

Supporting Information

CuSO₄-D-glucose an inexpensive and eco-efficient catalytic system: direct access to diverse quinolines through modified Friedländer approach involving S_NAr/reduction/annulation cascade in one-pot

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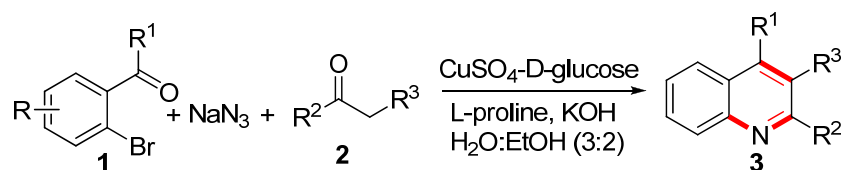
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Experimental Section

1. General Experimental Details

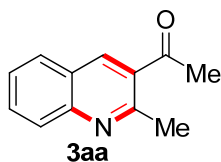
^1H and ^{13}C NMR spectra were recorded at 300 and 75 MHz, respectively. Chemical shift (δ) values are given in parts per million (ppm) with reference to tetramethylsilane (TMS) as the internal standard. Coupling constant (J) values are given in Hertz (Hz). The IR spectra were recorded on Varian 3100 FT-IR spectrophotometer. Melting points were determined with Buchi B-540 melting point apparatus and are uncorrected. Commercially obtained reagents were used after further purification when needed. All the reactions were monitored by TLC with silica gel coated plates. Column chromatography was carried out whenever needed, using silica gel of 100/200 mesh. Mixture of hexane/ethyl acetate in appropriate proportion (determined by TLC analysis) was used as eluent.

2. a. General procedure for the synthesis of compound 3

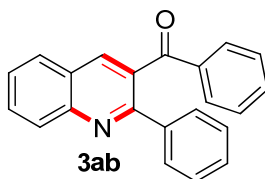


A mixture of 2-bromobenzaldehyde/2-bromoacetophenone **1** (1 mmol), NaN₃ (2 mmol) and cyclic/acyclic ketones **2** (1.1 mmol) in H₂O + EtOH (3:2, 5 mL) was placed in a 50 mL round bottom flask. To a stirring solution of above mixture added CuSO₄ (0.3 mmol), D-glucose (0.3 mmol), L-proline (0.2 mmol) and KOH (1 mmol). The reaction mixture was allowed to stir at 90 °C for 3-10 h. After completion of reaction (monitored on TLC), solvent was removed under reduced pressure and extracted with ethyl acetate. The combined organic layer was dried over anhydrous sodium sulphate, filtered and the solvent was removed under reduced pressure. The crude residue thus obtained was purified by column chromatography to give the desired quinolines **3**.

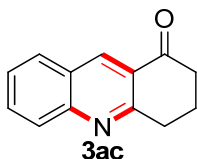
2. b. Characterization of Compounds 3



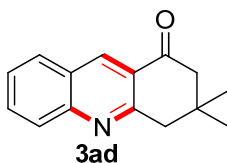
3-Acetyl-2-methyl quinoline (3aa)¹: Pale yellow solid, mp 74-75 °C; IR (KBr) cm^{-1} : 3053, 1788, 1624, 1579, 1456, 818 cm^{-1} ; ^1H NMR (300 MHz, CDCl_3) δ : 8.48 (s, 1H, ArH), 8.05 (d, $J = 8.4$ Hz, 1H, ArH), 7.87-7.76 (m, 2H, ArH), 7.57-7.52 (m, 1H, ArH), 2.91 (s, 3H, COCH_3) 2.72 (s, 3H, CH_3); ^{13}C NMR (75 MHz, CDCl_3): δ 199.9, 157.5, 138.2, 138.1, 131.6, 131.1, 128.5, 128.2, 126.6, 125.5, 29.2, 25.6.



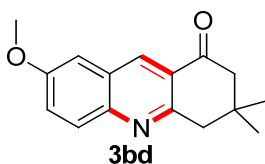
Phenyl(2-phenylquinolin-3-yl)methanone (3ab)²: Yellow solid, mp 135-137 °C; IR (KBr) cm^{-1} : 3163, 2960, 1756, 1684, 1562 cm^{-1} ; ^1H NMR (300 MHz, CDCl_3) δ : 8.23-8.15 (m, 5H, ArH), 8.00 (d, $J = 6.9$ Hz, 1H, ArH), 7.89-7.81 (m, 2H, ArH), 7.75-7.70 (m, 1H, ArH), 7.55-7.43 (m, 6H, ArH); ^{13}C NMR (75 MHz, CDCl_3) δ : 175.7, 157.3, 148.2, 139.6 (2C), 136.7, 132.4, 129.6, 129.2 (2C), 128.8 (3C), 128.6 (3C), 127.4 (2C), 127.1 (2C), 126.2, 118.9.



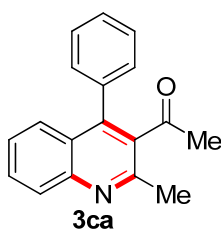
3,4-Dihydroacridin-1(2H)-one (3ac)¹: White solid, mp 103-105 °C; IR (KBr) cm^{-1} : 3463, 2926, 1737, 1452, 1230, 835 cm^{-1} ; ^1H NMR (300 MHz, CDCl_3) δ : 8.85 (s, 1H, ArH), 8.06 (d, $J = 8.4$ Hz, 1H, ArH), 7.94 (d, $J = 8.1$ Hz, 1H, ArH), 7.83-7.78 (m, 1H, ArH), 7.57 (t, $J = 7.2$ Hz, 1H, ArH), 3.34 (t, $J = 6.0$ Hz, 2H, CH_2), 2.82 (t, $J = 6.0$ Hz, 2H, CH_2), 2.32 (dd, $J_1 = 6.0$ Hz, $J_2 = 12.6$ Hz, 2H, CH_2); ^{13}C NMR (75 MHz, CDCl_3) δ : 197.8, 161.9, 137.1, 132.3, 129.7, 128.4, 126.7, 126.6, 126.2, 39.0, 33.3, 21.7.



3,3-Dimethyl-3,4-dihydroacridin-1(2H)-one (3ad)¹: White solid, mp 116-118 °C; IR (KBr) cm^{-1} : 3062, 1768, 1594, 1488, 1231 cm^{-1} ; ^1H NMR (300 MHz, CDCl_3) δ : 8.82 (s, 1H, ArH), 8.06 (d, $J = 8.7$ Hz, 1H, ArH), 7.94 (d, $J = 8.1$ Hz, 1H, ArH), 7.82-7.77 (m, 1H, ArH), 7.57-7.52 (m, 1H, ArH), 3.20 (s, 2H, CH_2), 2.65 (s, 2H, CH_2), 1.15 (s, 6H, $2 \times \text{CH}_3$); ^{13}C NMR (75 MHz, CDCl_3) δ : 197.9, 160.7, 149.9, 136.4, 132.1, 129.7, 128.5, 126.6 (2C), 125.2, 52.4, 47.1, 32.7, 28.3(2C).

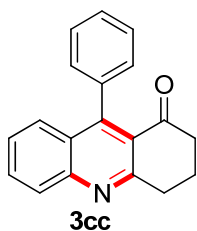


7-Methoxy-3,3-dimethyl-3,4-dihydroacridin-1(2H)-one (3bd)³: Yellow solid, mp 98-100 °C; IR (KBr) cm^{-1} : 3062, 1768, 1594, 1488, 1231 cm^{-1} ; ^1H NMR (300 MHz, CDCl_3) δ : 8.73 (s, 1H, ArH), 7.97 (d, $J = 9.0$ Hz, 1H, ArH), 7.47-7.43 (m, 1H, ArH), 7.167 (s, 1H, ArH), 3.93 (s, 3H, OCH_3), 3.16 (s, 2H, CH_2), 2.63 (s, 2H, CH_2), 1.14 (s, 6H, $2 \times \text{CH}_3$); ^{13}C NMR (75 MHz, CDCl_3) δ : 198.1, 158.2, 157.7, 146.1, 135.0, 129.8 (2C), 127.7, 125.3, 106.3, 55.6, 52.4, 46.7, 32.8, 28.3(2C).



3-Acetyl-2-methyl-4-phenylquinoline (3ca)⁴: Yellow solid, mp 112-114 °C; IR (KBr) cm^{-1} : 3053, 1788, 1624, 1579, 1456, 818 cm^{-1} ; ^1H NMR (300 MHz, CDCl_3) δ : 8.08 (d, $J = 8.4$ Hz, 1H, ArH), 7.72-7.67 (m, 1H, ArH), 7.62 (d, $J = 8.4$ Hz, 1H, ArH), 7.49-7.44 (m, 3H, ArH), 7.42-7.34 (m, 3H, ArH), 2.70 (s, 3H, CH_3), 2.00 (s, 3H, CH_3); ^{13}C NMR (75 MHz, CDCl_3) δ : 205.5, 153.3, 147.3, 143.7, 135.0, 134.6, 129.9, 129.8 (2C), 128.8, 128.7, 128.5

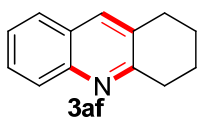
(2C), 126.3, 126.0, 124.8, 31.8, 23.7.



9-Phenyl-3,4-dihydroacridin-1(2H)-one (3cc)⁴: Pale yellow solid, mp 153-156 °C; IR (KBr) cm^{-1} : 3407, 3048, 2924, 1737, 1498, 1230, 749 cm^{-1} ; ^1H NMR (300 MHz, CDCl_3) δ : 8.08 (d, $J = 8.4$ Hz, 1H, ArH), 7.78 (m, 1H, ArH), 7.50-7.37 (m, 5H, ArH), 7.19-7.16 (m, 2H, ArH), 3.40 (t, $J = 6.3$ Hz, 2H, CH_2), 2.72 (t, $J = 6.3$ Hz, 2H, CH_2), 2.29 (dd, $J_1 = 6.6$ Hz, $J_2 = 12.6$ Hz, 2H, CH_2); ^{13}C NMR (75 MHz, CDCl_3) δ : 197.9, 162.2, 151.4, 148.5, 137.5, 131.7, 128.4 (2C), 128.1, 128.0 (2C), 127.9, 127.5 (2C), 126.4, 123.8, 40.6, 34.5, 21.3.

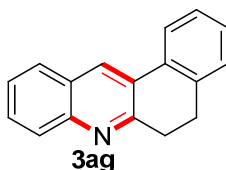


2,3-Dihydro-1H-cyclopenta[b]quinoline (3ae)¹: White solid, mp 55-57 °C; IR (KBr) cm^{-1} : 3053, 1646, 1562, 1212 cm^{-1} ; ^1H NMR (300 MHz, CDCl_3) δ : 8.02 (d, $J = 8.4$ Hz, 1H, ArH), 7.70 (s, 1H, ArH), 7.67-7.64 (m, 1H, ArH), 7.60-7.55 (m, 1H, ArH), 7.43-7.38 (m, 1H, ArH), 3.14 (t, $J = 7.5$ Hz, 2H, CH_2), 3.02 (t, $J = 7.2$ Hz, 2H, CH_2), 2.19-2.11 (dd, $J_1 = 7.5$ Hz, $J_2 = 15.0$ Hz, 2H, CH_2); ^{13}C NMR (75 MHz, CDCl_3) δ : 157.6, 147.2, 135.3, 130.0, 128.3, 128.2, 128.0, 127.1, 125.2, 34.3, 30.2, 23.3.

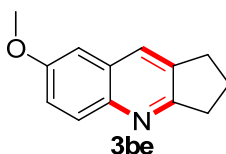


1,2,3,4-Tetrahydroacridine (3af)^{1,5}: White solid, mp 85-87 °C; IR (KBr) cm^{-1} : 3058, 1624, 1557, 1453, 1214 cm^{-1} ; ^1H NMR (300 MHz, CDCl_3) δ : 7.97 (d, $J = 8.4$ Hz, 1H, ArH), 7.70 (s, 1H, ArH), 7.67-7.64 (m, 1H, ArH), 7.60-7.55 (m, 1H, ArH), 7.42-7.37 (m, 1H, ArH), 3.13 (t,

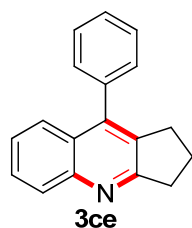
$J = 6.3$ Hz, 2H, CH₂), 2.96 (t, $J = 6.3$ Hz, 2H, CH₂), 1.99-1.95 (m, 2H, CH₂), 1.88-1.84 (m, 2H, CH₂); ¹³C NMR (75 MHz, CDCl₃) δ : 159.1, 146.4, 134.8, 130.8, 128.3, 128.1, 127.0, 126.7, 125.3, 33.4, 29.1, 23.1, 22.7.



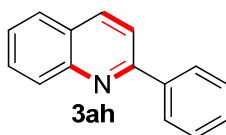
5,6-Dihydrobenzo[*a*]acridine (3ag)⁶: Yellow solid, mp 63-65 °C; IR (KBr) cm⁻¹: 3417, 2929, 1498, 1278, 1033, 789 cm⁻¹; ¹H NMR (300 MHz, CDCl₃) δ : 8.58 (d, $J = 7.5$ Hz, 1H, ArH), 8.13 (d, $J = 8.4$ Hz, 1H, ArH), 7.84 (s, 1H, ArH), 7.69-7.59 (m, 2H, ArH), 7.45-7.31 (m, 3H, ArH), 7.24 (d, $J = 7.2$ Hz, 1H, ArH), 3.08-3.04 (m, 2H, CH₂), 2.97-2.93 (m, 2H, CH₂); ¹³C NMR (75 MHz, CDCl₃) δ : 153.2, 147.5, 139.3, 134.6, 133.6, 130.4, 129.5, 129.3, 128.5, 127.8, 127.7, 127.2, 126.8, 126.0, 125.9, 28.7, 28.3.



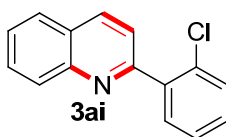
7-Methoxy-2,3-dihydro-1*H*-cyclopenta[*b*]quinoline (3be)⁷: White solid, mp 97-99 °C; IR (KBr) cm⁻¹: 3407, 3048, 2924, 1595, 1498, 1230, 749 cm⁻¹; ¹H NMR (300 MHz, CDCl₃) δ : 7.91 (d, $J = 9.3$ Hz, 1H, ArH), 7.77 (s, 1H, ArH), 7.28-7.24 (m, 1H, ArH), 7.00 (d, $J = 2.7$ Hz, 1H, ArH), 3.90 (s, 3H, OCH₃), 3.24 (t, $J = 7.5$ Hz, 2H, CH₂), 3.14-3.02 (m, 4H, 2xCH₂), 2.23-2.13 (m, 2H, CH₂); ¹³C NMR (75 MHz, CDCl₃) δ : 165.2, 157.0, 143.3, 135.9, 129.7, 129.3, 128.2, 120.4, 105.5, 55.4, 34.2, 30.5, 23.6.



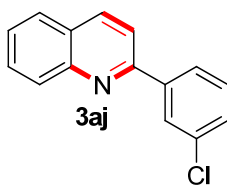
9-Phenyl-2,3-dihydro-1-cyclopenta[*b*]quinoline (3ce)⁴: Yellow solid, mp 133-135 °C; IR (KBr) cm^{-1} : 3053, 1625, 1586, 1230, 1033, 836 cm^{-1} ; ^1H NMR (300 MHz, CDCl_3) δ : 8.09 (d, $J = 8.4$ Hz, 1H, ArH), 7.63 (m, 2H, ArH), 7.51-7.45 (m, 3H, ArH), 7.37-7.34 (m, 3H, ArH), 3.24 (t, $J = 7.5$ Hz, 2H, CH_2), 2.90 (t, $J = 7.2$ Hz, 2H, CH_2), 2.21-2.11 (m, 2H, CH_2); ^{13}C NMR (75 MHz, CDCl_3) δ : 167.3, 147.7, 142.8, 136.7, 133.6, 129.2 (2C), 128.6, 128.4, 128.2, 127.9 (2C), 126.2, 125.6, 125.5, 35.1, 30.3, 23.5.



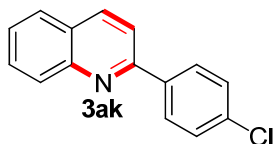
2-Phenylquinoline (3ah)^{5,6}: White solid, mp 85-87 °C; IR (KBr) cm^{-1} : 3056, 1612, 1598, 1557, 1478 cm^{-1} ; ^1H NMR (300 MHz, CDCl_3) δ : 8.21-8.14 (m, 3H, ArH), 7.88-7.80 (m, 2H, ArH), 7.74-7.69 (m, 1H, ArH), 7.55-7.43 (m, 5H, ArH); ^{13}C NMR (75 MHz, CDCl_3) δ : 157.3, 148.2, 139.6, 129.6, 129.2 (2C), 128.8 (2C), 127.5 (2C), 127.4, 127.1, 126.2, 118.9.



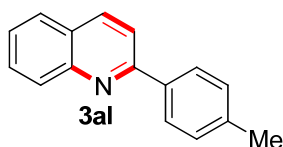
2-(2-Chlorophenyl)quinoline (3ai)⁸: White solid, mp 72-75 °C; IR (KBr) cm^{-1} : 3063, 1614, 1574, 1512, 1423 cm^{-1} ; ^1H NMR (300 MHz, CDCl_3) δ : 8.20-8.17 (m, 2H, ArH), 8.13-8.08 (m, 2H, ArH), 7.81-7.69 (m, 2H, ArH), 7.54-7.45 (m, 3H, ArH); ^{13}C NMR (75 MHz, CDCl_3) δ : 155.9, 148.1, 137.9, 136.9, 135.5, 129.9, 129.8, 128.9 (2C), 128.7 (2C), 127.4, 127.1, 126.4, 118.6.



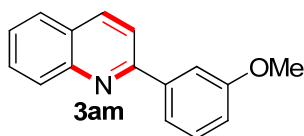
2-(2-Chlorophenyl)quinoline (3aj)⁹: White solid, mp 65-67 °C; IR (KBr) cm^{-1} : 3025, 2915, 1664, 1574, 1497, 1431, 815 cm^{-1} ; ^1H NMR (300 MHz, CDCl_3) δ : 8.24-8.16 (m, 3H, ArH), 8.03-7.97 (m, 1H, ArH), 7.85-7.71 (m, 3H, ArH), 7.56-7.51 (m, 2H, ArH); ^{13}C NMR (75 MHz, CDCl_3) δ : 155.7, 137.0, 134.9, 132.6, 130.8, 130.2, 129.9, 129.7, 129.3, 128.5, 127.7, 127.4, 126.6, 125.6, 118.6.



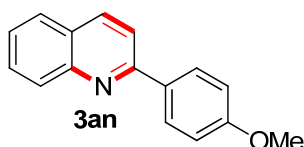
2-(4-Chlorophenyl)quinoline (3ak)⁸: White solid, mp 110-113 °C; IR (KBr) cm^{-1} : 3065, 1610, 1553, 1525, 1412 cm^{-1} ; ^1H NMR (300 MHz, CDCl_3) δ : 8.20-8.08 (m, 4H, ArH), 7.81-7.69 (m, 3H, ArH), 7.54-7.46 (3H, ArH); ^{13}C NMR (75 MHz, CDCl_3) δ : 155.9, 148.1, 138.0, 136.9, 135.5, 129.7, 129.6, 128.9 (2C), 128.7 (2C), 127.4, 127.1, 126.4, 118.4.



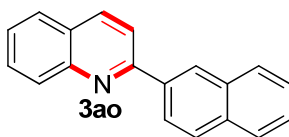
2-p-Tolylquinoline (3al)⁶: White solid, mp 80-82 °C; IR (KBr) cm^{-1} : 3422, 2915, 1668, 1618, 1596, 1497, 815, 788 cm^{-1} ; ^1H NMR (300 MHz, CDCl_3) δ : 8.15 (d, $J = 8.4$ Hz, 2H, ArH), 8.06 (d, $J = 8.1$ Hz, 2H, ArH), 7.83-7.68 (m, 3H, ArH), 7.49-7.47 (m, 1H, ArH), 7.32 (d, $J = 7.8$ Hz, 2H, ArH), 2.41 (s, 3H, CH_3); ^{13}C NMR (75 MHz, CDCl_3) δ : 157.2, 148.2, 139.3, 136.8, 136.5, 129.6 (2C), 129.4 (2C), 127.3 (3C), 127.0, 126.0, 118.7, 21.2.



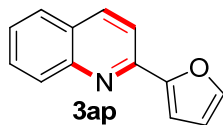
2-(3-Methoxyphenyl)quinoline (3am)⁹: Yellow oil, IR (Neat) cm^{-1} : 3152, 1604, 1563, 1498 cm^{-1} ; ^1H NMR (300 MHz, CDCl_3) δ : 8.17 (d, $J = 8.4$ Hz, 1H, ArH), 8.10 (d, $J = 8.7$ Hz, 1H, ArH), 7.78-7.65 (m, 5H, ArH), 7.47-7.35 (m, 2H, ArH), 6.99 (d, $J = 8.1$ Hz, 1H, ArH), 3.86 (s, 3H, OCH_3); ^{13}C NMR (75 MHz, CDCl_3) δ : 160.0, 156.8, 148.0, 140.9, 136.5, 129.6, 129.5, 129.4, 127.3, 127.1, 126.1, 119.8, 118.8, 115.2, 112.6, 55.2.



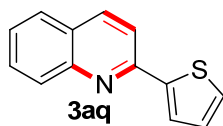
2-(4-Methoxyphenyl)quinoline (3an)⁶: White solid, mp 117-120 $^\circ\text{C}$; IR (KBr) cm^{-1} : 3039, 2921, 2840, 1604, 1499, 1251, 1029, 818 cm^{-1} ; ^1H NMR (300 MHz, CDCl_3) δ : 8.14-8.11 (m, 4H, ArH), 7.80-7.75 (m, 2H, ArH), 7.71-7.65 (m, 1H, ArH), 7.49-7.44 (m, 1H, ArH), 7.03 (d, $J = 8.7$ Hz, 2H, ArH), 3.85 (s, 3H, OCH_3); ^{13}C NMR (75 MHz, CDCl_3) δ : 160.7, 156.8, 148.2, 136.5, 132.1, 129.5, 129.4, 128.8, 127.3, 126.8, 125.8, 118.4, 114.1 (2C), 55.3.



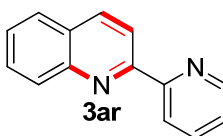
2-(Naphthalen-2-yl)quinoline (3ao)⁶: White solid, mp 163-165 $^\circ\text{C}$; IR (KBr) cm^{-1} : 3058, 1622, 1567 cm^{-1} ; ^1H NMR (300 MHz, CDCl_3) δ : 8.59 (s, 1H, ArH), 8.37 (d, $J = 8.7$ Hz, 1H, ArH), 8.22 (d, $J = 8.4$ Hz, 2H, ArH), 8.00-7.96 (m, 3H, ArH), 7.89-7.86 (m, 1H, ArH), 7.82 (d, $J = 8.1$ Hz, 1H, ArH), 7.75-7.70 (m, 1H, ArH), 7.53-7.49 (m, 2H, ArH); ^{13}C NMR (75 MHz, CDCl_3) δ : 157.1, 148.3, 136.7, 133.8, 133.4, 129.6, 128.9, 128.7 (2C), 128.5, 127.6, 127.4, 127.2, 127.1, 126.6, 126.2 (2C), 125.0, 119.0.



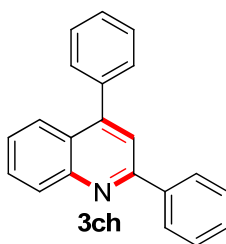
2-(Furan-2-yl)quinoline (3ap)⁶: White solid, mp 90-92 °C; IR (KBr) cm^{-1} : 3152, 1618, 1523 cm^{-1} ; ^1H NMR (300 MHz, CDCl_3) δ : 8.15-8.12 (m, 2H, ArH), 7.81-7.61 (m, 4H, ArH), 7.47 (t, $J = 7.5$ Hz, 1H, ArH), 7.22-7.21 (m, 1H, ArH), 6.57 (bs, 1H, ArH); ^{13}C NMR (75 MHz, CDCl_3) δ : 153.6, 148.9, 148.0, 144.0, 136.6, 129.8, 129.3, 127.5, 127.1, 126.1, 117.4, 112.1, 110.0.



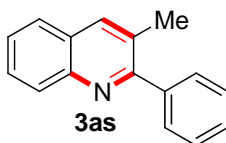
2-(Thiophen-2-yl)quinoline (3aq)⁶: White solid, mp 125-128 °C; IR (KBr) cm^{-1} : 3101, 3054, 1624, 1578, 1223 cm^{-1} ; ^1H NMR (300 MHz, CDCl_3) δ : 8.11-8.06 (m, 2H, ArH), 7.77-7.65 (m, 4H, ArH), 7.48-7.43 (m, 2H, ArH), 7.15-7.12 (m, 1H, ArH); ^{13}C NMR (75 MHz, CDCl_3) δ : 152.2, 148.0, 145.3, 136.5, 129.7, 129.2, 128.5, 128.0, 127.4, 127.1, 126.0, 125.7, 117.5.



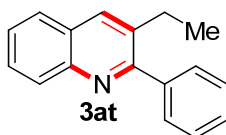
2-(Pyridin-3-yl)quinoline (3ar)¹⁰: White solid, mp 93-95 °C; IR (KBr) cm^{-1} : 3059, 2924, 1599, 1095, 787 cm^{-1} ; ^1H NMR (300 MHz, CDCl_3) δ : 8.51 (d, $J = 7.8$ Hz, 1H, ArH), 8.25 (d, $J = 8.7$ Hz, 1H, ArH), 8.18 (d, $J = 8.4$ Hz, 1H, ArH), 7.86-7.71 (m, 4H, ArH), 7.56-7.47 (m, 3H, ArH); ^{13}C NMR (75 MHz, CDCl_3) δ : 154.5, 150.0, 148.6, 148.2, 137.0 (2C), 134.8, 129.9, 129.6, 127.4, 127.2, 126.7 (2C), 118.4.



2,4-Diphenylquinoline (3ch)¹¹: White solid, mp 112-115 °C; IR (KBr) cm^{-1} : 3423, 3086, 2955, 1589, 1095, 846 cm^{-1} ; ^1H NMR (300 MHz, CDCl_3) δ : 7.81 (d, $J = 7.2$ Hz, 4H, ArH), 7.67-7.56 (m, 4H, ArH), 7.51-7.38 (m 5H, ArH), 7.35-7.31 (m, 2H, ArH); ^{13}C NMR (75 MHz, CDCl_3) δ : 163.1, 140.5, 137.5, 136.2, 136.0, 133.6, 133.0, 132.3, 131.8, 131.0, 130.0, 129.9, 129.0, 128.8, 128.5, 128.2, 128.1, 127.1, 119.4, 118.5, 118.5.



3-Methyl-2-phenylquinoline (3as)^{5,6}: Yellow oil; IR (Neat) cm^{-1} : 3052, 1618, 1553, 1431, 1097, 756 cm^{-1} ; ^1H NMR (300 MHz, CDCl_3) δ : 8.13 (d, $J = 8.4$ Hz, 1H, ArH), 7.96 (s, 1H, ArH), 7.74 (d, $J = 8.1$ Hz, 1H, ArH), 7.65-7.56 (m, 3H, ArH), 7.46-7.40 (m, 4H, ArH), 2.43 (s, 3H, CH_3); ^{13}C NMR (75 MHz, CDCl_3) δ : 160.4, 146.5, 140.8, 136.6, 129.2, 129.0, 128.7 (2C), 128.6, 128.1 (2C), 128.0, 127.5, 126.6, 126.2, 20.5.

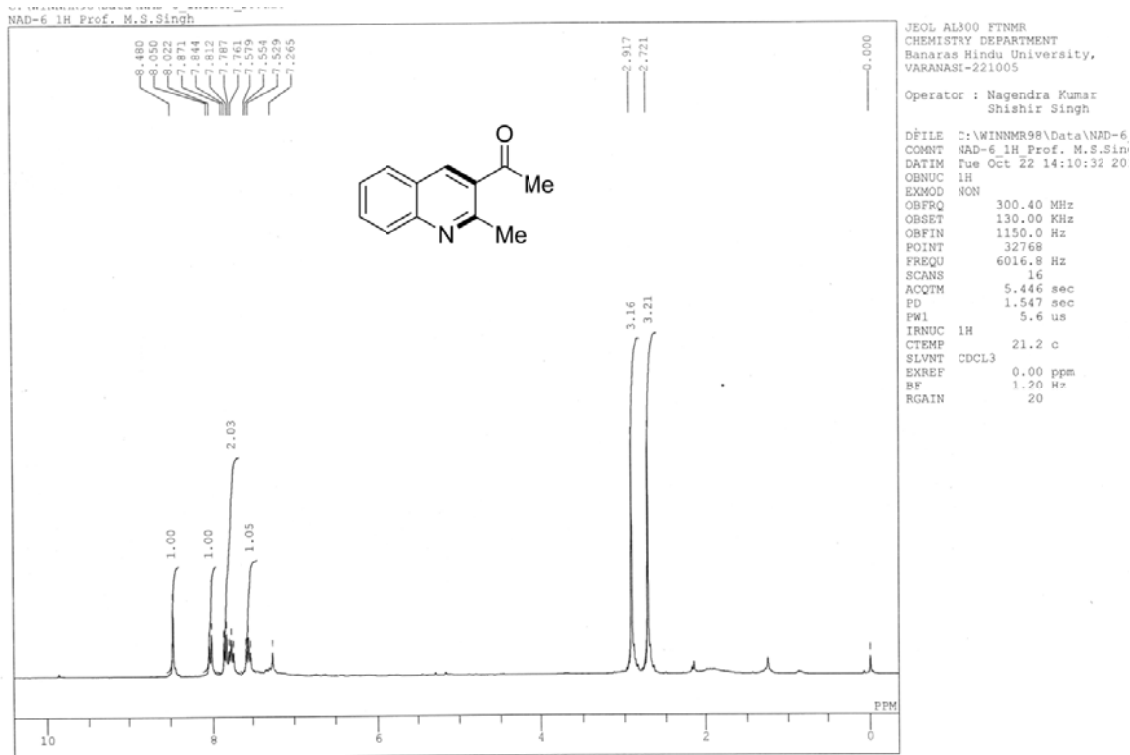


3-Ethyl-2-phenylquinoline (3at)¹²: Yellow oil. IR (Neat) cm^{-1} : 3048, 2924, 1595, 1432, 749 cm^{-1} ; ^1H NMR (300 MHz, CDCl_3) δ : 8.14 (d, $J = 8.4$ Hz, 1H, ArH), 8.01 (s, 1H, ArH), 7.79 (d, $J = 7.8$ Hz, 1H, ArH), 7.66-7.61 (m, 1H, ArH), 7.54-7.52 (m, 2H, ArH), 7.48-7.41 (m, 4H, ArH), 2.81-2.73 (m, 2H, CH_2), 1.19 (t, $J = 7.8$ Hz, 3H, CH_3); ^{13}C NMR (75 MHz, CDCl_3) δ : 160.5, 146.2, 140.8, 135.1, 134.8, 129.1, 128.7, 128.6, 128.1, 127.9, 127.6, 126.8, 126.2, 25.9, 14.6.

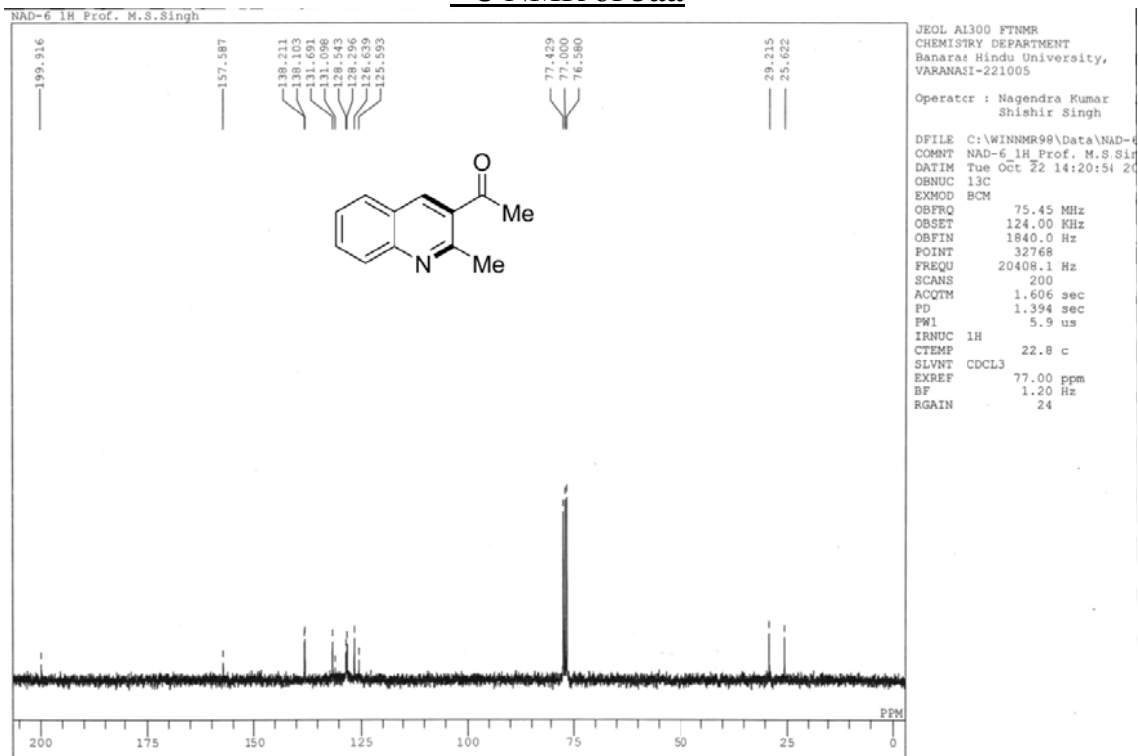
3. References

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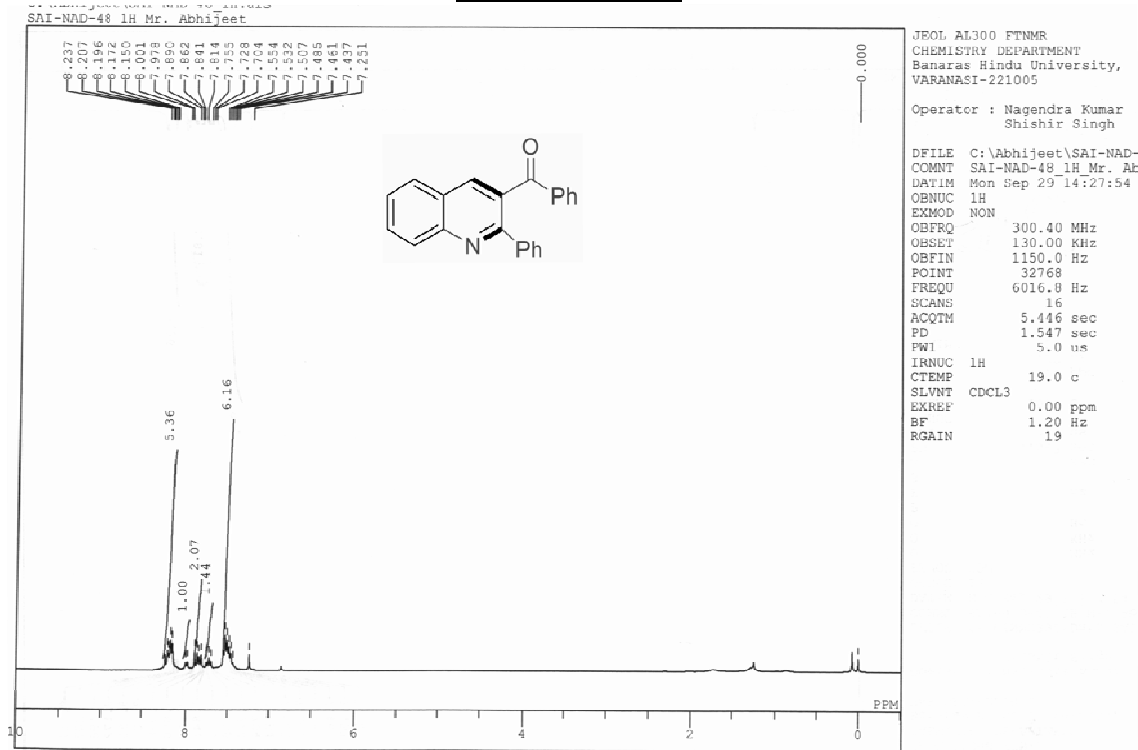
¹H NMR of 3aa



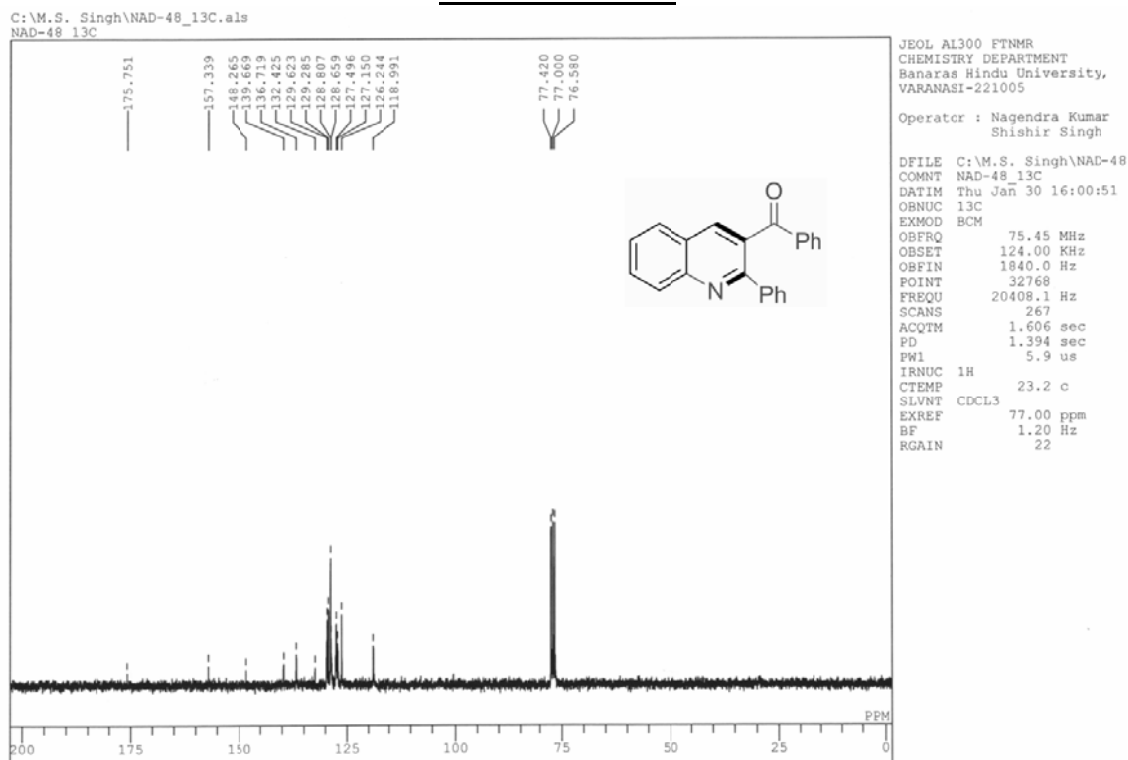
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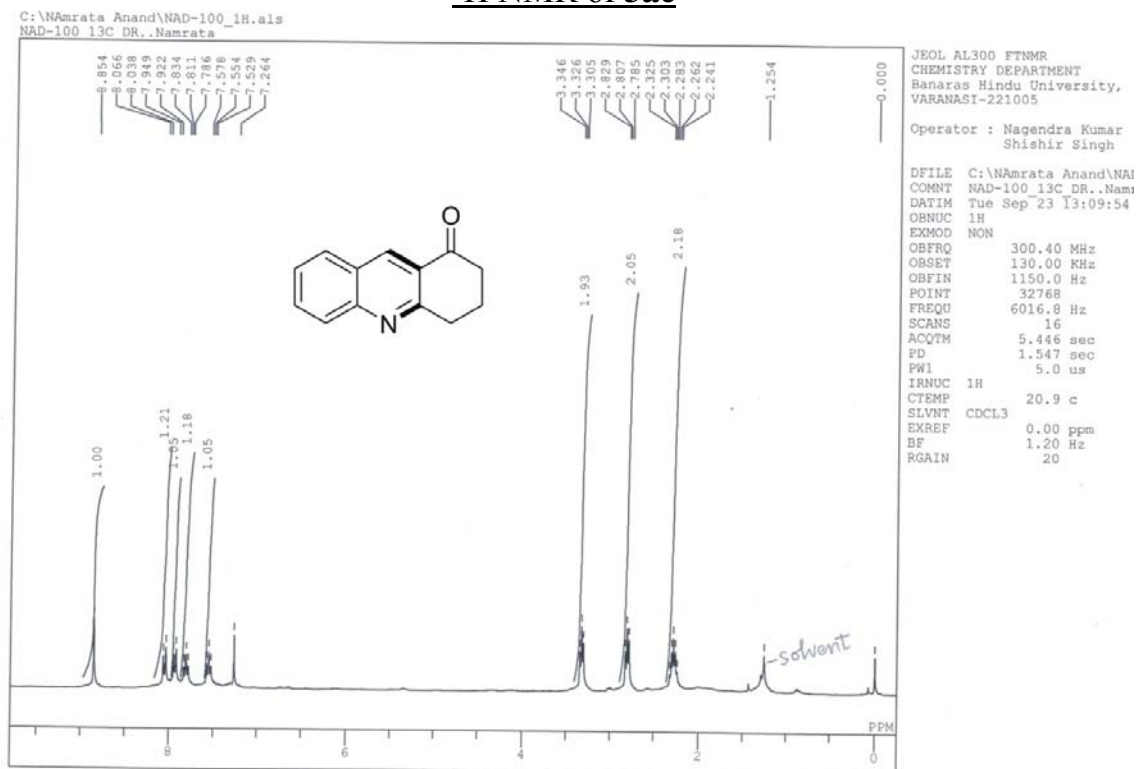
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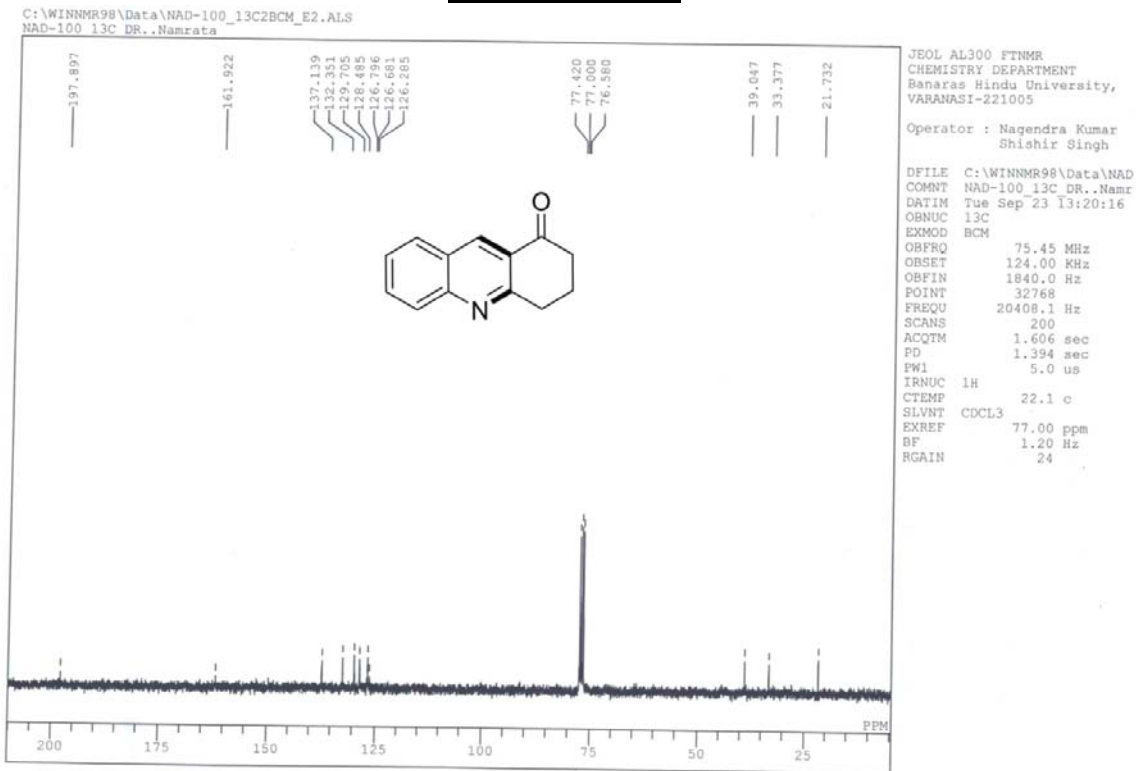
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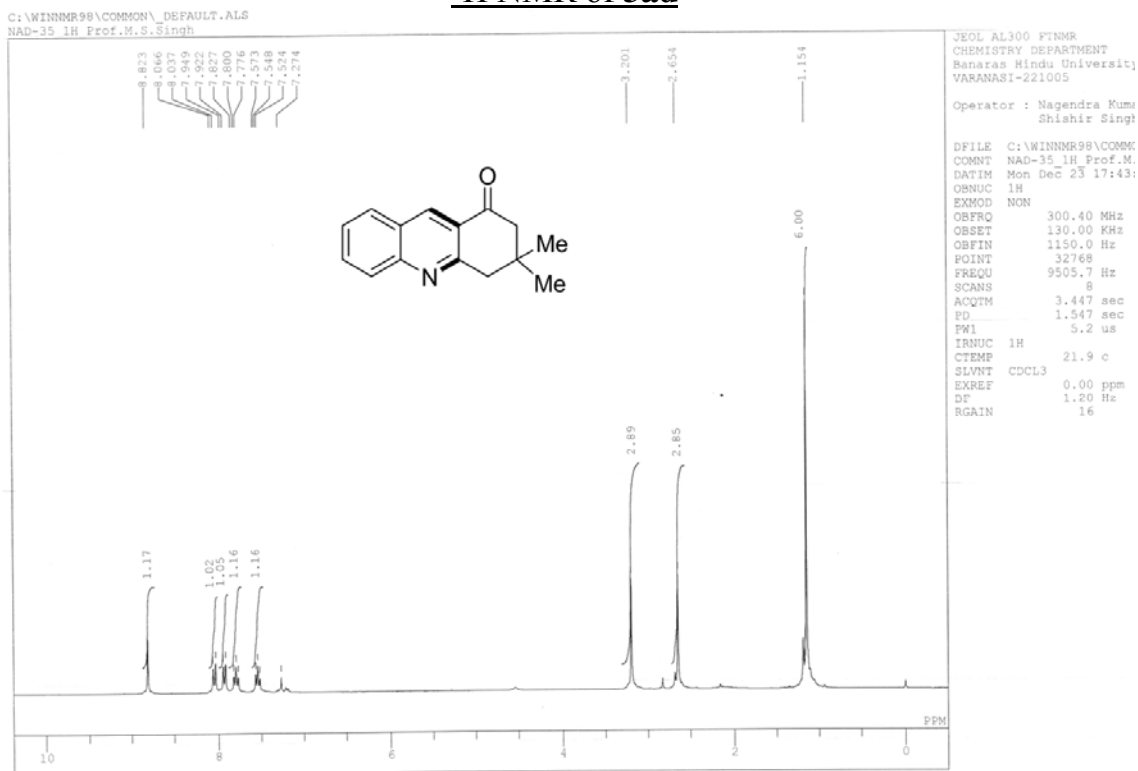
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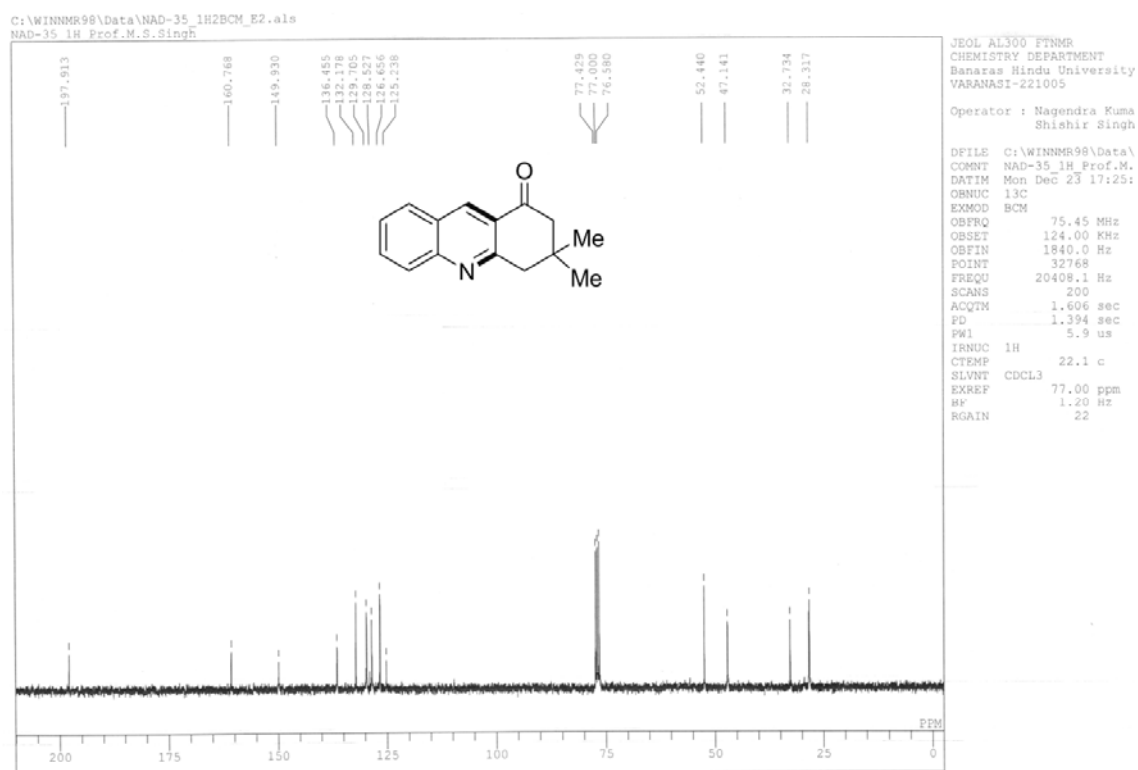
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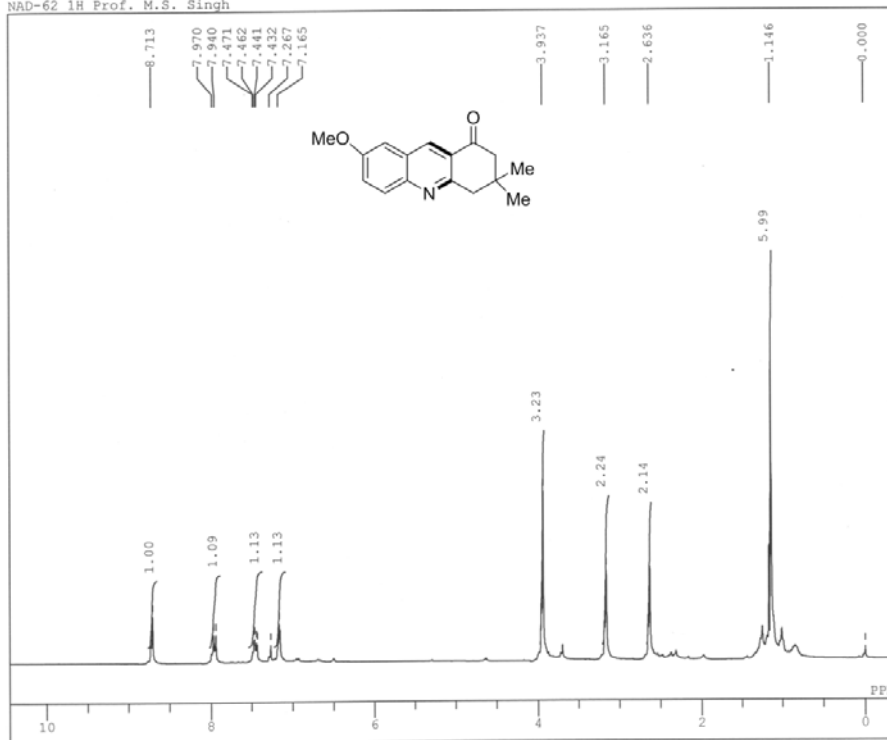


¹³C NMR of 3ad



¹H NMR of 3bd

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NAD-62 1H Prof. M.S. Singh



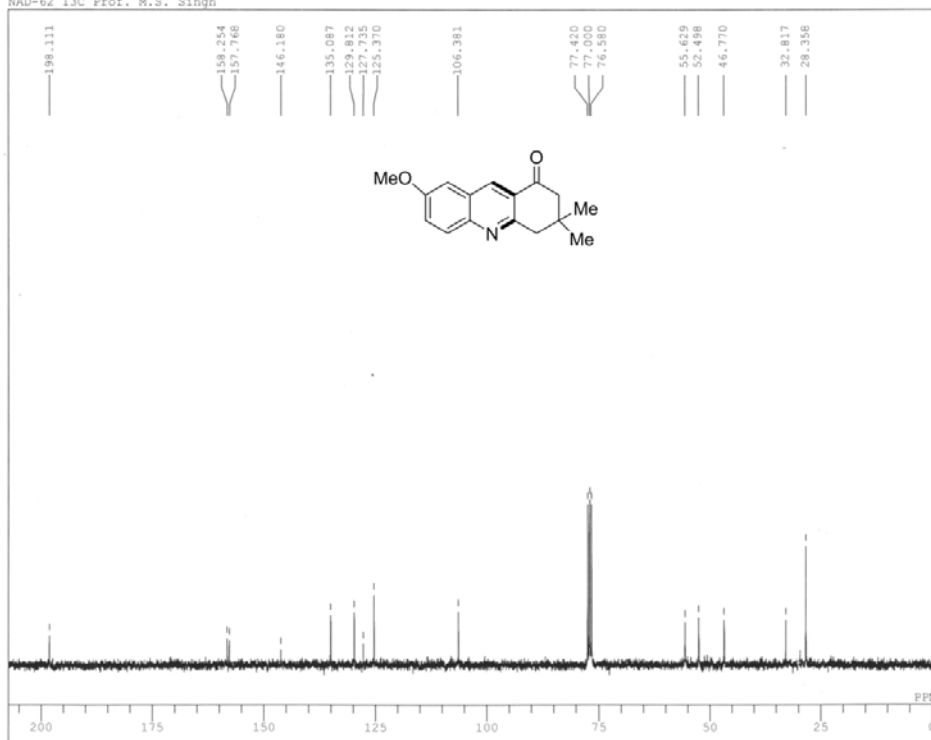
JEOL AL300 FTNMR
CHEMISTRY DEPARTMENT
Banaras Hindu University,
VARANASI-221005

Operator : Nagendra Kumar
Shishir Singh

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RGAIN 16

¹³C NMR of 3bd

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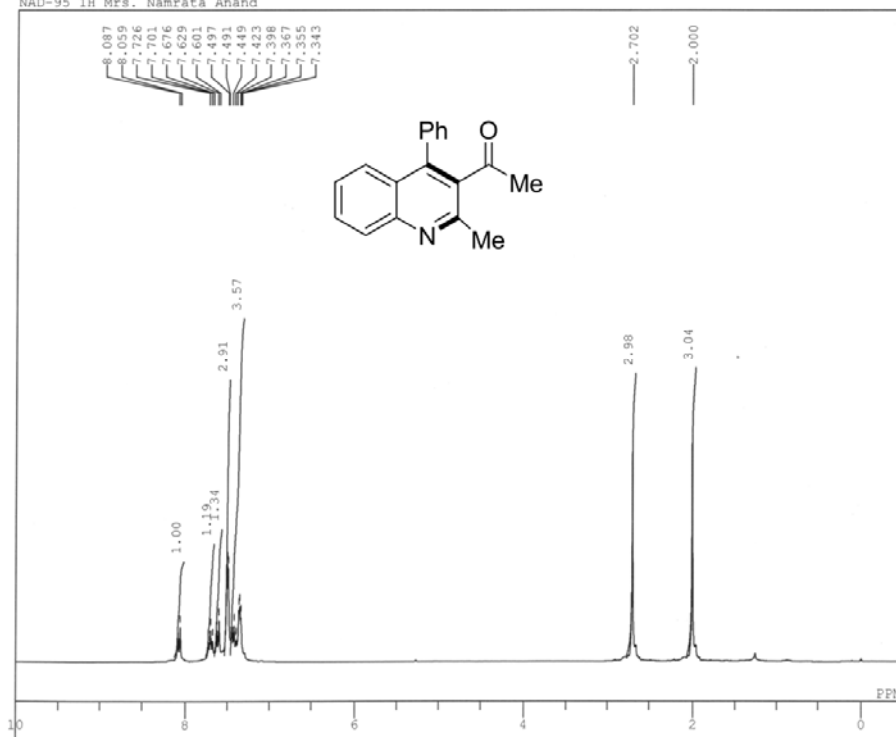
JEOL AL300 FTNMR
CHEMISTRY DEPARTMENT
Banaras Hindu University,
VARANASI-221005

Operator : Nagendra Kuma
Shishir Singr

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¹H NMR of 3ca

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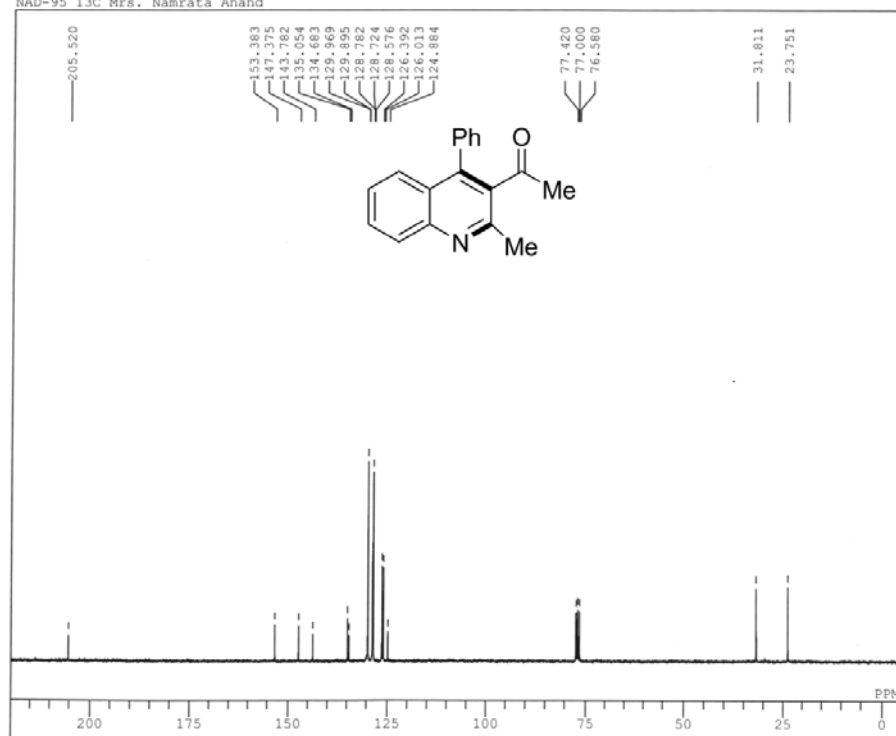
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CHEMISTRY DEPARTMENT
Banaras Hindu University,
VARANASI-221005

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Shishir Singh

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¹³C NMR of 3ca

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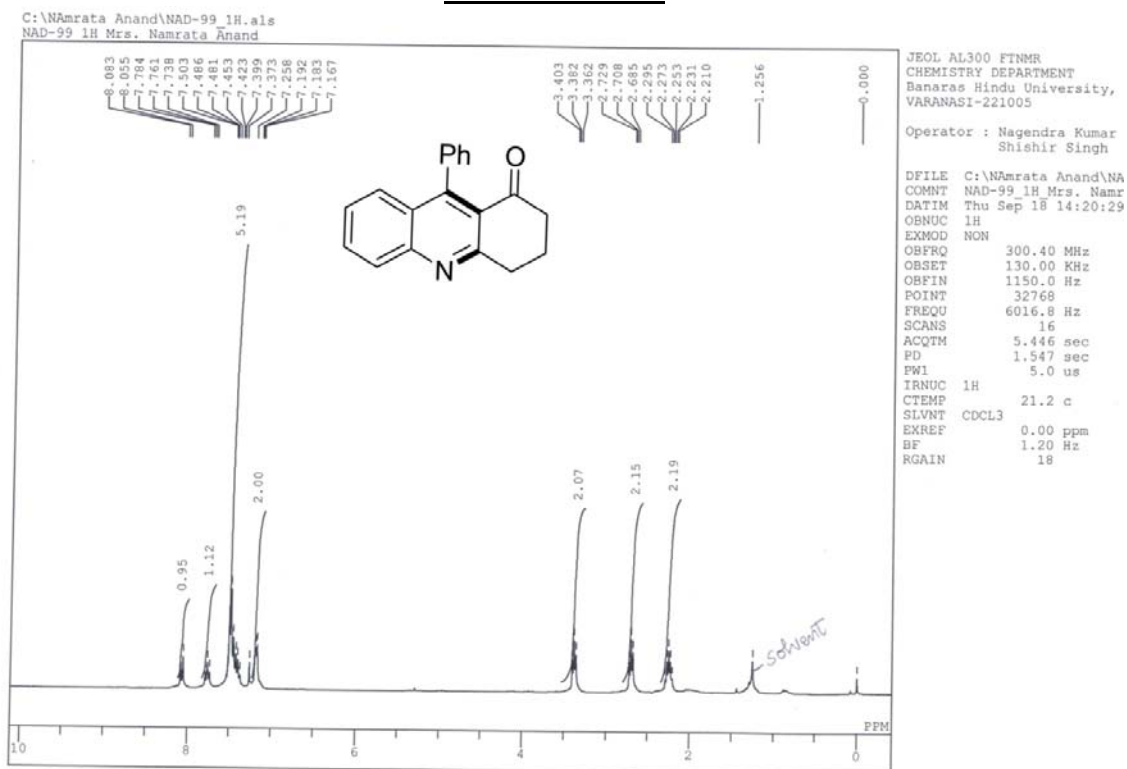


JEOL AL300 FTNMR
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Banaras Hindu University,
VARANASI-221005

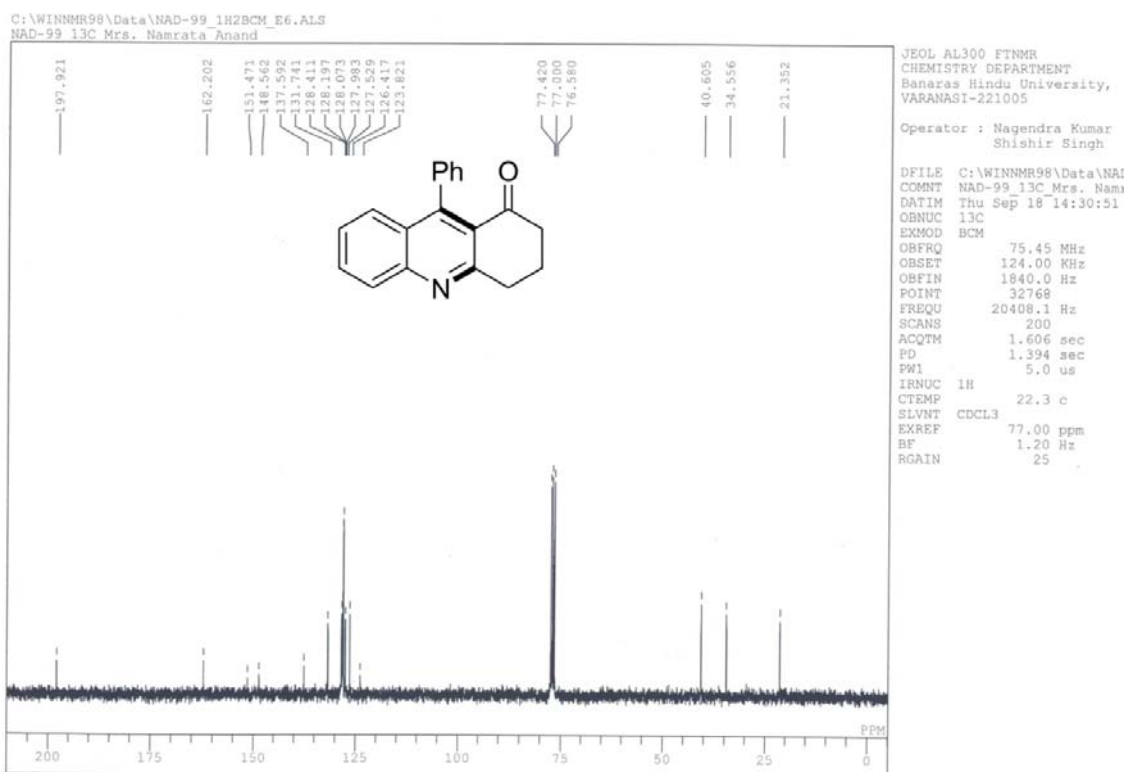
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Shishir Singh

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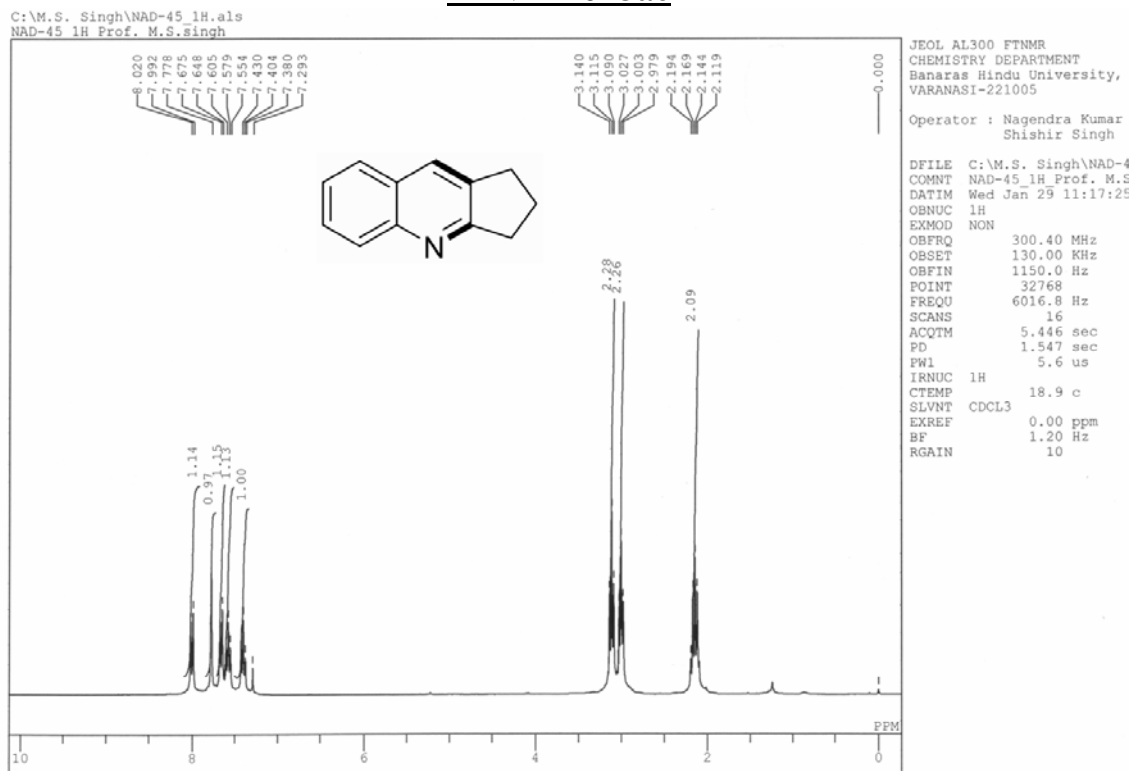
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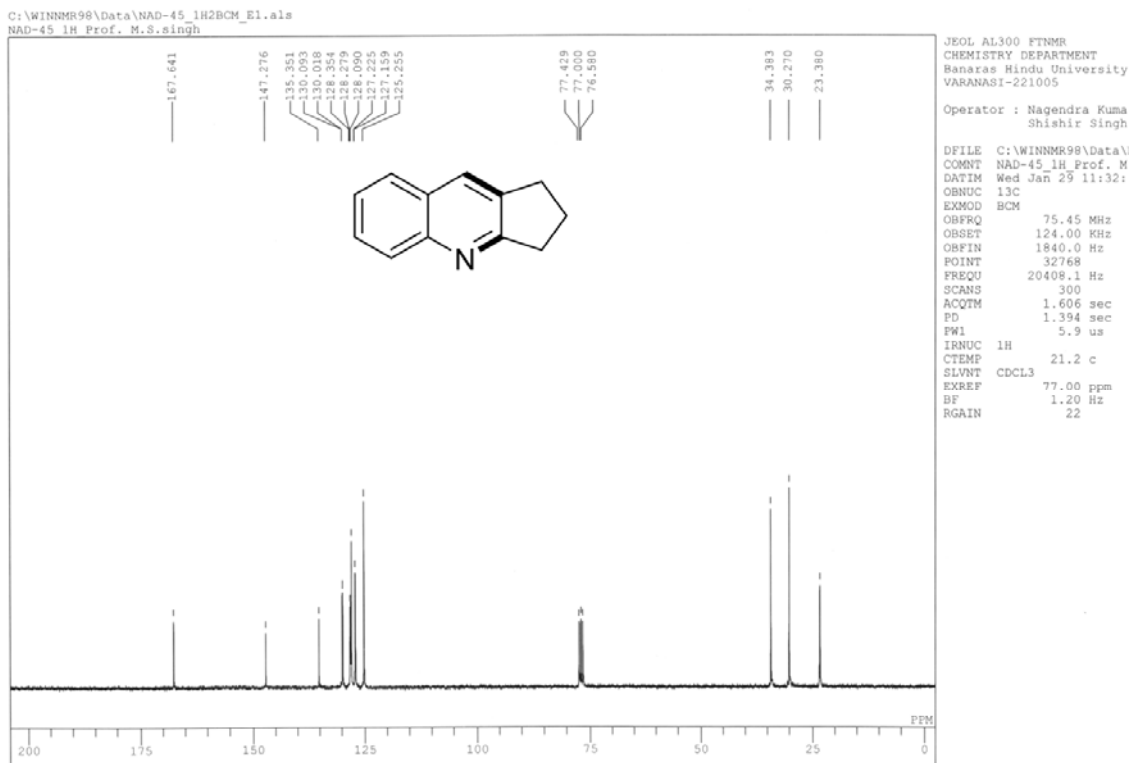
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¹H NMR of 3ae

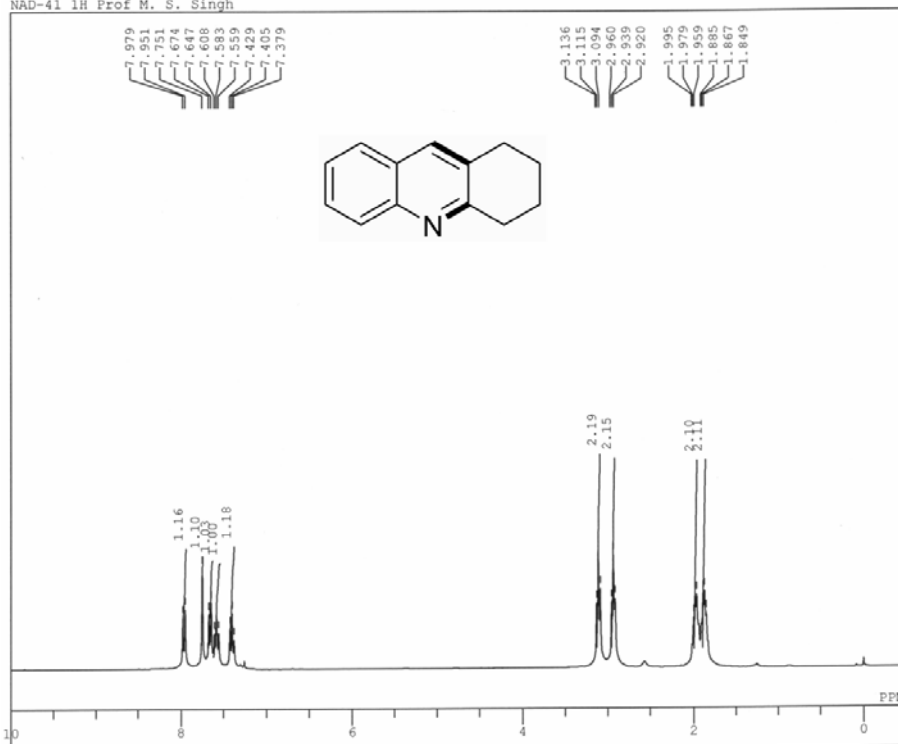


¹³C NMR of 3ae



¹H NMR of 3af

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NAD-41 1H Prof M. S. Singh



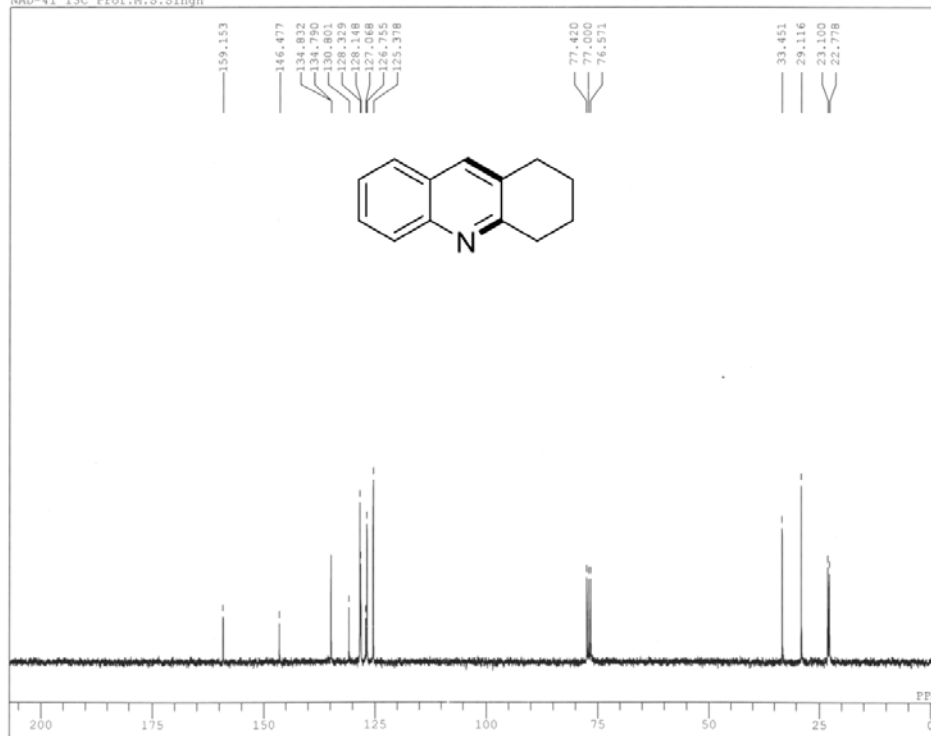
JEOL AL300 FTNMR
CHEMISTRY DEPARTMENT
Banaras Hindu University,
VARANASI-221005

Operator : Nagendra Kumar
Shishir Singh

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¹³C NMR of 3af

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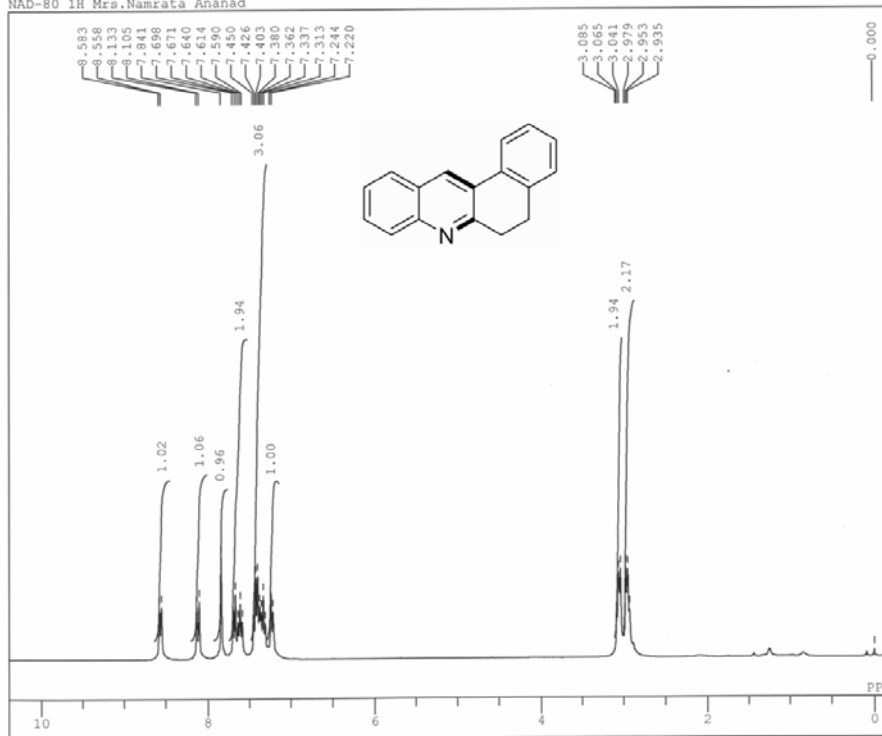
JEOL AL300 FTNMR
CHEMISTRY DEPARTMENT
Banaras Hindu University
VARANASI-221005

Operator : Nagendra Kuma
Shishir Singh

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RGAIN 24

¹H NMR of 3ag

C:\M.S. Singh\NAD-80_1H.als
NAD-80 1H Mrs.Namrata Ananad



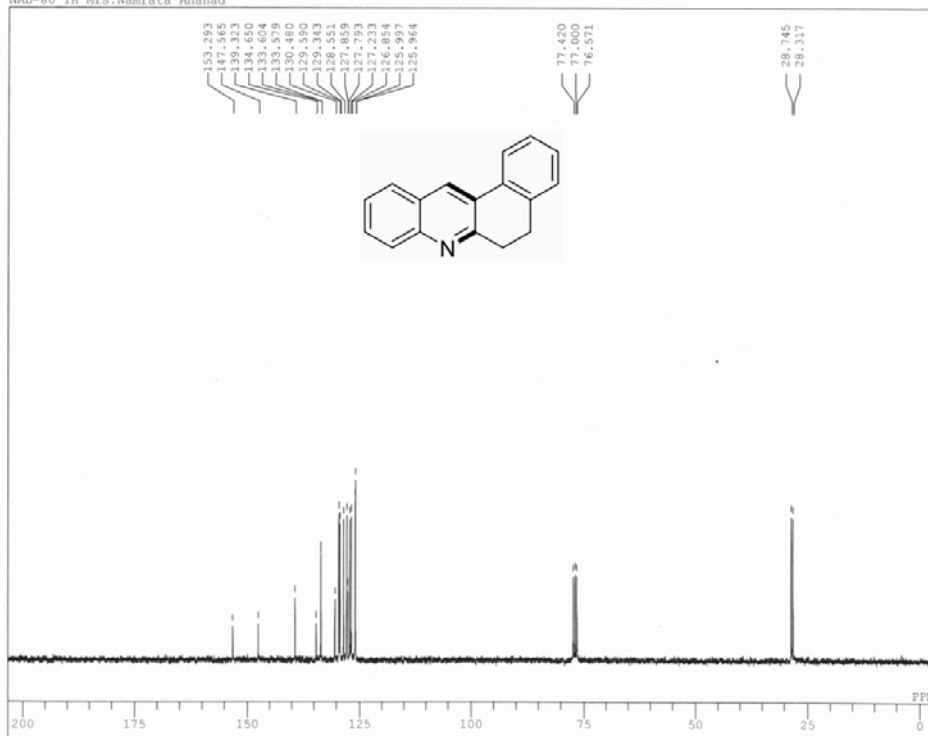
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Banaras Hindu University,
VARANASI-221005

Operator : Nagendra Kumar
Shishir Singh

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SLVNT CDCL3
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¹³C NMR of 3ag

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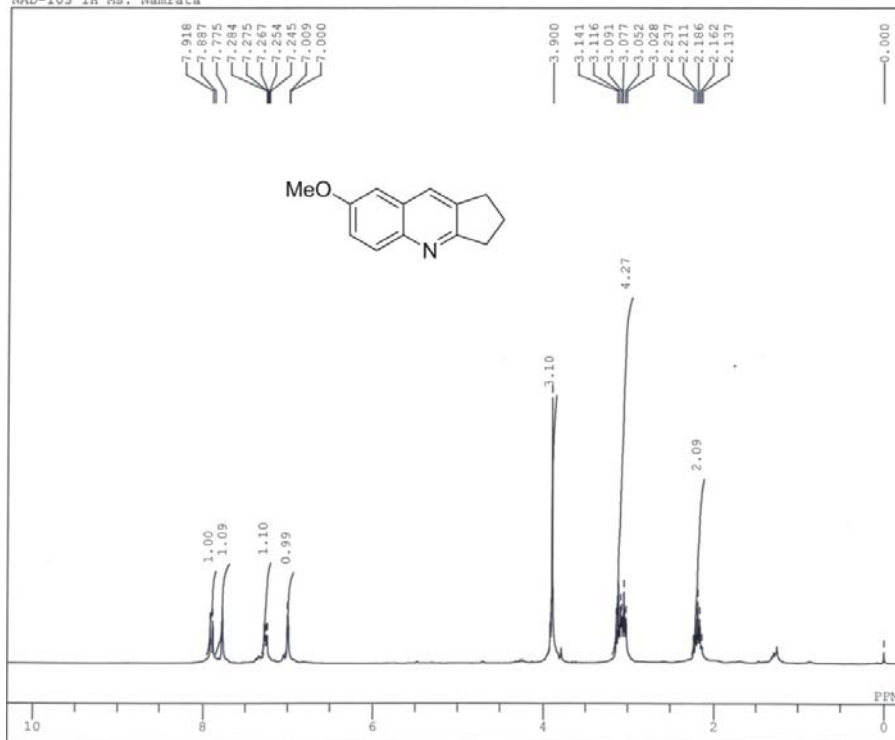
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CHEMISTRY DEPARTMENT
Banaras Hindu Universit,
VARANASI-221005

Operator : Nagendra Kum
Shishir Singl

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RGAIN 22

¹H NMR of 3be

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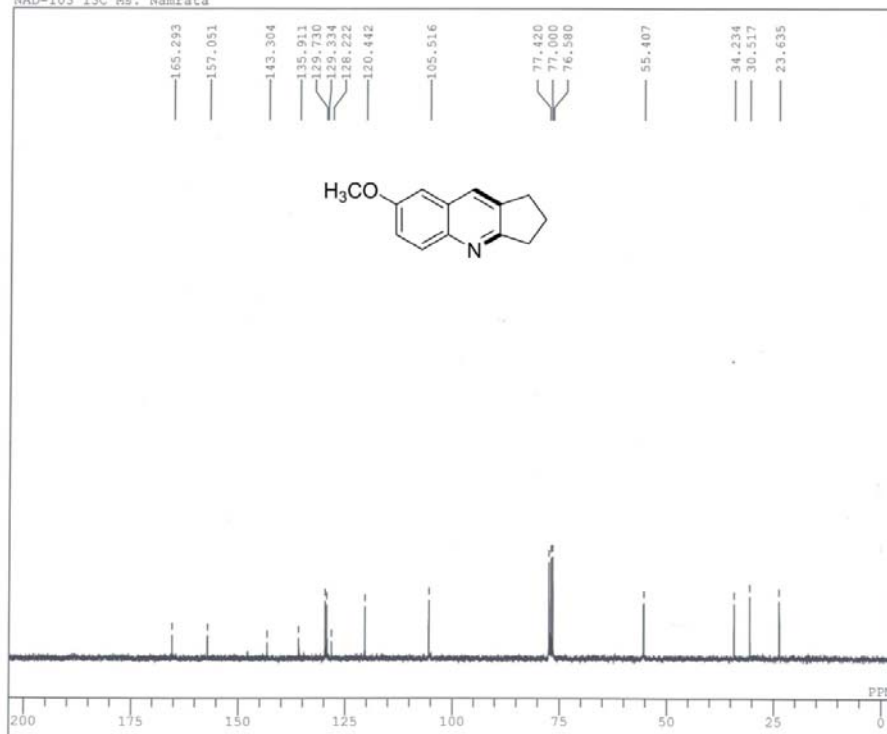
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Banaras Hindu University,
VARANASI-221005

Operator : Nagendra Kumar
Shishir Singh

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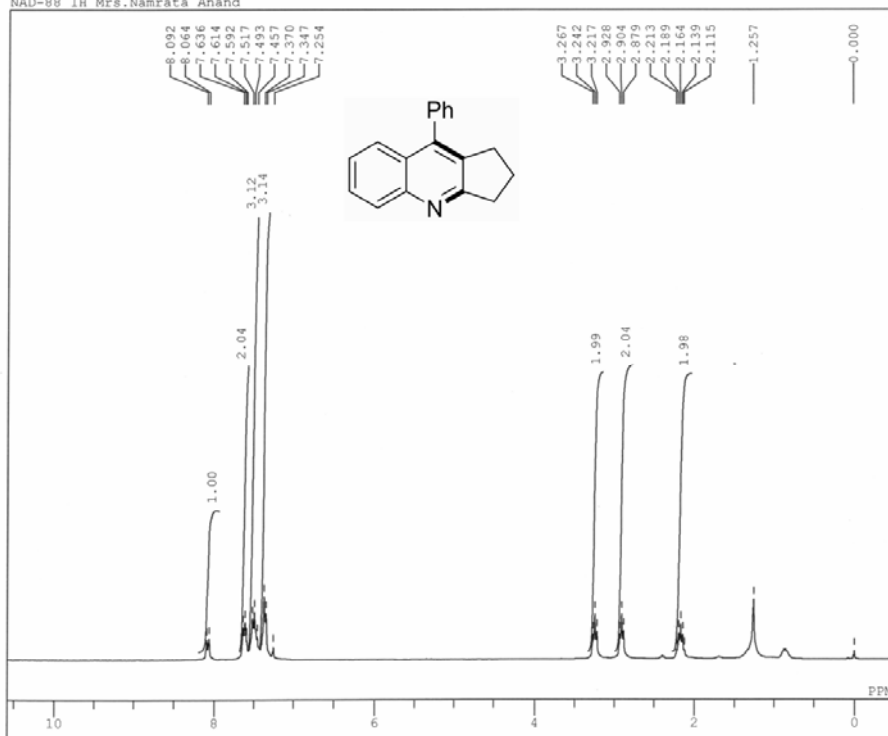
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VARANASI-221005

Operator : Nagendra Kumar
Shishir Singh

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RGAIN 24

¹H NMR of 3ce

C:\Namrata Anand\NAD-88 1H.als
NAD-88 1H Mrs.Namrata Anand



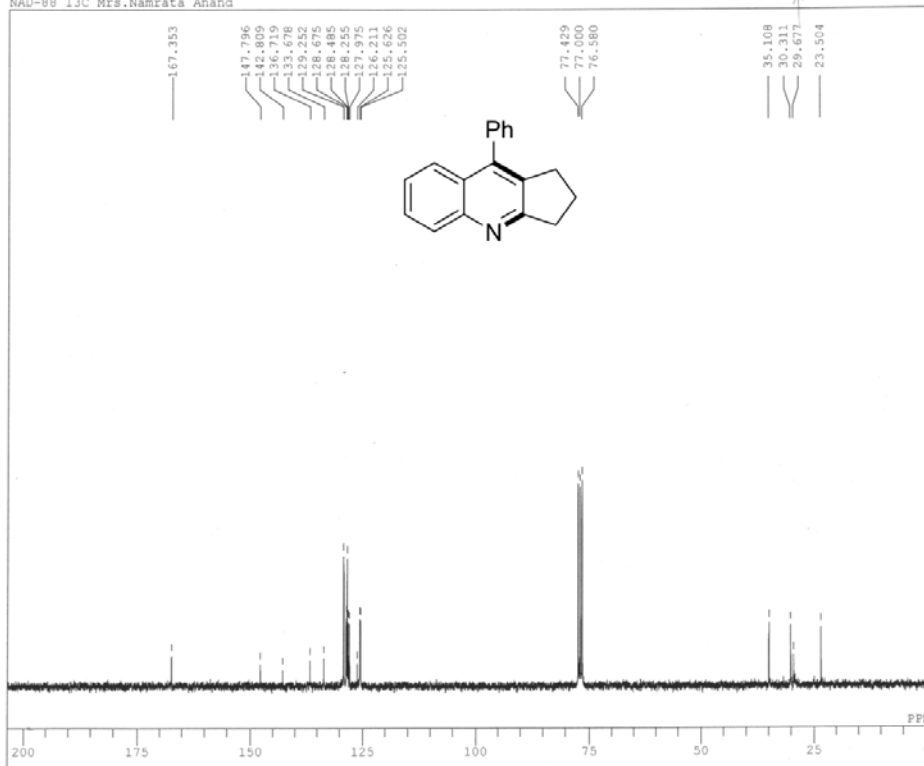
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CHEMISTRY DEPARTMENT
Banaras Hindu University,
VARANASI-221005

Operator : Nagendra Kumar
Shishir Singh

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¹³C NMR of 3ce

C:\WINNMR99\COMMON\DEFAULT.ALS
NAD-88 13C Mrs.Namrata Anand



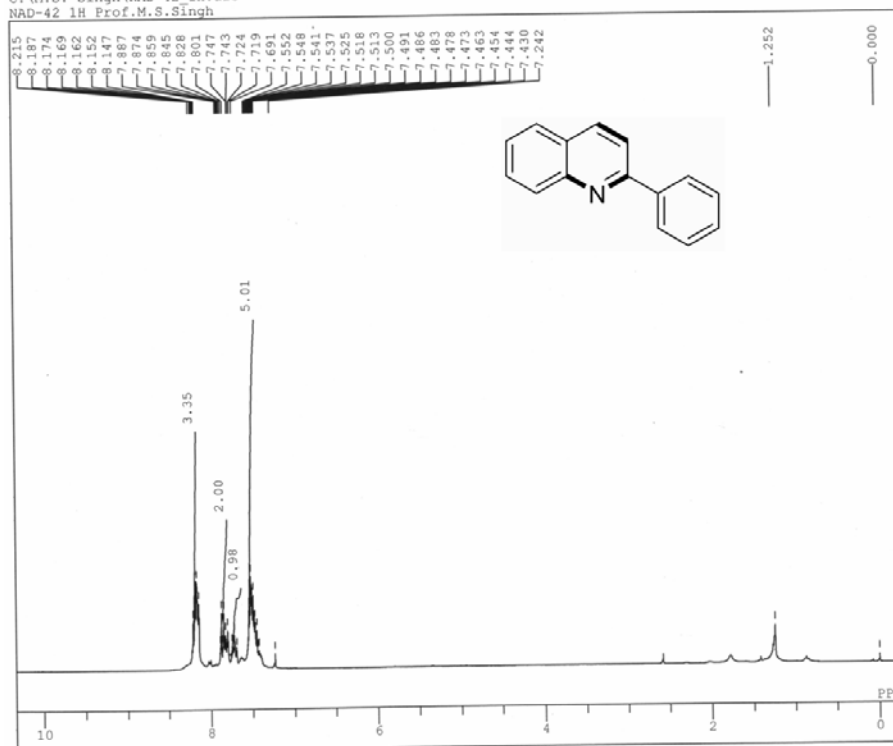
JEOL AL300 FTNMR
CHEMISTRY DEPARTMENT
Banaras Hindu Universit
VARANASI-221005

Operator : Nagendra Kum
Shishir Sing

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RGAIN 24

¹H NMR of 3ah

C:\M.S. Singh\NAD-42 1H.als
NAD-42 1H Prof.M.S.Singh



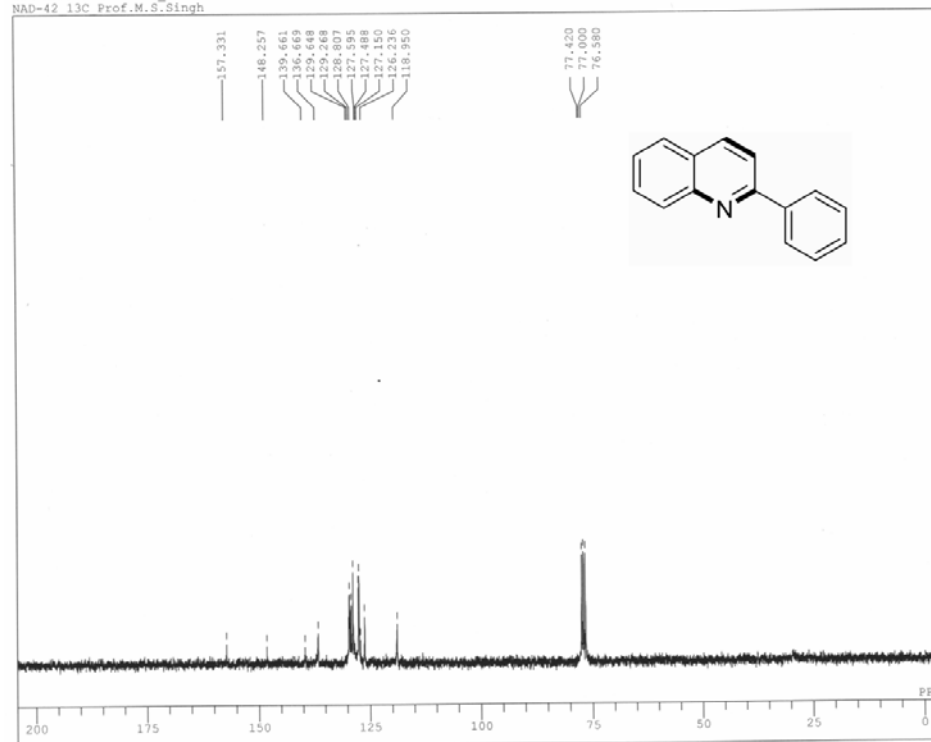
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CHEMISTRY DEPARTMENT
Banaras Hindu University,
VARANASI-221005

Operator : Nagendra Kumar
Shishir Singh

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¹³C NMR of 3ah

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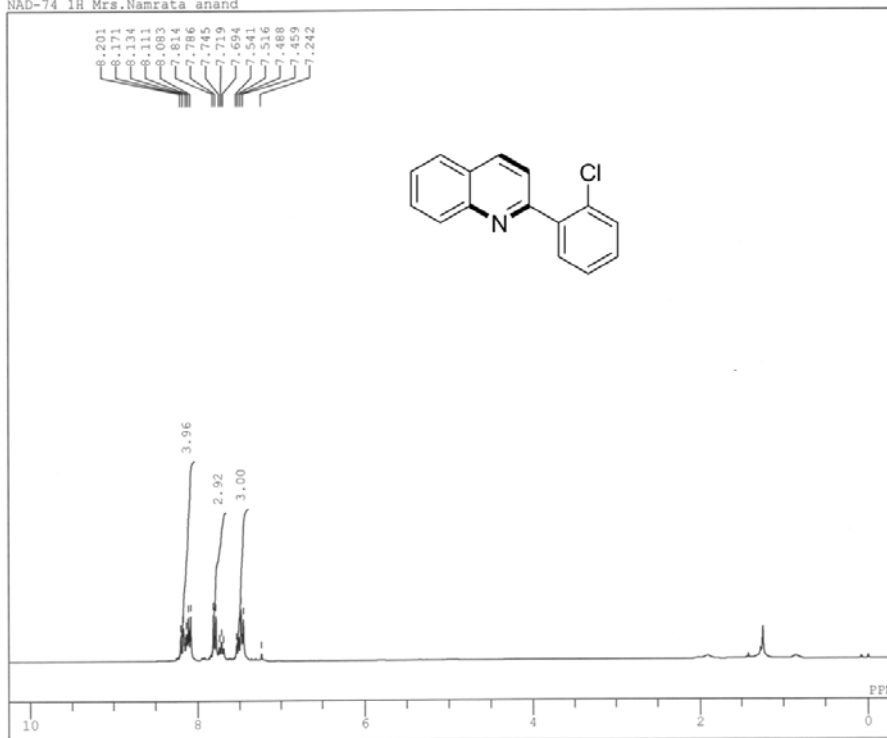
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CHEMISTRY DEPARTMENT
Banaras Hindu University
VARANASI-221005

Operator : Nagendra Kuma
Shishir Singh

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RGAIN 23

¹H NMR of 3ai

C:\Namrata\NAD-74_1H.als
NAD-74 1H Mrs.Namrata anand



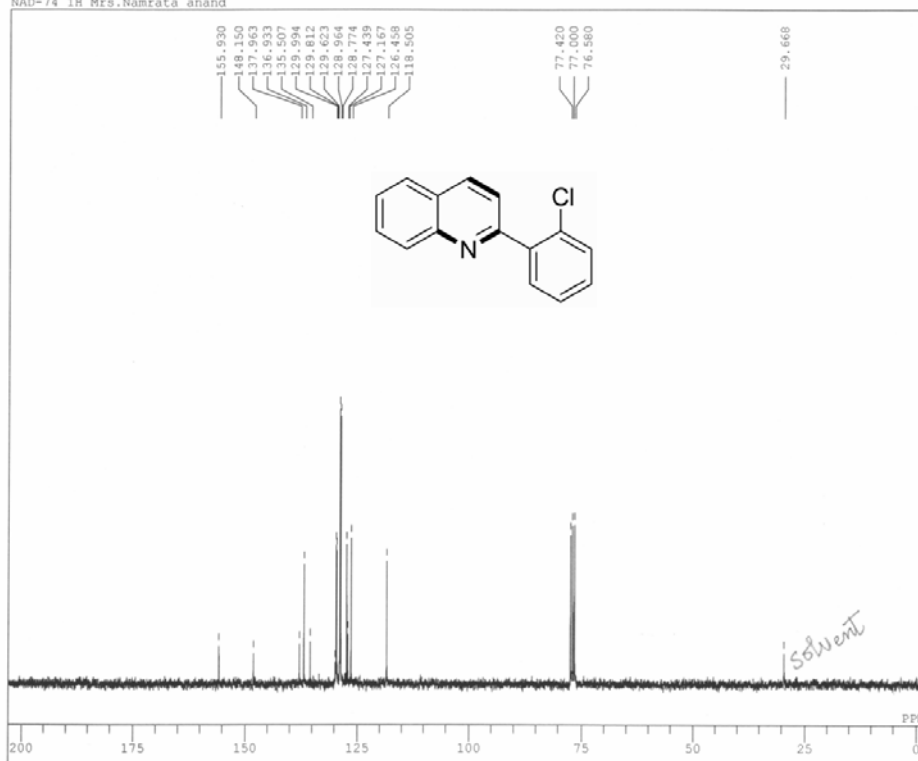
JEOL AL300 FTNMR
CHEMISTRY DEPARTMENT
Banaras Hindu University,
VARANASI-221005

Operator : Nagendra Kumar
Shishir Singh

DFILE C:\Namrata\NAD-74_1H
COMNT NAD-74_1H Mrs.NamFat
DATIM Tue Aug 12 11:52:22
1H
OBNUC 1H
EXMOD NON
OBFRQ 300.40 MHz
OBSET 130.00 KHz
OBFIN 1150.0 Hz
POINT 32768
FREQU 6016.8 Hz
SCANS 16
ACQTM 5.446 sec
PD 1.547 sec
PW1 5.2 us
IRNUC 1H
CTEMP 21.7 c
SLVNT CDCL3
EXREF 0.00 ppm
BF 1.20 Hz
RGAIN 15

¹³C NMR of 3ai

C:\WINNMR98\Data\NAD-74_1H2BCM_E3.als
NAD-74 1H Mrs.Namrata anand

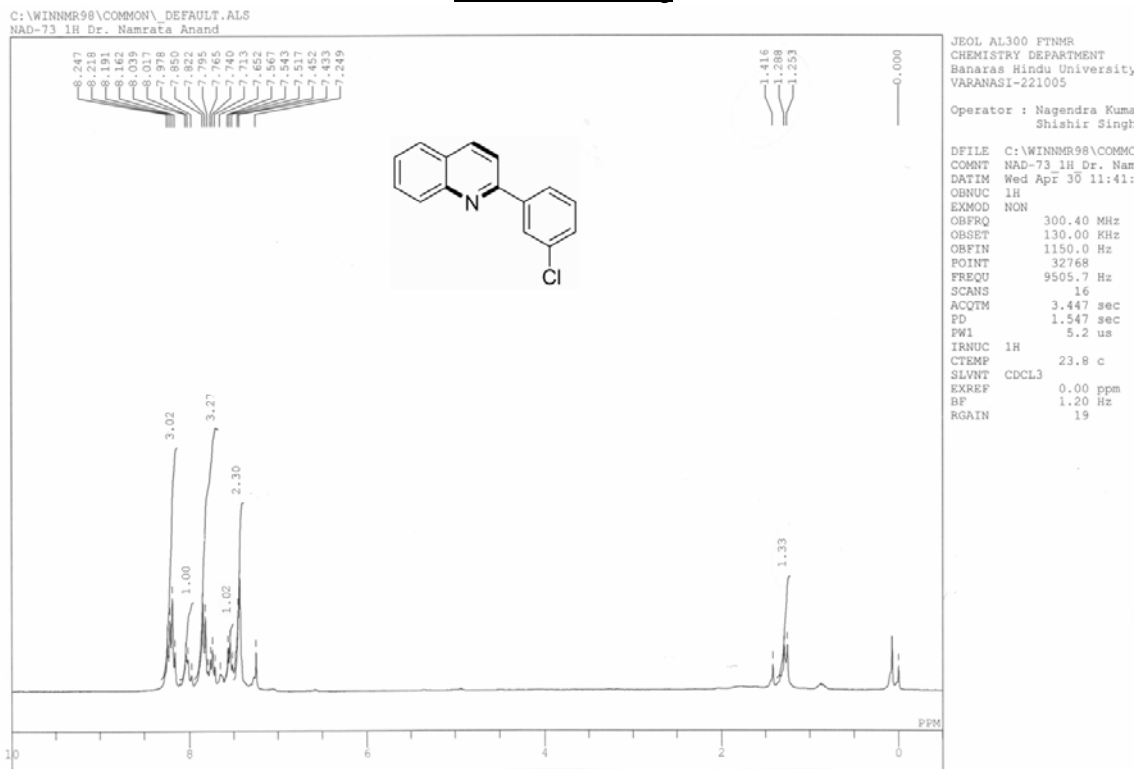


JEOL AL300 FTNMR
CHEMISTRY DEPARTMENT
Banaras Hindu University,
VARANASI-221005

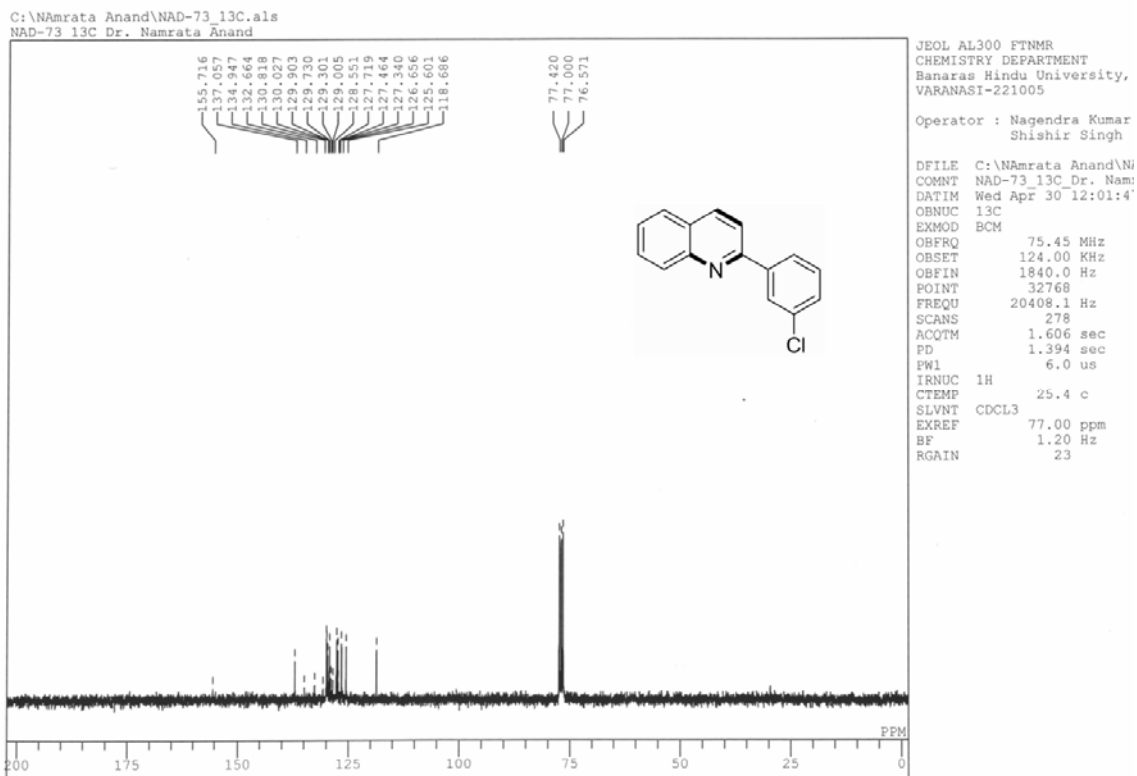
Operator : Nagendra Kum
Shishir Sing

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COMNT NAD-74_1H Mrs.Na
DATIM Tue Aug 12 12:02
13C
EXMOD BCM
OBFRQ 75.45 MHz
OBSET 124.00 KHz
OBFIN 1840.0 Hz
POINT 32768
FREQU 20408.1 Hz
SCANS 200
ACQTM 1.606 sec
PD 1.394 sec
PW1 6.0 us
IRNUC 1H
CTEMP 23.3 c
SLVNT CDCL3
EXREF 77.00 ppm
BF 1.20 Hz
RGAIN 24

¹H NMR of 3aj

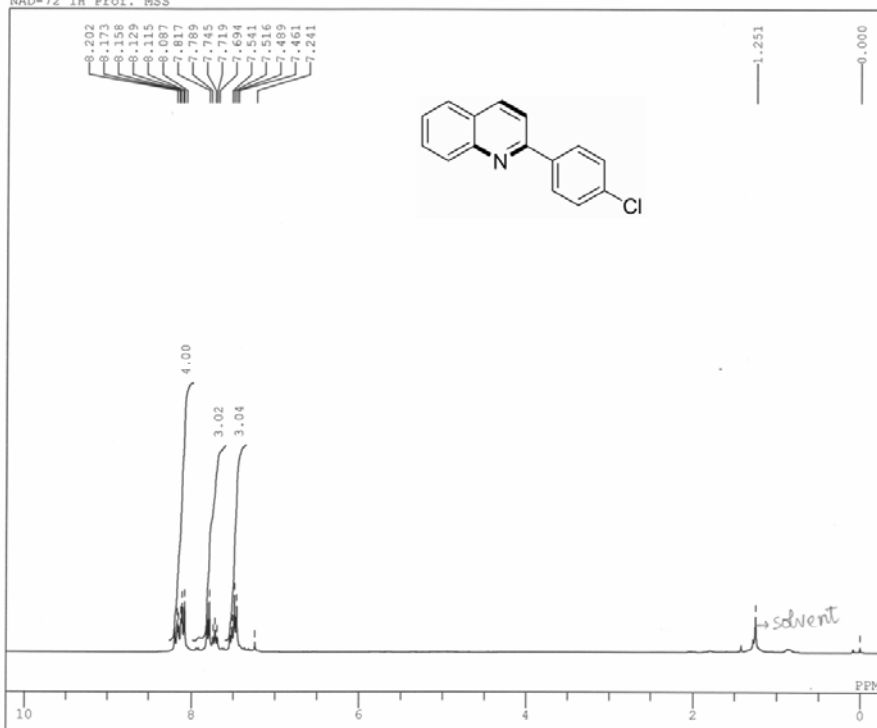


¹³C NMR of 3aj



¹H NMR of 3ak

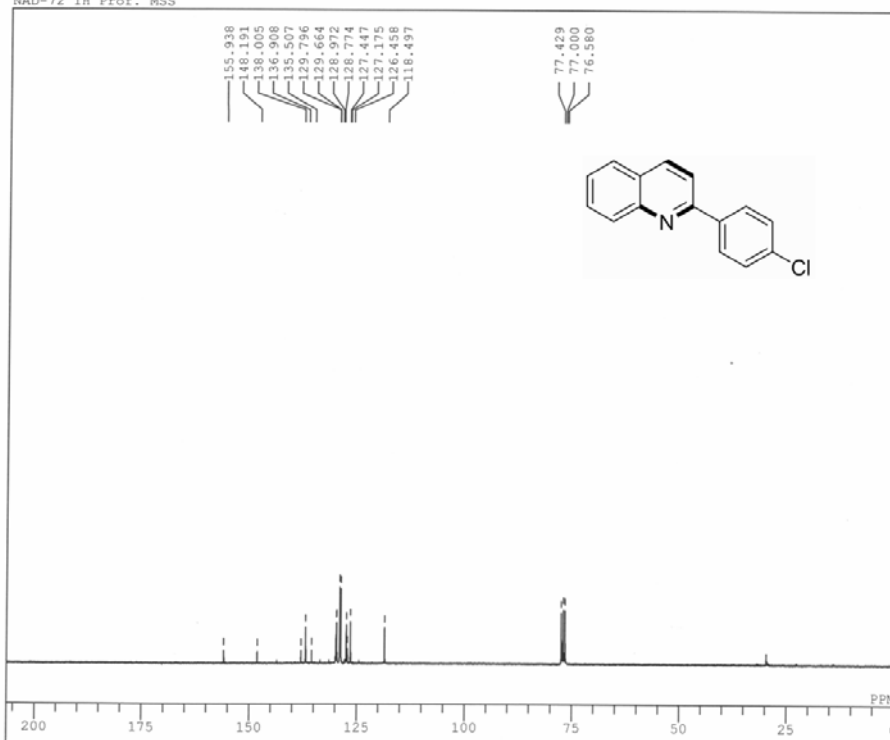
C:\M.S. Singh\NAD-72_1H.als
NAD-72 1H Prof. MSS



JEOL AL300 FTNMR
CHEMISTRY DEPARTMENT
Banaras Hindu University,
VARANASI-221005
Operator : Nagendra Kumar
Shishir Singh
DFILE C:\M.S. Singh\NAD-72
COMNT NAD-72_1H Prof. MSS
DATIM Thu Apr 17 05:10:19
OBNUC 1H
EXMOD NON
OBFRO 300.40 MHz
OBSET 130.00 KHz
OBFIN 1150.0 Hz
POINT 32768
FREQU 6016.8 Hz
SCANS 16
ACQTM 5.446 sec
PD 1.547 sec
PW1 5.2 us
IRNUC 1H
CTEMP 18.3 c
SLVNT CDCL3
EXREF 0.00 ppm
BF 1.20 Hz
RGAIN 14

¹³C NMR of 3ak

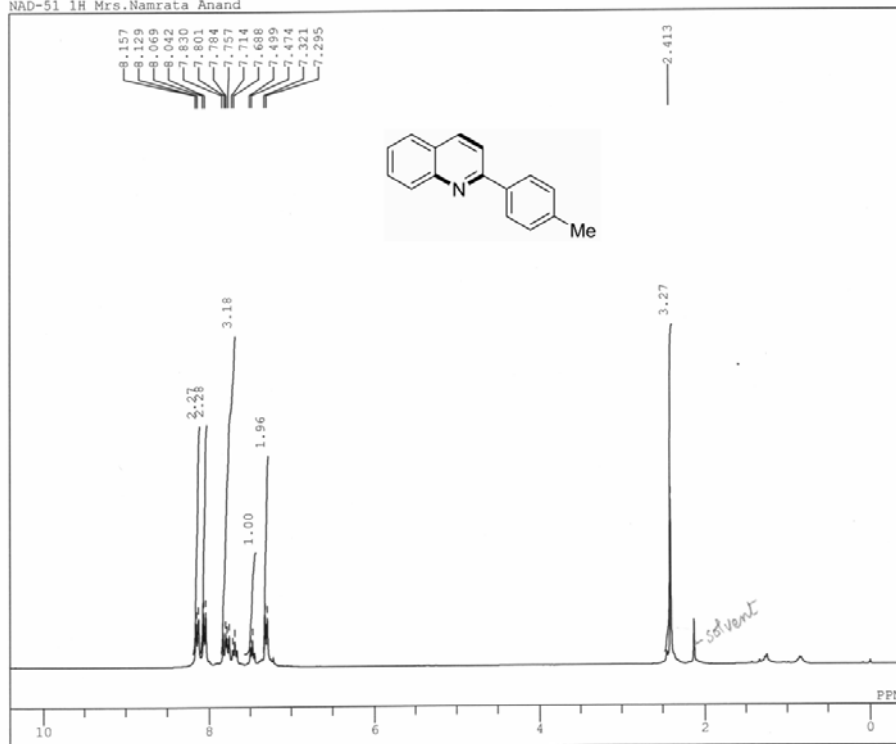
C:\M.S. Singh\NAD-72_13C.als
NAD-72 1H Prof. MSS



JEOL AL300 FTNMR
CHEMISTRY DEPARTMENT
Banaras Hindu University,
VARANASI-221005
Operator : Nagendra Kumar
Shishir Singh
DFILE C:\M.S. Singh\NAD-7
COMNT NAD-72_1H Prof. MSS
DATIM Thu Apr 17 05:07:56
OBNUC 13C
EXMOD BCM
OBFRO 75.45 MHz
OBSET 124.00 KHz
OBFIN 1840.0 Hz
POINT 32768
FREQU 20408.1 Hz
SCANS 2000
ACQTM 1.606 sec
PD 1.394 sec
PW1 6.0 us
IRNUC 1H
CTEMP 19.1 c
SLVNT CDCL3
EXREF 77.00 ppm
BF 1.20 Hz
RGAIN 23

¹H NMR of 3aI

C:\M.S. Singh\NAD-51_1H.als
NAD-51 1H Mrs.Namrata Anand



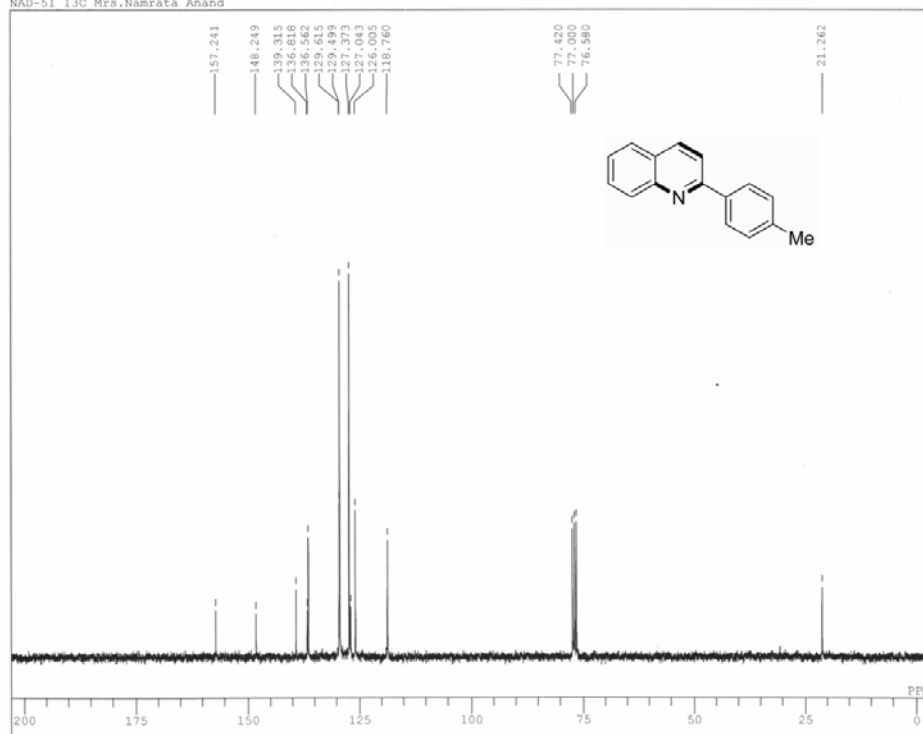
JEOL AL300 FTNMR
CHEMISTRY DEPARTMENT
Banaras Hindu University,
VARANASI-221005

Operator : Nagendra Kumar
Shishir Singh

DFILE C:\M.S. Singh\NAD-5
COMNT NAD-51_1H Mrs.Namra
DATIM Thu Apr 17 17:13:42
OBNUC 1H
EXMOD NON
OBFRQ 300.40 MHz
OBSET 130.00 KHz
OBFIN 1150.0 Hz
POINT 32768
FREQU 9505.7 Hz
SCANS 37
ACQTM 3.447 sec
PD 1.547 sec
FW1 5.2 us
IRNUC 1H
CTEMP 19.9 c
SLVNT CDCL3
EXREF 0.00 ppm
BF 1.20 Hz
RGAIN 14

¹³C NMR of 3aI

C:\WINNMR98\COMMON\DEFAULT.ALS
NAD-51 13C Mrs.Namrata Anand



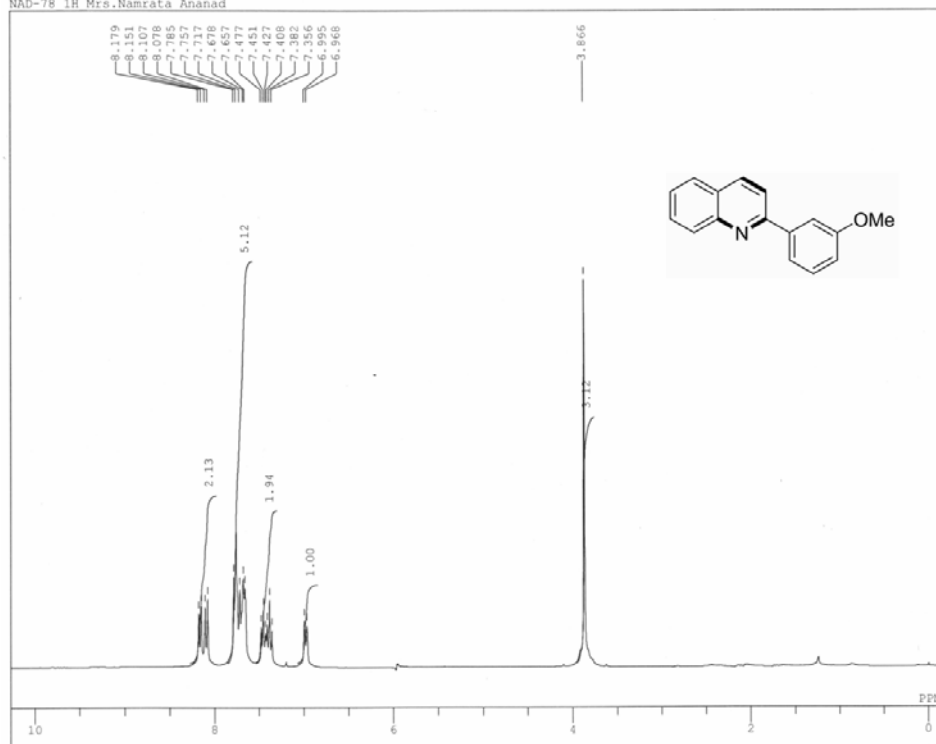
JEOL AL300 FTNMR
CHEMISTRY DEPARTMENT
Banaras Hindu University
VARANASI-221005

Operator : Nagendra Kuma
Shishir Singh

DFILE C:\WINNMR98\COMMON
COMNT NAD-51 13C Mrs.Na
DATIM Thu Apr 17 17:26:
OBNUC 13C
EXMOD BCM
OBFRQ 75.45 MHz
OBSET 124.00 KHz
OBFIN 1840.0 Hz
POINT 32768
FREQU 20408.1 Hz
SCANS 215
ACQTM 1.606 sec
PD 1.394 sec
FW1 6.0 us
IRNUC 1H
CTEMP 21.7 c
SLVNT CDCL3
EXREF 77.00 ppm
DF 1.20 Hz
RGAIN 22

¹H NMR of 3am

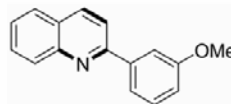
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NAD-78 1H Mrs.Namrata Anand



JEOL AL300 FTNMR
CHEMISTRY DEPARTMENT
Banaras Hindu University,
VARANASI-221005

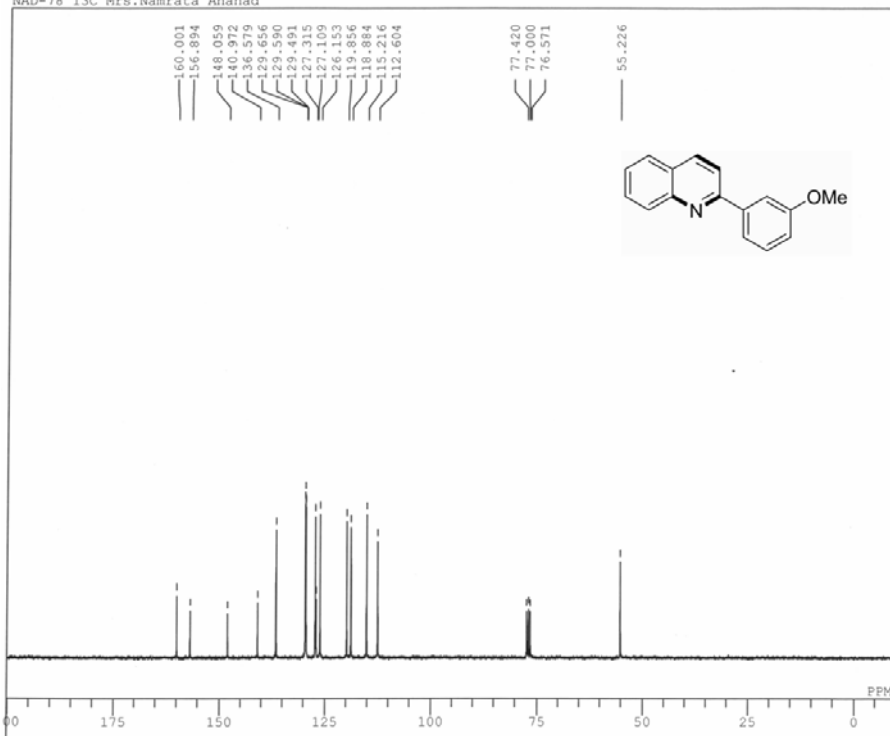
Operator : Nagendra Kumar
Shishir Singh

DFILE C:\WINNMR98\COMMON
COMNT NAD-78 1H Mrs.Nar
DATIM Tue Apr 29 12:12:
OBNUC 1H
EXMOD NON
OBFRQ 300.40 MHz
OBSET 130.00 KHz
OBFIN 1150.0 Hz
POINT 32768
FREQU 9505.7 Hz
SCANS 23
AQTM 3.447 sec
PD 1.547 sec
FW1 5.2 us
IRNUC 1H
CTEMP 22.5 c
SIVNT CDCL3
EXREF 0.00 ppm
BF 1.20 Hz
RGAIN 11



¹³C NMR of 3am

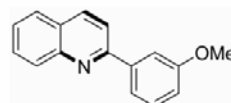
C:\NAmrata Anand\NAD-78 13C.als
NAD-78 13C Mrs.Namrata Anand



JEOL AL300 FTNMR
CHEMISTRY DEPARTMENT
Banaras Hindu University,
VARANASI-221005

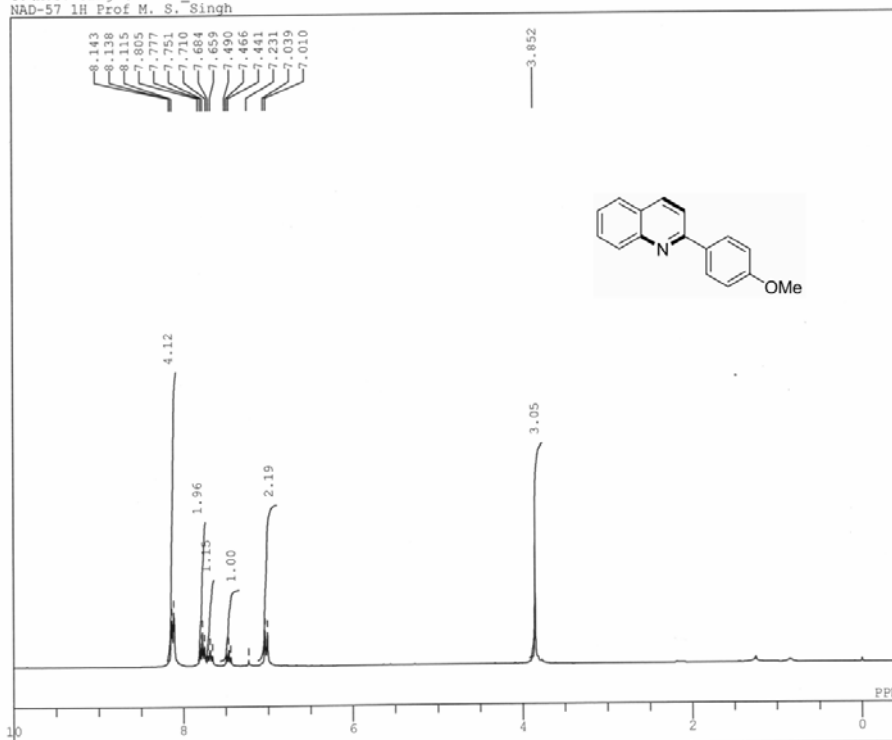
Operator : Nagendra Kumar
Shishir Singh

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DATIM Tue Apr 29 12:02:36
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EXMOD BCM
OBFRQ 75.45 MHz
OBSET 124.00 KHz
OBFIN 1840.0 Hz
POINT 32768
FREQU 20408.1 Hz
SCANS 309
AQTM 1.606 sec
PD 1.394 sec
FW1 6.0 us
IRNUC 1H
CTEMP 24.1 c
SIVNT CDCL3
EXREF 77.00 ppm
BF 1.20 Hz
RGAIN 23



¹H NMR of 3an

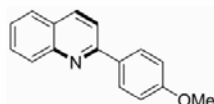
C:\M.S. Singh\NAD-57_1H.als
NAD-57 1H Prof M. S. Singh



JEOL AL300 FTNMR
CHEMISTRY DEPARTMENT
Banaras Hindu University,
VARANASI-221005

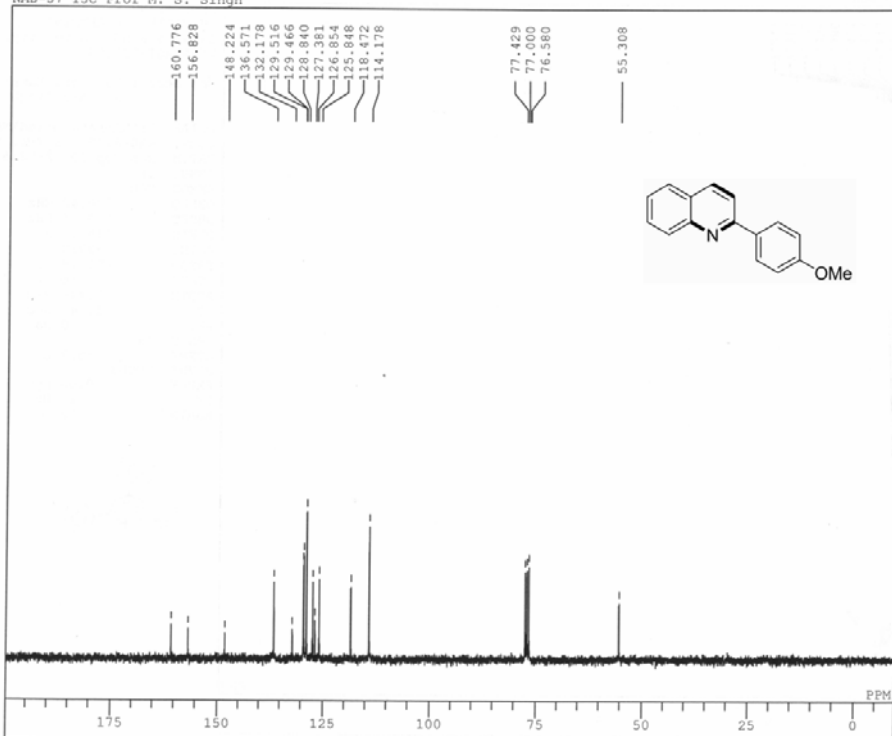
Operator : Nagendra Kumar
Shishir Singh

DFILE C:\M.S. Singh\NAD-57
COMNT NAD-57_1H_Prof M. S.
DATIM Wed Apr 02 15:49:08
OBNUC 1H
EXMOD NON
OBFRQ 300.40 MHz
OBSET 130.00 KHz
OBFIN 1150.0 Hz
POINT 32768
FREQU 9505.7 Hz
SCANS 63
ACQTM 3.447 sec
PD 1.547 sec
PW1 5.2 us
IRNUC 1H
CTEMP 16.1 c
SLVNT CDCL3
EXREF 0.00 ppm
BF 1.20 Hz
RGAIN 15



¹³C NMR of 3an

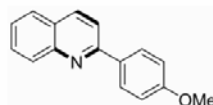
C:\M.S. Singh\NAD-57_13C.als
NAD-57 13C Prof M. S. Singh



JEOL AL300 FTNMR
CHEMISTRY DEPARTMENT
Banaras Hindu University,
VARANASI-221005

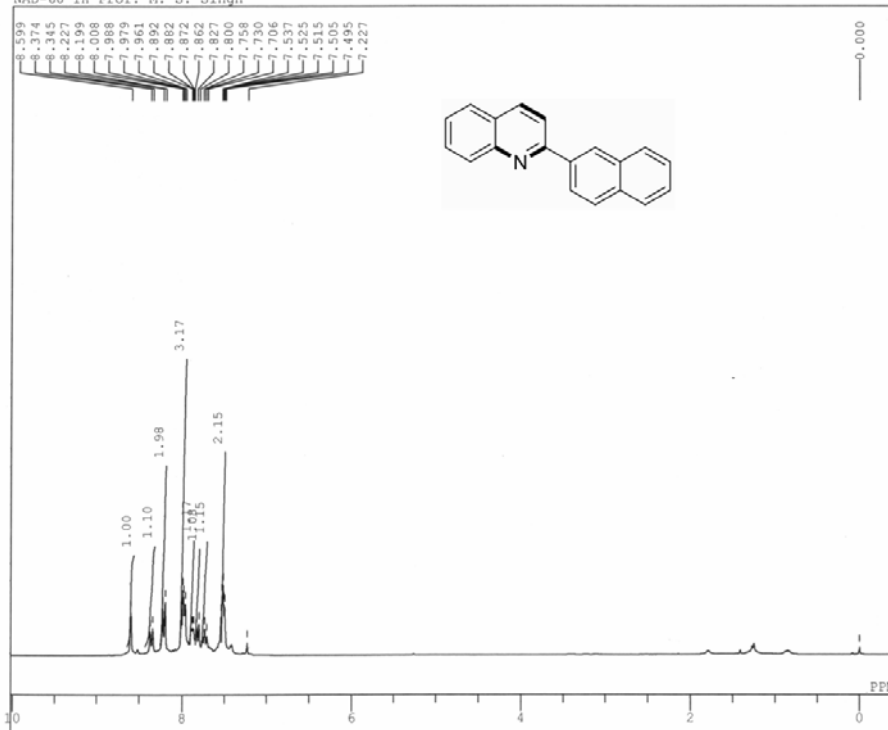
Operator : Nagendra Kumar
Shishir Singh

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EXMOD BCM
OBFRQ 75.45 MHz
OBSET 124.00 KHz
OBFIN 1840.0 Hz
POINT 32768
FREQU 20408.1 Hz
SCANS 116
ACQTM 1.606 sec
PD 1.394 sec
PW1 6.0 us
IRNUC 1H
CTEMP 17.9 c
SLVNT CDCL3
EXREF 77.00 ppm
BF 1.20 Hz
RGAIN 23



¹H NMR of 3ao

C:\M.S. Singh\NAD-60 1H.als
NAD-60 1H Prof. M. S. Singh



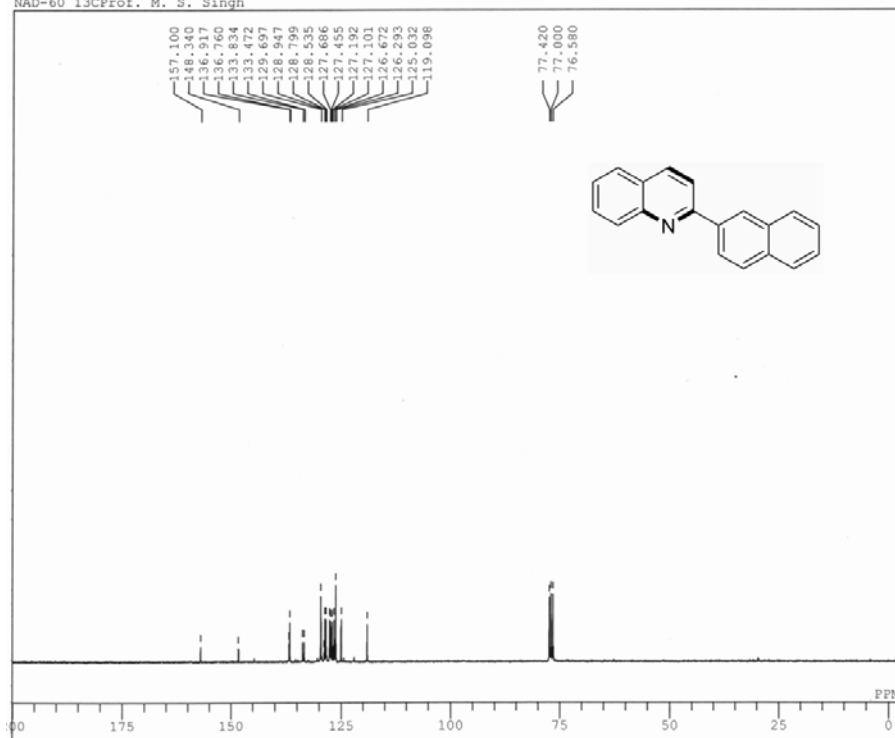
JEOL AL300 FTNMR
CHEMISTRY DEPARTMENT
Banaras Hindu University,
VARANASI-221005

Operator : Nagendra Kumar
Shishir Singh

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COMNT NAD-60 1H Prof. M. S
DATIM Fri Mar 28 04:14:56
OBNUC 1H
EXMOD NON
OBFRQ 300.40 MHz
OBSET 130.00 KHz
OBFIN 1150.0 Hz
POINT 32768
FREQU 6016.8 Hz
SCANS 16
ACQTM 5.446 sec
PD 1.547 sec
PW1 5.2 us
IRNUC 1H
CTEMP 15.6 c
SLVNT CDCL3
EXREF 0.00 ppm
BF 1.20 Hz
RGAIN 15

¹³C NMR of 3ao

C:\M.S. Singh\NAD-60 13C.als
NAD-60 13C Prof. M. S. Singh



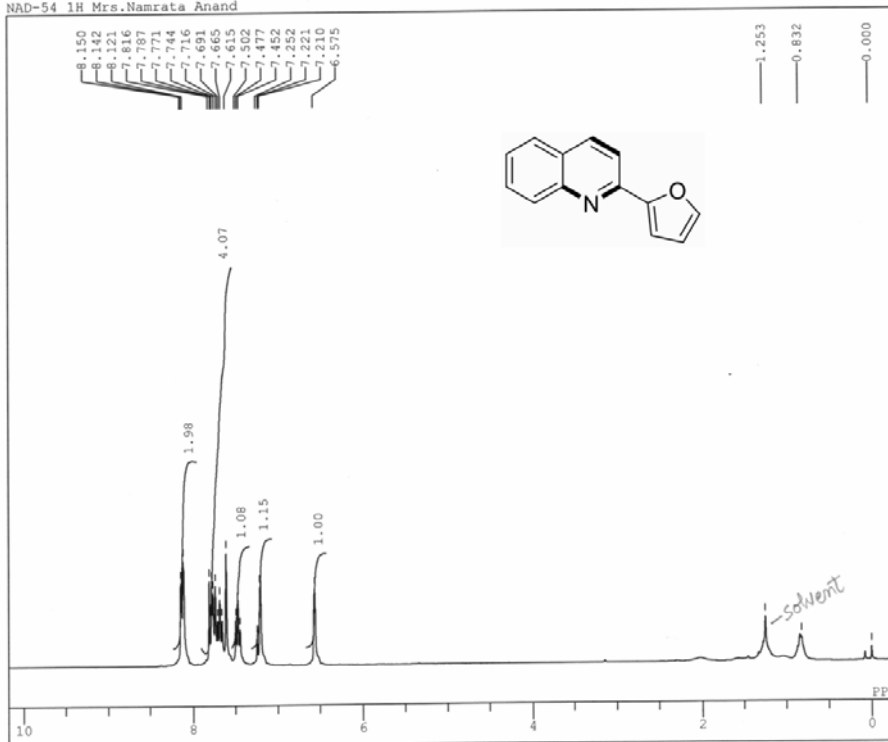
JEOL AL300 FTNMR
CHEMISTRY DEPARTMENT
Banaras Hindu University,
VARANASI-221005

Operator : Nagendra Kumar
Shishir Singh

DFILE C:\M.S. Singh\NAD-60
COMNT NAD-60 13C Prof. M. S
DATIM Fri Mar 28 04:12:26
OBNUC 13C
EXMOD BCM
OBFRQ 75.45 MHz
OBSET 124.00 KHz
OBFIN 1840.0 Hz
POINT 32768
FREQU 20408.1 Hz
SCANS 2000
ACQTM 1.606 sec
PD 1.394 sec
PW1 6.0 us
IRNUC 1H
CTEMP 16.5 c
SLVNT CDCL3
EXREF 77.00 ppm
BF 1.20 Hz
RGAIN 24

¹H NMR of 3ap

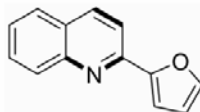
C:\NAmrata Anand\NAD-54_1H.als
NAD-54_1H Mrs.Namrata Anand



JEOL AL300 FTNMR
CHEMISTRY DEPARTMENT
Banaras Hindu University,
VARANASI-221005

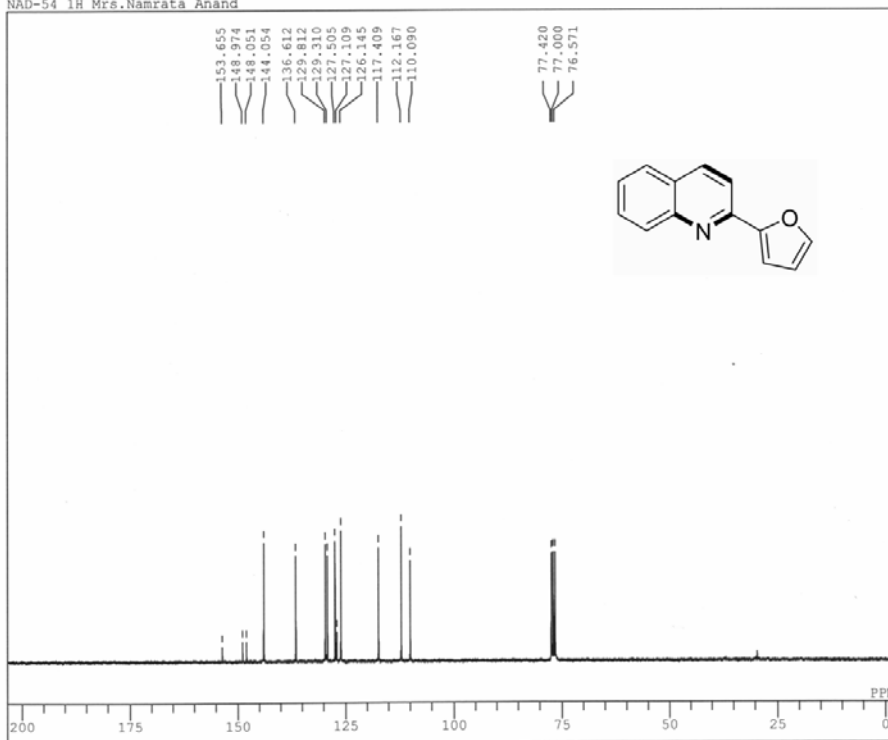
Operator : Nagendra Kumar
Shishir Singh

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DATIM Thu May 01 17:53:21
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EXMOD NON
OBFREQ 300.40 MHz
OBSET 130.00 KHz
OBFIN 1150.0 Hz
POINT 32768
FREQU 6016.8 Hz
SCANS 16
ACQTM 5.446 sec
PD 1.547 sec
PW1 5.2 us
IRNUC 1H
CTEMP 24.8 c
SLVNT CDCL3
EXREF 0.00 ppm
BF 1.20 Hz
RGAIN 16



¹³C NMR of 3ap

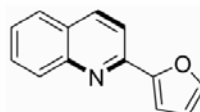
C:\NAmrata Anand\NAD-54_13C.als
NAD-54_1H Mrs.Namrata Anand



JEOL AL300 FTNMR
CHEMISTRY DEPARTMENT
Banaras Hindu University,
VARANASI-221005

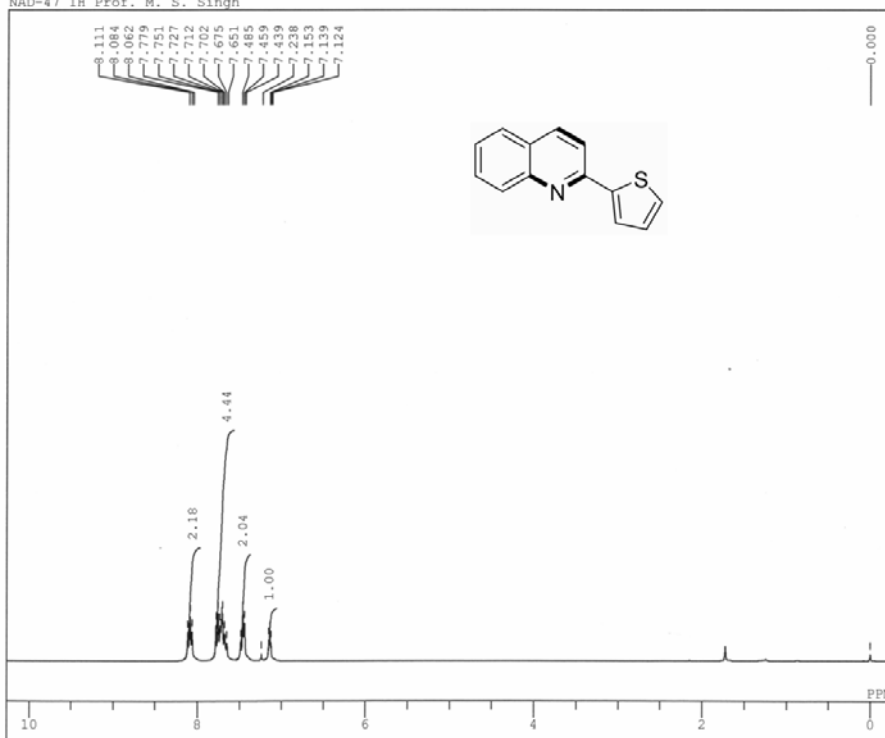
Operator : Nagendra Kumar
Shishir Singh

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DATIM Thu May 01 19:33:43
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EXMOD BCM
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OBSET 124.00 KHz
OBFIN 1840.0 Hz
POINT 32768
FREQU 20408.1 Hz
SCANS 2000
ACQTM 1.606 sec
PD 1.394 sec
PW1 6.0 us
IRNUC 1H
CTEMP 24.1 c
SLVNT CDCL3
EXREF 77.00 ppm
BF 1.20 Hz
RGAIN 24



¹H NMR of 3aq

C:\M.S. Singh\NAD-47_1H.als
NAD-47 1H Prof. M. S. Singh



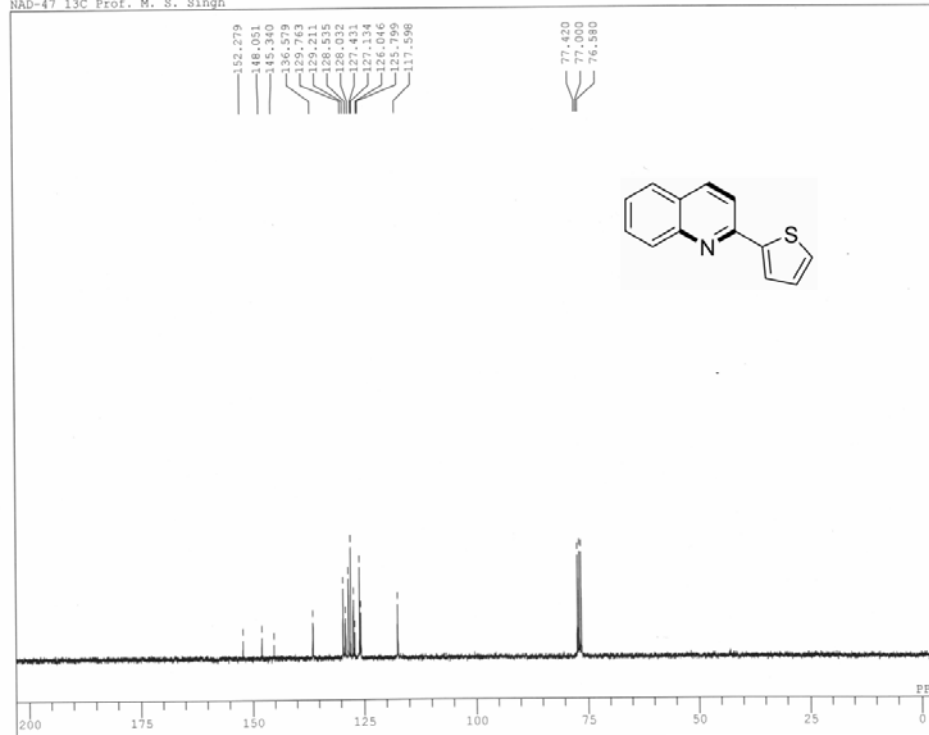
JEOL AL300 FTNMR
CHEMISTRY DEPARTMENT
Banaras Hindu University,
VARANASI-221005

Operator : Nagendra Kumar
Shishir Singh

DFILE C:\M.S. Singh\NAD-4
COMNT NAD-47 1H Prof. M.
DATIM Wed Feb 05 11:40:30
OBNUC 1H
EXMOD NON
OBFRQ 300.40 MHz
OBSET 130.00 KHz
OBFIN 1150.0 Hz
POINT 32768
FREQU 9505.7 Hz
SCANS 32
ACQTM 3.447 sec
PD 1.547 sec
FW1 5.2 us
IRNUC 1H
CTEMP 20.7 c
SLVNT CDCL3
EXREF 0.00 ppm
BF 1.20 Hz
RGAIN 16

¹³C NMR of 3aq

C:\WINNMR98\COMMON_DEFAULT.ALS
NAD-47 13C Prof. M. S. Singh

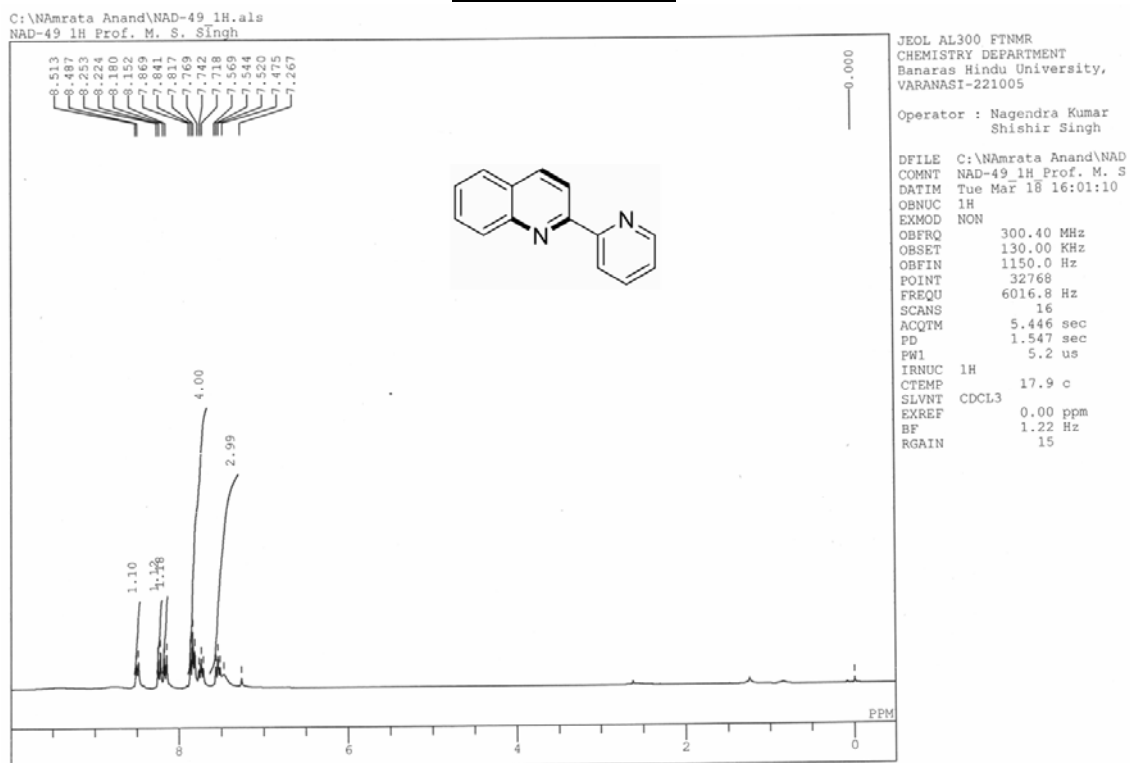


JEOL AL300 FTNMR
CHEMISTRY DEPARTMENT
Banaras Hindu University
VARANASI-221005

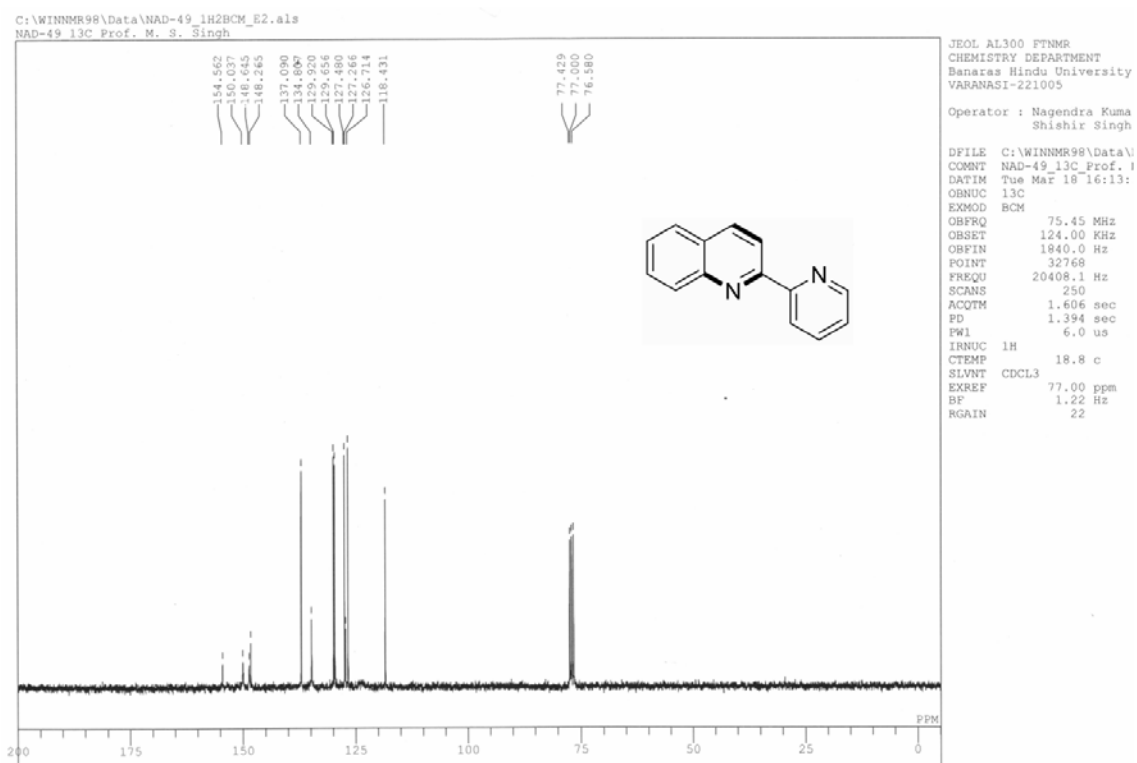
Operator : Nagendra Kum
Shishir Sing

DFILE C:\WINNMR98\COMM
COMNT NAD-47 13C Prof.
DATIM Wed Feb 05 11:35
OBNUC 13C
EXMOD BCM
OBFRQ 75.45 MHz
OBSET 124.00 KHz
OBFIN 1840.0 Hz
POINT 32768
FREQU 20408.1 Hz
SCANS 322
ACQTM 1.606 sec
PD 1.394 sec
FW1 5.9 us
IRNUC 1H
CTEMP 20.1 c
SLVNT CDCL3
EXREF 77.00 ppm
BF 1.20 Hz
RGAIN 24

¹H NMR of 3ar

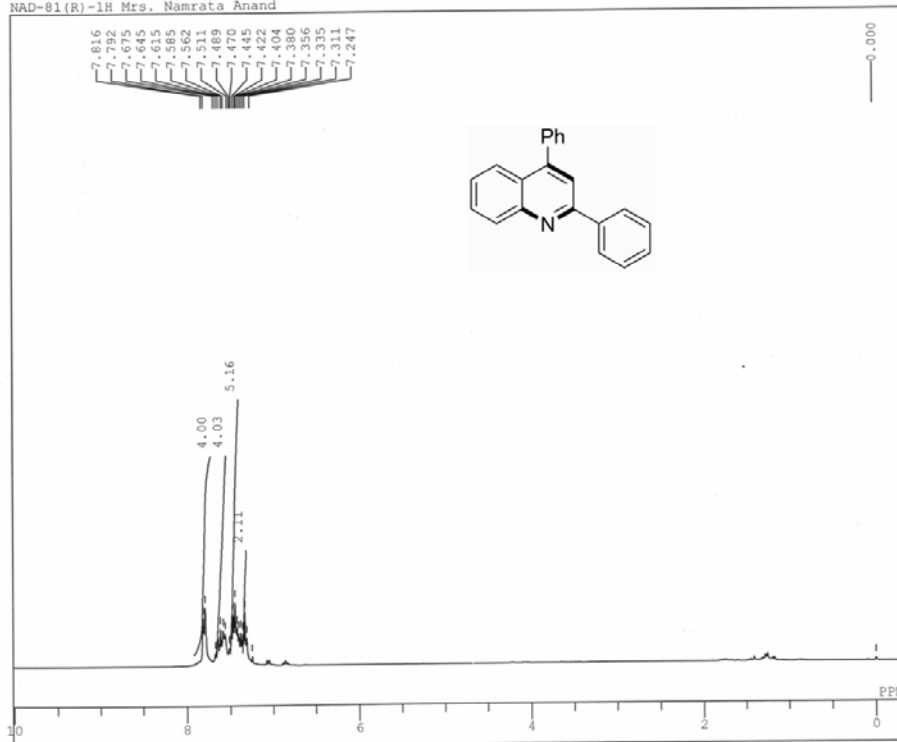


¹³C NMR of 3ar



¹H NMR of 3ch

C:\Namrata Anand\NAD-81(R)-1H.als
NAD-81(R)-1H Mrs. Namrata Anand



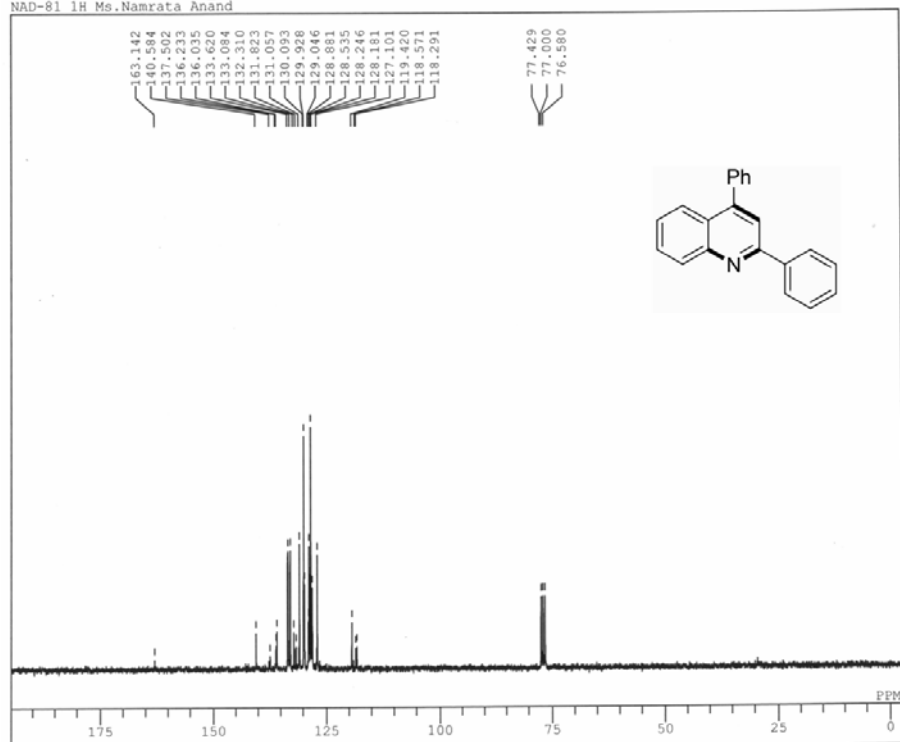
JEOL AL300 FTNMR
CHEMISTRY DEPARTMENT
Banaras Hindu University,
VARANASI-221005

Operator : Nagendra Kumar
Shishir Singh

DFILE C:\Namrata Anand\NA
COMNT NAD-81(R)-1H Mrs. N
DATIM Mon Sep 29 12:58:57
OBNUC 1H
EXMOD NON
OBFRQ 300.40 MHz
OBSET 130.00 KHz
OBFIN 1150.0 Hz
POINT 32768
FREQU 6016.8 Hz
SCANS 16
ACQTM 5.446 sec
PD 1.547 sec
PW1 5.0 us
IRNUC 1H
CTEMP 19.7 c
SLVNT CDCL3
EXREF 0.00 ppm
BF 1.20 Hz
RGAIN 12

¹³C NMR of 3ch

C:\Namrata Anand\NAD-81 13C.als
NAD-81 1H Ms. Namrata Anand

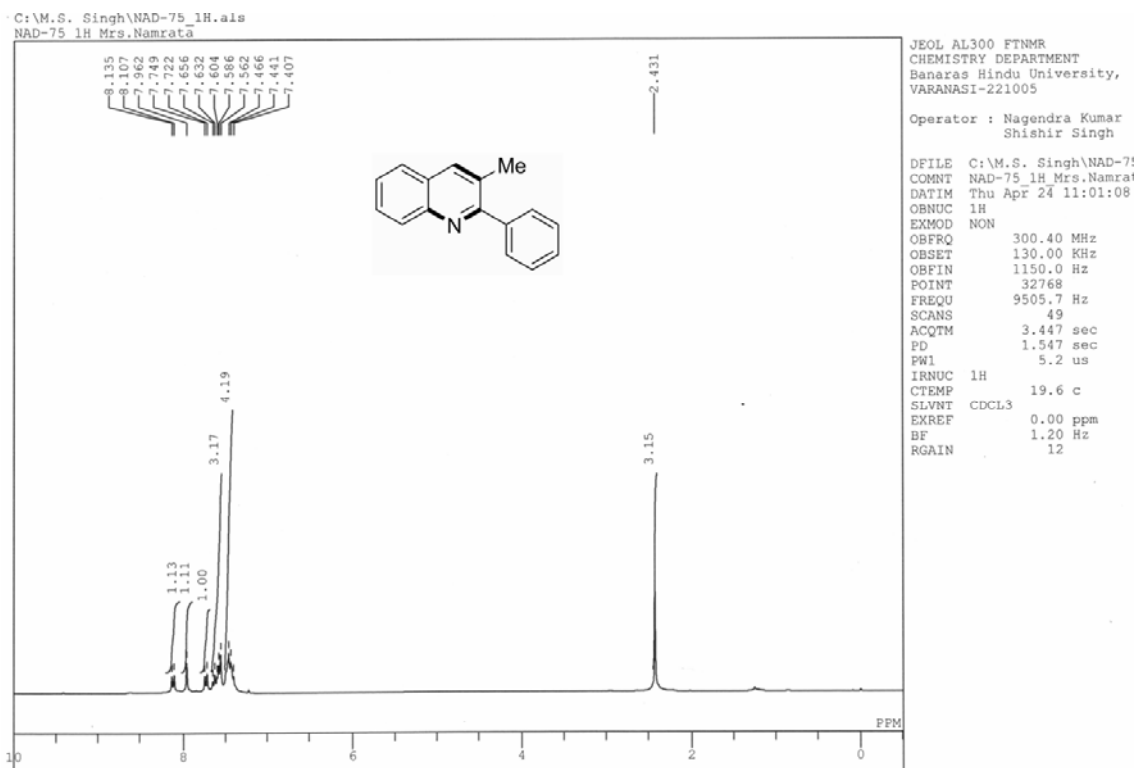


JEOL AL300 FTNMR
CHEMISTRY DEPARTMENT
Banaras Hindu University,
VARANASI-221005

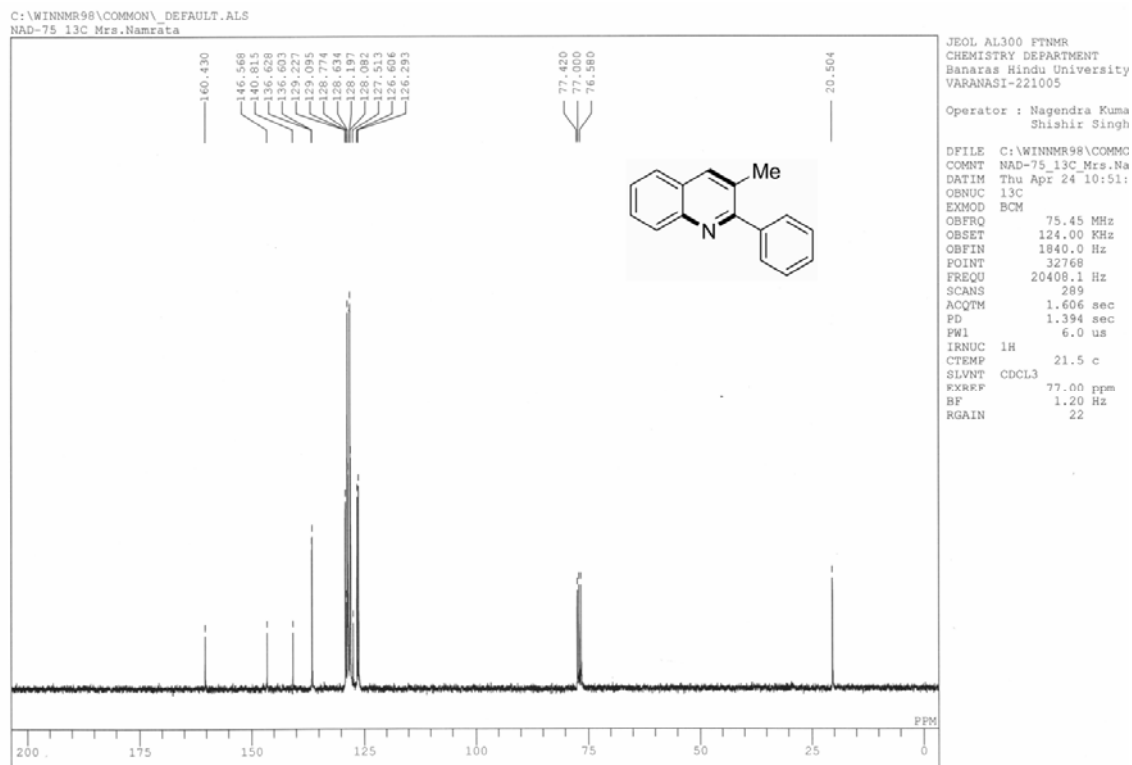
Operator : Nagendra Kumar
Shishir Singh

DFILE C:\Namrata Anand\NA
COMNT NAD-81 1H Ms. Namrat
DATIM Thu May 22 03:19:04
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EXMOD BCM
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OBSET 124.00 KHz
OBFIN 1840.0 Hz
POINT 32768
FREQU 20408.1 Hz
SCANS 200
ACQTM 1.606 sec
PD 1.394 sec
PW1 6.0 us
IRNUC 1H
CTEMP 26.2 c
SLVNT CDCL3
EXREF 77.00 ppm
BF 1.20 Hz
RGAIN 24

¹H NMR of 3as

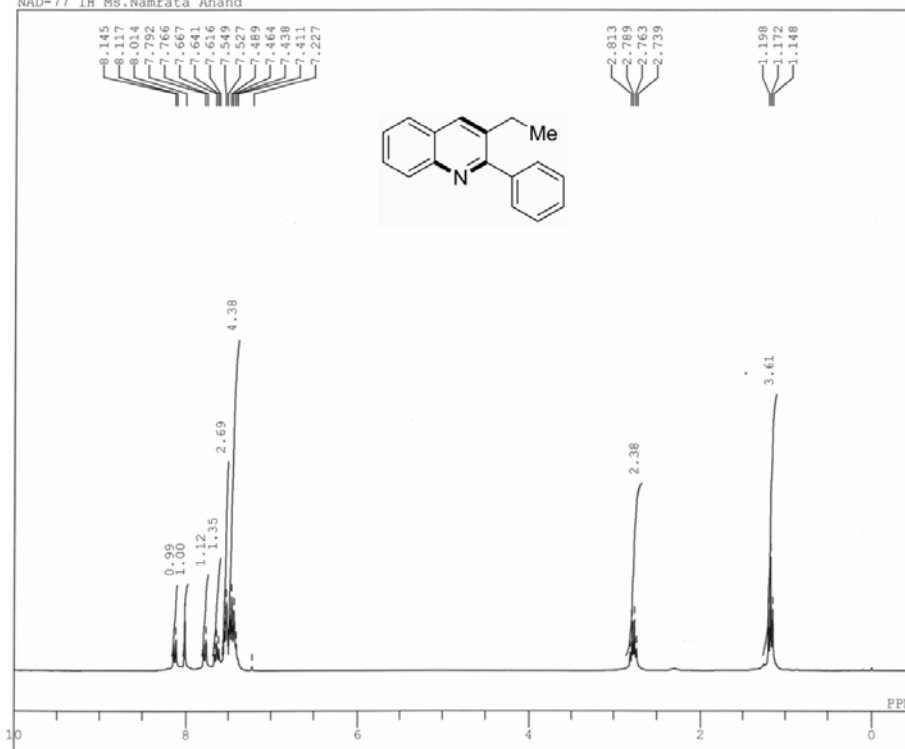


¹³C NMR of 3as



¹H NMR of 3at

C:\WINNMR98\Data\NAD-77_1H1NON_ES.ALS
NAD-77 1H Ms.Namrata Anand



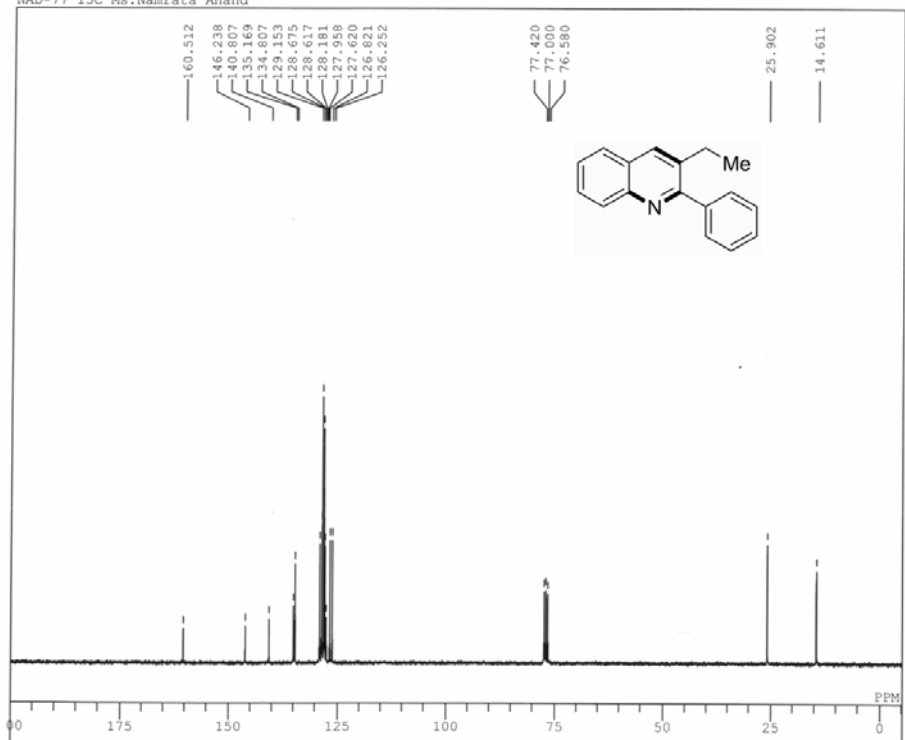
JEOL AL300 FTNMR
CHEMISTRY DEPARTMENT
Banaras Hindu University,
VARANASI-221005

Operator : Nagendra Kumar
Shishir Singh

DFILE C:\WINNMR98\Data\N
COMNT NAD-77_1H Ms.Namra
DATIM Fri Sep 26 12:12:4
OBNUC 1H
EXMOD NON
OBFRQ 300.40 MHz
OBSET 130.00 KHz
OBFIN 1150.0 Hz
POINT 32768
FREQU 6016.8 Hz
SCANS 16
ACQTM 5.446 sec
PD 1.547 sec
PW1 5.0 us
IRNUC 1H
CTEMP 22.0 c
SLVNT CDCL3
EXREF 0.00 ppm
BF 1.20 Hz
RGAIN 13

¹³C NMR of 3at

C:\WINNMR98\Data\NAD-77_1H2BCM_ES.ALS
NAD-77 13C Ms.Namrata Anand



JEOL AL300 FTNMR
CHEMISTRY DEPARTMENT
Banaras Hindu University,
VARANASI-221005

Operator : Nagendra Kumar
Shishir Singh

DFILE C:\WINNMR98\Data\NAD
COMNT NAD-77_13C Ms.Namrat
DATIM Fri Sep 26 12:28:03
OBNUC 13C
EXMOD BCM
OBFRQ 75.45 MHz
OBSET 124.00 KHz
OBFIN 1840.0 Hz
POINT 32768
FREQU 20408.1 Hz
SCANS 300
ACQTM 1.606 sec
PD 1.394 sec
PW1 5.0 us
IRNUC 1H
CTEMP 23.3 c
SLVNT CDCL3
EXREF 77.00 ppm
BF 1.20 Hz
RGAIN 22