<Supporting Information>

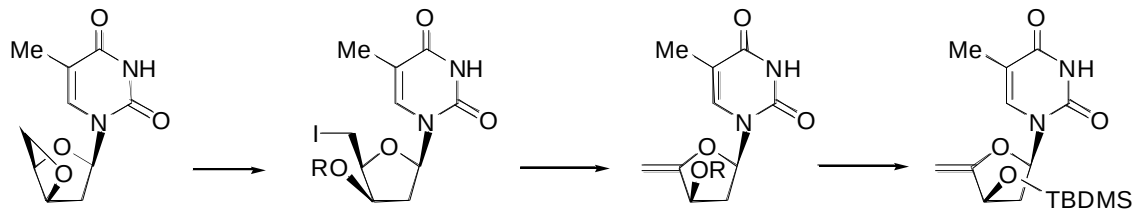
Nucleophilic Substitution at the 4'-Position of Nucleoside: New Access to a Promising Anti-HIV Agent 2′,3′-Didehydro-3′-deoxy-4′-ethynylthymidine (4′-Ed4T)

CONTENTS

General Experimental Section

^{1}H and ^{13}C NMR spectra were recorded either at 400 MHz or at 500 MHz. Chemical sifts are reported relative to Me_4Si. Mass spectra (MS) were taken in FAB mode with *m*-nitrobenzyl alcohol as a matrix. Column chromatography was carried out on silica gel. Thin-layer chromatography (TLC) was performed on silica gel. When necessary, analytical samples were purified by high performance liquid chromatography (HPLC). THF was distilled from benzophenone ketyl.

SCHEME A. Preparation of 3 from 1-(3,5-anhydro-2-deoxy-β-D-*threo*-pentofuranosyl)thymine (I)[a]



I **II** R = H, **III** R = Ac, **IV** R = Ac, **V** R = H, **3**

[a] Horwitz, J. P.; Chua, J.; Da Rooge, M. A.; Noel, M.; Klundt, I. L. *J. Org. Chem.* **1966**, *31*, 205.

1-(2,5-Dideoxy-5-iodo-β-D-*threo*-pentofuranosyl)thymine (II). To a solution of **I** (4.0 g, 17.8 mmol) in AcOH (40 mL) was added NaI (13.4 g, 89.2 mmol). The mixture was stirred

at 90 °C for 0.5 h, evaporated, and partitioned between $CHCl_3$/saturated aq $NaHCO_3$. Evaporation of the organic layer gave crystalline **II** (5.35 g, 85%): mp 151-153 °C; UV (MeOH) λ_{max} 266 nm (ε 10100), λ_{min} 234 nm (ε 2200); ^{1}H NMR ($CDCl_3$) δ ; 1.88 (3H, d, *J* = 1.2 Hz), 2.05 (1H, dd, *J* = 15.1 and 8.0 Hz), 2.67 (1H, ddd, *J* = 15.1, 8.4, and 5.3 Hz), 3.37 (1H, dd, *J* = 9.7 and 6.4 Hz), 3.47 (1H, dd, *J* = 9.7 and 7.7 Hz), 4.15 (1H, ddd, *J* = 7.7, 6.4, and 3.3 Hz), 4.75 (1H, dd, *J* = 5.3 and 3.3 Hz), 6.19 (1H, dd, *J* = 8.4 and 2.2 Hz), 7.87 (1H, d, *J* = 1.2Hz); ^{13}C NMR (DMSO-d_6) *δ* : 1.4, 11.9, 68.1, 83.1, 83.4, 94.9, 108.5, 136.4, 149.9, 163.2. FAB-MS (*m/z*) 353 $[M+H]^+$. *Anal*. Calcd for $C_{10}H_{13}IN_2O_4$: C, 34.11; H, 3.72; N, 7.96. Found: C, 34.30; H, 3.51; N, 7.58..

1-(3-*O*-Acetyl-2,5-dideoxy-5-iodo-β-D-*threo*-pentofuranosyl)thymine (III). To a solution of **II** (5.3 g, 15.1 mmol) in pyridine (30 mL) was added Ac_2O (4.3 mL, 45.2 mmol). The reaction mixture was stirred at rt for 13 h. Evaporation of the solvent gave crystalline **III** (5.53 g, 93%): mp 160-162 °C; UV (MeOH) λ_{max} 266 nm (ε 9900), λ_{min} 234 nm (ε 2000); ^{1}H NMR ($CDCl_3$) δ 1.96 (3H, d, *J* = 0.7 Hz), 2.11 (3H, s), 2.11-2.16 (1H, m), 2.82 (1H, ddd, *J* = 15.8, 8.0, and 5.7 Hz), 3.32-3.39 (2H, m), 4.28 (1H, dt, *J* = 7.1 and 3.3 Hz), 5.48 (1H, dd, *J* = 5.7 and 3.3 Hz), 6.30 (1H, dd, *J* = 8.0 and 2.8 Hz), 7.38 (1H, d, *J* = 0.7 Hz), 8.59 (1H, br); ^{13}C NMR ($CDCl_3$) *δ* : 12.8, 20.8, 39.8, 72.2, 82.4, 84.5, 110.8, 135.1, 150.1, 163.3, 169.2. FAB-MS (*m/z*) 395 $[M+H]^+$. Anal. Cald for $C_{12}H_{15}IN_2O_5$: C, 36.57; H, 3.84; N, 7.11. Found: C, 36.62; H, 3.51; N, 6.89.

1-(3-*O*-Acetyl-2,5-dideoxy-β-L-*glycero*-pent-4-enofuranosyl)thymine (IV). A mixture of

III (5.5 g, 14.0 mmol) and DBN (6.9 mL, 55.8 mmol) in CH_3CN (40 mL) was stirred at rt for 17 h under Ar atmosphere. After being neutralized with AcOH, the reaction mixture was evaporated and partitioned between $CHCl_3$/saturated aq $NaHCO_3$. Column chromatography (hexane/EtOAc = 1/1) of the organic layer gave **IV** (3.34 g, 90%) as a foam: ^{1}H NMR ($CDCl_3$) δ 1.96 (3H, d, *J* = 1.3 Hz), 2.06 (3H, s), 2.21 (1H, dt, *J* = 15.2 and 2.7 Hz), 2.83 (1H, dt, *J* = 15.2 and 7.1 Hz), 4.51 (1H, dd, *J* = 2.7 and 0.8 Hz), 4.73 (1H, dd, *J* = 2.7 and 0.7 Hz), 5.70-5.73 (1H, m), 6.44 (1H, dd, *J* = 7.1 and 2.7 Hz), 7.25 (1H, d, *J* = 1.3 Hz), 8.54 (1H, br); ^{13}C NMR ($CDCl_3$) *δ* : 12.7, 21.0, 37.4, 70.2, 85.5, 89.0, 110.8, 134.8, 150.2, 159.2, 163.6, 169.5. FAB-MS (*m/z*) 267 (M^++H); High resolution FAB-MS $[M+H]^+$ Calcd for $C_{12}H_{15}N_2O_5$: 267.0981, found: 267.0926 (M^++H).

1-[3-*O*-(*tert*-Butyldimethylsilyl)-2,5-dideoxy-β-L-*glycero*-pent-4-enofuranosyl]-thymine (3). Compound **IV** (5.2 g, 19.5 mmol) was dissolved in NH_3/MeOH (150 mL). The solution was kept standing at rt for 9 h. The solvent was evaporated. The resulting syrupy **V** was dried under reduced pressure, and then dissolved in DMF (60 mL). To this were added imidazole (5.32 g, 78.1 mmol) and TBDMSCl (8.83 g, 58.6 mmol). After being stirred at rt for 11 h, the mixture was partitioned between EtOAc/H_2O. Column chromatography (hexane/EtOAc = 10/1) of the organic layer gave **3** (6.43 g, 97%) as a foam: UV (MeOH) λ_{max} 266 nm (ε 11600), λ_{min} 236 nm (ε 5700); ^{1}H NMR ($CDCl_3$) δ 0.11 and 0.14 (6H, each as s), 0.88 (9H, s), 1.92 (3H, d, *J* = 1.2 Hz), 2.03 (1H, dt, *J* = 10.8 and 3.2 Hz), 2.61-2.68 (1H, m), 4.25 (1H, dd, *J* = 2.2 and 0.7 Hz), 4.57 (1H, dd, *J* = 2.2 and 0.7 Hz), 4.68 (1H, dd, *J* = 6.8

and 3.2 Hz), 6.46 (1H, dd, *J* = 7.2 and 3.2 Hz), 7.44 (1H, d, *J* = 1.2 Hz), 9.12 (1H, br); ^{13}C NMR ($CDCl_3$) δ : –5.1, –4.9, 12.5, 17.8, 25.4, 40.1, 79.8, 84.9, 85.2, 110.7, 135.6, 150.6, 163.0, 164.1. FAB-MS (*m/z*) 339 $[M+H]^+$. Anal. Calcd for $C_{16}H_{26}N_2O_4Si$: C, 56.78; H, 7.74; N, 8.28. Found: C, 56.61; H, 7.87; N, 8.17.

Reaction of $Pb(OAc)_4$ with 2-methylene-5-(*R*)-(thymin-1-yl)-2,5-dihydro-furan (9).

To a toluene (3.0 mL) solution of **9** (33 mg, 0.16 mmol) was added $Pb(OAc)_4$ (106.4 mg, 0.24 mmol) at 0 °C under Ar atmosphere. The reaction mixture was stirred for 5 h at rt, diluted with EtOAc, and filtered through a celite pad. The filtrate was partitioned between EtOAc and saturated aq $NaHCO_3$. Column chromatography (hexane/EtOAc= 3/1) of the organic layer gave **10** (solid, 18.2 mg, 35%, containing a small amount of **11** formed during evaporation of the solvents) and **11** (solid, 21.2 mg, 50%).

Physical data for the major isomer of **10**: ^{1}H NMR (DMSO-d_6) δ 2.02 (3H, s), 2.04 (3H, s), 3.25 (3H, s), 4.34 and 4.49 (2H, each as d, *J* = 11.5 Hz), 6.40 (1H, dd, *J* = 5.9 and 1.5 Hz), 6.61 (1H, dd, *J* = 1.7 and 5.9 Hz), 6.83 (1H, d, *J* = 1.7 Hz), 7.15 (1H, d, *J* = 1.3 Hz), 11.43 (1H, br); FAB-MS (*m/z*) 324 (M^++H); ^{13}C NMR ($CDCl_3$) δ 12.0, 12.1, 14.1, 20.4, 21.4, 21.6, 59.7, 63.3, 63.8, 87.9, 90.0, 95.4, 110.1, 111.4, 111.8, 131.0, 131.1, 132.0, 135.7, 150.6, 150.6, 163.9, 168.4, 168.6, 169.7. High resolution FAB-MS (*m/z*) calcd for $C_{14}H_{17}N_2O_7$: 325.1036. Found: 325.1075.

Physical data for **11**: m.p. 156-157 °C; UV (MeOH) λ_{max} 259 nm (ε 8600), λ_{min} 236 nm (ε 7400); ^{1}H NMR ($CDCl_3$) δ 2.00 (3H, d, *J* = 1.2 Hz), 2.10 (3H, s), 5.04 (2H, s), 6.47

(1H, d, *J* = 3.2 Hz), 6.50 (1H, d, *J* = 3.2 Hz), 7.41 (1H, d, *J* = 1.2 Hz), 8.88 (1H, br); ^{13}C NMR ($CDCl_3$) δ 12.3, 20.8, 57.67, 103.3, 111.8, 112.8, 137.2, 143.1, 146.5, 163.0, 170.5. FAB-MS (*m/z*) 265 $[M+H]^+$. *Anal*. Calcd for $C_{12}H_{12}N_2O_5$: C, 54.55; H, 4.58; N, 10.60. Found: C, 54.65; H, 4.46; N, 10.39.

Reaction of $Pb(OAc)_4$ with

1-[3-*O*-(*tert*-butyldimethylsilyl)-2,5-dideoxy-β-L-*glycero*-pent-4-enofuranosyl]thymine (3). To a toluene (5.0 mL) solution of **3** (100 mg, 0.3 mmol), was added $Pb(OAc)_4$ (196 mg, 0.44 mmol) at 0 °C under Ar atmosphere. The reaction mixture was stirred at rt for 16 h, filtered through a celite pad, and then partitioned between $CHCl_3$/saturated aq $NaHCO_3$. Column chromatography (hexane/EtOAc = 3/1) of the organic layer gave **12a** (foam, 62.8 mg, 28%) and **13a** (syrup, 52 mg, 60%).

Physical data for **12a**: UV (MeOH) λ_{max} 265 nm (ε 9100), λ_{min} 233 nm (ε 1700); ^{1}H NMR ($CDCl_3$) δ 0.11 and 0.16 (6H, each as s), 0.91 (9H, s), 1.92 (3H, d, *J* = 1.3 Hz), 2.07 and 2.10 (6H, each as s), 2.16-2.17 (1H, m), 2.82-2.89 (1H, m), 4.64-4.69 (2H, m), 4.89 (1H, d, *J* = 11.9 Hz), 6.50 (1H, dd, *J* = 8.2 and 2.8 Hz), 7.53 (1H, d, *J* = 1.3 Hz), 8.03 (1H, br); ^{13}C NMR ($CDCl_3$) δ –5.2, –5.0, 12.5, 17.9, 20.7, 21.7, 25.5, 29.7, 39.6, 61.1, 73.9, 85.2, 111.1, 111.3, 135.8, 150.1, 163.3, 169.1, 169.9. FAB-MS (*m/z*) 457 $[M+H]^+$. Anal. Calcd for $C_{20}H_{32}N_2O_8Si$: C, 52.61; H, 7.06; N, 6.14. Found: C, 52.69; H, 7.10; N, 5.94.

Physical data for **13a**: ^{1}H NMR ($CDCl_3$) δ 0.11 and 0.16 (6H, each as s), 0.91 (9H, s),

2.17 (3H, s), 2.86 (1H, ddd, J = 17.1, 5.1, and 1.3 Hz), 2.95 (1H, ddd, J = 17.1, 5.1, and 1.3 Hz), 4.60 (1H, t, J = 5.1 Hz), 4.99 (1H, d, J = 17.6 Hz), 5.11 (1H, d, J = 17.6 Hz), 9.71 (1H, t, J = 1.3 Hz); ^{13}C NMR ($CDCl_3$) δ : –5.18, –5.15, –0.02, 17.9, 20.5, 25.6, 25.6, 29.9, 48.5, 66.7, 72.8, 170.3, 198.0; FAB-MS (*m/z*) 289 (M^++H). High resolution FAB-MS (*m/z*) calcd for $C_{13}H_{24}O_5Si$: 289.1464 $[M+H]^+$. Found: 289.1471.

Reaction of $Pb(OAc)_4$ with 3 in the presence of *i*-Pr_2NEt. To a toluene (10.0 mL) solution of **3** (500 mg, 1.48 mmol) was added *i*-Pr_2NEt (0.48 mL, 2.7 mmol) and $Pb(OAc)_4$ (980 mg, 2.22 mmol) at 0 °C under Ar atmosphere. The reaction mixture was stirred at rt for 21 h, filtered through a celite pad, and partitioned between $CHCl_3$/saturated aq $NaHCO_3$. Column chromatography (hexane/EtOAc = 2/1) of the organic layer gave a mixture of **12a** and **12b** (216 mg, 32%, **12a**/**12b** = 1/0.4). Compounds **12a** (foam, t_R 27.6 min) and **12b** (foam, t_R 30.0 min) were separated by HPLC (hexane/AcOEt = 3/2).

Physical data for **12b** : UV (MeOH) λ_{max} 265 nm (ε 9000), λ_{min} 233 nm (ε 1600); ^{1}H NMR ($CDCl_3$) δ 0.07 and 0.08 (6H, each as s), 0.85 (9H, s), 1.94 (3H, d, J = 1.0 Hz), 2.12 and 2.15 (6H, each as s), 2.25-2.28 (1H, m), 2.63-2.69 (1H, m), 4.48-4.54 (3H, m), 4.89 (1H, d, J = 11.9 Hz), 6.19 (1H, t, J = 6.1 Hz), 7.65 (1H, d, J = 1.0 Hz), 8.57 (1H, br); ^{13}C NMR ($CDCl_3$) δ –5.3, –4.9, 12.8, 17.8, 20.7, 21.7, 25.4, 39.3, 63.5, 71.8, 84.0, 108.8, 110.7, 136.0, 150.3, 163.7, 168.0, 169.9. FAB-MS (*m/z*) 457 $[M+H]^+$. Anal. Calcd for $C_{20}H_{32}N_2O_8Si$: C, 52.61; H, 7.06; N, 6.14. Found: C, 52.90; H, 7.10; N, 5.97.

Reaction of 14 with Me_3Al: formation of the spiro derivatives (15a and 15b) and 1-[5-*O*-benzoyl-3-*O*-(*tert*-butyldimethylsilyl)-2-deoxy-4-*C*-methyl-β-D-*threo*-pentofuranosyl]thymine (16a). To a CH_2Cl_2 (4 mL) solution of **14** (50 mg, 0.086 mmol) was added Me_3Al (1 M hexane solution, 0.34 mL, 0.34 mmol) at 0 °C under Ar atmosphere. The mixture was stirred at rt for 13 h, quenched with saturated aq $NaHCO_3$, and filtered through a celite pad. The filtrate was partitioned between $CHCl_3$/saturated aq $NaHCO_3$. Preparative TLC (hexane/EtOAc = 1/1) of the organic layer gave **16a** (foam, 6 mg, 15%) and a mixture of **15a** and **15b** (31 mg, 76%, **15a**/**15b** = 1:1). Compounds **15a** (foam, t_R 8.6 min) and **15b** (foam, t_R 9.4 min) were separated by HPLC (hexane/EtOAc = 2/1).

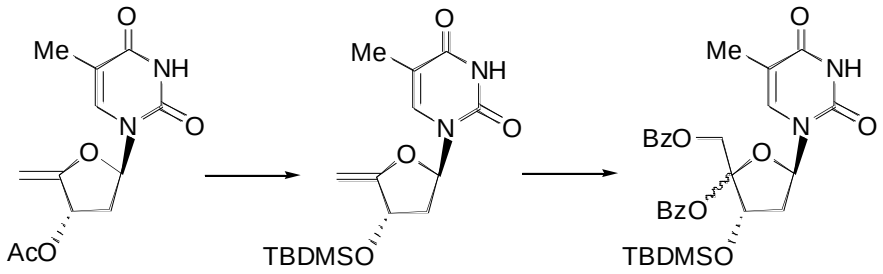
Physical data for **16a**: UV (MeOH) λ_{max} 269 nm (ε8800), λ_{min} 247 nm (ε4800); ^{1}H NMR ($CDCl_3$) δ 0.05 and 0.09 (6H, each as s), 0.87 (9H, s), 1.36 (3H, s), 1.88 (3H, d, *J* = 1.2 Hz), 2.01-2.04 (1H, m), 2.88 (1H, ddd, *J* = 7.7, 5.5, and 14.7 Hz), 4.24 (1H, dd, *J* = 2.0 and 5.5 Hz), 4.49 (1H, d, *J* = 11.5 Hz), 4.62 (1H, d, *J* = 11.5 Hz), 6.25 (1H, dd, *J* = 3.3 and 7.7 Hz), 7.45-7.47 (2H, m), 7.57-7.61 (1H, m), 7.65 (1H, d, *J* = 1.2 Hz), 8.04-8.07 (2H, m), 8.41 (1H, br);); ^{13}C NMR ($CDCl_3$) δ –5.3, –4.8, 12.5, 17.9, 21.8, 25.5, 41.6, 66.6, 75.9, 84.1, 86.8, 110.5, 129.8, 133.3, 136.3, 150.2, 163.56, 166.2. FAB-MS (*m/z*) 475 $[M+H]^+$. Anal. Calcd for $C_{24}H_{34}N_2O_6Si$·1/3 EtOAc: C, 60.73; H, 7.22; N, 5.90. Found: C, 60.49; H, 7.64; N, 5.24.

Physical data for **15a**: UV (MeOH) λ_{max} 266 nm (ε 9300), λ_{min} 233 nm (ε 1700);

^{1}H NMR ($CDCl_3$) δ 0.10 and 0.18 (6H, each as s), 0.90 (9H, s), 1.63 (3H, s), 1.83 (3H, d, *J* = 1.0 Hz), 1.91 (1H, dd, *J* = 14.6 and 2.0 Hz), 2.94 (1H, ddd, *J* = 14.6, 8.0, and 5.0 Hz), 3.95 (1H, d, *J* = 9.8 Hz), 4.24 (1H, d, *J* = 5.0 Hz), 4.41 (1H, d, *J* = 9.8 Hz), 6.30 (1H, dd, *J* = 8.0 and 2.0 Hz), 7.27-7.36 (4H, m), 7.46 (2H, dt, *J* = 6.6 and 1.5 Hz), 8.50 (1H, br); HMBC: C$\underline{H_3}$/Ph(CH_3)$\underline{C}$(O)O; ^{13}C NMR ($CDCl_3$) δ –5.1, –4.8, 12.5, 17.9, 25.6, 28.7, 67.7, 74.7, 83.5, 110.2, 112.0, 115.2, 125.2, 128.1, 136.3, 142.6, 150.2, 163.5. FAB-MS (*m/z*) 475 $[M+H]^+$. Anal. Calcd for $C_{23}H_{34}N_2O_6Si$: C, 60.73; H, 7.22; N, 5.90. Found: C, 60.74; H, 7.36; N, 5.79.

Physical data for **15b**: UV (MeOH) λ_{max} 266 nm (ε 9700), λ_{min} 234 nm (ε 1900); ^{1}H NMR ($CDCl_3$) δ –0.19 and –0.12 (6H, each as s), 0.79 (9H, s), 1.74 (3H, s), 1.90 (3H, d, *J* = 1.0 Hz), 1.93 (1H, dd, *J* = 14.9 and 2.0 Hz), 2.89 (1H, ddd, *J* = 14.9, 8.0, and 5.1 Hz), 4.02 (1H, d, *J* = 7.6 Hz), 4.02 (1H, d, *J* = 5.1 Hz), 4.26 (1H, d, *J* = 7.6 Hz), 6.46 (1H, dd, *J* = 8.0 and 2.0 Hz), 7.30-7.39 (3H, m), 7.43-7.47 (3H, m), 8.64 (1H, br);); HMBC: C$\underline{H_3}$/Ph(CH_3)$\underline{C}$(O)O; ^{13}C NMR ($CDCl_3$) δ –5.5, –5.1, 12.6, 17.8, 25.5, 28.5, 40.0, 69.3, 74.8, 84.0, 110.5, 112.0, 114.9, 124.9, 128.2, 128.3, 136.3, 142.4, 150.3, 163.6. FAB-MS (*m/z*) 475 $[M+H]^+$. Anal. Calcd for $C_{23}H_{34}N_2O_6Si$: C, 60.73; H, 7.22; N, 5.90. Found: C, 60.52; H, 7.42; N, 6.01.

SCHEME B. Preparation of 19 from 1-(3-*O*-acetyl-2,5-dideoxy-β-D-*glycero*-pent-4-enofuranosyl)thymine (VI)[a]



VI **VII** **19**

[a] Verheyden, J. P. H.; Moffatt, J. G. *J. Org. Chem.* **1974**, *39*, 3573.

1-[3-*O*-(*tert*-Butyldimethylsilyl)-2,5-dideoxy-β-D-*glycero*-pent-4-enofuranosyl]-thymine (VII). Compound **VI** (6.90 g, 25.9 mmol) was dissolved in NH_3/MeOH (350 mL) and kept standing in refrigerator for 19 h. The solvent was evaporated and the residual syrup was dried under reduced pressure. To a solution of this syrup in DMF (60 mL) were added imidazole (5.29 g, 77.8 mmol) and TBDMSCl (7.81 g, 51.8 mmol). After being stirred at rt for 15 h, the reaction mixture was partitioned between EtOAc/H_2O. Column chromatography hexane/EtOAc = 3/1) of the organic layer gave **VII** (7.87 g, 90%) as a foam: UV (MeOH) λ_{max} 264 nm (ε 11100), λ_{min} 234 nm (ε 4900); ^{1}H NMR ($CDCl_3$) δ 0.13 (6H, s), 0.91 (9H, s), 1.94 (3H, d, *J* = 1.2 Hz), 2.13-2.20 (1H, m), 2.40 (1H, ddd, *J* = 13.6, 6.2, and 3.4 Hz), 4.24 (1H, d, *J* = 2.0 Hz), 4.54 (1H, d, *J* = 2.0 Hz), 4.75 (1H, dd, *J* = 6.0 and 3.4 Hz), 6.49 (1H, t, *J* = 6.2 Hz), 6.98 (1H, d, *J* = 1.2 Hz), 8.47 (1H, br); ^{13}C NMR ($CDCl_3$) δ : –4.8, –4.7, 12.6, 18.0, 25.6, 25.7, 40.7, 70.7, 85.1, 86.1, 111.7, 134.5, 150.0, 162.7, 163.5. FAB-MS (*m/z*) 339 $[M+H]^+$. Anal. Calcd for $C_{16}H_{26}N_2O_4Si$: C, 56.78; H, 7.74; N, 8.28. Found: C, 57.04; H,

7.99; N, 8.14.

1-[5-*O*-Benzoyl-4-benzoyloxy-3-*O*-(*tert*-butyldimethylsilyl)-2-deoxy-β-D-*erythro*-pentofuranosyl]thymine (19a) and 1-[5-*O*-Benzoyl-4-benzoyloxy-3-*O*-(*tert*-butyldimethylsilyl)-2-deoxy-α-L-*threo*-pentofuranosyl]thymine (19b).

To a toluene (8 mL) solution of **VII** (338.5 mg, 1.0 mmol) were added *i*-Pr_2NEt (0.61 mL, 3.5 mmol) and $Pb(OBz)_4$ (2.42 g, 3.5 mmol) at 0 °C under Ar atmosphere. After being stirred at rt for 24 h, the reaction mixture was quenched with saturated aq $NaHCO_3$ and filtered through a celite pad. The filtrate was partitioned between $CHCl_3$/saturated aq $NaHCO_3$. Column chromatography (hexane/EtOAc = 2/1) gave a mixture of **VII**, **19a**, and **19b**. To decompose **VII**, the mixture was treated with 80% aq AcOH (10 mL) in THF (16 mL) at rt for 5 days. The solvent was evaporated and the residue was partitioned between $CHCl_3$/saturated aq $NaHCO_3$. Column chromatography (hexane/EtOAc = 2/1) of the organic layer gave a mixture of **19a** and **19b** (238.8 mg, 41%, **19a**/**19b** = 1.3/1.0). Compounds **19a** (foam, t_R 10.0 min) and **19b** (foam, t_R 11.6 min) were isolated by HPLC (hexane/EtOAc = 1/1) separation.

Physical data for **19a**: UV (MeOH) λ_{max} 265 nm (ε 11900) and 230 nm (ε 28000), λ_{min} 250 nm (ε 9500); ^{1}H NMR ($CDCl_3$) δ 0.02 and 0.07 (6H, each as s), 0.71 (9H, s), 1.77 (3H, s), 2.63-2.69 (1H, m), 2.75-2.79 (1H, m), 4.78 (1H, d, J = 11.5 Hz), 4.99-5.00 (1H, m), 5.03 (1H, d, J = 11.5 Hz), 6.26 (1H, dd, J = 8.3 and 3.7 Hz), 7.15 (1H, s), 7.42-7.47 (5H, m), 7.51-7.64 (3H, m), 8.03-8.09 (5H, m), 9.86 (1H, br); NOE

experiment: H-6/H-5'a (0.3%), H-3'/H-5'a (3.9%) and H-3'/H-5'b (1.2%); ^{13}C NMR ($CDCl_3$) δ –5.2, –4.7, 12.2, 17.6, 25.3, 40.2, 64.7, 73.2, 89.9, 108.7, 110.9, 118.3, 128.6, 129.7, 129.8, 133.2, 133.4, 149.7, 163.7, 164.5, 165.9. FAB-MS (m/z) 581 $[M+H]^+$. Anal. Calcd for $C_{30}H_{36}N_2O_8Si$: C, 62.05; H, 6.25; N, 4.82. Found: C, 61.90; H, 6.26; N, 4.78.

Physical data for **19b**: UV (MeOH) λ_{max} 26 nm (ε 10600) and 230 nm (ε 26400), λ_{min} 251 nm (ε 8400); ^{1}H NMR ($CDCl_3$) δ 0.17 and 0.18 (6H, each as s), 0.94 (9H, s), 1.72 (3H, d, *J* = 1.2 Hz), 2.32 (1H, ddd, *J* = 13.7, 8.7, and 4.3 Hz), 2.48 (1H, dd, *J* = 13.7 and 6.0 Hz), 5.01 (1H, d, *J* = 4.3 Hz), 5.05 (1H, d, *J* = 12.0 Hz), 5.11 (1H, d, *J* = 12.0 Hz), 6.74 (1H, dd, *J* = 8.7 and 6.0 Hz), 7.32-7.37, 7.47-7.52, 7.62-7.66, 7.90-7.92 and 8.03-8.06 (11H, each as m), 8.47 (1H, br); NOE experiment: CH_3-Si/H-5'a (1.4%) and *t*-Bu-Si/H-5'a (0.8%); ^{13}C NMR ($CDCl_3$) δ –5.1, –4.7, 12.4, 17.9, 25.6, 62.0, 75.5, 86.9, 111.8, 112.0, 128.3, 128.6, 129.5, 129.6, 129.6, 133.1, 133.9, 134.9, 150.1, 163.2, 164.3, 165.5. FAB-MS (*m/z*) 581 $[M+H]^+$. Anal. Calcd for $C_{30}H_{36}N_2O_8Si$: C, 62.05; H, 6.25; N, 4.82. Found: C, 61.96; H, 6.37; N, 4.81.

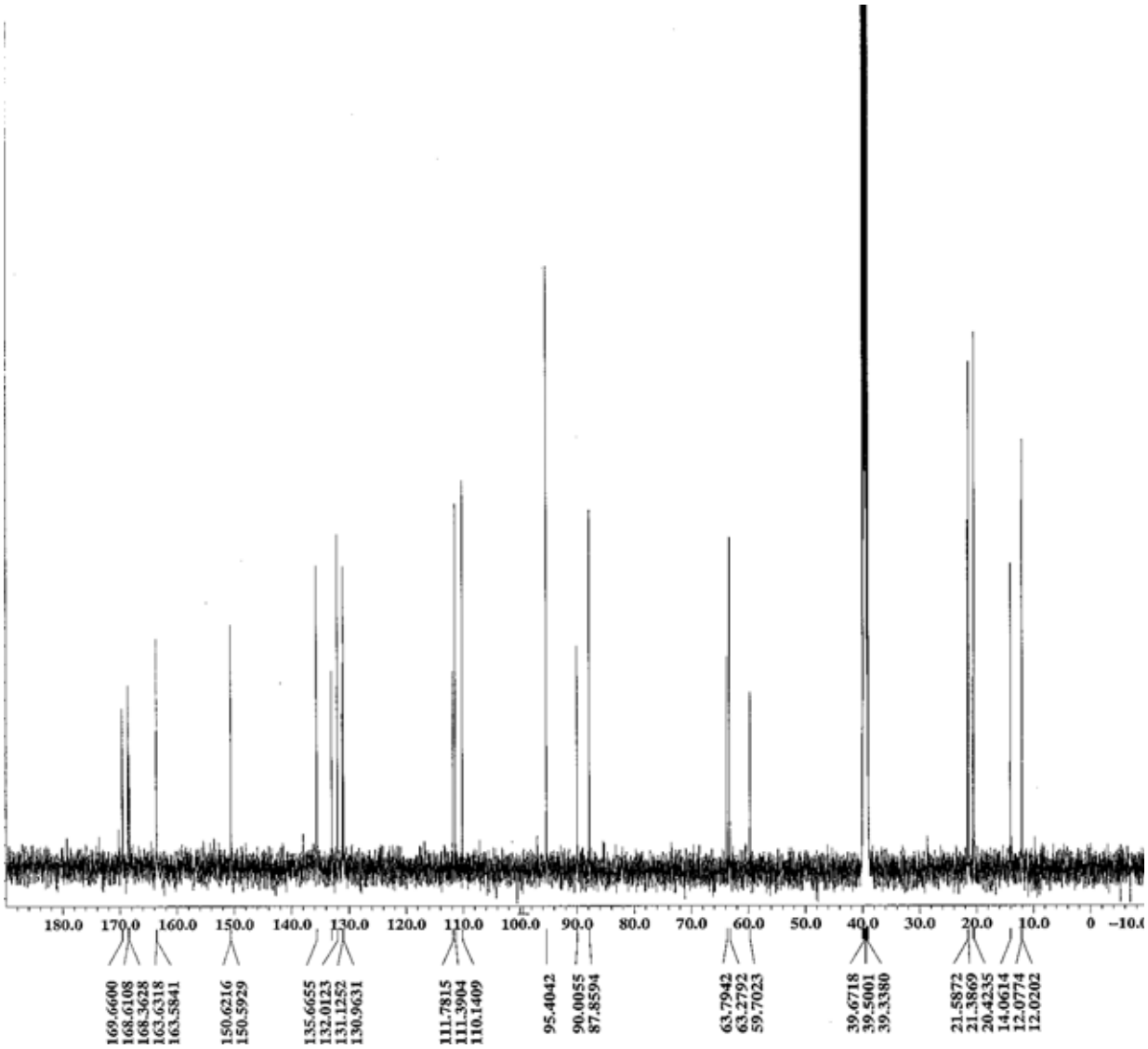


Fig. 1: ^{13}C NMR spectrum of compound **10** in DMSO-d_6

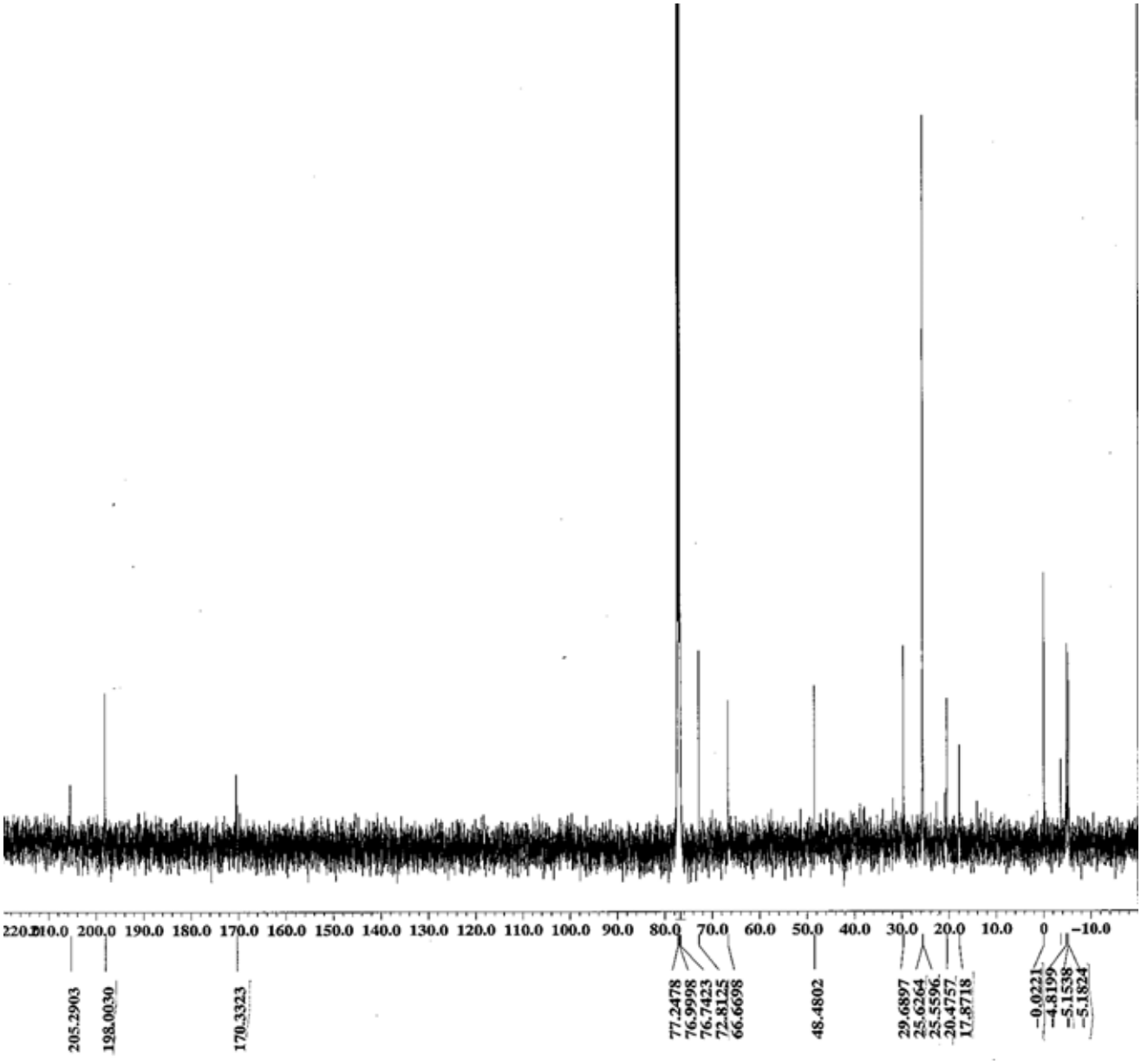


Fig. 2: ^{13}C NMR spectrum of compound **13** in $CDCl_3$

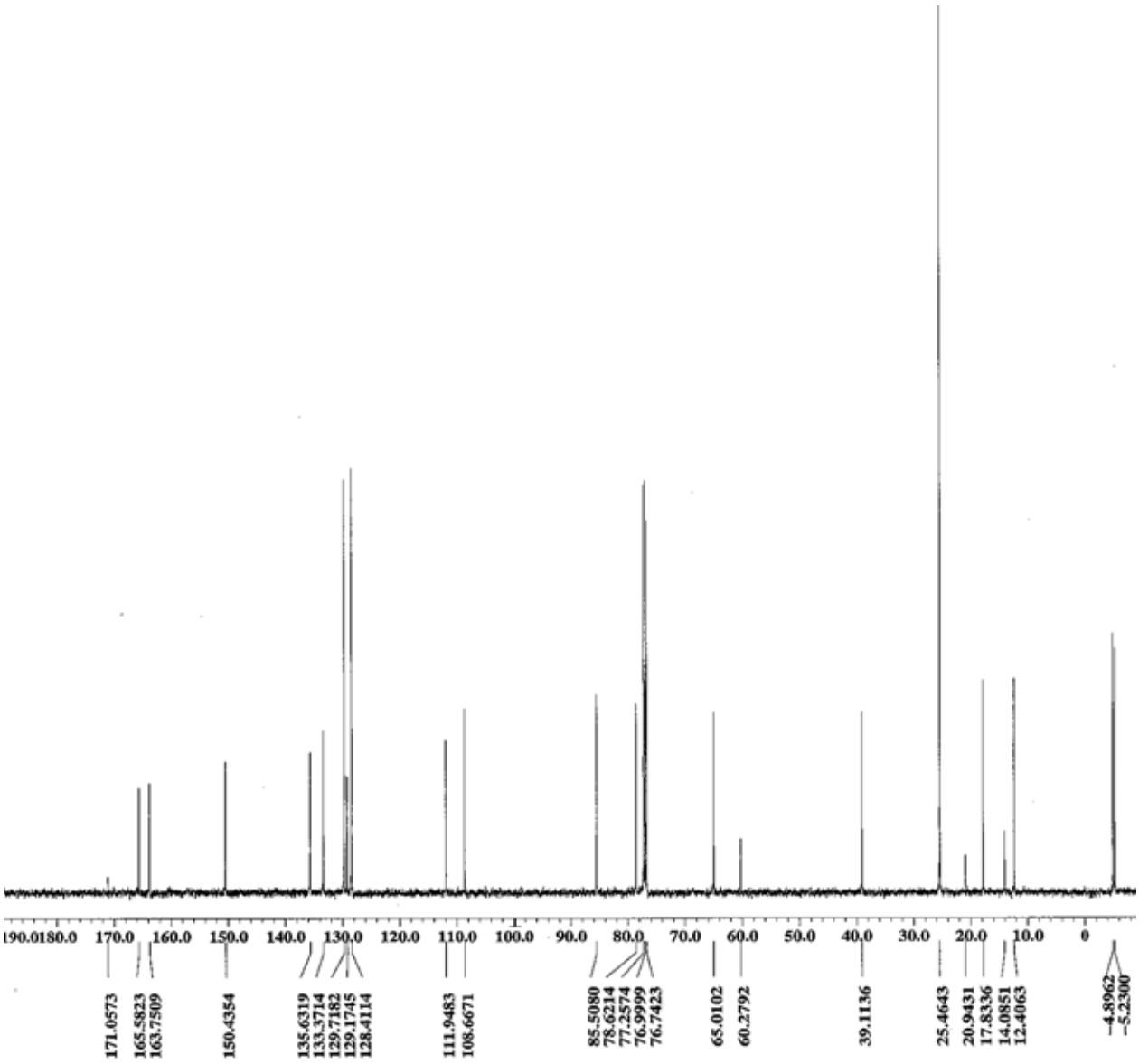


Fig. 3: ^{13}C NMR spectrum of compound **17a** in $CDCl_3$

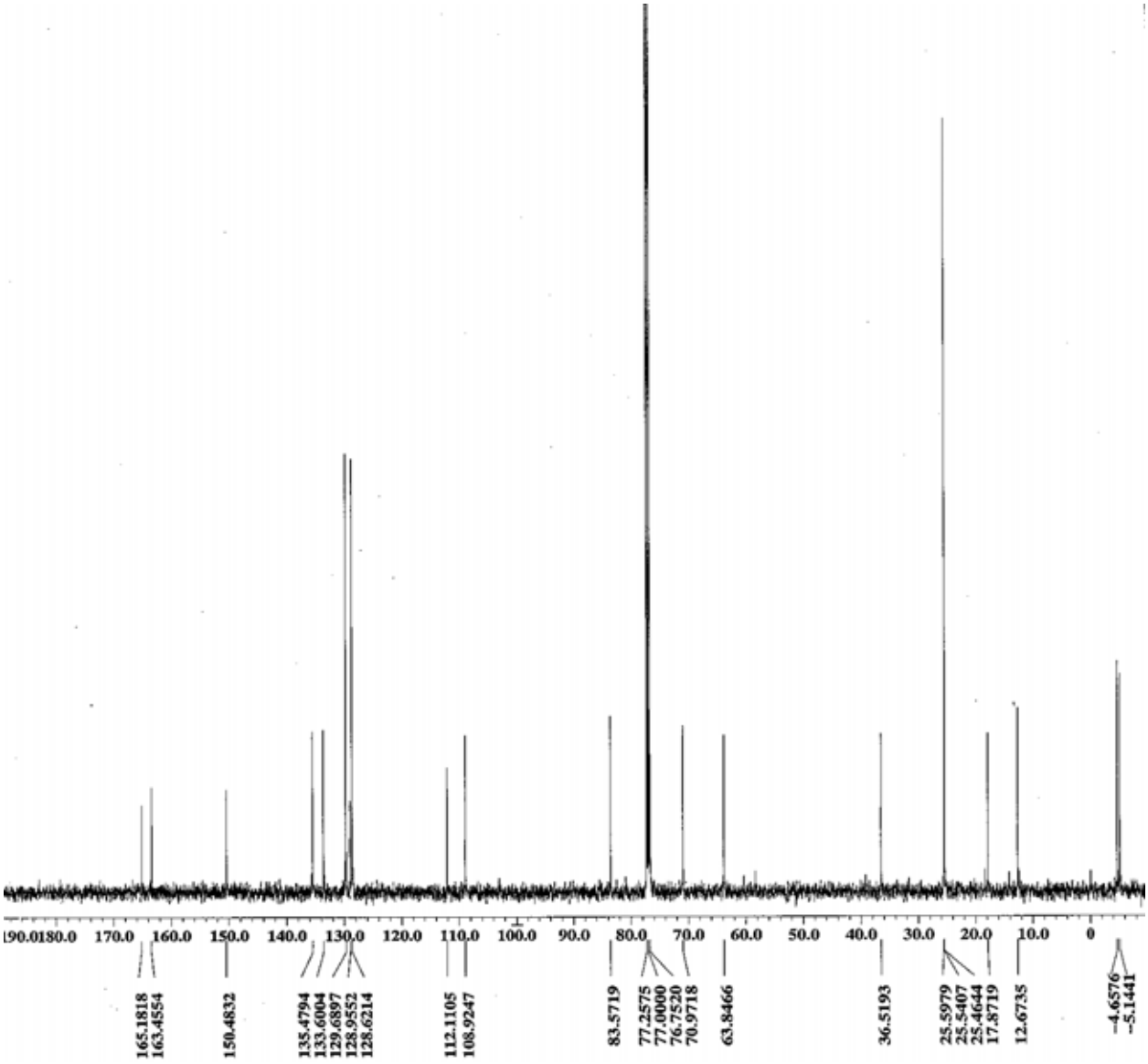


Fig. 4: ^{13}C NMR spectrum of compound **17b** in $CDCl_3$

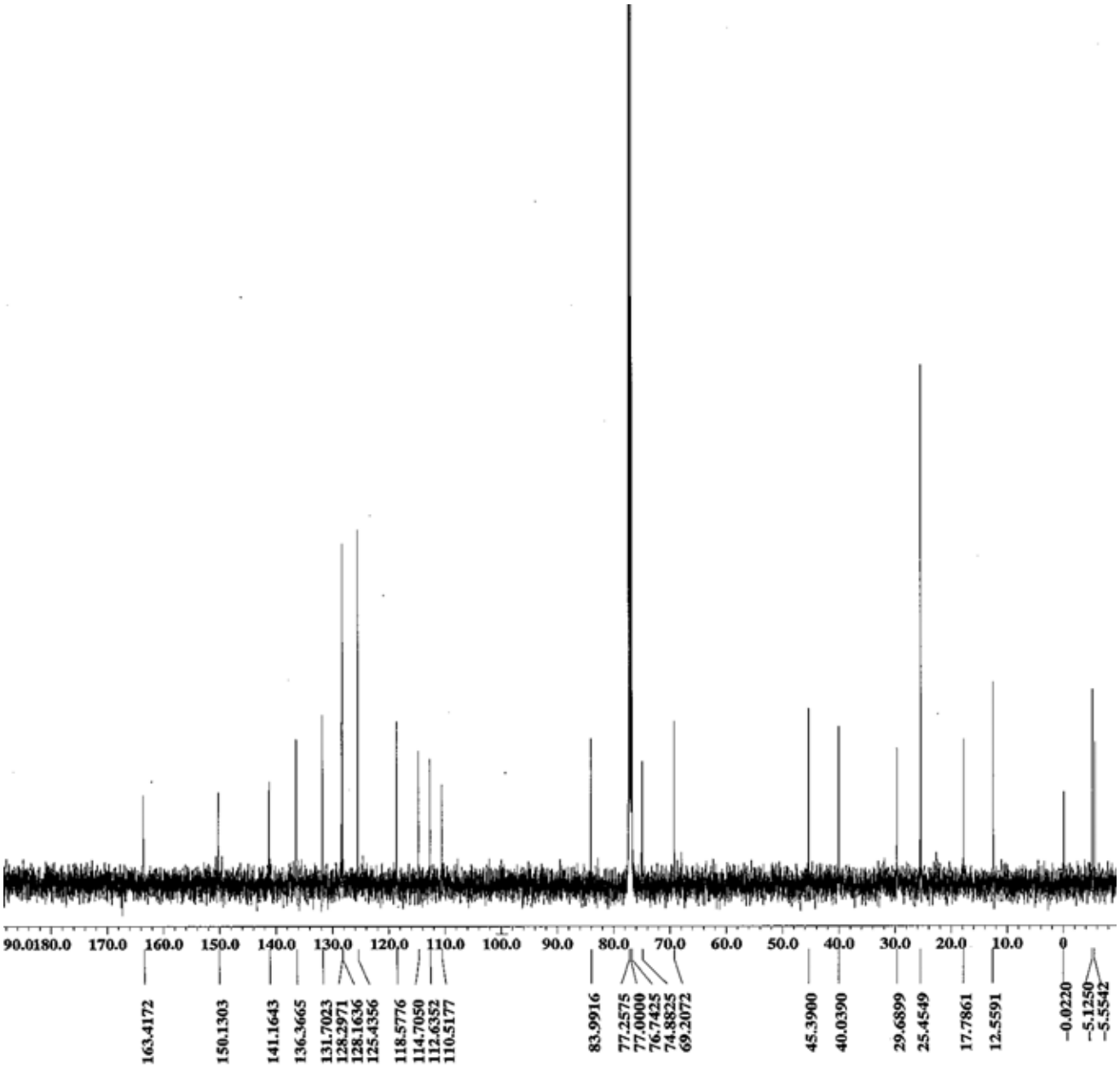


Fig. 5: ^{13}C NMR spectrum of compound **23** in $CDCl_3$

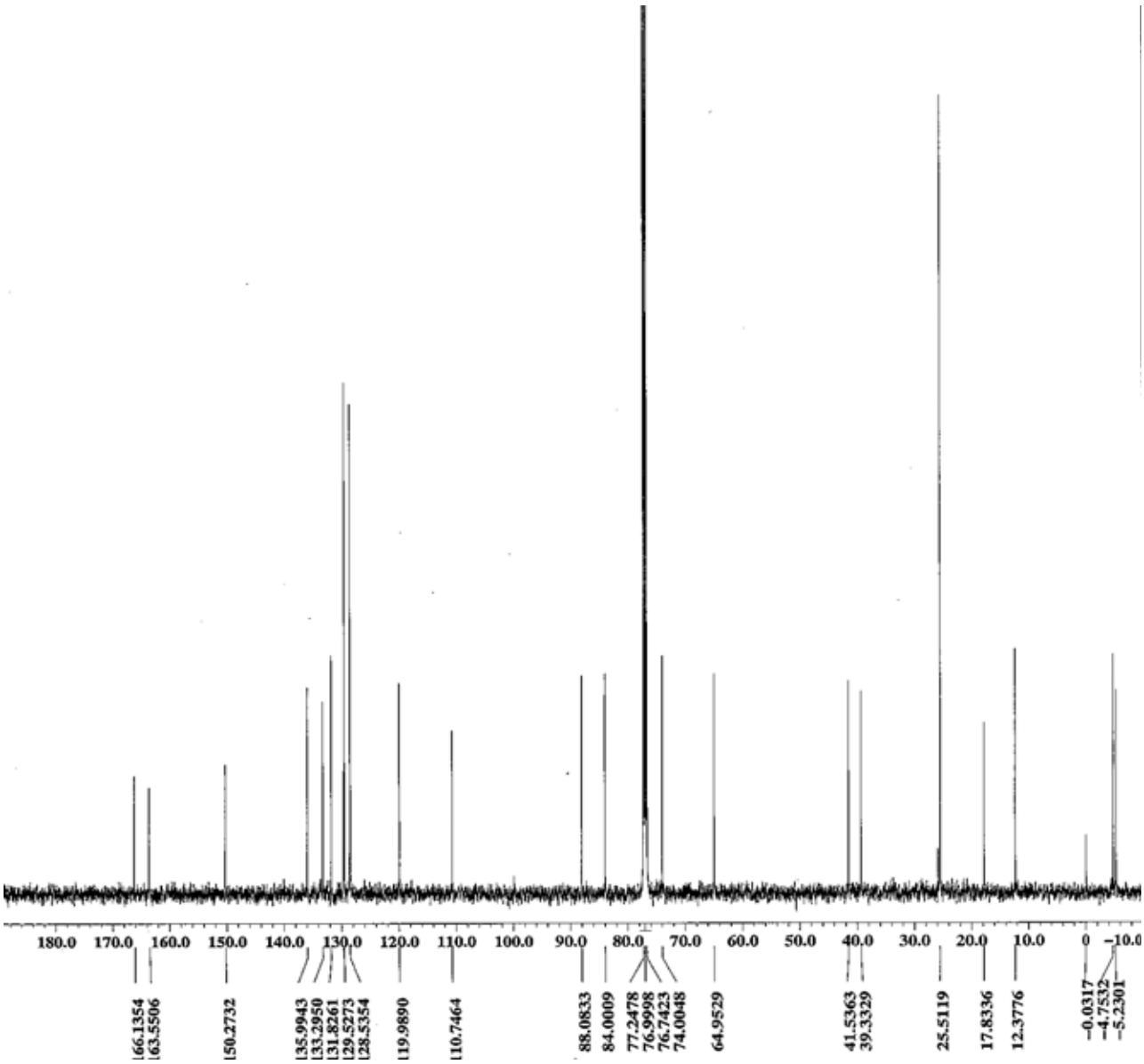


Fig. 6: ^{13}C NMR spectrum of compound **24a** in $CDCl_3$

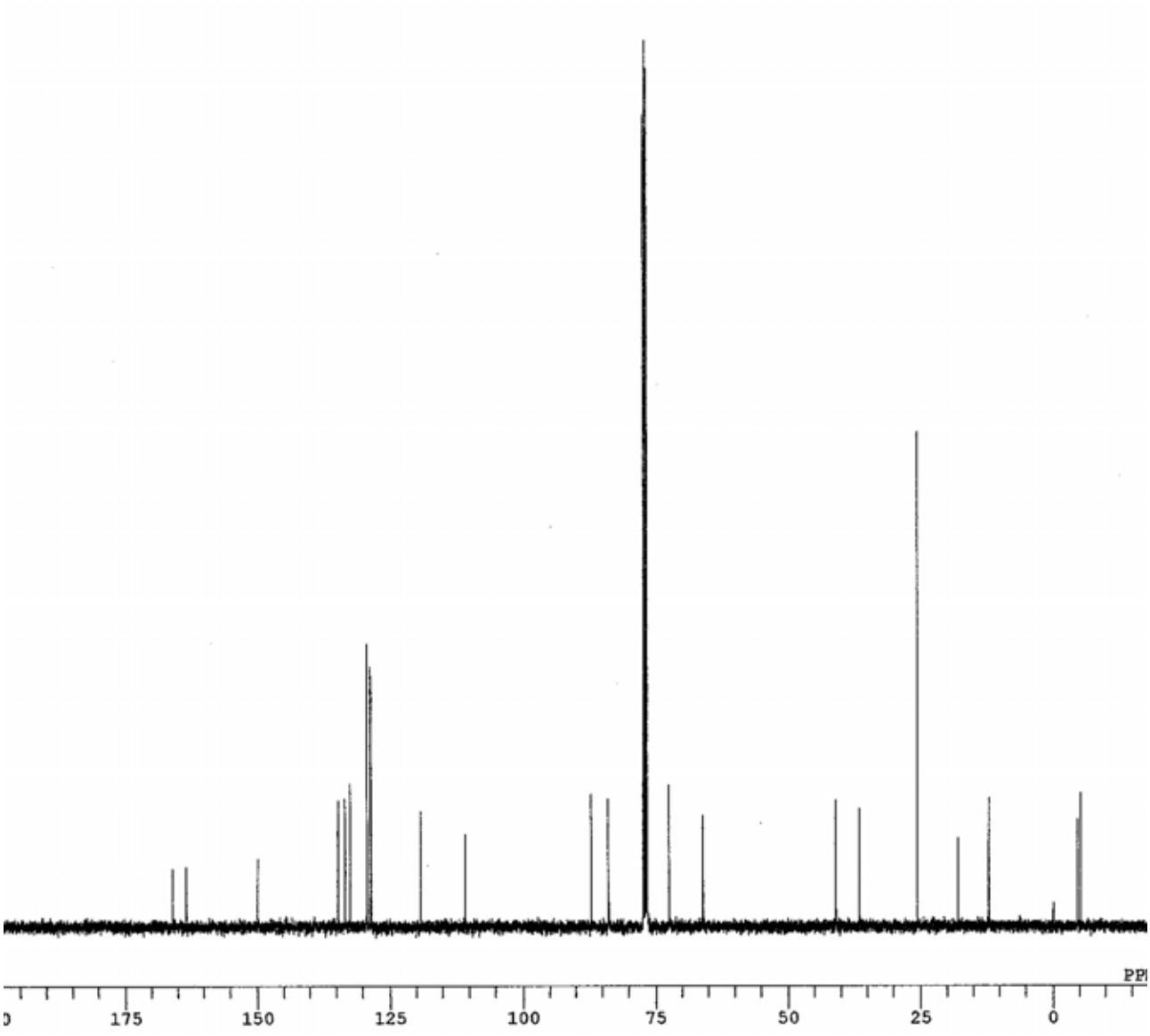


Fig. 7: ^{13}C NMR spectrum of compound **24b** in $CDCl_3$

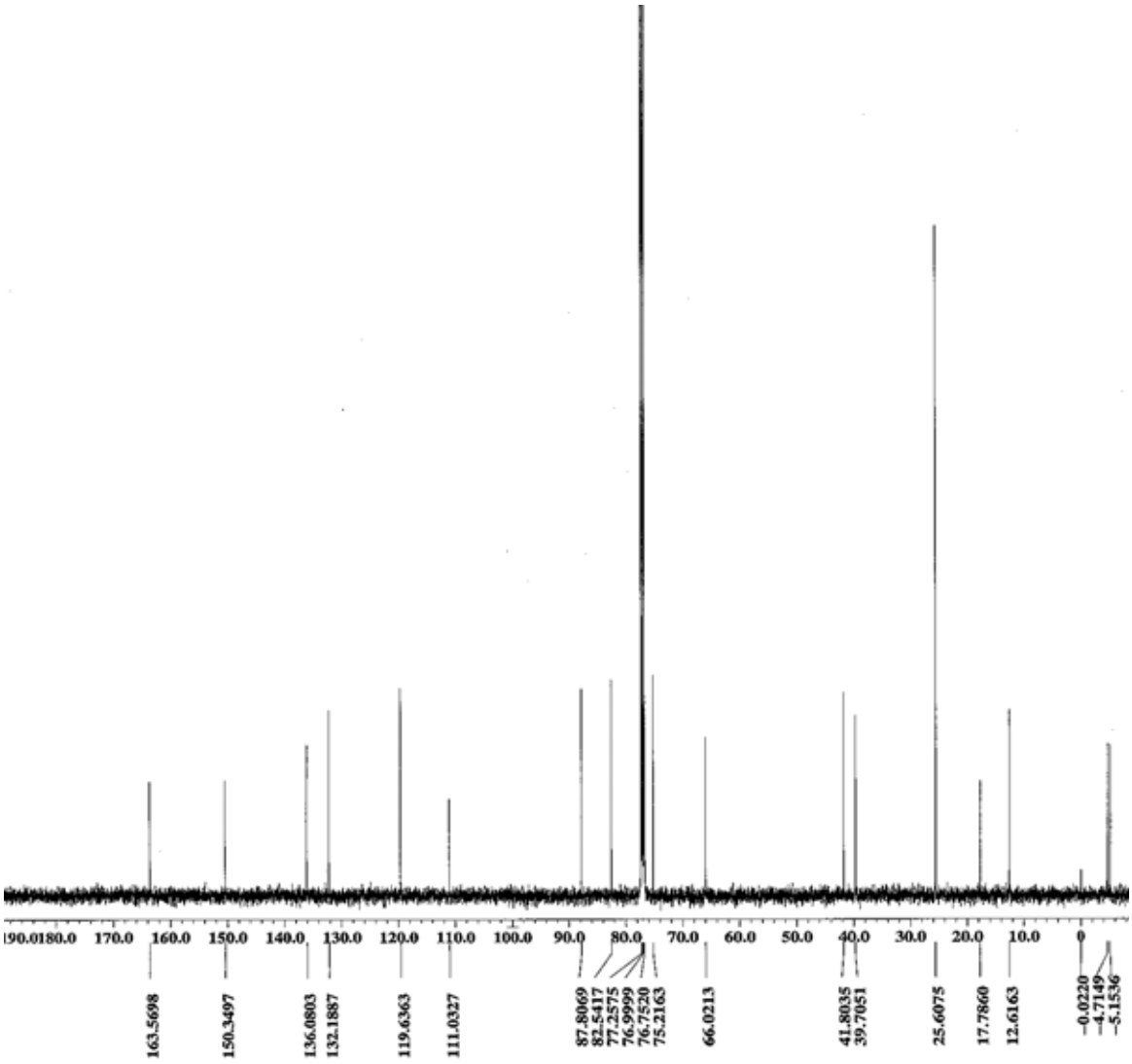


Fig. 8: ^{13}C NMR spectrum of compound **25** in $CDCl_3$

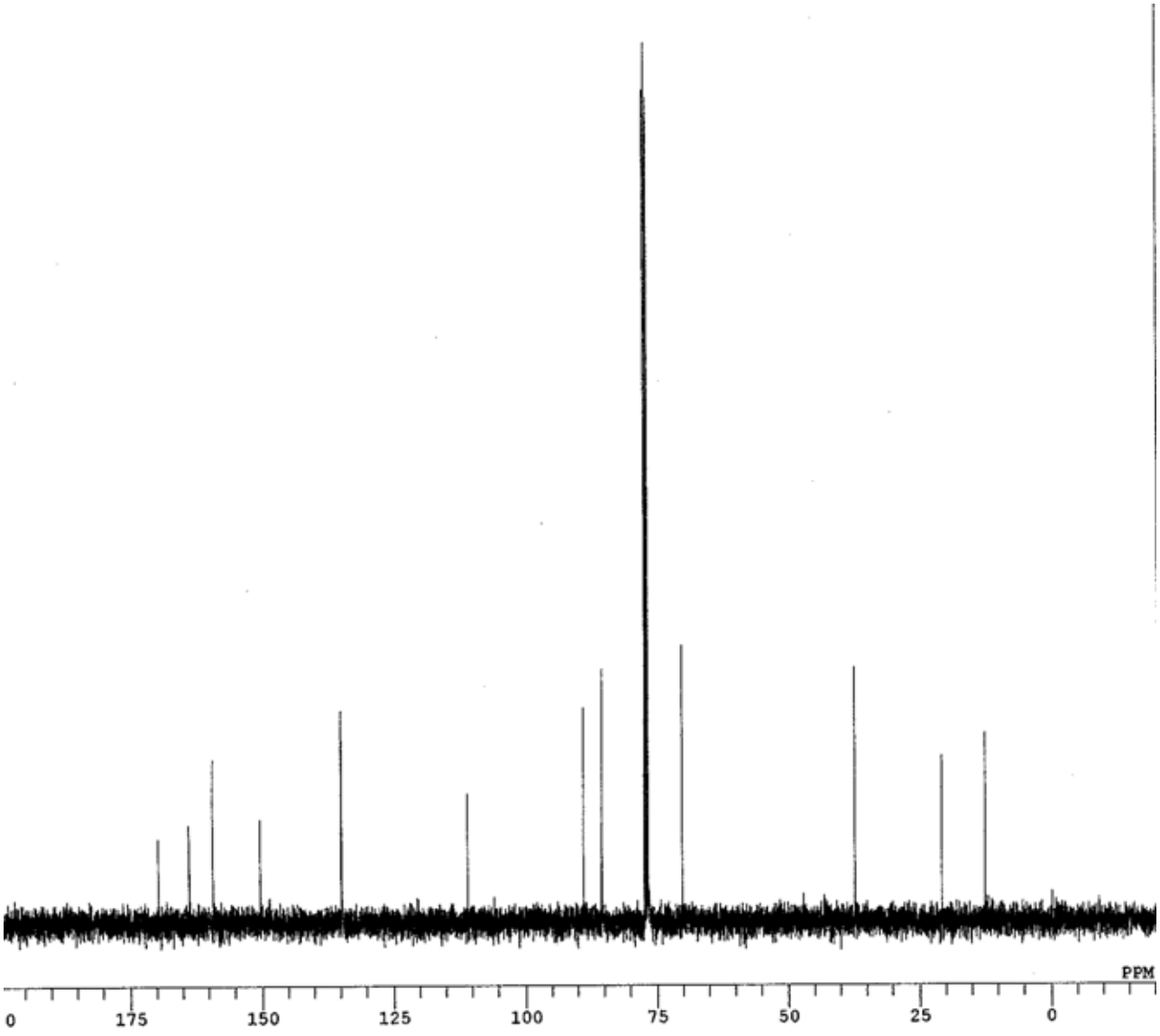


Fig. 9: ^{13}C NMR spectrum of compound **IV** in $CDCl_3$