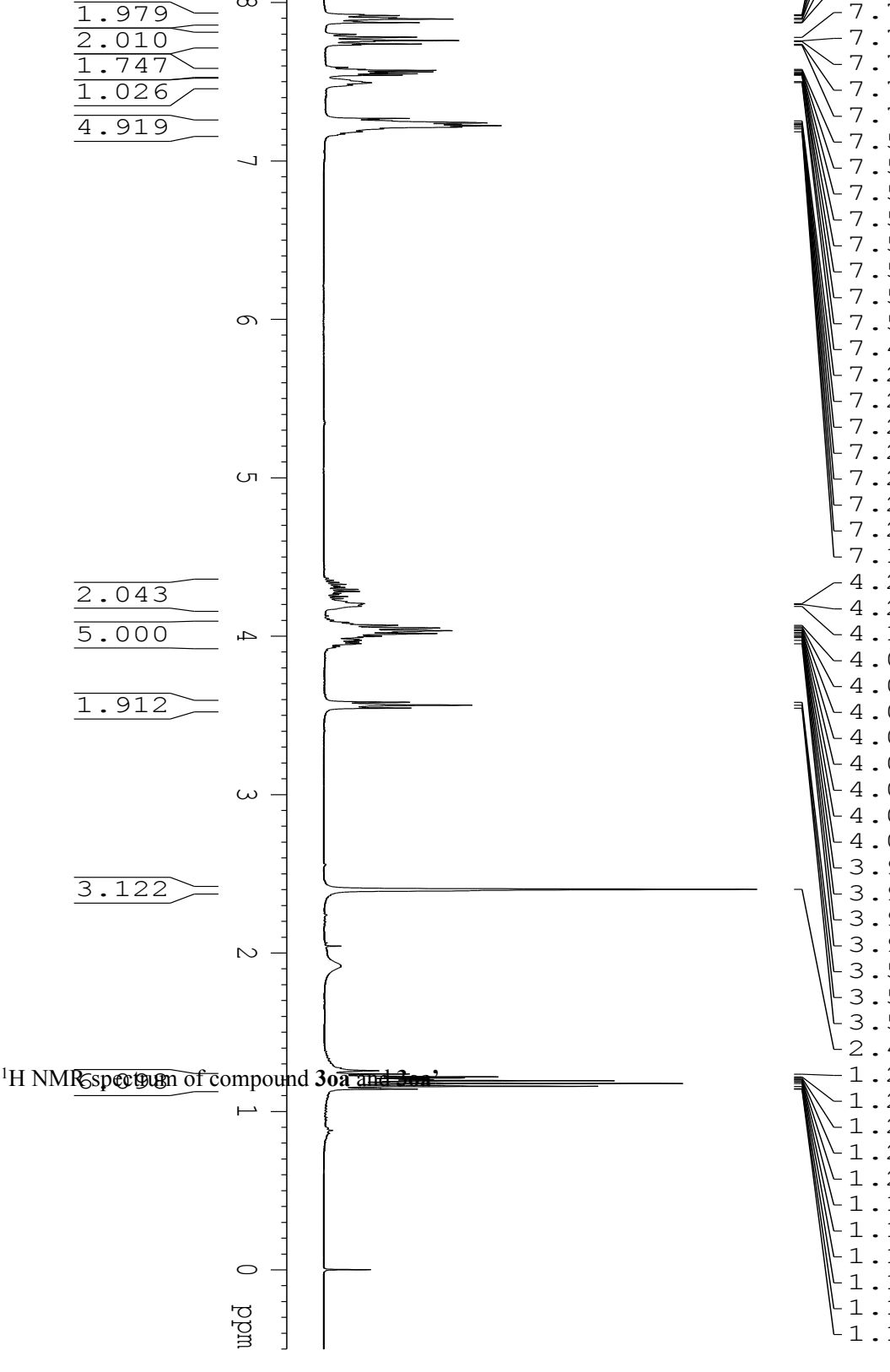
^{1}H NMR spectrum of compound **3la**



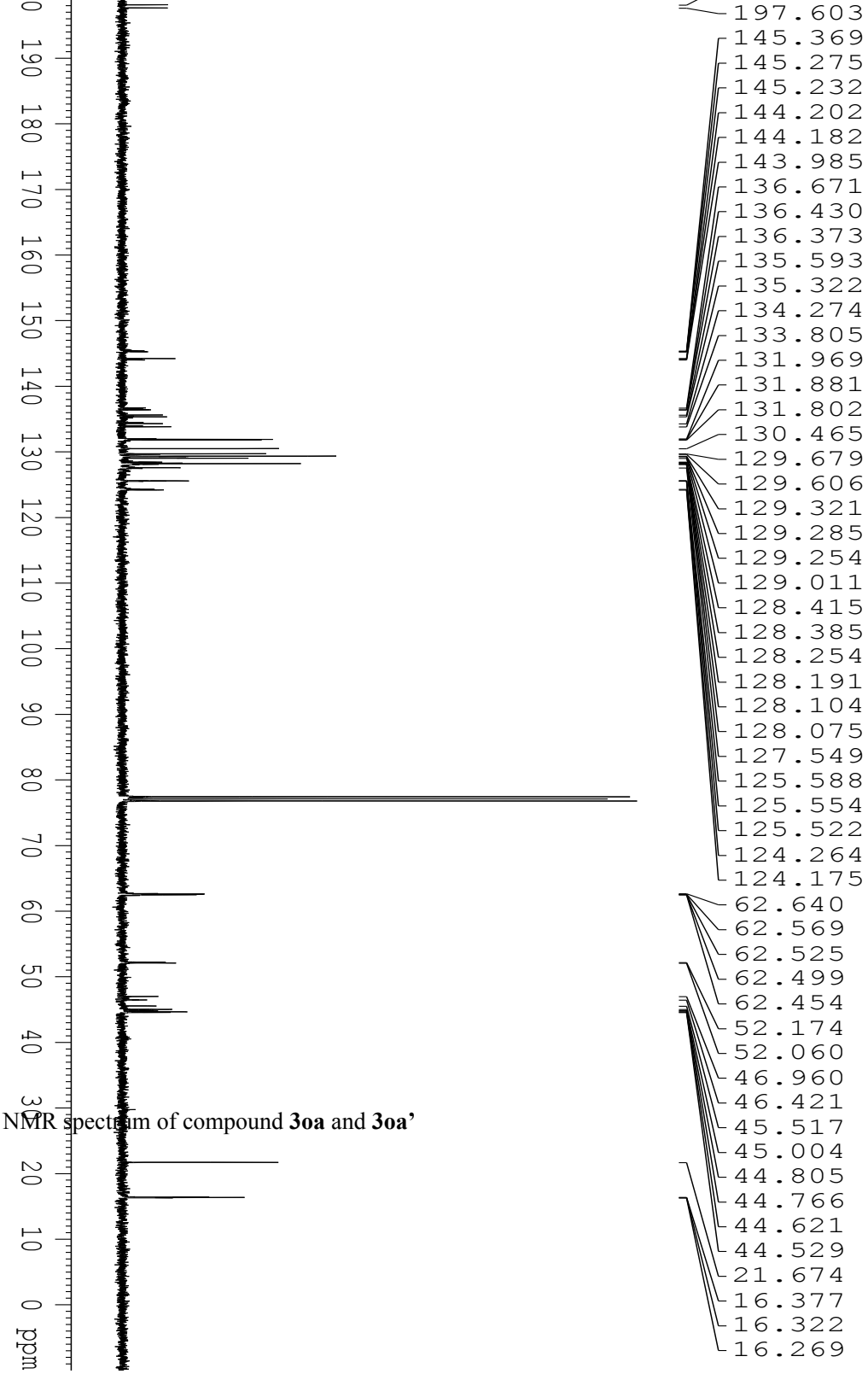
^{13}C NMR spectrum of compound **3la**



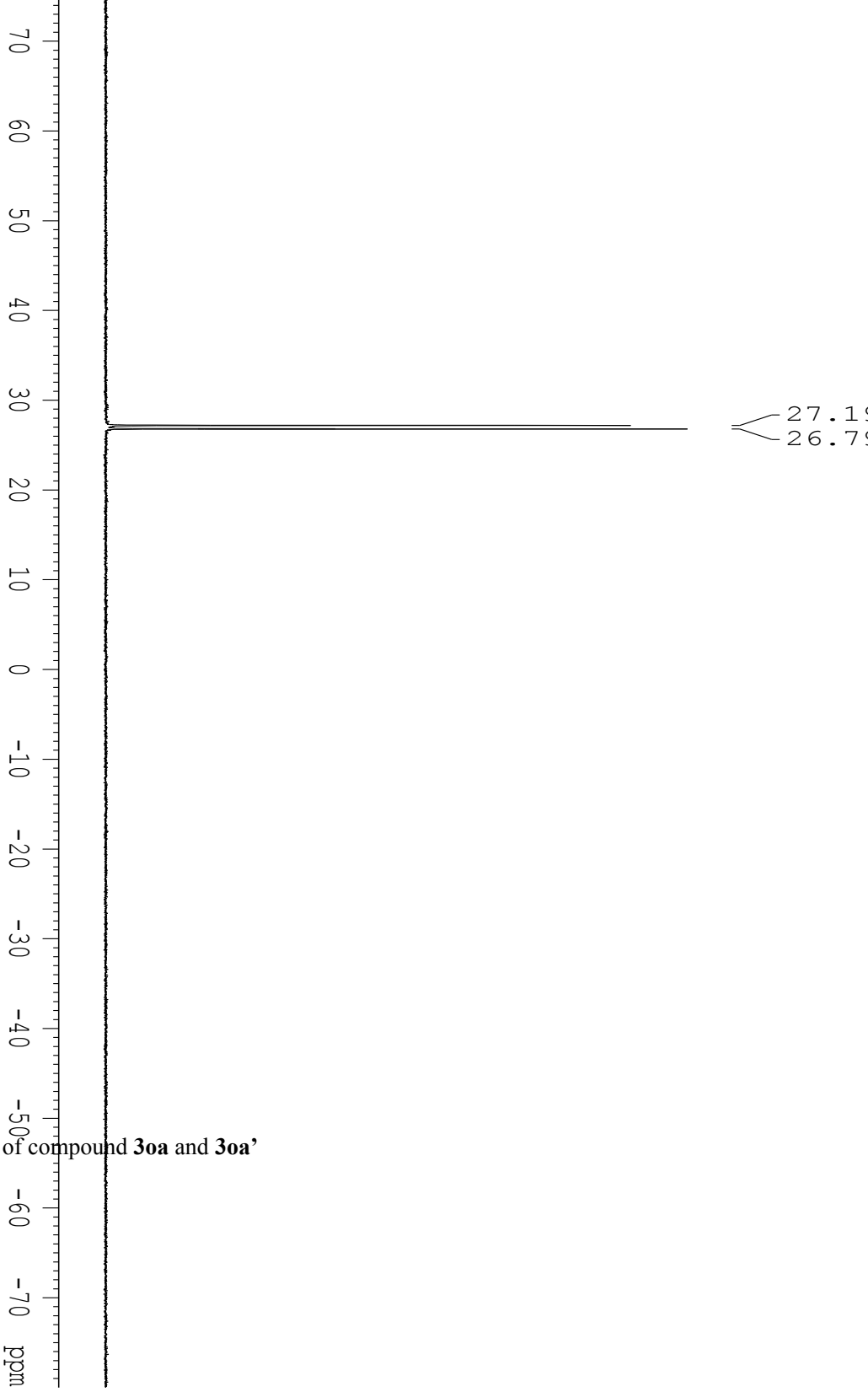
^{31}P NMR spectrum of compound **3la**



^{1}H NMR spectrum of compound **3oa** and ~~**3oa'**~~

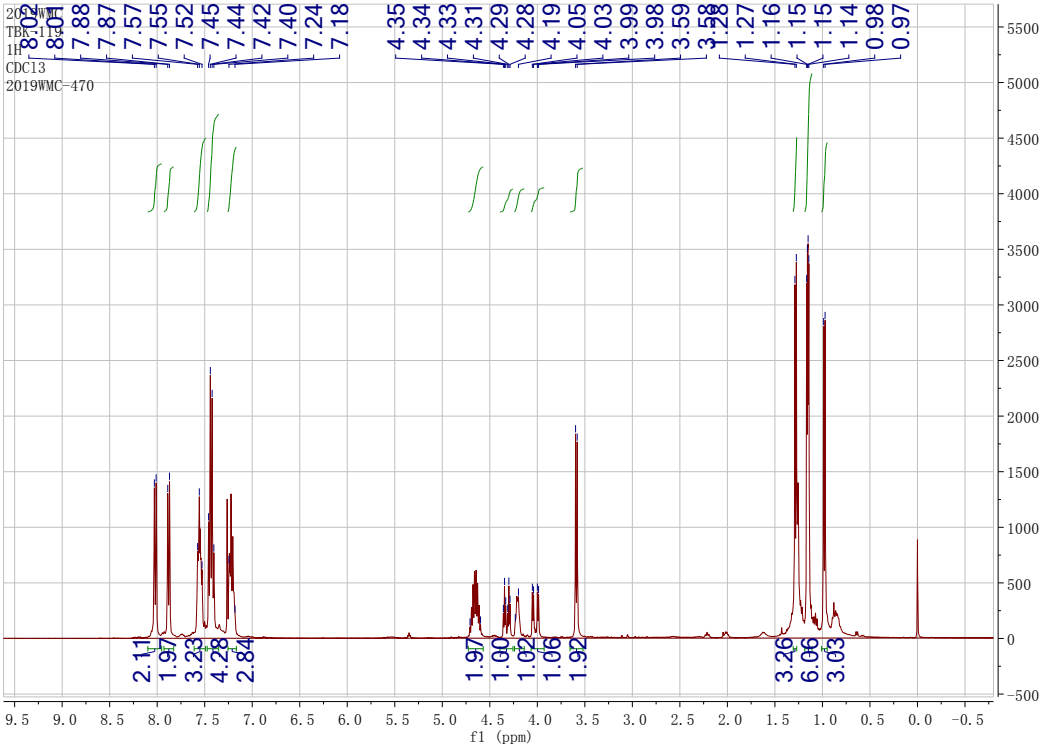


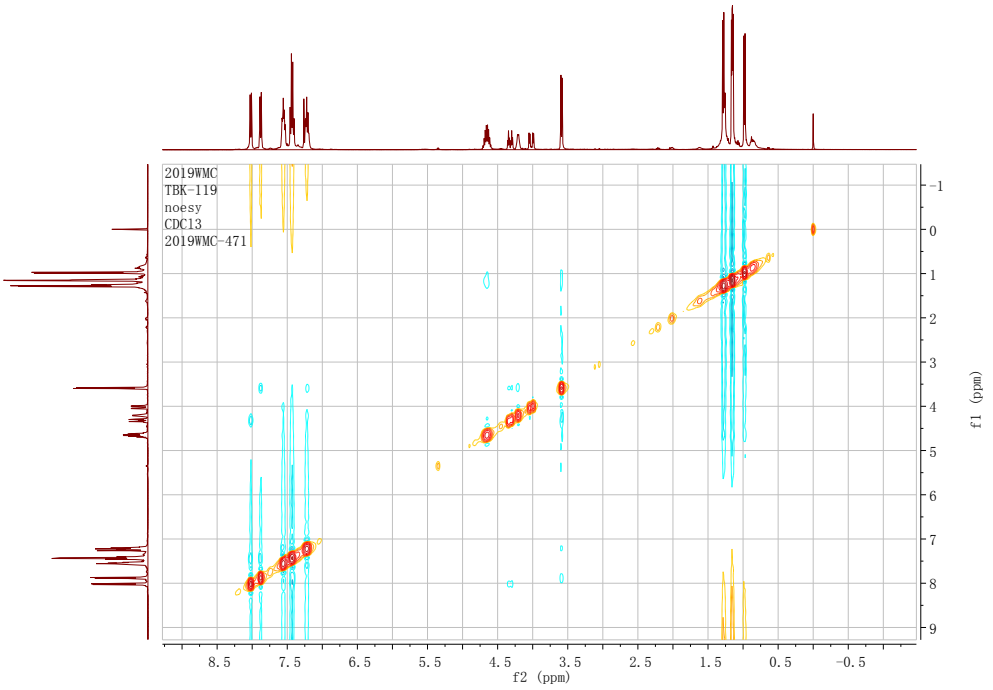
^{13}C NMR spectrum of compound **3oa** and **3oa'**

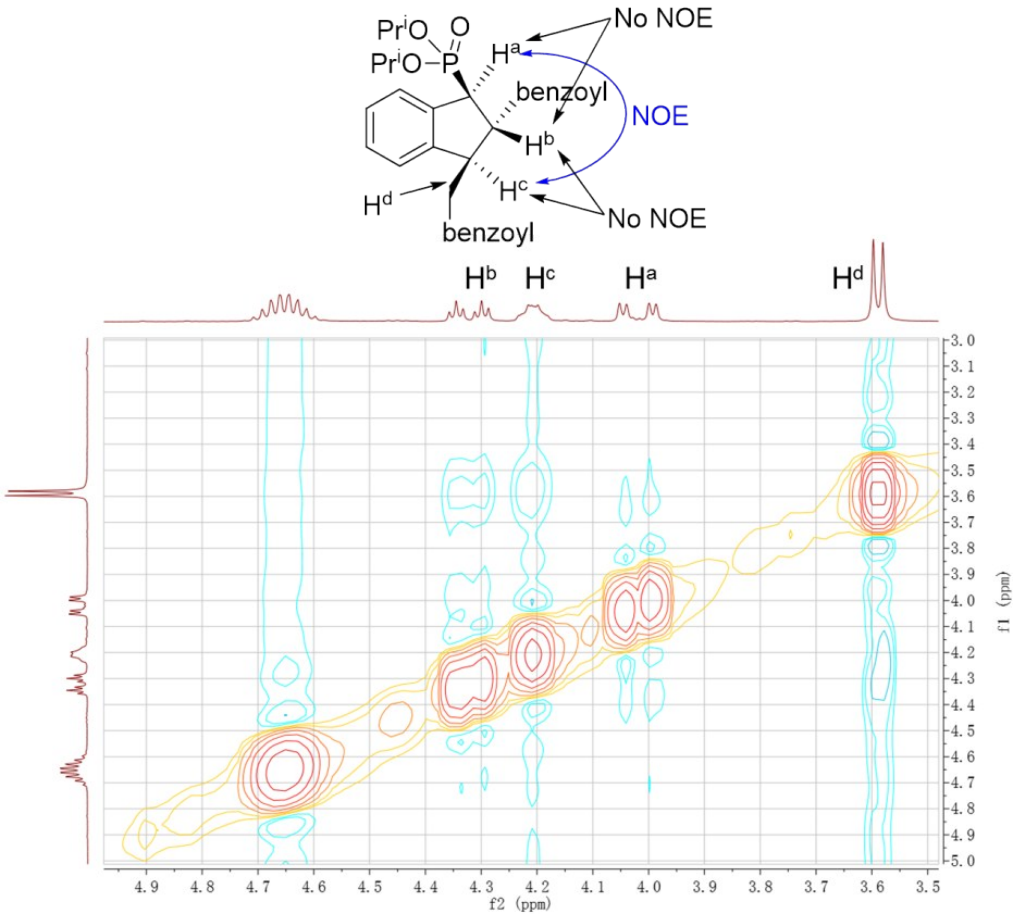


^{31}P NMR spectrum of compound **3oa** and **3oa'**

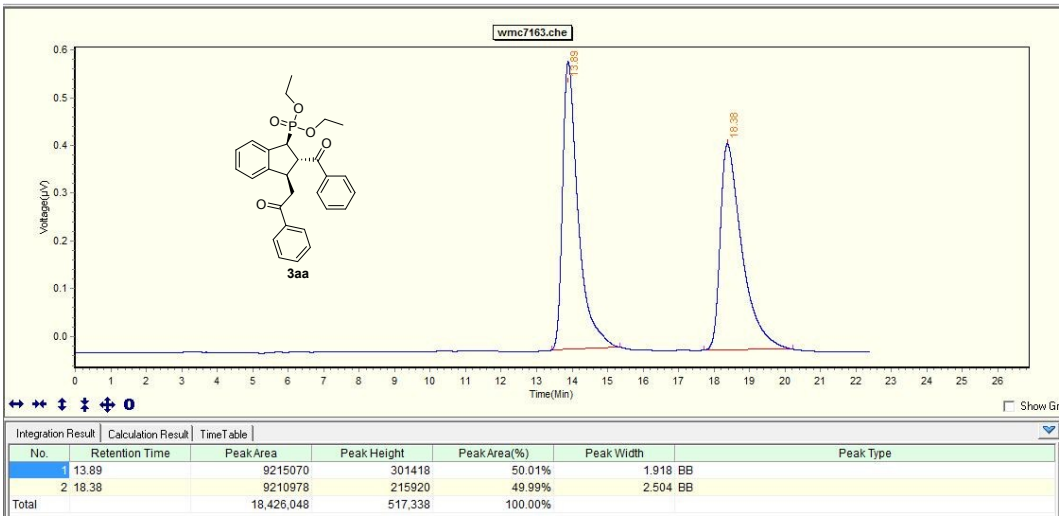
2D Spectra of NOE of 3ac





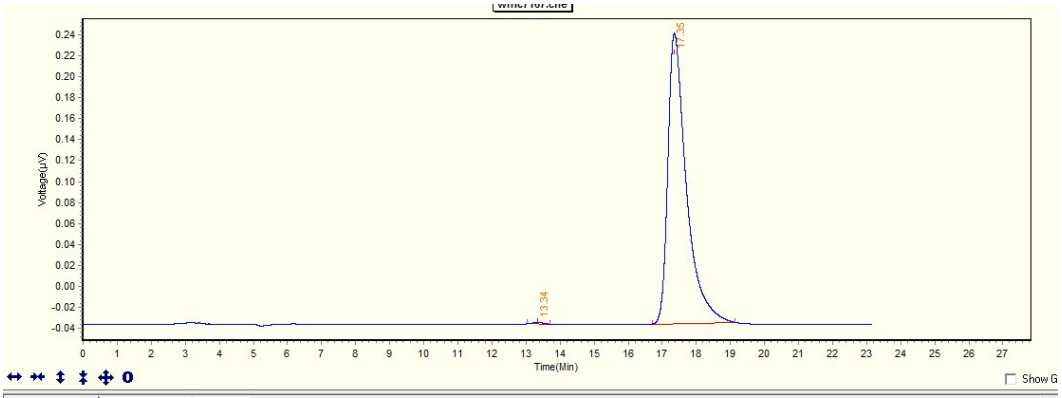

PriO
O
PriO–P
Ha
benzoyl
No NOE
NOE
Hb
Hc
Hd
No NOE
benzoyl
Hb
Hc
Ha
Hd
f2 (ppm)
f1 (ppm)

HPLC Spectra of Compounds 3



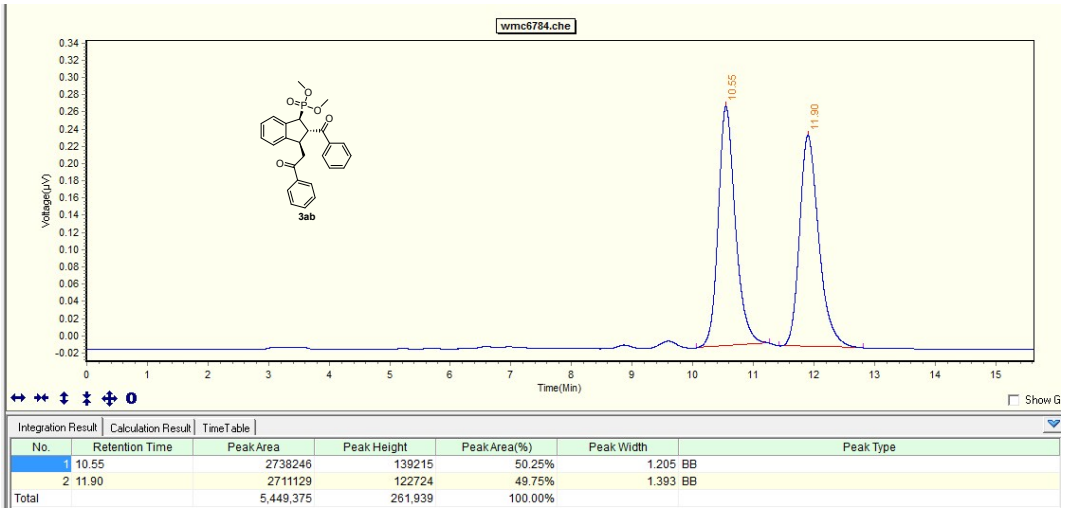
Integration Result | Calculation Result | TimeTable

No.	Retention Time	Peak Area	Peak Height	Peak Area(%)	Peak Width	Peak Type
1	13.89	9215070	301418	50.01%	1.918	BB
2	18.38	9210978	215920	49.99%	2.504	BB
Total		18,426,048	517,338	100.00%		



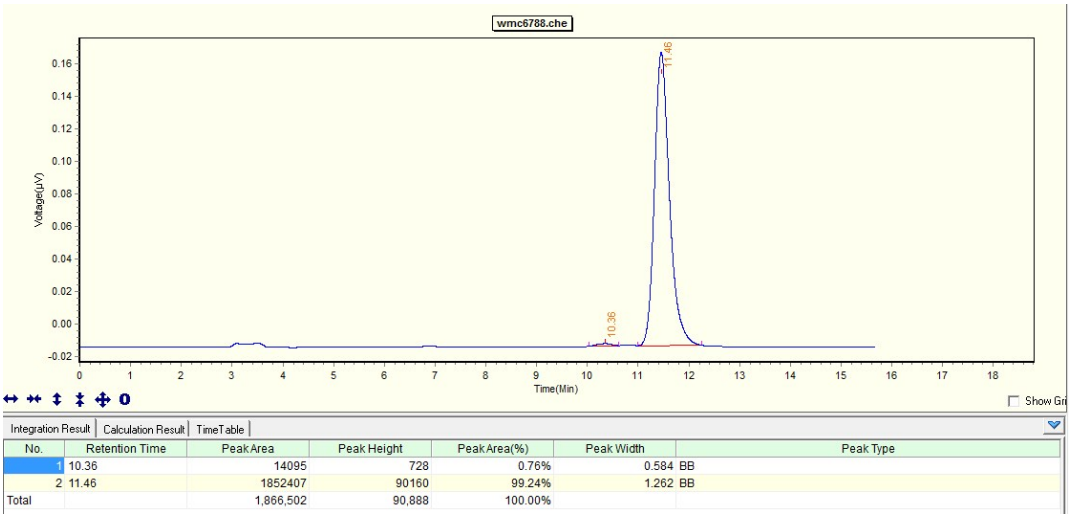
Integration Result | Calculation Result | TimeTable

No.	Retention Time	Peak Area	Peak Height	Peak Area(%)	Peak Width	Peak Type
1	13.34	15572	752	0.30%	0.669	BB
2	17.35	5232384	138358	99.70%	2.423	BB
Total		5,247,956	139,110	100.00%		



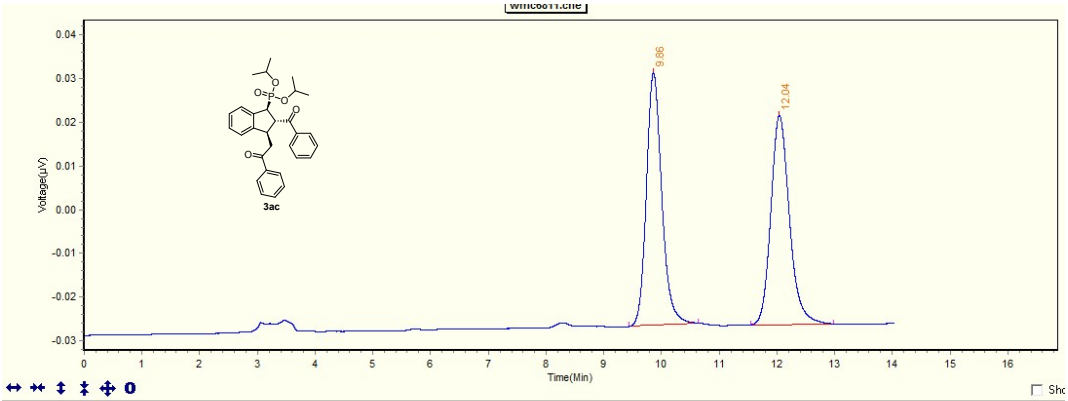
Integration Result | Calculation Result | TimeTable

No.	Retention Time	Peak Area	Peak Height	Peak Area(%)	Peak Width	Peak Type
1	10.55	2738246	139215	50.25%	1.205	BB
2	11.90	2711129	122724	49.75%	1.393	BB
Total		5,449,375	261,939	100.00%		



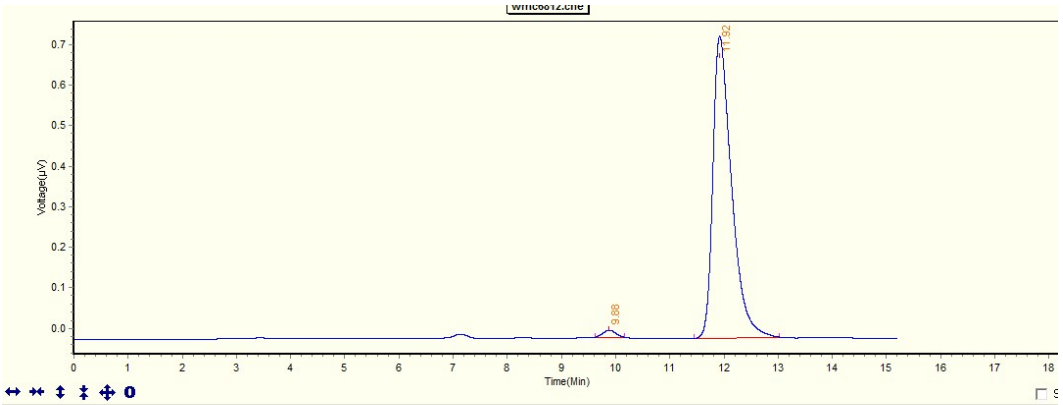
Integration Result | Calculation Result | TimeTable

No.	Retention Time	Peak Area	Peak Height	Peak Area(%)	Peak Width	Peak Type
1	10.36	14095	728	0.76%	0.584	BB
2	11.46	1852407	90160	99.24%	1.262	BB
Total		1,866,502	90,888	100.00%		



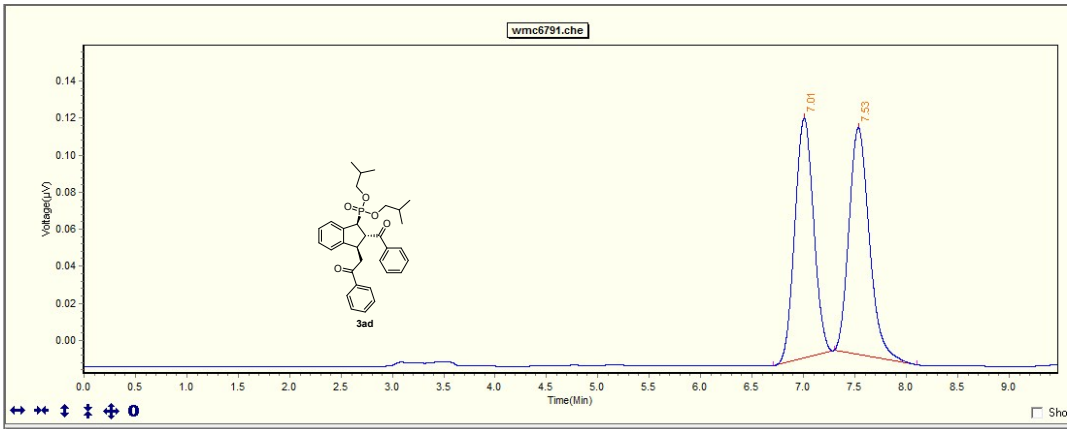
Integration Result | Calculation Result | TimeTable

No.	Retention Time	Peak Area	Peak Height	Peak Area(%)	Peak Width	Peak Type
1	9.86	535526	28923	49.89%	1.198	BB
2	12.04	537791	23998	50.11%	1.435	BB
Total		1,073,317	52,921	100.00%		



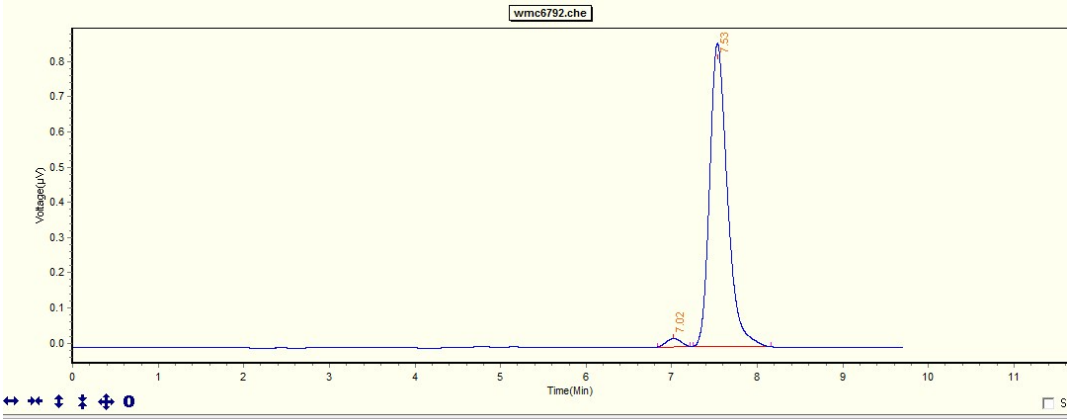
Integration Result | Calculation Result | TimeTable

No.	Retention Time	Peak Area	Peak Height	Peak Area(%)	Peak Width	Peak Type
1	9.88	140912	8697	1.56%	0.542	BB
2	11.92	8914859	371662	98.44%	1.573	BB
Total		9,055,771	380,359	100.00%		



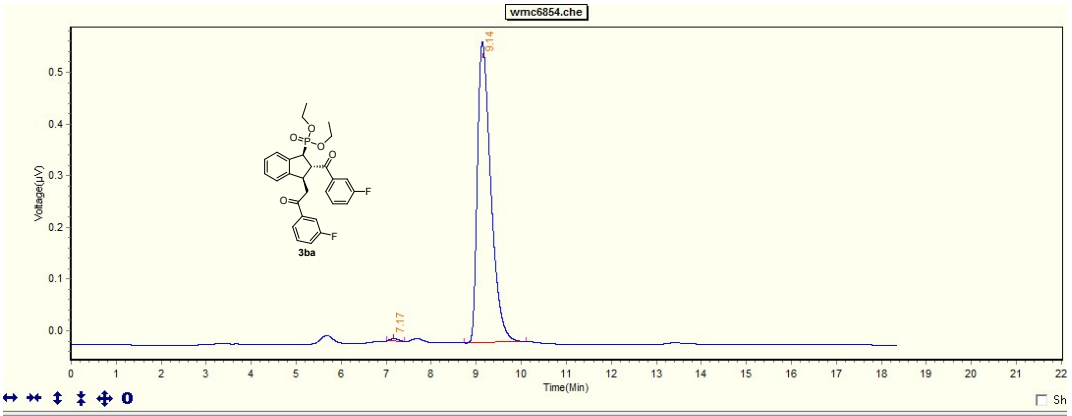
Integration Result | Calculation Result | TimeTable

No.	Retention Time	Peak Area	Peak Height	Peak Area(%)	Peak Width	Peak Type
1	7.53	839434	61111	50.63%	0.802	BB
2	7.01	818554	64604	49.37%	0.595	BB
Total		1,657,988	125,715	100.00%		



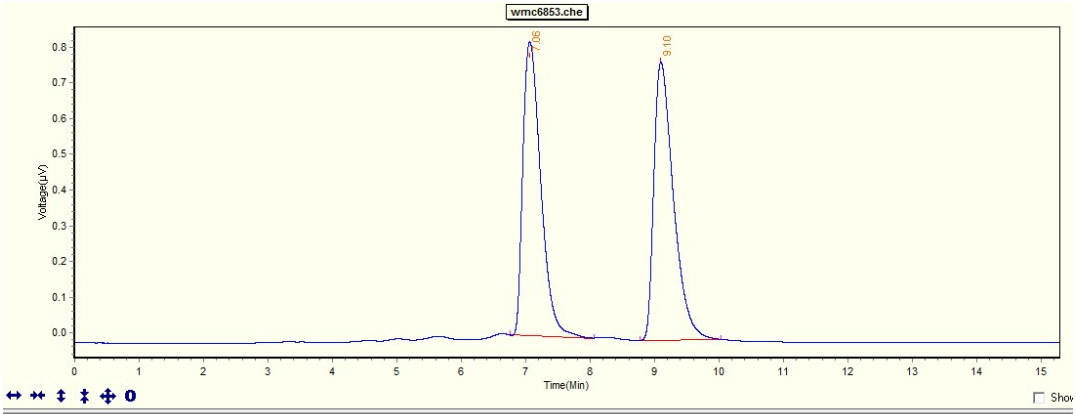
Integration Result | Calculation Result | TimeTable

No.	Retention Time	Peak Area	Peak Height	Peak Area(%)	Peak Width	Peak Type
1	7.02	136568	11787	2.16%	0.381	BB
2	7.53	6192596	430467	97.84%	0.912	BB
Total		6,329,164	442,254	100.00%		



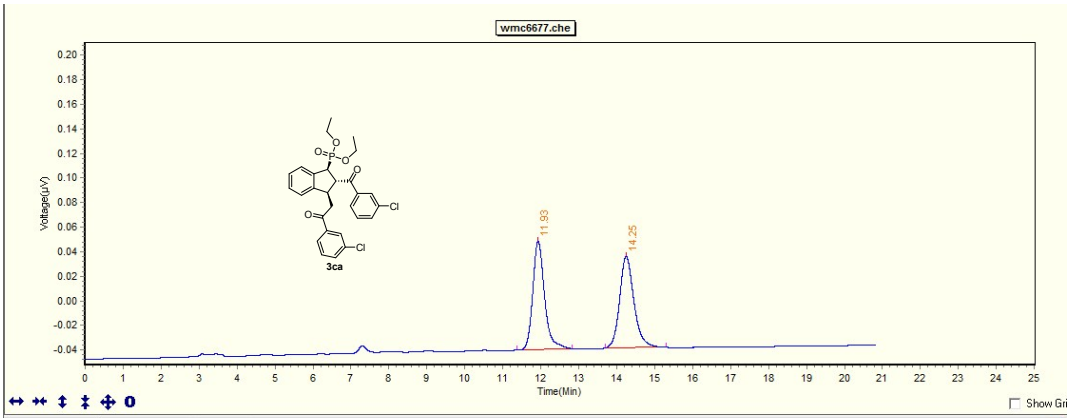
Integration Result | Calculation Result | TimeTable

No.	Retention Time	Peak Area	Peak Height	Peak Area(%)	Peak Width	Peak Type
1	7.17	30286	2270	0.50%	0.392	BB
2	9.14	6015849	290581	99.50%	1.375	BB
Total		6,046,135	292,851	100.00%		



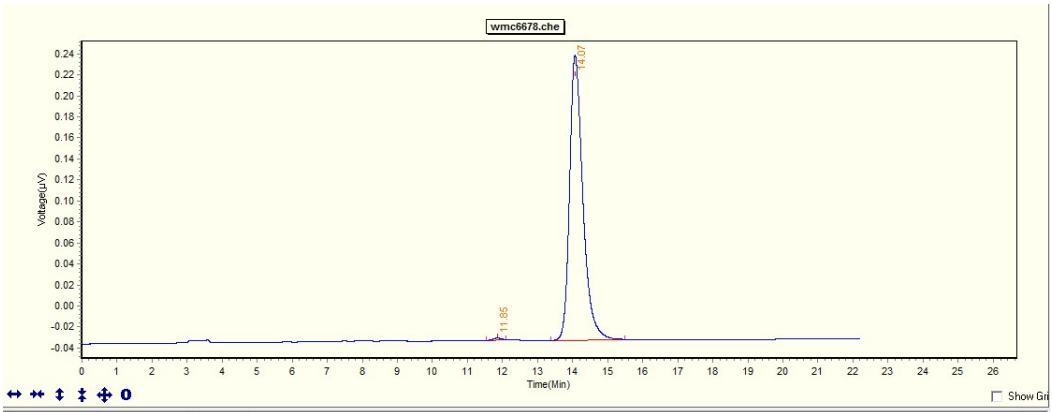
Integration Result | Calculation Result | TimeTable

No.	Retention Time	Peak Area	Peak Height	Peak Area(%)	Peak Width	Peak Type
1	7.06	7933122	411004	49.14%	1.303	BB
2	9.10	8212203	389327	50.86%	1.257	BB
Total		16,145,325	800,331	100.00%		



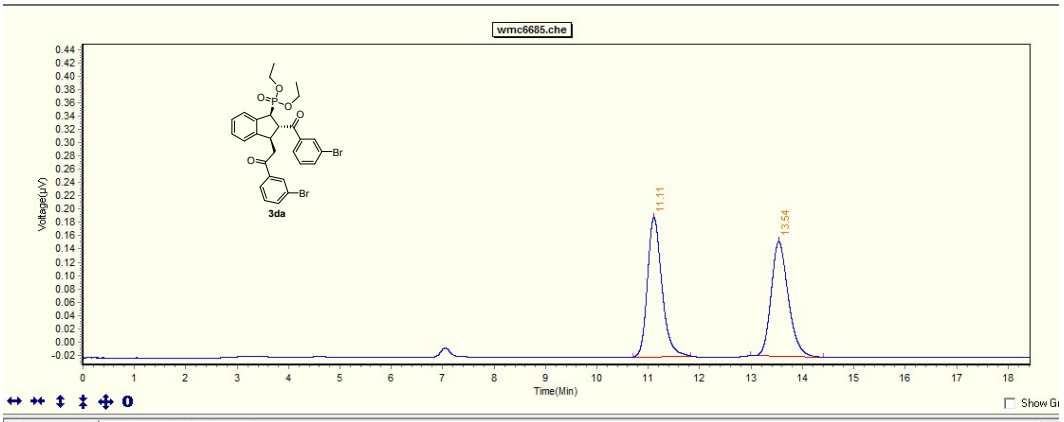
Integration Result | Calculation Result | TimeTable

No.	Retention Time	Peak Area	Peak Height	Peak Area(%)	Peak Width	Peak Type
1	11.93	952752	44033	49.49%	1.453	BB
2	14.25	972416	37134	50.51%	1.603	BB
Total		1,925,168	81,167	100.00%		



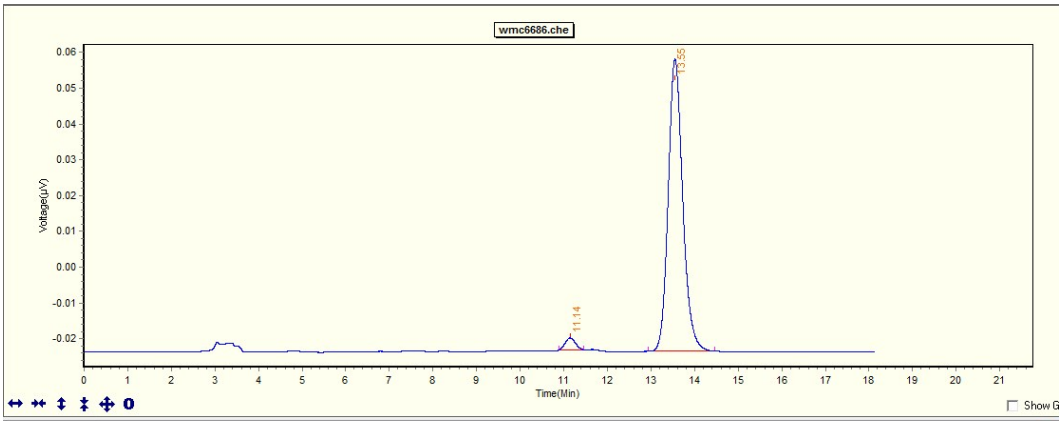
Integration Result | Calculation Result | TimeTable

No.	Retention Time	Peak Area	Peak Height	Peak Area(%)	Peak Width	Peak Type
1	11.85	17059	1005	0.48%	0.561	BB
2	14.07	3566913	135394	99.52%	2.109	BB
Total		3,583,972	136,399	100.00%		



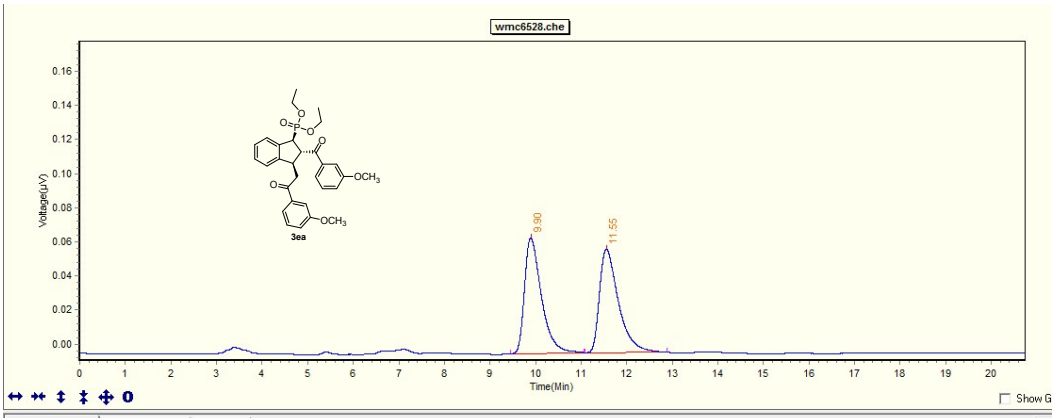
Integration Result | Calculation Result | TimeTable

No.	Retention Time	Peak Area	Peak Height	Peak Area(%)	Peak Width	Peak Type
1	11.11	2036857	104724	50.51%	1.125	BB
2	13.54	1995732	86431	49.49%	1.42	BB
Total		4,032,589	191,155	100.00%		



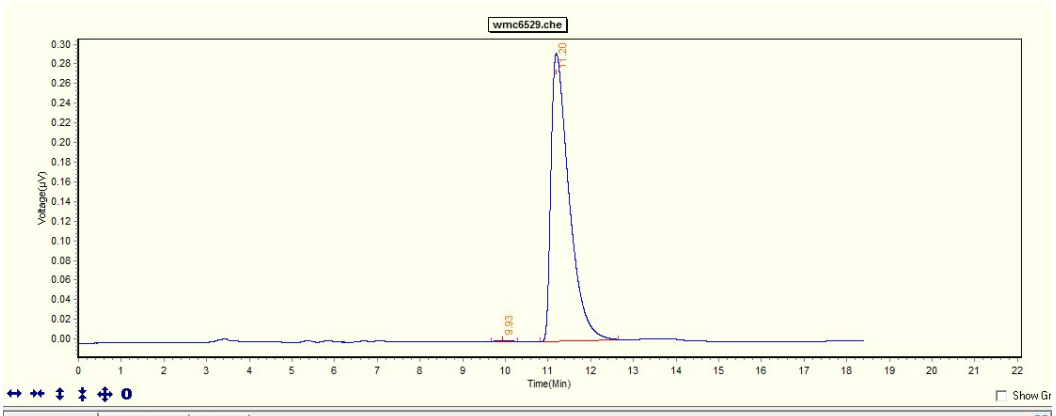
Integration Result | Calculation Result | TimeTable

No.	Retention Time	Peak Area	Peak Height	Peak Area(%)	Peak Width	Peak Type
1	11.14	27255	1669	2.80%	0.567	BB
2	13.55	946381	40800	97.20%	1.524	BB
Total		973,636	42,469	100.00%		



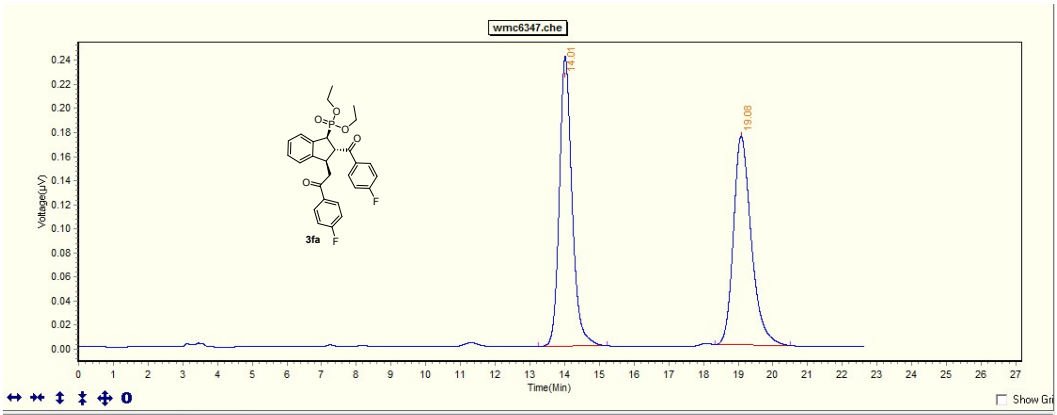
Integration Result | Calculation Result | TimeTable

No.	Retention Time	Peak Area	Peak Height	Peak Area(%)	Peak Width	Peak Type
1	9.90	871868	33879	49.95%	1.613	BB
2	11.55	873440	30260	50.05%	1.799	BB
Total		1,745,308	64,139	100.00%		



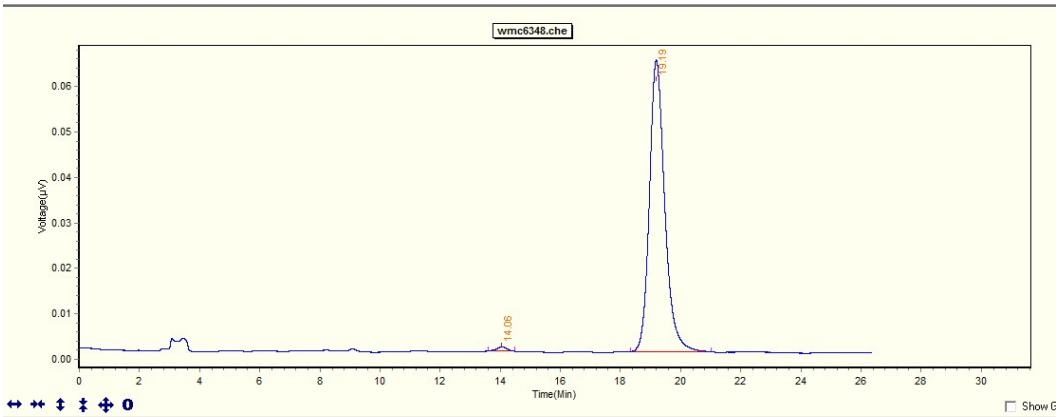
Integration Result | Calculation Result | TimeTable

No.	Retention Time	Peak Area	Peak Height	Peak Area(%)	Peak Width	Peak Type
1	9.93	9409	445	0.22%	0.617	BB
2	11.20	4305995	146417	99.78%	1.828	BB
Total		4,315,404	146,862	100.00%		



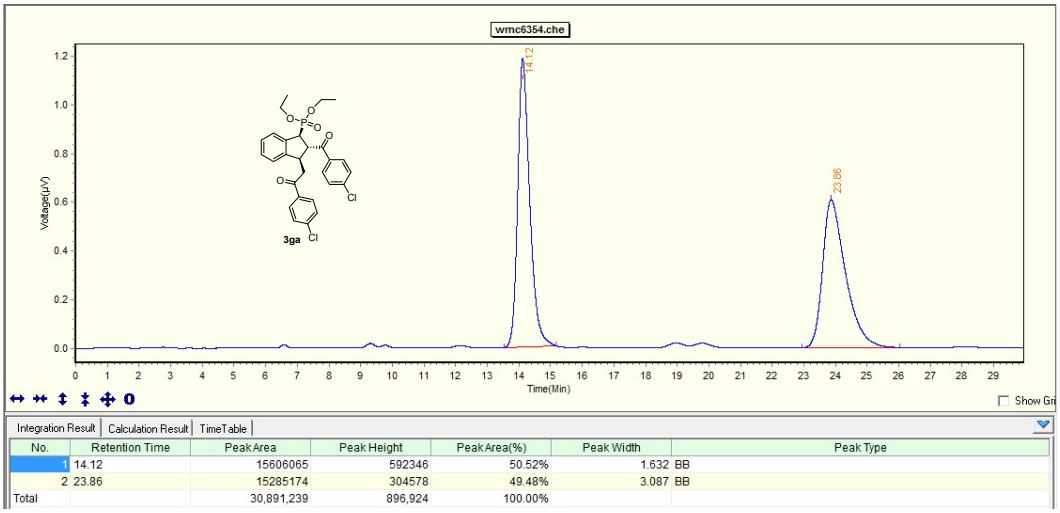
Integration Result | Calculation Result | TimeTable

No.	Retention Time	Peak Area	Peak Height	Peak Area(%)	Peak Width	Peak Type
1	14.01	3064569	120235	49.75%	1.978	BB
2	19.08	3095903	86691	50.25%	2.167	BB
Total		6,160,472	206,926	100.00%		



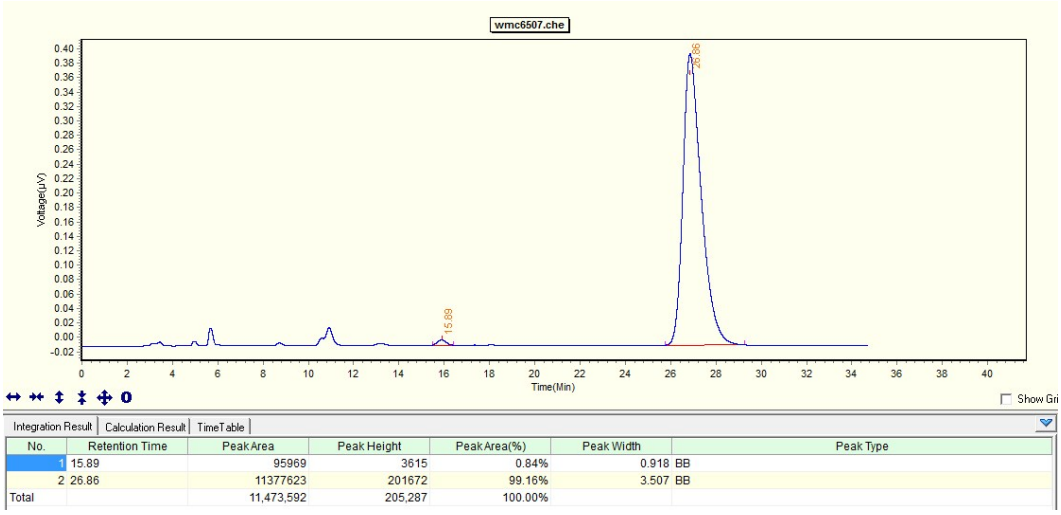
Integration Result | Calculation Result | TimeTable

No.	Retention Time	Peak Area	Peak Height	Peak Area(%)	Peak Width	Peak Type
1	14.06	11169	452	0.97%	0.883	BB
2	19.19	1138023	32046	99.03%	2.682	BB
Total		1,149,192	32,498	100.00%		



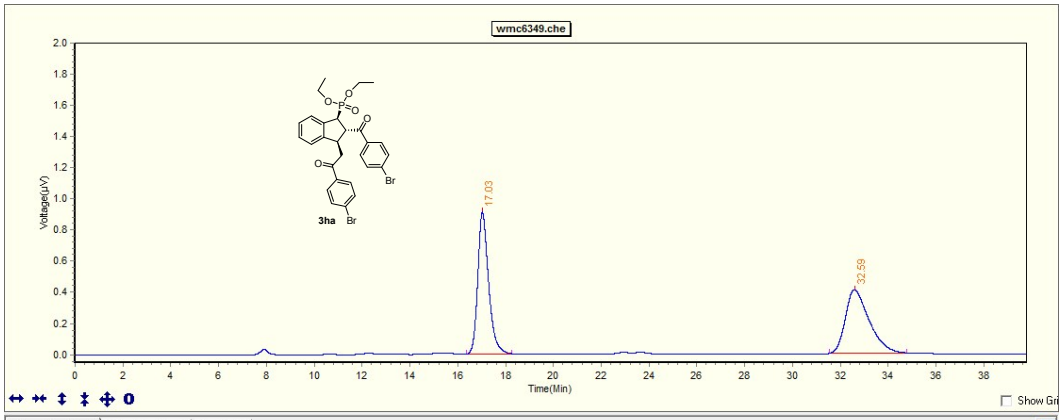
Integration Result | Calculation Result | TimeTable

No.	Retention Time	Peak Area	Peak Height	Peak Area(%)	Peak Width	Peak Type
1	14.12	15606065	592346	50.52%	1.632	BB
2	23.86	15285174	304578	49.48%	3.087	BB
Total		30,891,239	896,924	100.00%		



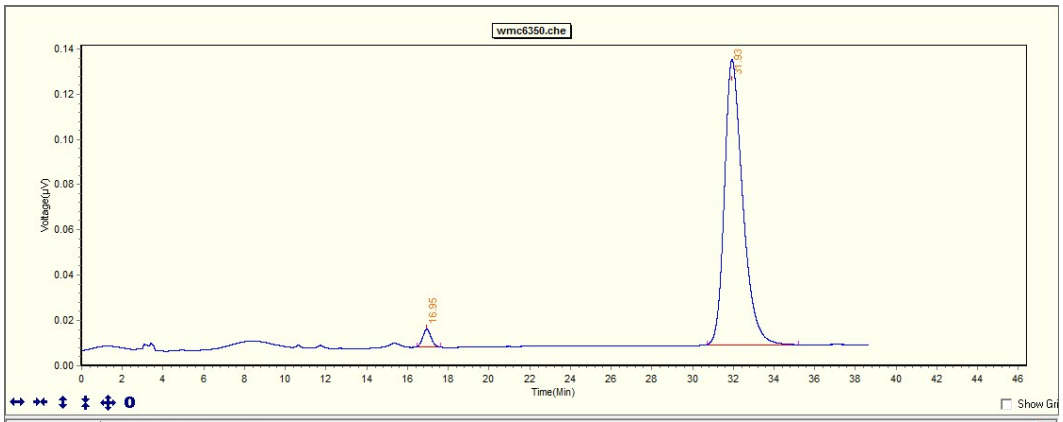
Integration Result | Calculation Result | TimeTable

No.	Retention Time	Peak Area	Peak Height	Peak Area(%)	Peak Width	Peak Type
1	15.89	95969	3615	0.84%	0.918	BB
2	26.86	11377623	201672	99.16%	3.507	BB
Total		11,473,592	205,287	100.00%		



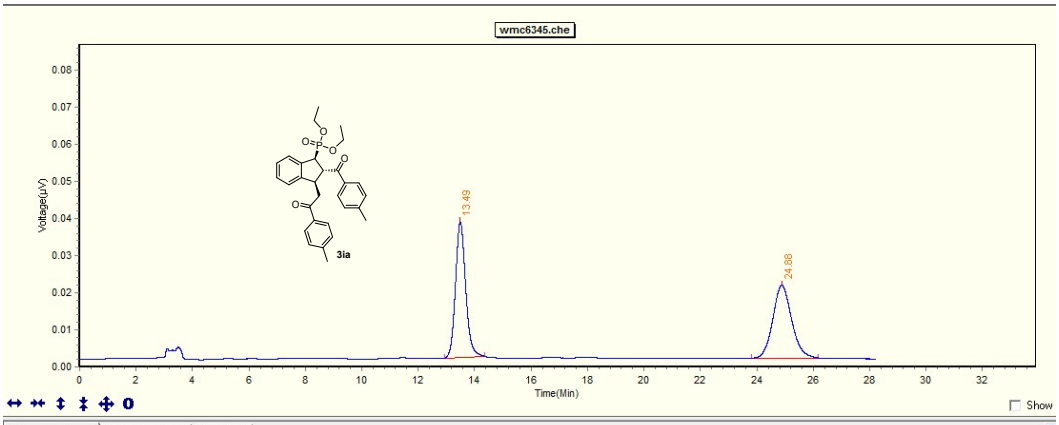
Integration Result | Calculation Result | TimeTable

No.	Retention Time	Peak Area	Peak Height	Peak Area(%)	Peak Width	Peak Type
1	17.03	14253425	454693	50.45%	1.893	BB
2	32.59	13996591	204248	49.55%	3.233	BB
Total		28,250,016	658,941	100.00%		



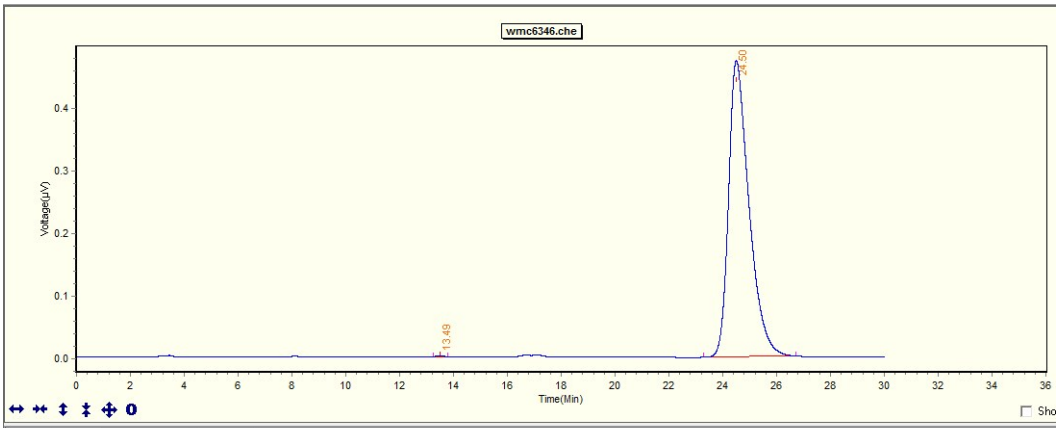
Integration Result | Calculation Result | TimeTable

No.	Retention Time	Peak Area	Peak Height	Peak Area(%)	Peak Width	Peak Type
1	16.95	109340	3883	2.70%	1.156	BB
2	31.93	3935474	62972	97.30%	4.487	BB
Total		4,044,814	66,855	100.00%		



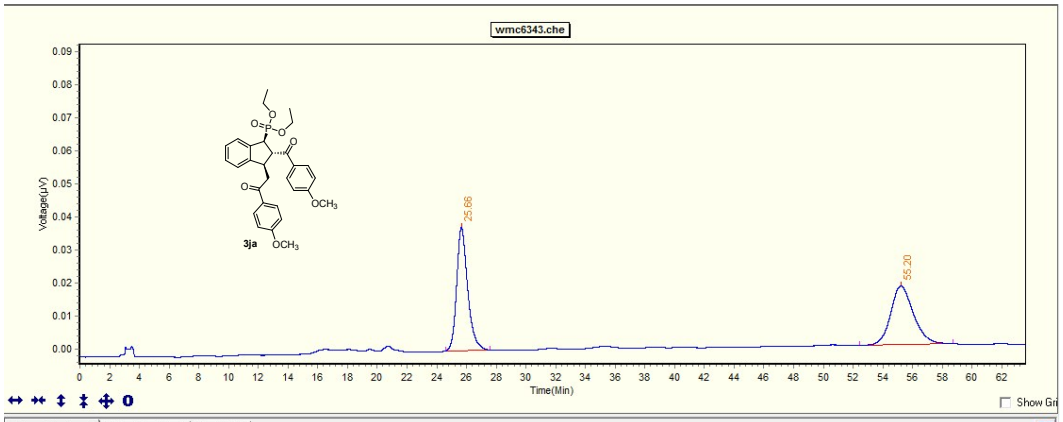
Integration Result | Calculation Result | TimeTable

No.	Retention Time	Peak Area	Peak Height	Peak Area(%)	Peak Width	Peak Type
1	13.49	457317	18274	50.18%	1.419	BB
2	24.88	454034	9821	49.82%	2.364	BB
Total		911,351	28,095	100.00%		



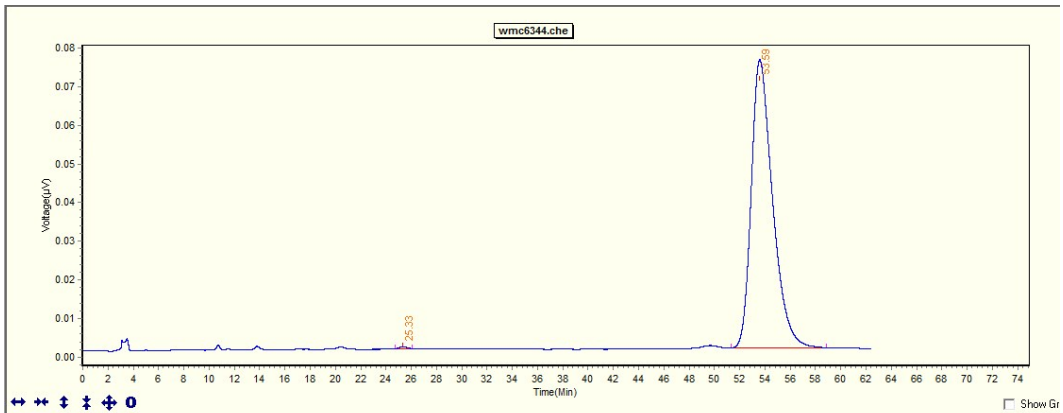
Integration Result | Calculation Result | TimeTable

No.	Retention Time	Peak Area	Peak Height	Peak Area(%)	Peak Width	Peak Type
1	13.49	16545	913	0.13%	0.536	BB
2	24.50	12506287	236678	99.87%	3.428	BB
Total		12,522,832	237,591	100.00%		



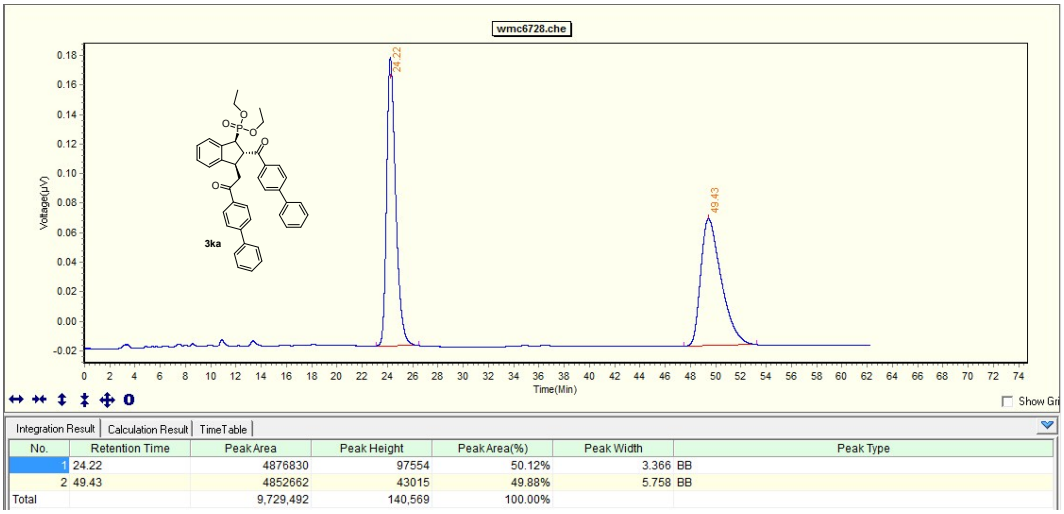
Integration Result | Calculation Result | TimeTable

No.	Retention Time	Peak Area	Peak Height	Peak Area(%)	Peak Width	Peak Type
1	25.66	958498	18616	50.29%	2.981	BB
2	55.20	947470	8891	49.71%	6.278	BB
Total		1,905,968	27,507	100.00%		



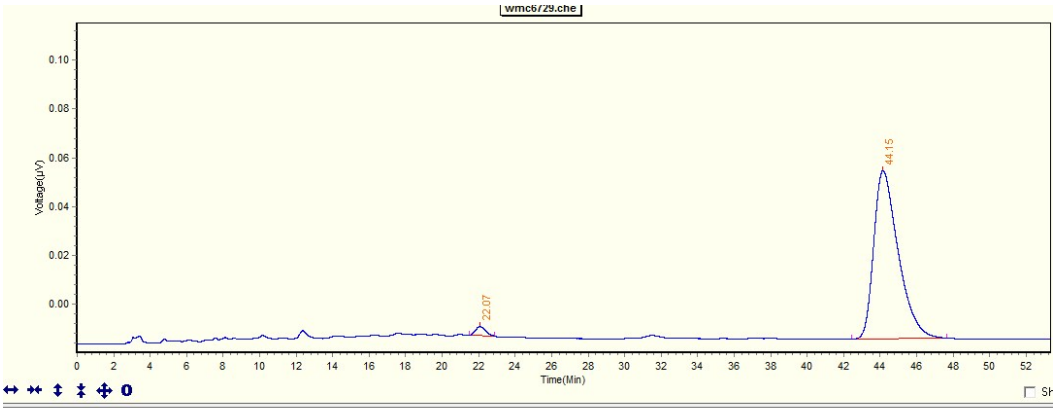
Integration Result | Calculation Result | TimeTable

No.	Retention Time	Peak Area	Peak Height	Peak Area(%)	Peak Width	Peak Type
1	25.33	10639	261	0.24%	1.345	BB
2	53.59	4387566	37340	99.76%	7.544	BB
Total		4,398,205	37,601	100.00%		



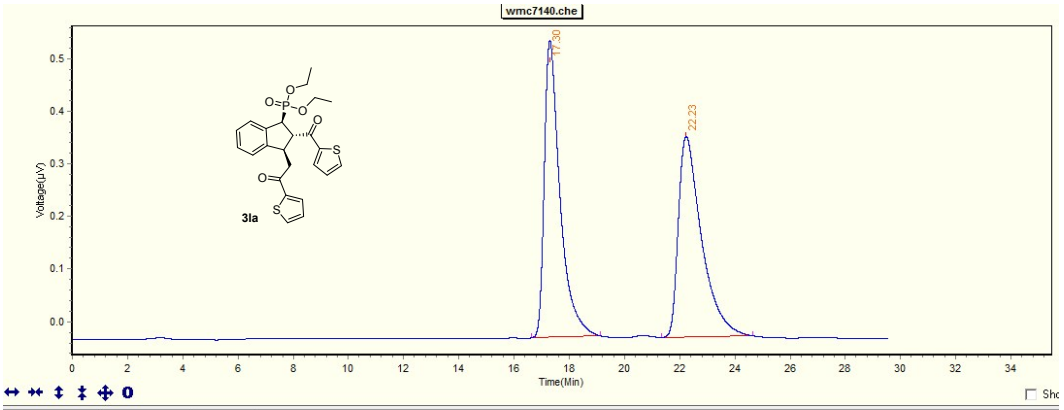
Integration Result | Calculation Result | TimeTable

No.	Retention Time	Peak Area	Peak Height	Peak Area(%)	Peak Width	Peak Type
1	24.22	4876830	97554	50.12%	3.366	BB
2	49.43	4852662	43015	49.88%	5.758	BB
Total		9,729,492	140,569	100.00%		



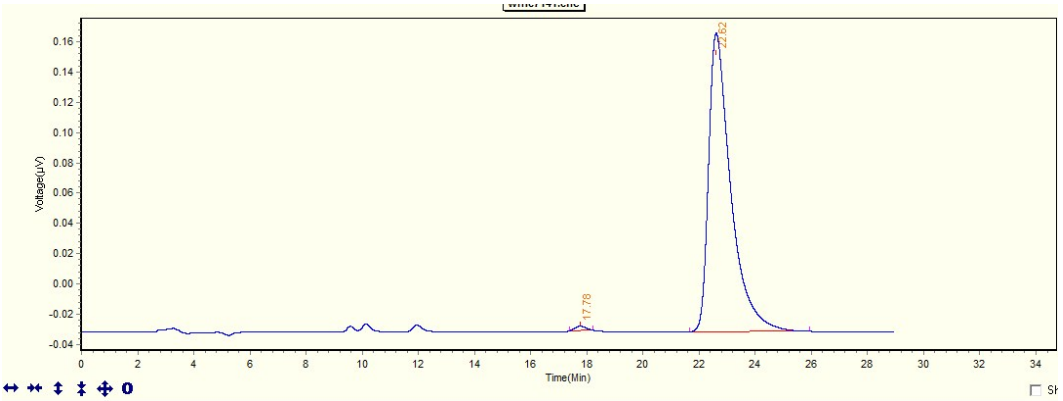
Integration Result | Calculation Result | TimeTable

No.	Retention Time	Peak Area	Peak Height	Peak Area(%)	Peak Width	Peak Type
1	22.07	70848	1848	2.16%	1.383	BB
2	44.15	3212319	34472	97.84%	5.212	BB
Total		3,283,167	36,320	100.00%		



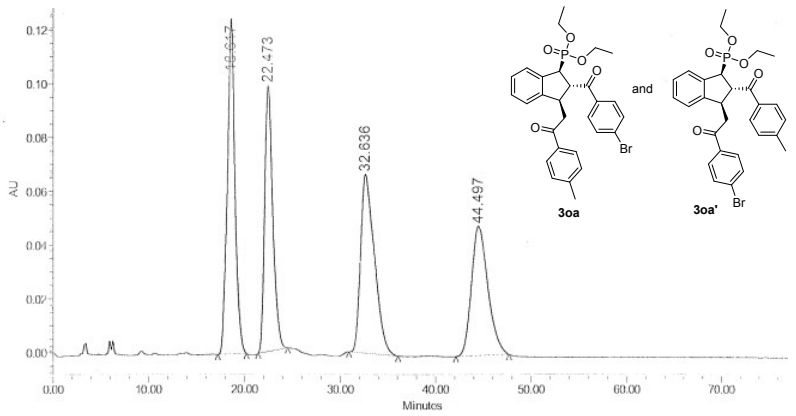
Integration Result | Calculation Result | TimeTable

No.	Retention Time	Peak Area	Peak Height	Peak Area(%)	Peak Width	Peak Type
1	17.30	11166195	282410	50.00%	2.497	BB
2	22.23	11164676	191227	50.00%	3.305	BB
Total		22,330,871	473,637	100.00%		

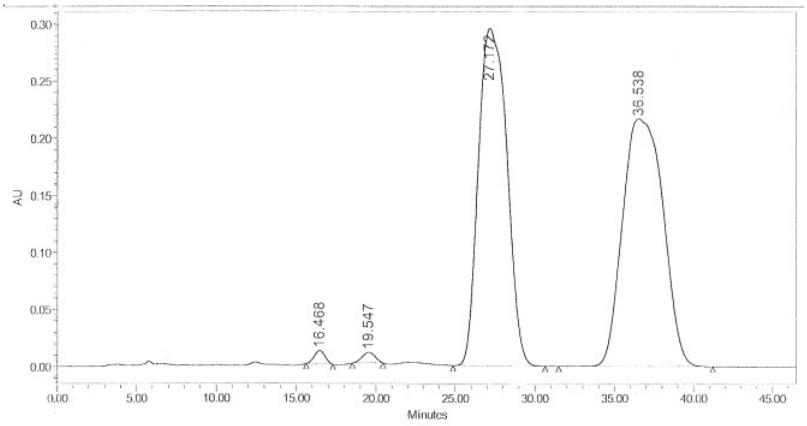


Integration Result | Calculation Result | TimeTable

No.	Retention Time	Peak Area	Peak Height	Peak Area(%)	Peak Width	Peak Type
1	17.78	39602	1444	0.72%	0.834	BB
2	22.62	5439365	98755	99.28%	4.278	BB
Total		5,478,967	100,199	100.00%		



	RT (min)	Area (μV*sec)	% Area	Height (μV)	% Height
1	18.617	6921511	27.27	124661	36.83
2	22.473	5837982	23.00	98999	29.25
3	32.636	6774304	26.69	66552	19.66
4	44.497	5849981	23.05	48291	14.27



	RT (min)	Area (μV*sec)	% Area	Height (μV)	% Height
1	16.468	544317	0.71	11741	2.20
2	19.547	529352	0.69	9310	1.74
3	27.172	37004340	48.21	295589	55.40
4	36.538	38679226	50.39	216922	40.66