Synthesis, Resolution and VCD Analysis of an Enantiopure Diazaoxatricornan Derivative

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Supporting Information

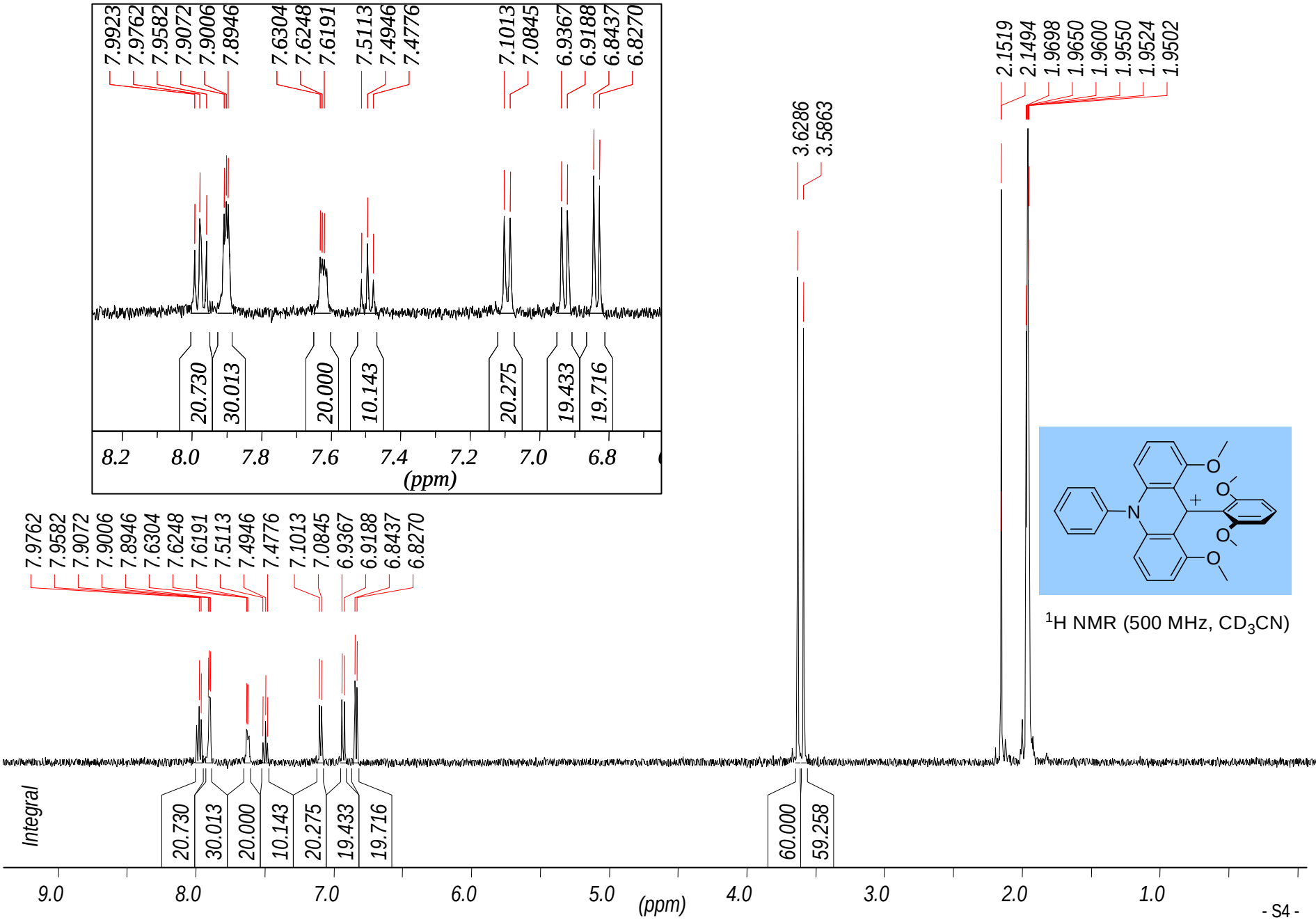
Complete Ref. 24, Frisch, M. J.; Trucks, G. W.; Schlegel, H. B.; Scuseria, G. E.; Robb, M. A.; Cheeseman, J. R.; Montgomery, J. A.; Vreven, T.; Kudin, K. N.; Burant, J. C.; Millam, J. M.; Iyengar, S. S.; Tomasi, J.; Barone, V.; Mennucci, B.; Cossi, M.; Scalmani, G.; Rega, N.; Petersson, G. A.; Nakatsuji, H.; Hada, M.; Ehara, M.; Toyota, K.; Fukuda, R.; Hasegawa, J.; Ishida, M.; Nakajima, T.; Honda, Y.; Kitao, O.; Nakai, H.; Klene, M.; Li, X.; Knox, J. E.; Hratchian, H. P.; Cross, J. B.; Adamo, C.; Jaramillo, J.; Gomperts, R.; Stratmann, R. E.; Yazyev, O.; Austin, A. J.; Cammi, R.; Pomelli, C.; Ochterski, J. W.; Ayala, P. Y.; Morokuma, K.; Voth, G. A.; Salvador, P.; Dannenberg, J. J.; Zakrzewski, V. G.; Dapprich, S.; Daniels, A. D.; Strain, M. C.; Farkas, O.; Malick, D. K.; Rabuck, A. D.; Raghavachari, K.; Foresman, J. B.; Ortiz, J. V.; Cui, Q.; Baboul, A. G.; Clifford, S.; Cioslowski, J.; Stefanov, B. B.; Liu, G.; Liashenko, A.; Piskorz, P.; Komaromi, I.; Martin, R. L.; Fox, D. J.; Keith, T.; Al-Laham, M. A.; Peng, C. Y.; Nanayakkara, A.; Challacombe, M.; Gill, P. M. W.; Johnson, B.; Chen, W.; Wong, M. W.; Gonzalez, C.; Pople, J. A. In; Rev. C.01 ed.; Gaussian, Inc.: Wallingford CT, 2003;

1. General Remarks: Otherwise stated solvents and chemicals were purchased and used as received. NMR spectra were recorded on a AMX-300 and 400 MHz apparatus at room temperature (25 °C). ^{1}H-NMR: chemical shifts are given in ppm relative to Me_4Si with the solvent resonance used as the internal standard (CD_3CN δ = 1.94 ppm; $CDCl_3$ δ = 7.26 ppm). Data were reported as follows: chemical shift (δ) in ppm on the δ scale, multiplicity (s = singlet, d = doublet, t = triplet and m = multiplet), coupling constant (Hz), and integration. ^{13}C-NMR (100 and 75 MHz): chemical shifts were given in ppm relative to Me_4Si, with the solvent resonance used as the internal standard (CD_3CN δ = 1.32 and 118.26 ppm; $CDCl_3$ = 77.16 ppm). For ^{19}F NMR, chemical shifts were given in ppm using C_6F_6 as reference. IR spectra were recorded with a Perkin-Elmer 1650 FT-IR spectrometer using a diamond ATR Golden Gate sampling and are reported in wavenumbers (cm^{-1}). Melting points (Mp) were measured in open capillary tubes on a Stuart Scientific SMP3 melting point apparatus and were uncorrected. UV spectra were measured with a 1.0 cm quartz cell; λmax are given in nm and molar absorption coefficient ε in $cm^{-1}\cdot dm^3\cdot mol^{-1}$. Optical rotations were measured on a JASCO P-1030 polarimeter in a thermostated (20 °C) 10.0 cm long microcell with high pressure lamps of sodium and mercury and are reported as follows: $[\alpha]_\lambda^T$ (c (g/100 ml), solvent). Circular dichroism spectra were recorded on a JASCO J-715 polarimeter in a 1.0 cm quartz cell; λ are given in nm and molar circular dichroic absorptions (Δε in $cm^2\cdot mmol^{-1}$). Retention times (t_R) are given in minutes (min). Mass determination were recorded with a Finnigan SSQ 7000 Electrospray mass spectrometer (ESI-MS). Accurate mass measurements were performed on an quadrupole-time of flight instrument (QStar XL, AB/MDS Sciex, Concord, Ontario, Canada) using electrospray positive mode ionization. The analytes were infused at typically 5-10 µl/min using an Haward syringe pump. The instrument was optimized in such a way that up-front collision induced dissociation was minimized and the resolution was of about 10000.

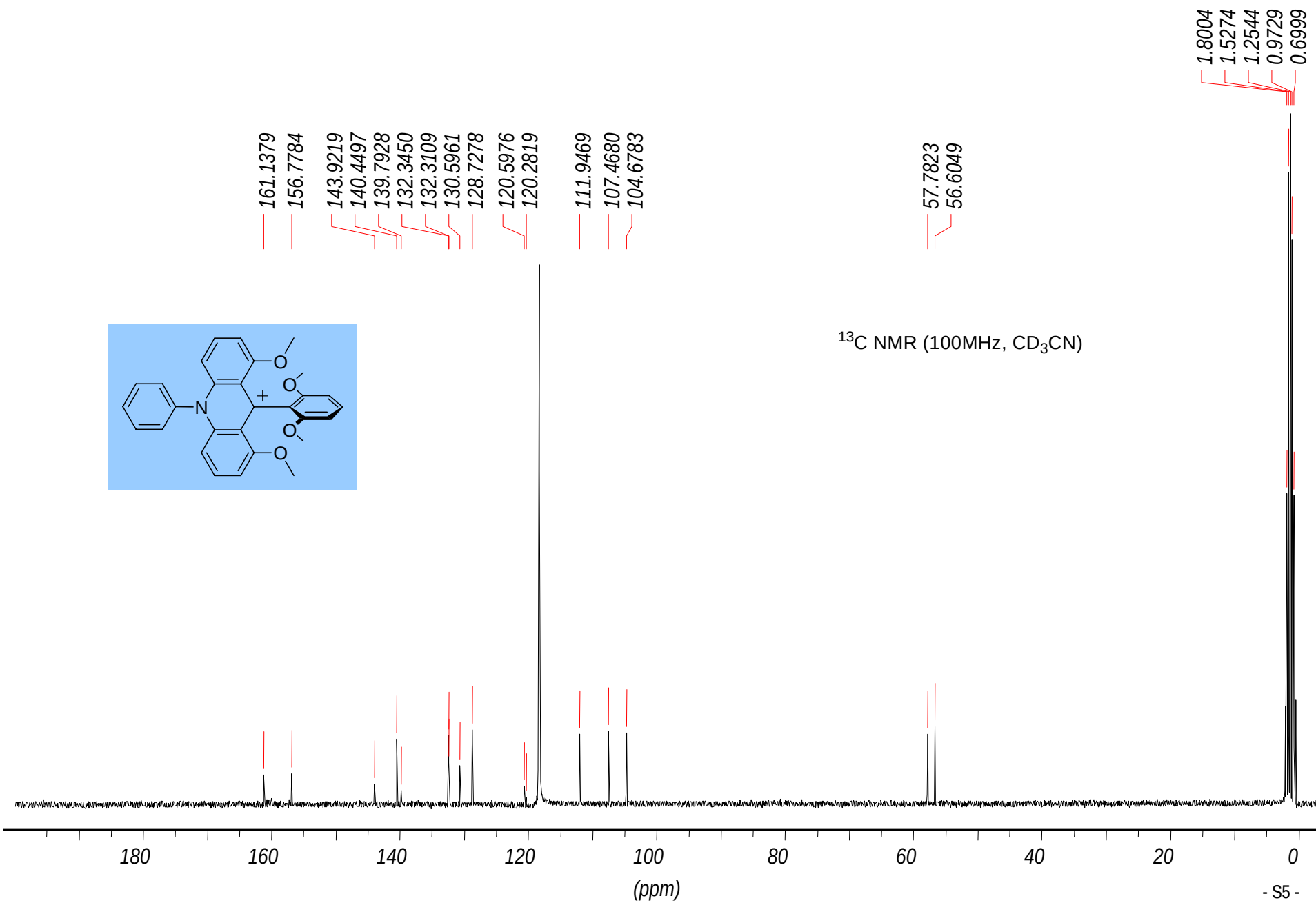
Analytical enantioselective HPLC chromatographic separations were performed using an analytical HPLC columns (0.46 cm x 25 cm) Chiralcel OJ-H (5 µm particle size) or Chiralpak AD-H (5 µm particle size), which were purchased from Chiral Technologies (Strasbourg, France). The chromatographies were carried out at a flow rate varying between 0.2 and 1 ml/min and at room temperature. Typically, 20 micro-litre of a 0.2 % solution in ethanol were injected. Detection was performed by UV at 254 nm. Retention times (tR) are given in minutes (min). HPLC instrument

was a Shimadzu Class VP system consisting of a SCL-10A system controller, a LC-10 pump, SPD-DAD UV-Vis detector and SIL-10AD auto-injector. HPLC control, data acquisition and evaluation were performed with the Shimadzu Class VP software. For preparative separation of enantiomers, a preparative (25 mm x 250 mm) HPLC column packed with Chiralcel OJ, particle size 20 μm (Daicel Chemical Industries, Japan) was used. HPLC preparative instrument was a VWR 'La Prep' system consisting of a P 110 pump, a P314 UV detector, and equipped with the EZChrom Elite software. The prep HPLC was connected to a Labocol Vario 2000 fraction collector from Labomatic (LABOMATIC Instruments AG, Allschwill, Switzerland).

9-(2,6-dimethoxyphenyl)-1,8-dimethoxy-10-phenyl-9,10-dihydro-acridinium tetrafluoroborate salt [8][BF_4]

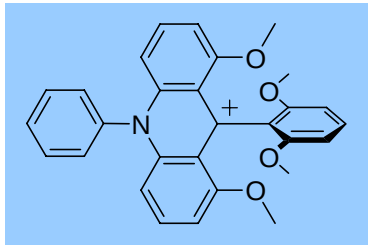


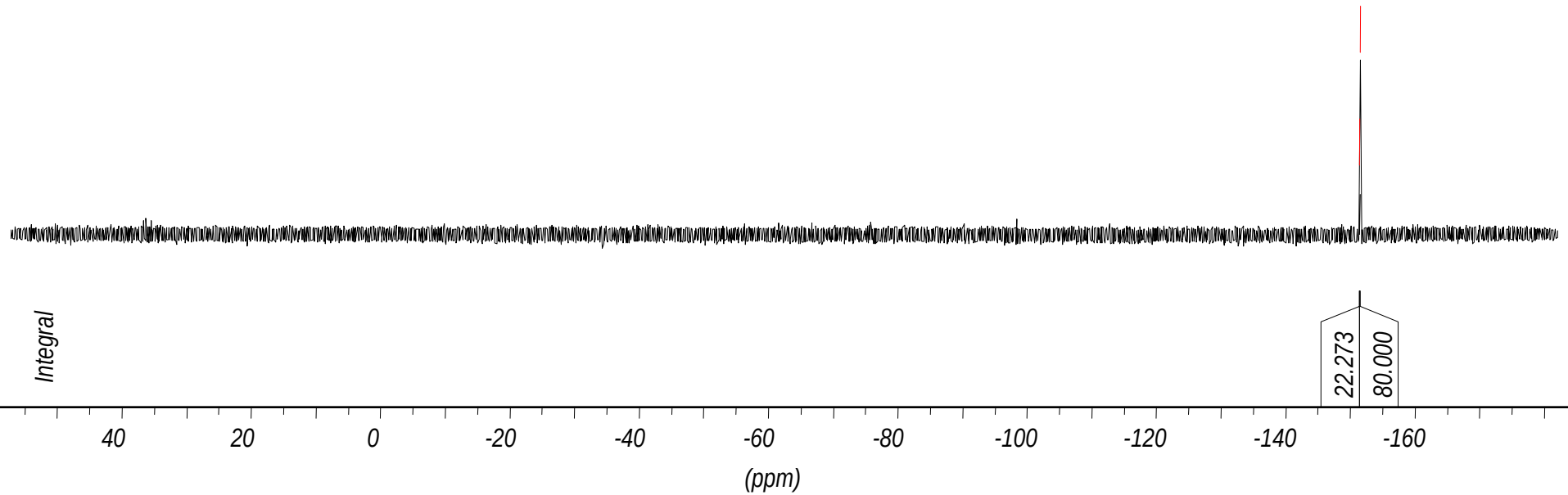
9-(2,6-dimethoxyphenyl)-1,8-dimethoxy-10-phenyl-9,10-dihydro-acridinium tetrafluoroborate salt [8][BF_4]



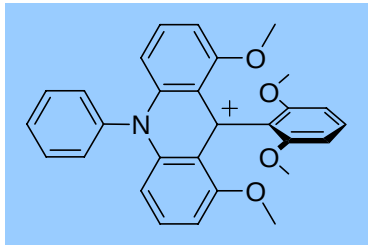
9-(2,6-dimethoxyphenyl)-1,8-dimethoxy-10-phenyl-9,10-dihydro-acridinium tetrafluoroborate salt [8][BF_4]

^{19}F NMR (282 MHz, CD_2Cl_2)

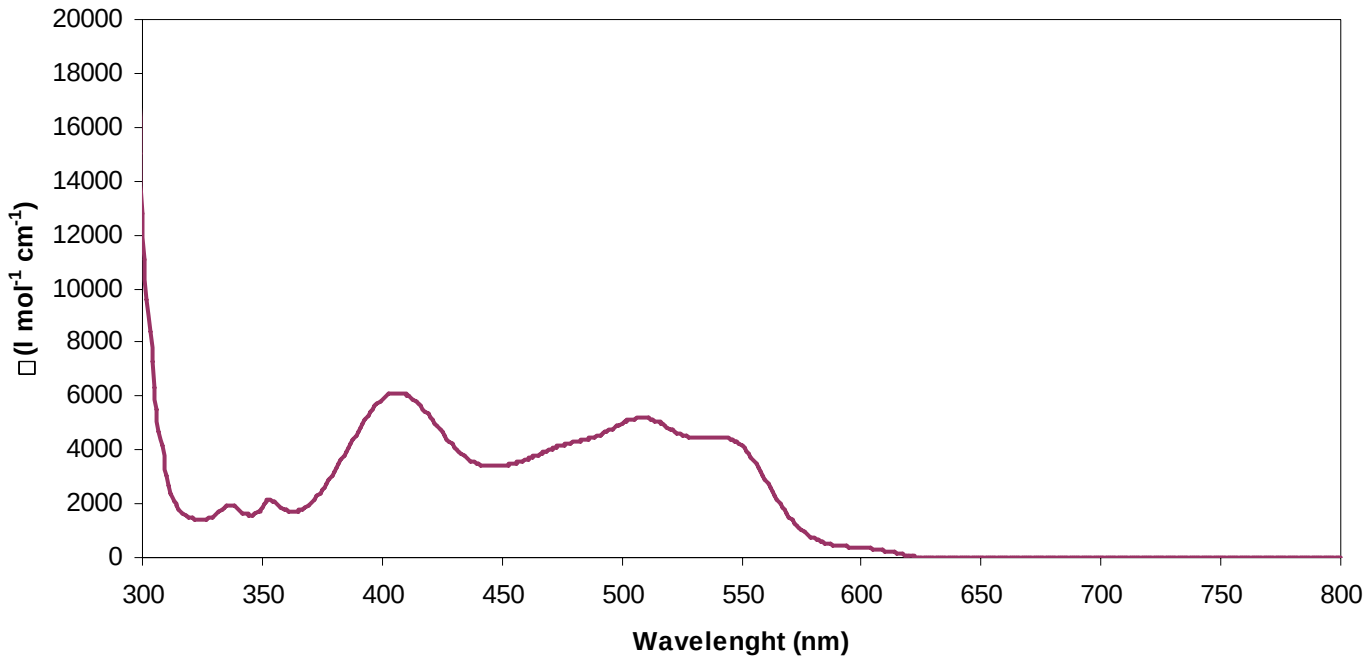




9-(2,6-dimethoxyphenyl)-1,8-dimethoxy-10-phenyl-9,10-dihydro-acridinium tetrafluoroborate salt [8][BF_4]



UV, CH_2Cl_2, 10^{-4}M



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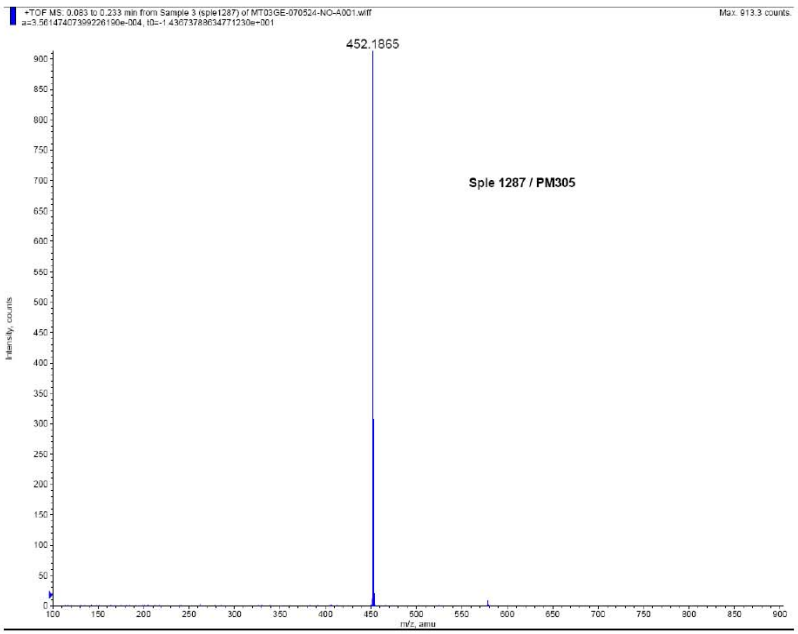
Life Sciences Mass Spectrometry

Sample name: PM305	Date of reception: 21/05/07
Sample number: 1287	Date of analysis: 24/05/07
Operator: Nathalie Oudry	Instrument: QSTAR XL (AB/MDS Sciex)
Principal investigator: Prof. G. Hopfgartner	Ionisation mode: ESI (positive)

Results:

Expected Formula	Observed m/z $[M-BF_4]^+$	Expected m/z (amu)	Accuracy (ppm)	Resolution (FWHM)
$C_{29}H_{26}NO_4$	452.1865	452.1856	1.9	9550

Mass spectrum of the sample:



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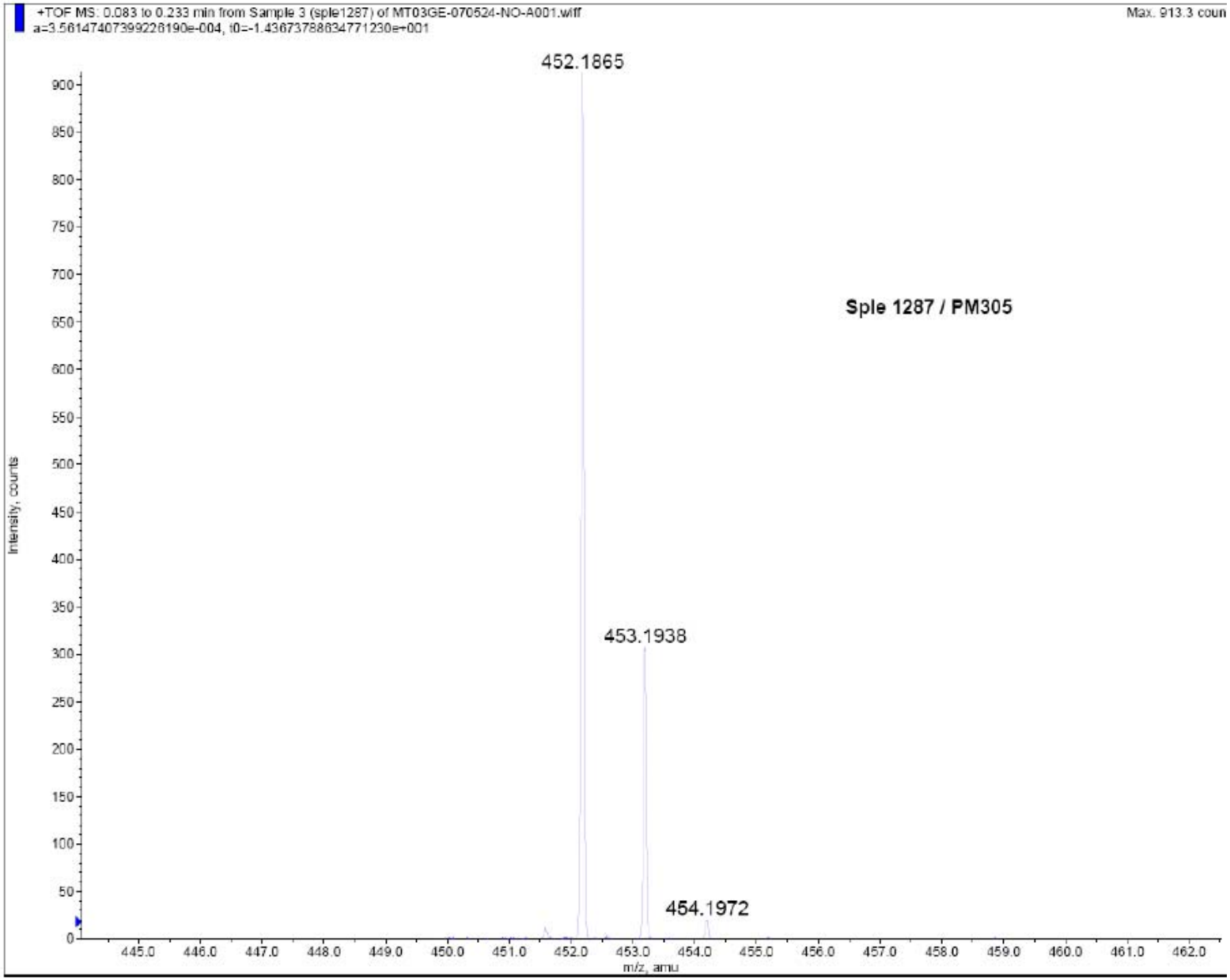
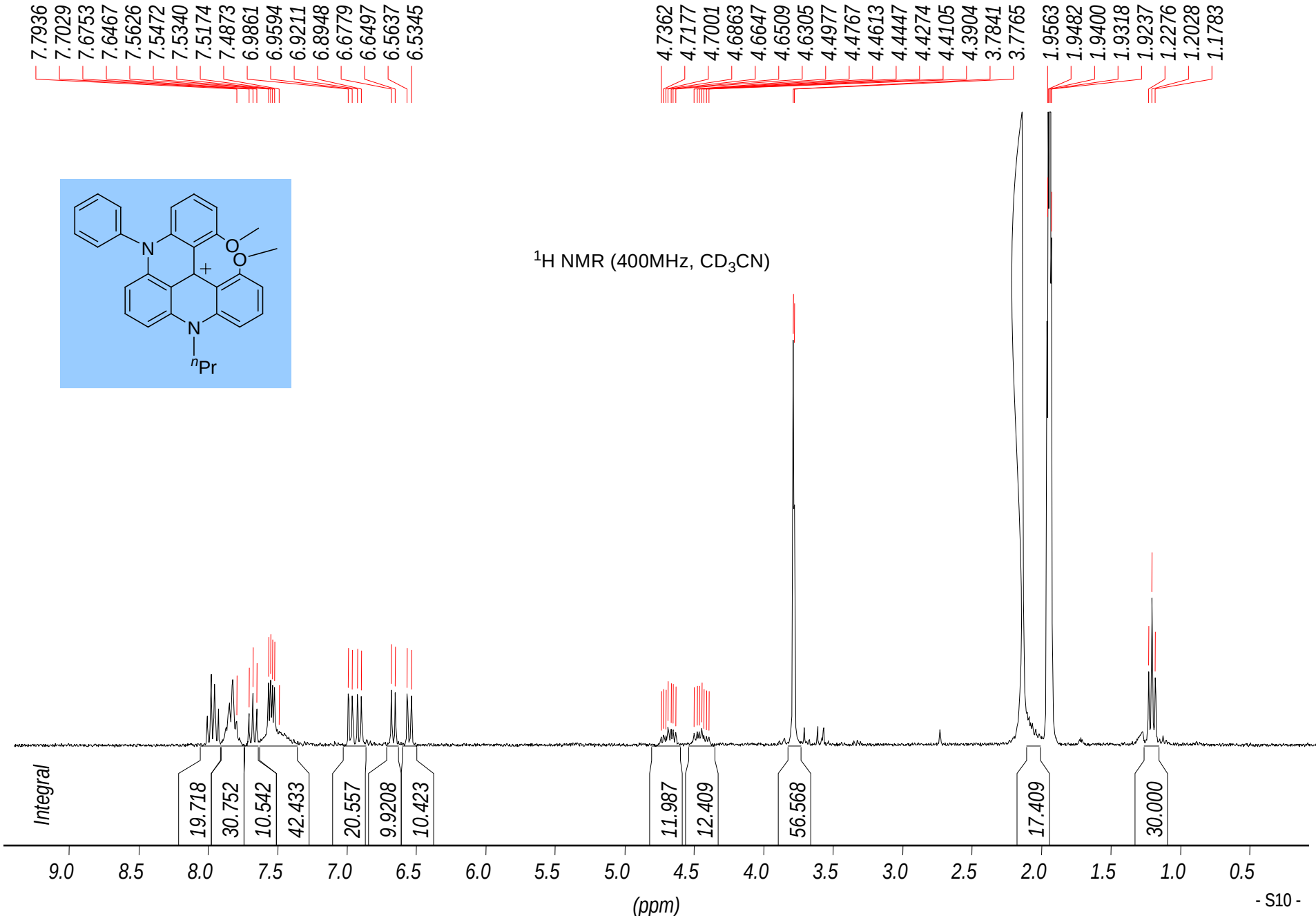
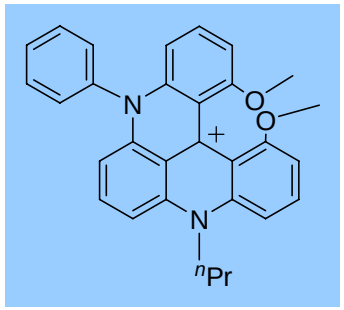
9-(2,6-dimethoxyphenyl)-1,8-dimethoxy-10-phenyl-9,10-dihydro-acridinium tetrafluoroborate salt [8][BF_4]



Racemic-5-phenyl-9-propyl-1,13-dimethoxy-quinacridinium tetrafluoroborate salt [9][BF_4].



Racemic-5-phenyl-9-propyl-1,13-dimethoxy-quinacridinium tetrafluoroborate salt [9][BF_4].



^{13}C NMR (100MHz, CD_3CN)

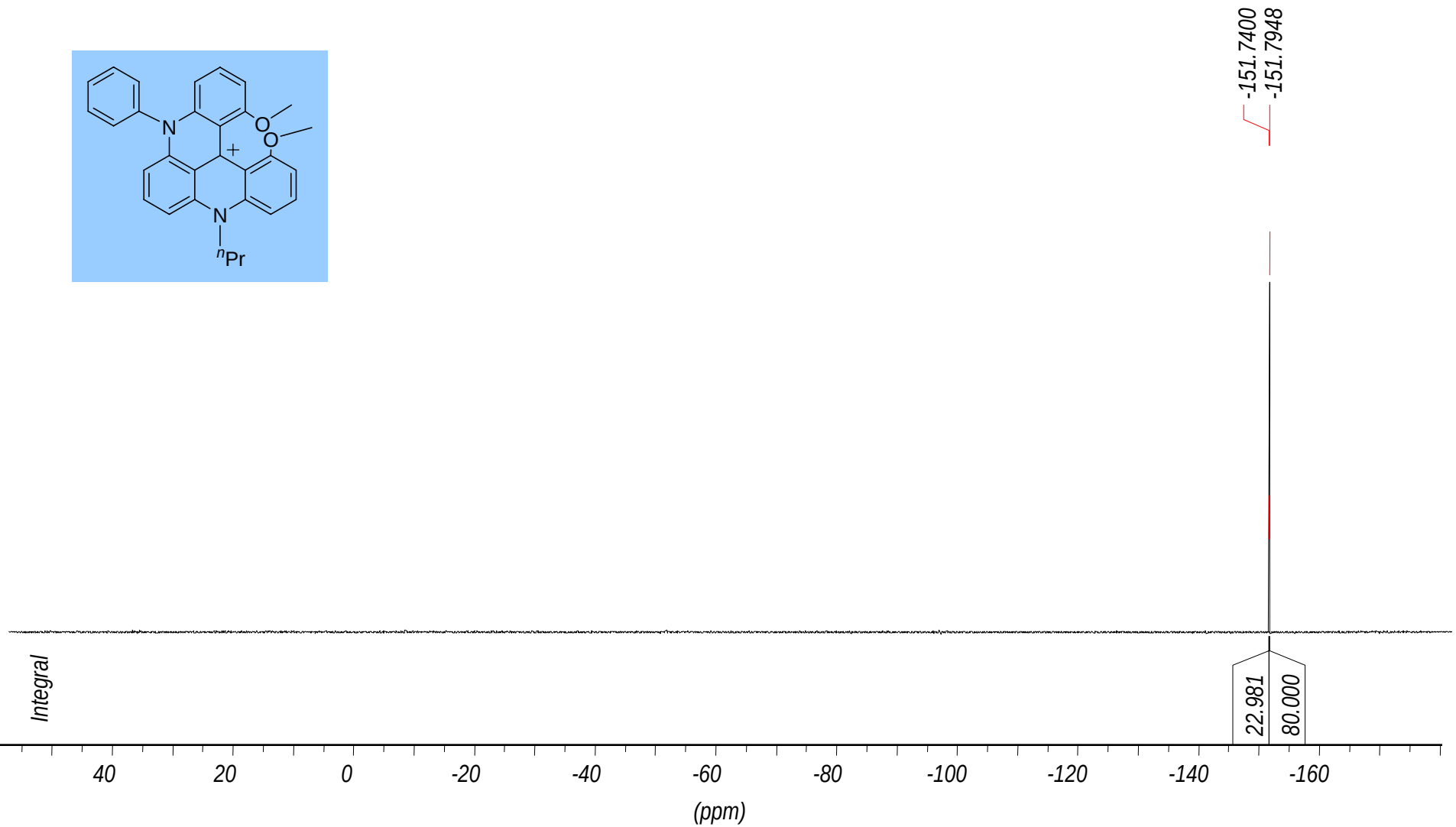
160.8481
160.4360
144.6190
144.5448
143.4485
141.4539
139.6900
139.1625
138.3053
137.5223
137.0360
131.5219
119.8590
118.2600
114.1059
113.3476
109.6715
108.5753
107.2483
106.0449
104.0420
104.0008
56.5333
56.5085
52.2473
20.3989
11.1181

180 160 140 120 100 80 60 40 20 0

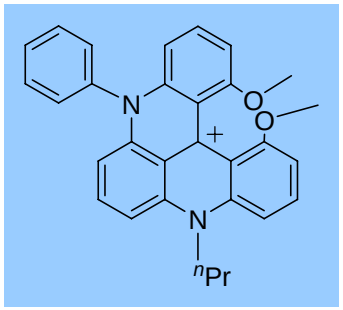
(ppm)

Racemic-5-phenyl-9-propyl-1,13-dimethoxy-quinacridinium tetrafluoroborate salt [9][BF_4].

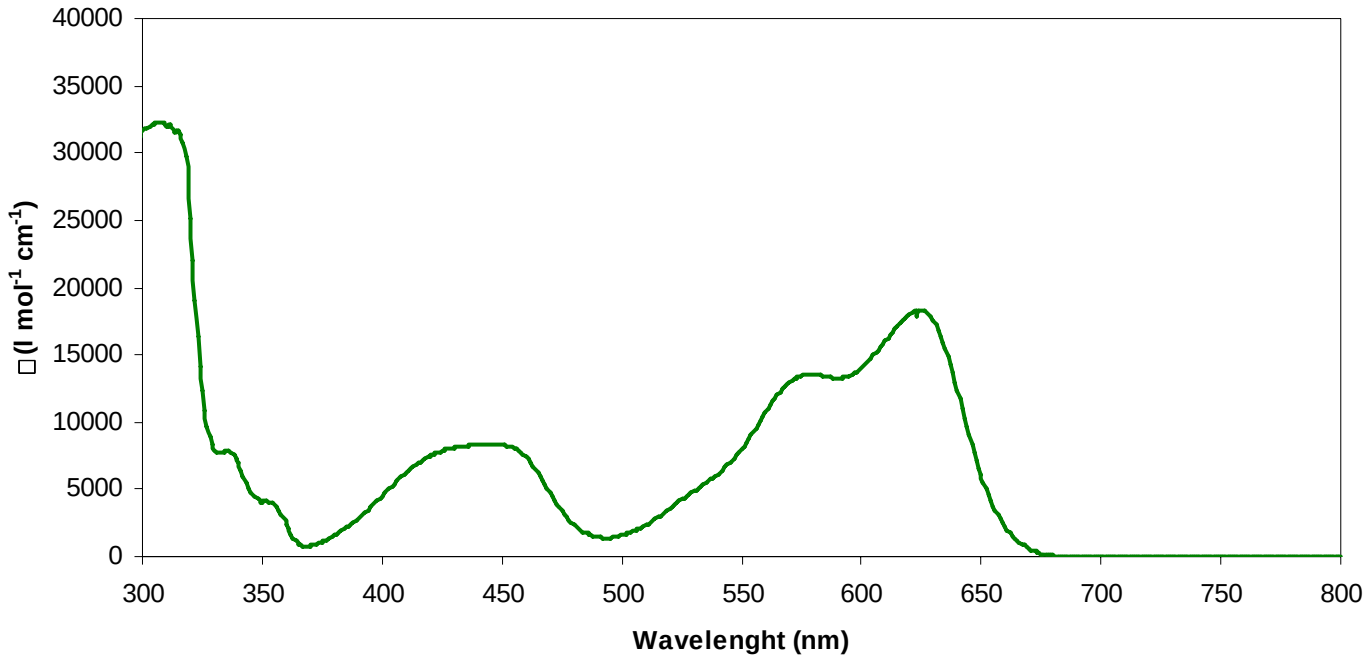
^{19}F NMR (282 MHz, CD_3CN)



Racemic-5-phenyl-9-propyl-1,13-dimethoxy-quinacridinium tetrafluoroborate salt [9][BF_4].



UV, CH_2Cl_2, 10^{-4}M



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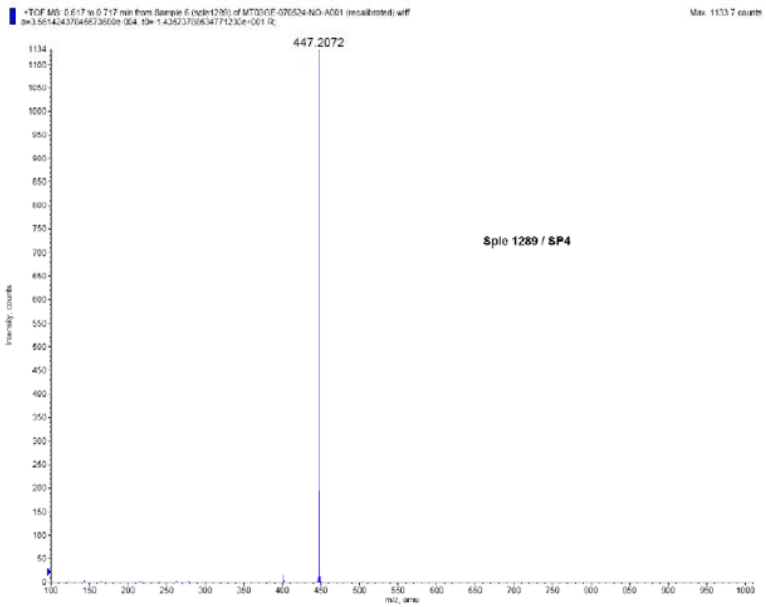
Life Sciences Mass Spectrometry

Sample name: SP4	Date of reception: 21/05/07
Sample number: 1289	Date of analysis: 24/05/07
Operator: Nathalie Oudry	Instrument: QSTAR XL (AB/MDS Sciex)
Principal investigator: Prof. G. Hopfgartner	Ionisation mode: ESI (positive)

Results:

Expected Formula	Observed m/z $[M-BF_4]^+$	Expected m/z (amu)	Accuracy (ppm)	Resolution (FWHM)
$C_{30}H_{27}N_2O_2$	447.2072	447.2067	1.1	9500

Mass spectrum of the sample:



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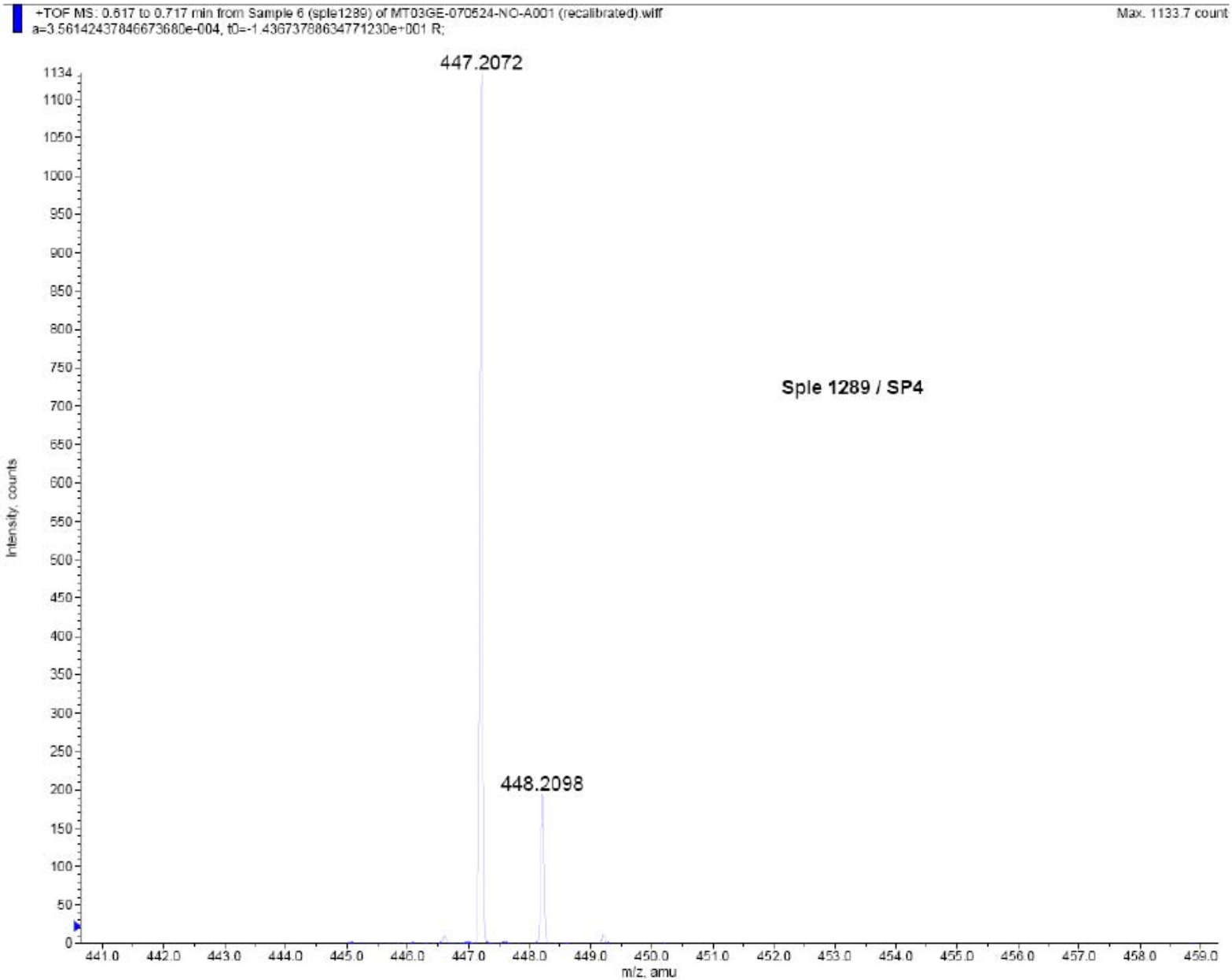
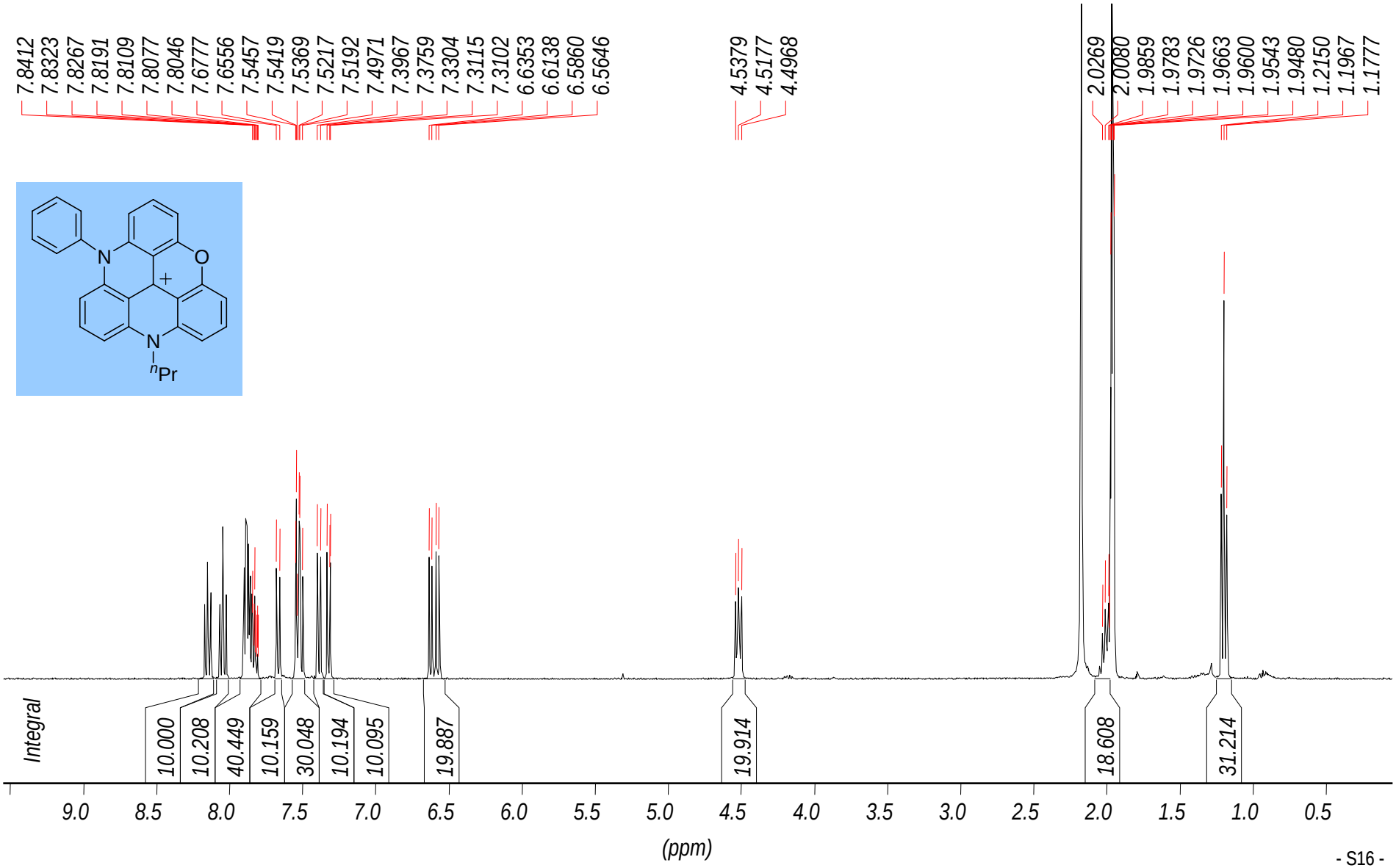
Racemic-5-phenyl-9-propyl-1,13-dimethoxy-quinacridinium tetrafluoroborate salt [9][BF_4].

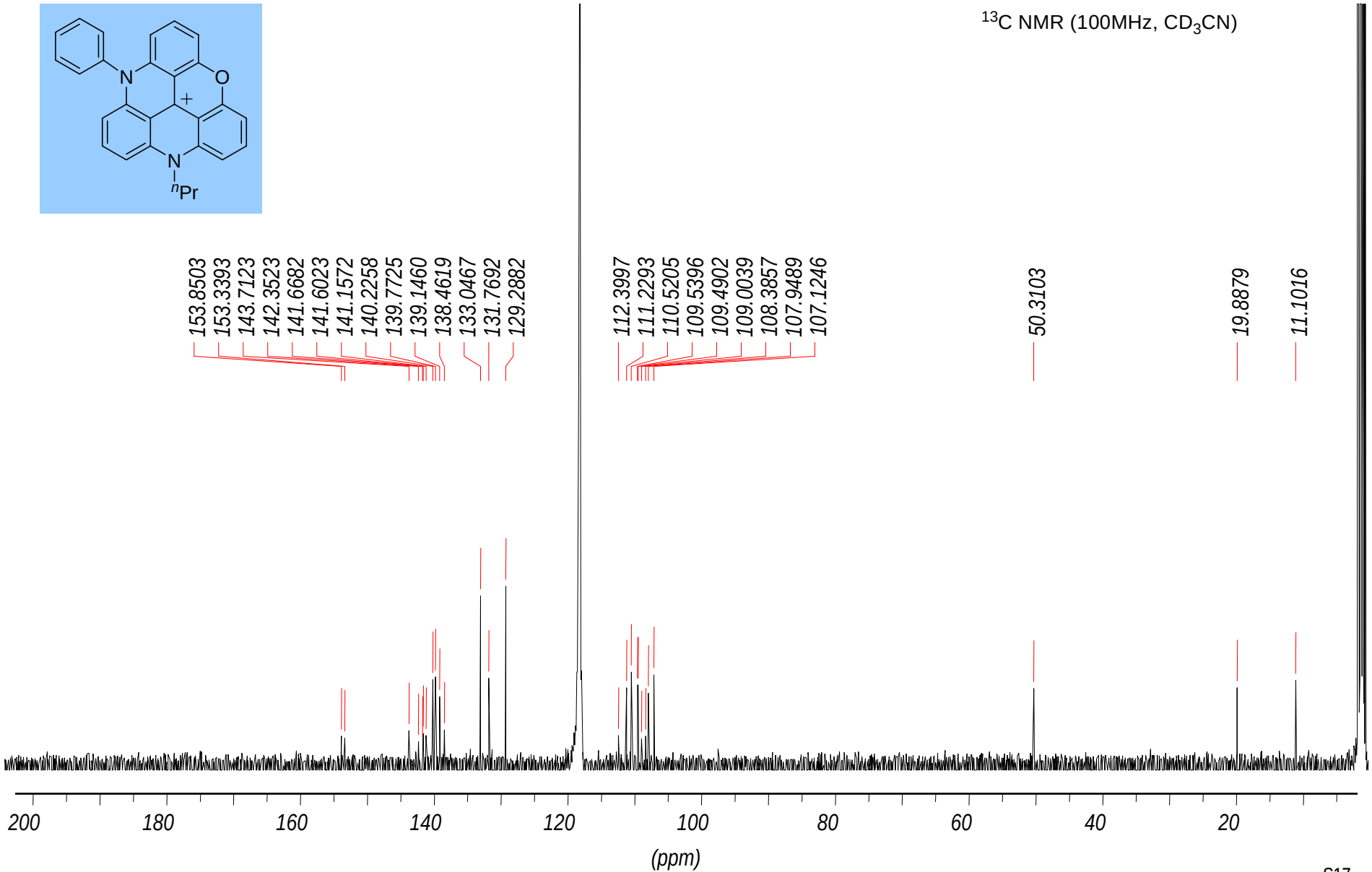


8-Phenyl-12-propyl-12,12c-dihydro-8H-4-oxa-8,12diazadibenzo[cd,mn]pyrenium tetrafluoroborate salt [5a][BF_4].

^{1}H NMR (400 MHz, CD_3CN)

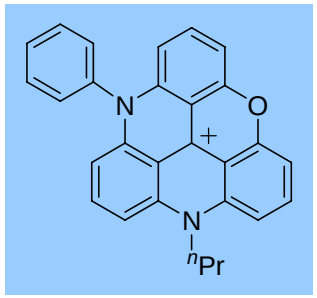


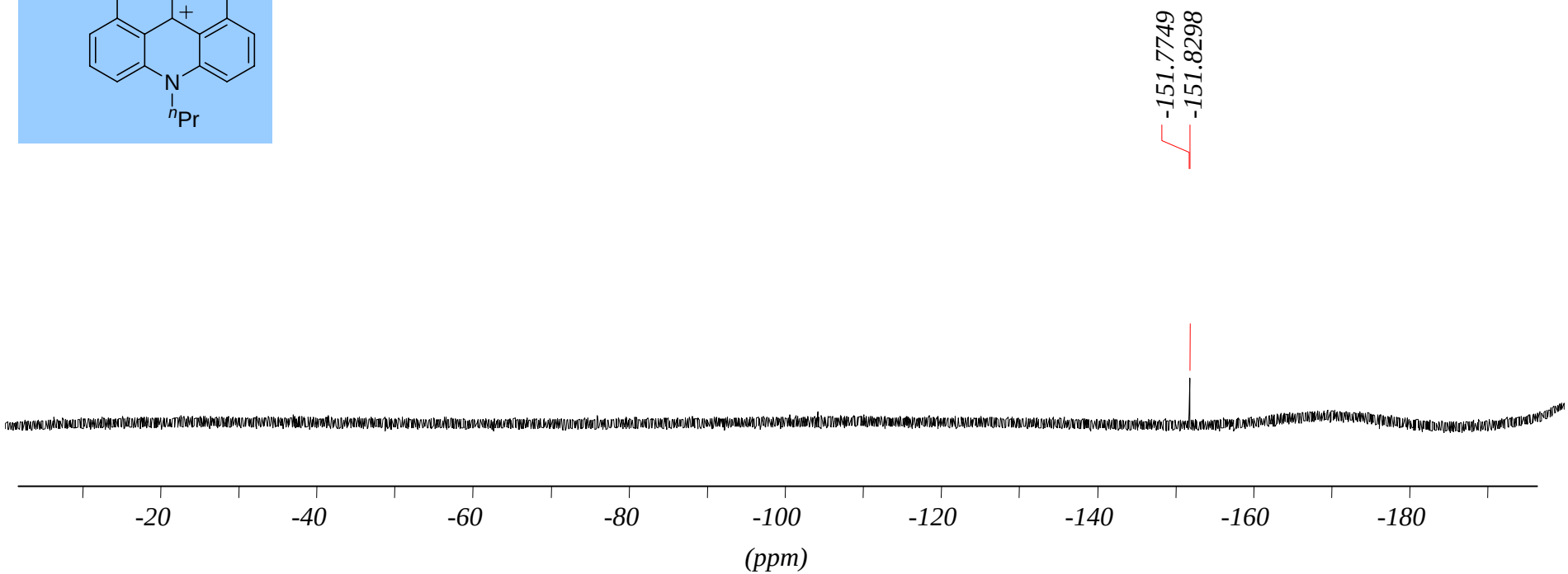
8-Phenyl-12-propyl-12,12c-dihydro-8H-4-oxa-8,12diazadibenzo[cd,mn]pyrenium tetrafluoroborate salt [5a][BF_4].



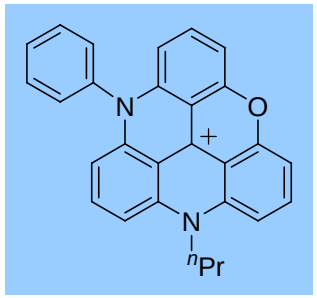
8-Phenyl-12-propyl-12,12c-dihydro-8H-4-oxa-8,12diazadibenzo[cd,mn]pyrenium tetrafluoroborate salt [5a][BF_4].

^{19}F NMR (376 MHz, CD_3CN)

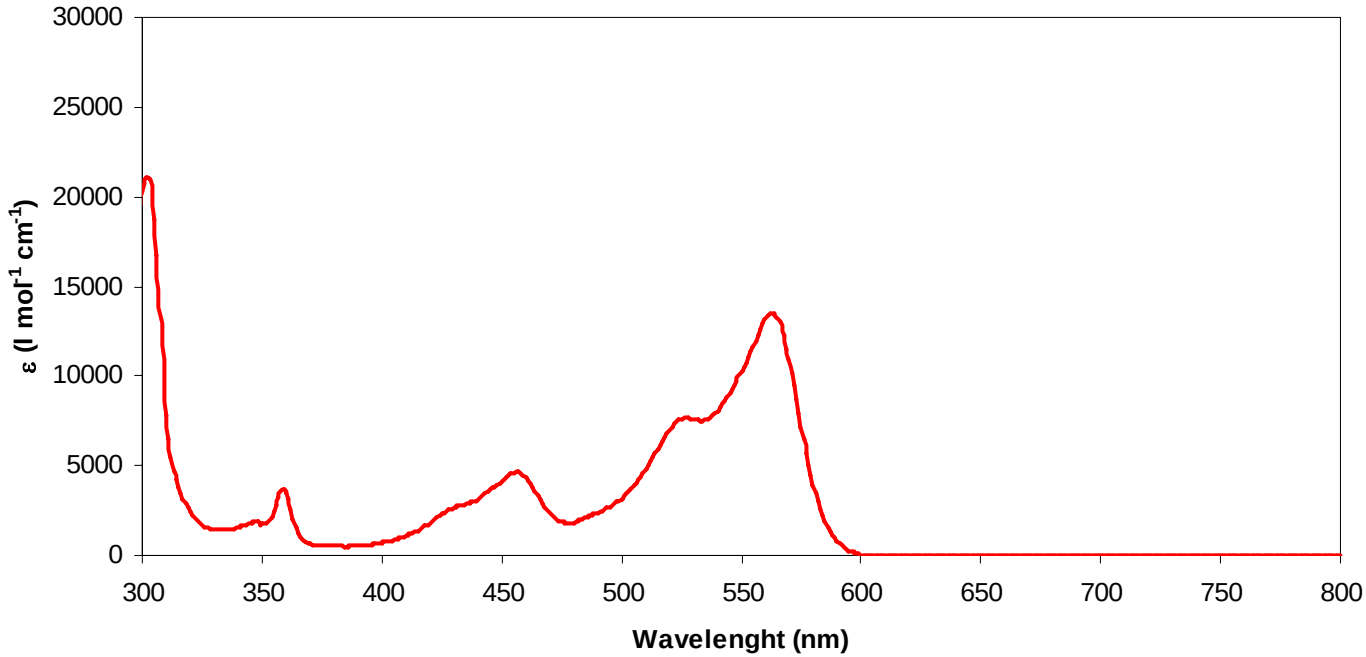




8-Phenyl-12-propyl-12,12c-dihydro-8H-4-oxa-8,12diazadibenzo[cd,mn]pyrenium tetrafluoroborate salt [5a][BF_4].



UV, CH_2Cl_2, 10^{-4}M



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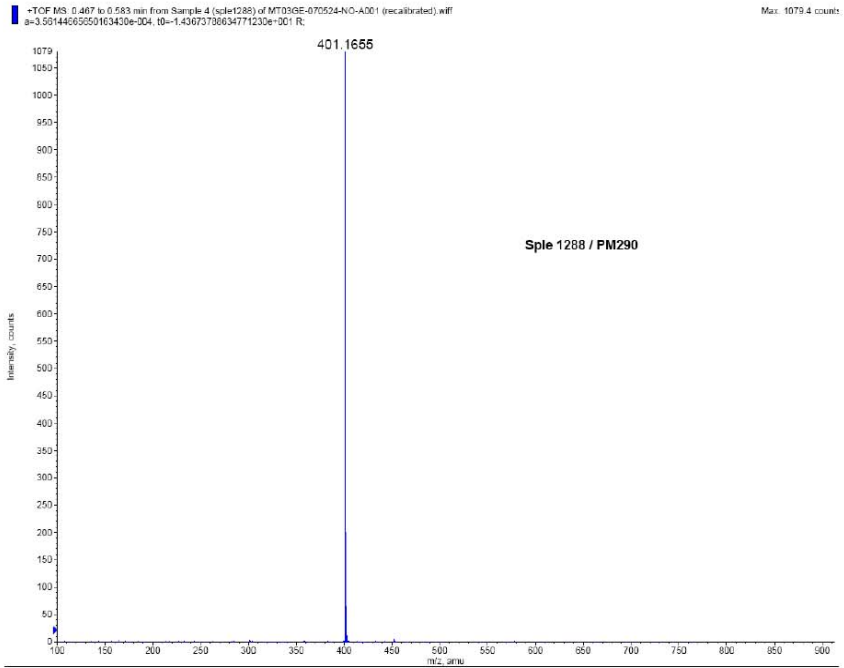
Life Sciences Mass Spectrometry

Sample name: PM290	Date of reception: 21/05/07
Sample number: 1288	Date of analysis: 24/05/07
Operator: Nathalie Oudry	Instrument: QSTAR XL (AB/MDS Sciex)
Principal investigator: Prof. G. Hopfgartner	Ionisation mode: ESI (positive)

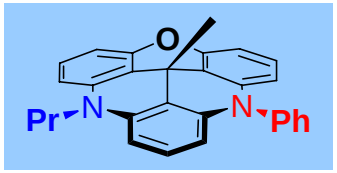
Results:

Expected Formula	Observed m/z $[M-BF_4]^+$	Expected m/z (amu)	Accuracy (ppm)	Resolution (FWHM)
$C_{28}H_{21}N_2O$	401.1655	401.1648	1.6	9000

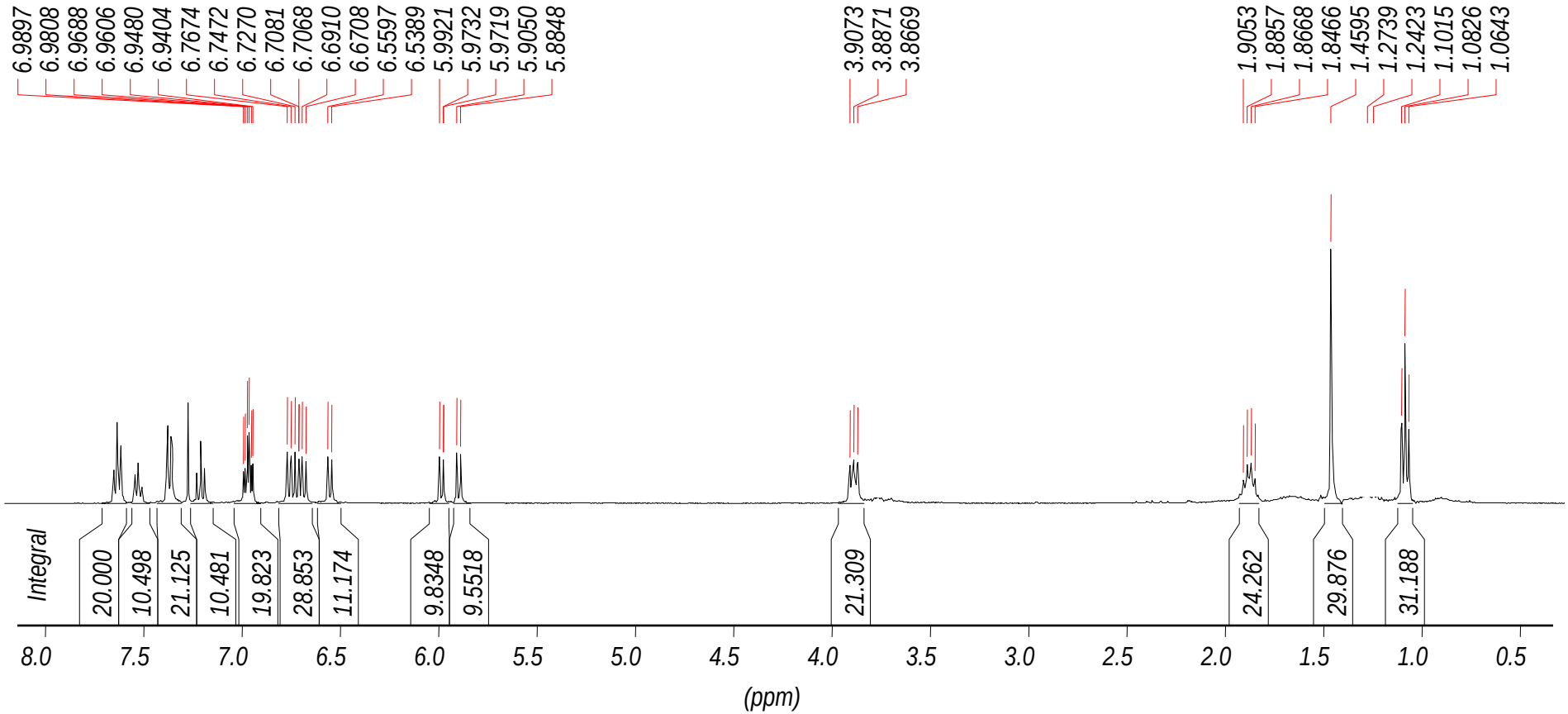
Mass spectrum of the sample:



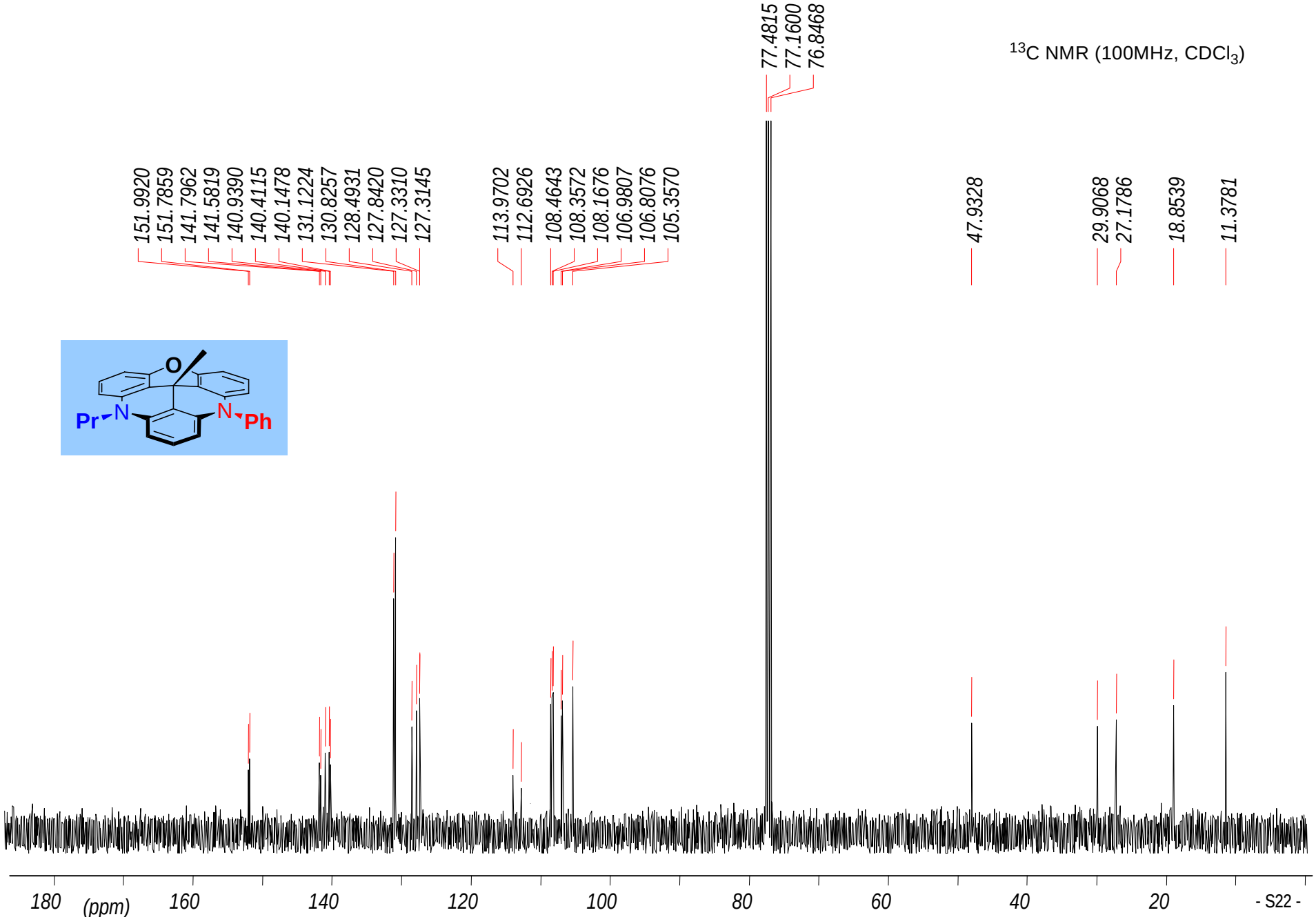
Racemic 12c-Methyl-12-phenyl-8-propyl-12,12c-dihydro-8H-4-oxa-8,12-diaza-dibenzo [cd,mn]pyrene 6a.



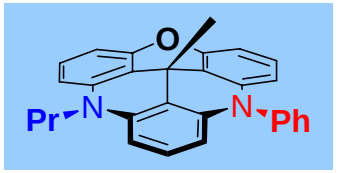
^{1}H NMR (400 MHz, $CDCl_3$)

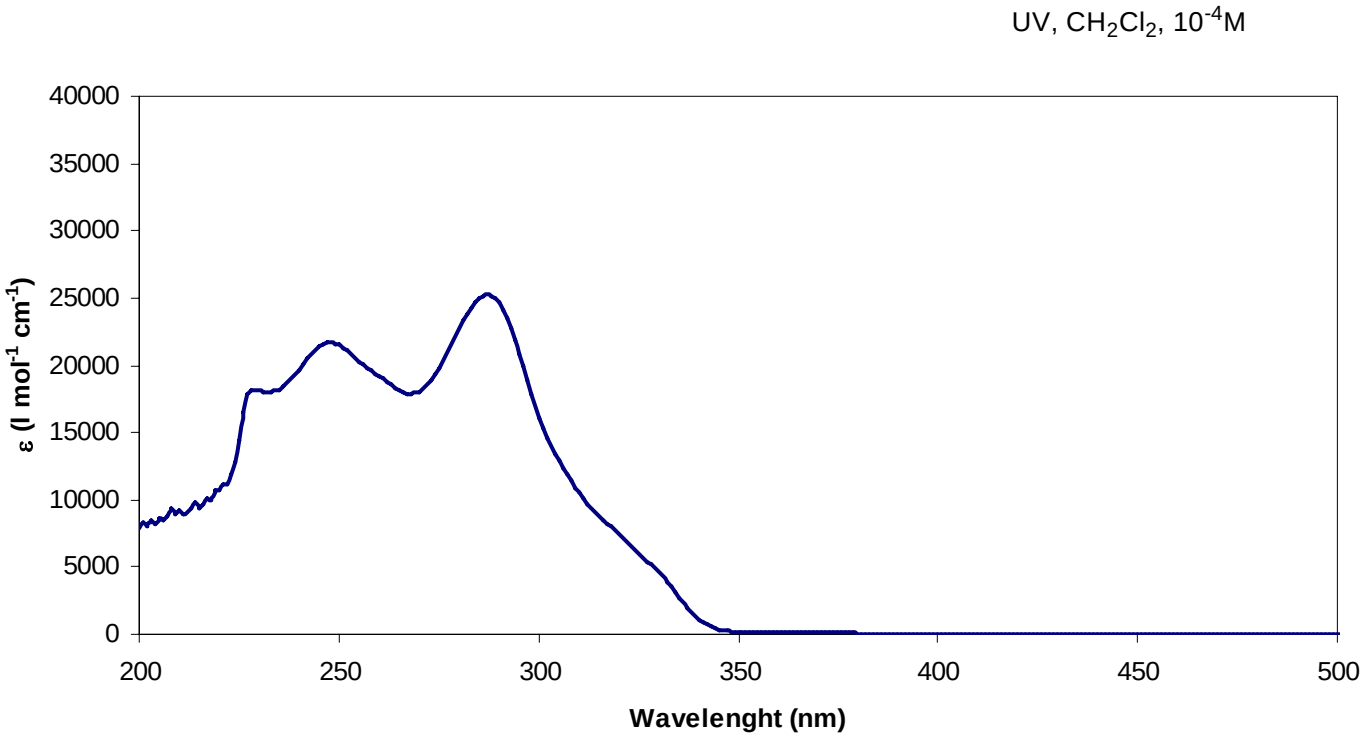


Racemic 12c-Methyl-12-phenyl-8-propyl-12,12c-dihydro-8H-4-oxa-8,12-diaza-dibenzo [cd,mn]pyrene 6a.

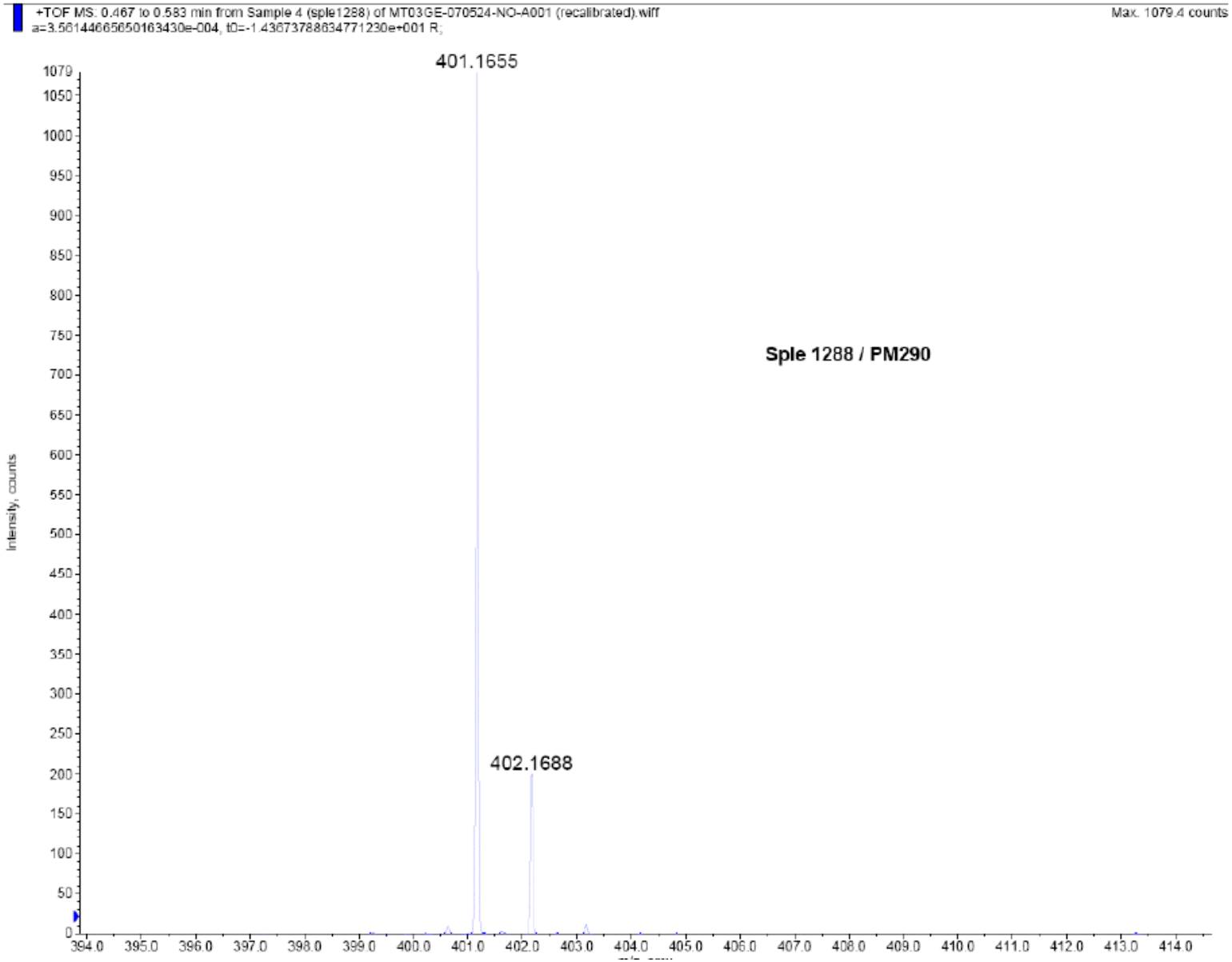


Racemic 12c-Methyl-12-phenyl-8-propyl-12,12c-dihydro-8H-4-oxa-8,12-diaza-dibenzo [cd,mn]pyrene 6a.





Racemic 12c-Methyl-12-phenyl-8-propyl-12,12c-dihydro-8H-4-oxa-8,12-diaza-dibenzo [cd,mn]pyrene 6a.



6. Calculated spectra (top IR, bottom VCD, b3pw91, 6-31G(d,p)) for different conformers