Supporting information for Chemical communication

Confined Space and Cations Enhance the Power of a Chiral Auxiliary: Photochemistry of 1,2-Diphenylcyclopropane Derivatives

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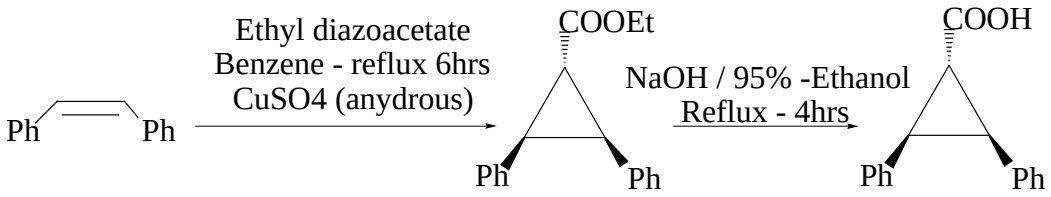
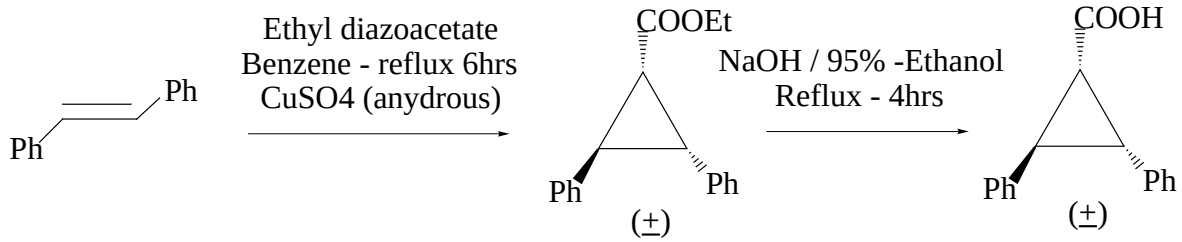
Synthesis of 2, 3-diphenyl cyclopropane-1-carboxylic acid:

trans, trans- 2, 3-diphenyl cyclopropane-1-carboxylic acid was synthesized (**scheme-1**) using the method as described by a)Orchin, M. Blatchford, J. K. *J. Org. Chem*. 1964, **29**, 839; b) D'yakanov, I. A. Komendantev, M. I. Gui-siya, F. Korichev, G. L. *J. Gen. Chem. USSR*, 1962**, 32**, 928.



Scheme-1

(Racemic) 2, 3-diphenyl cyclopropane-1-carboxylic acid was synthesized (**Scheme-2**) as above but *trans*-stilbene was used instead of *cis*-stilbene.

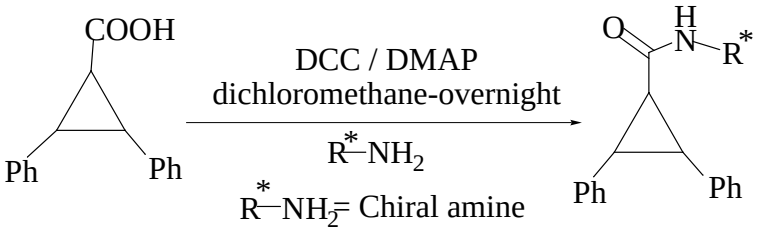


Scheme-2

Synthesis of amide derivatives:

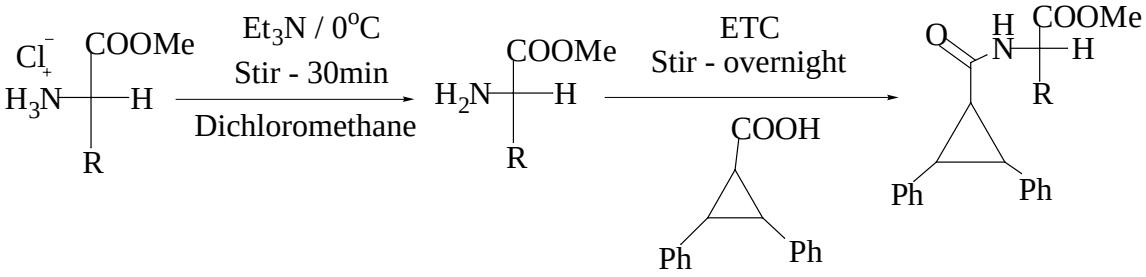
2,3-diphenylcyclopropane-1-carobxylic acid was coupled with the corresponding chiral amine (**Sheme-3**) using DCC/DMAP (Hassner, A. Alexanian, V. *Tetrehedron Lett.* 1978, **46**,

4475.) and purified by column chromatography using silica gel and hexane-ethylacetate as the eluent. The amides were then characterized by ^{1}H-NMR, ^{13}C-NMR and GC/MS.



Scheme-3

For the amides of amino acid derivatives, the hydrochloride salt of the amino acid derivative (1.3 eq.)was first quenched with triethylamine at 0^{o}C in dichloromethane solvent followed by the addition of the 2,3-diphenylcyclopropane-1-carboxylic acid (1.0 eq.) and 1-[3-(dimethylamino)propyl]-3-ethylcarbodiimide methiodide (ETC - 1.2 eq.)



Scheme-4

The mixture was allowed to warm up to room temperature and then stirred at room temperature overnight (**scheme-4**). The amide was then purified by column chromatography (silica gel) with hexane-ethylacetate as the eluent. (Kress, J. Rosner, A. Hirsch, A. *Chem. Eur. J.* 2000, **6**, 247-257.). The amides were characterized using ^{1}HNMR, ^{13}C-NMR and GC/MS.

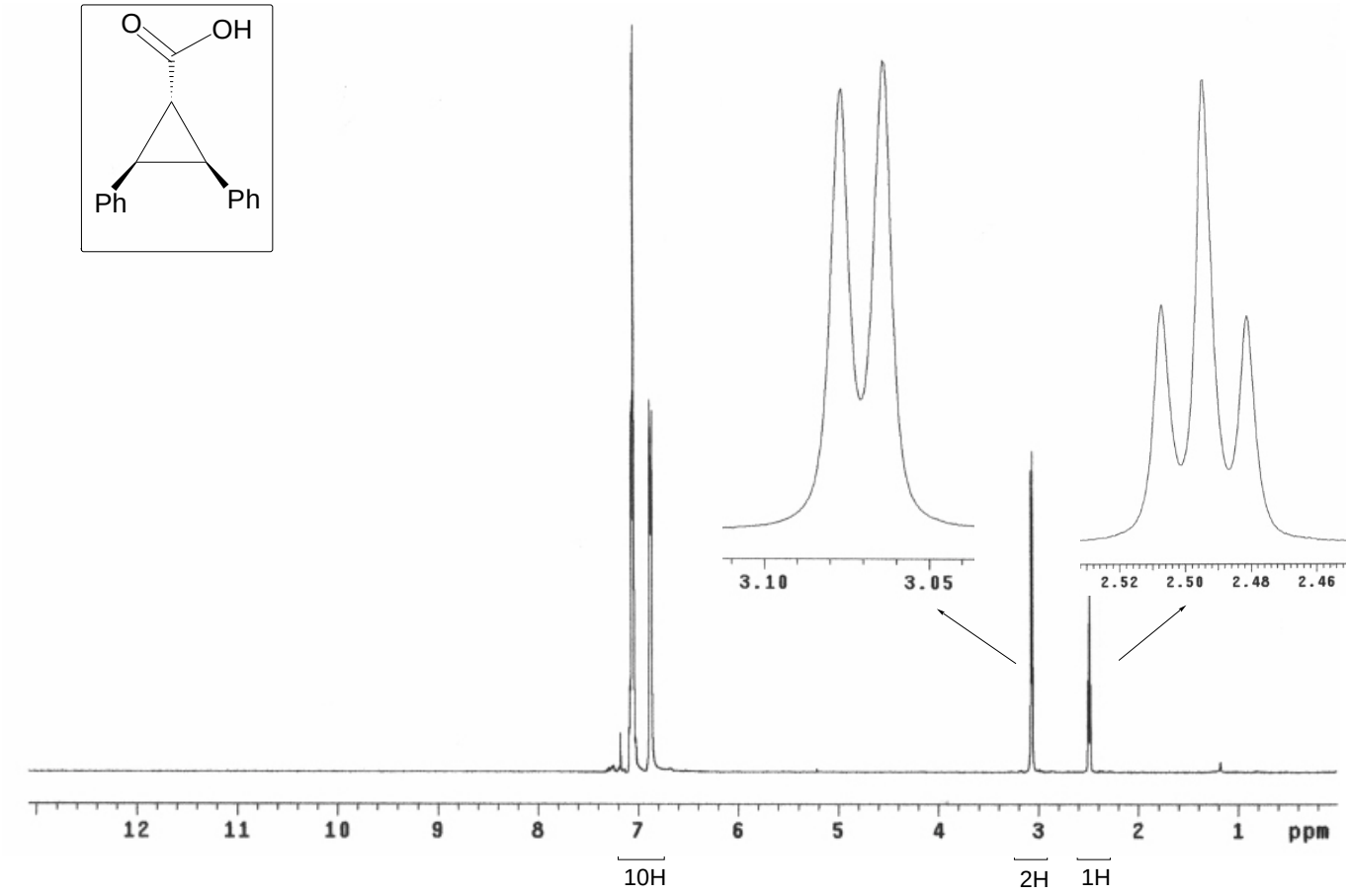
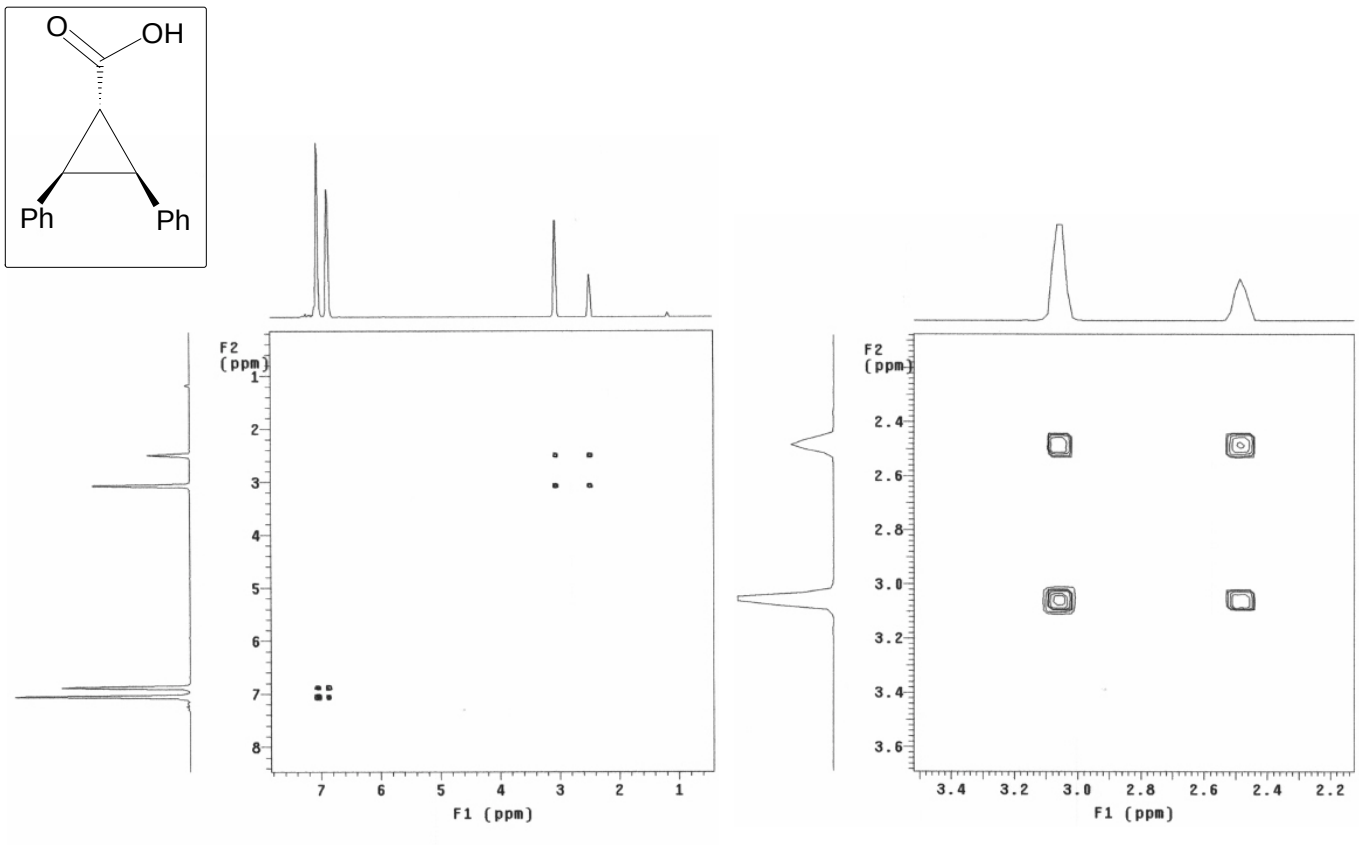


Figure - **1**: ^{1}H - NMR ($CDCl_3$, 400MHz) 2β,3β-diphenylcyclopropane-1α-carboxylic acid



Cross peaks of cyclopropane protons

Figure - **2**: ^{1}H-^{1}H COSY ($CDCl_3$, 400MHz) 2β,3β-diphenylcyclopropane-1α-carboxylic acid

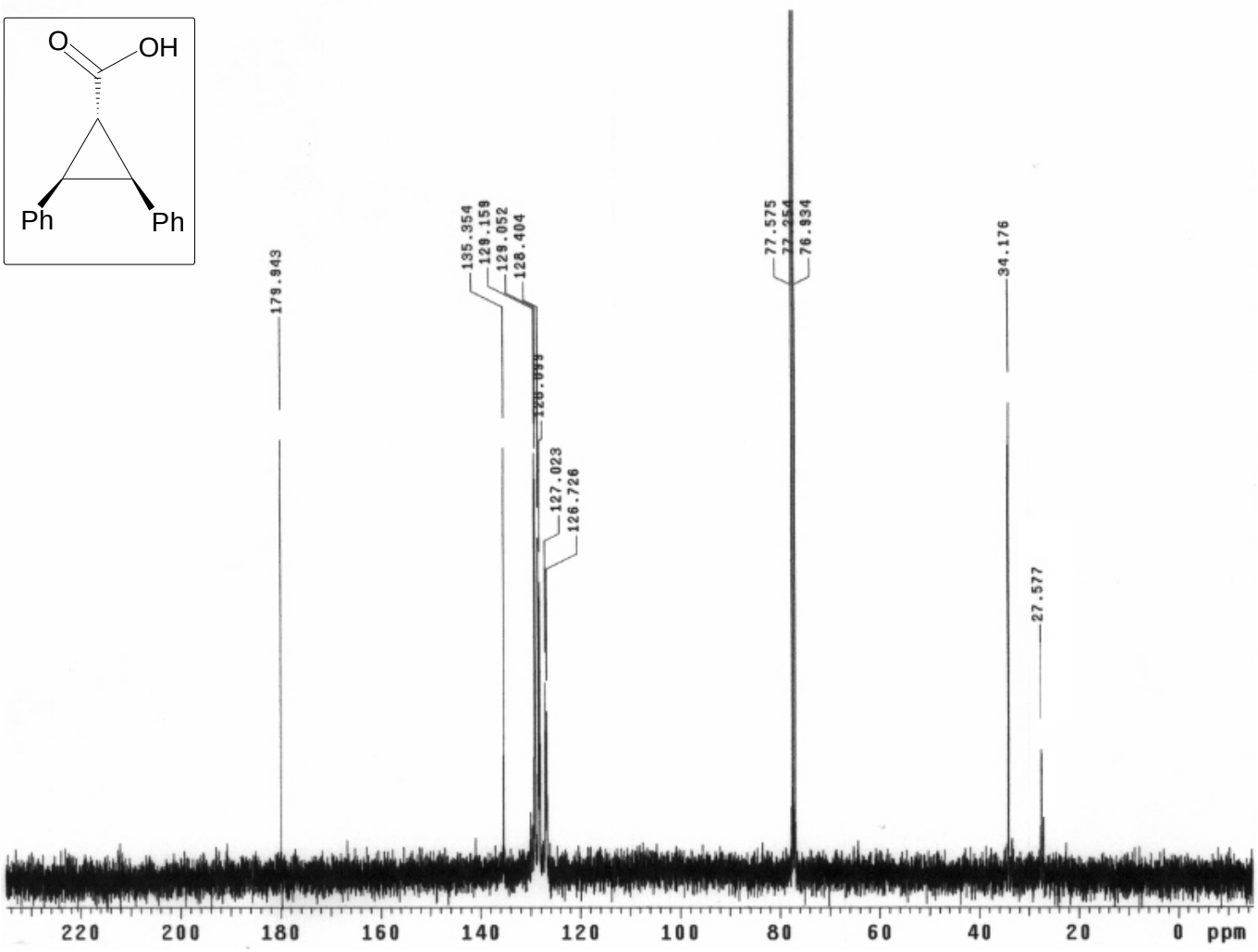


Figure - **3**: ^{13}C - NMR ($CDCl_3$, 400MHz) 2β,3β-diphenylcyclopropane-1α-carboxylic acid

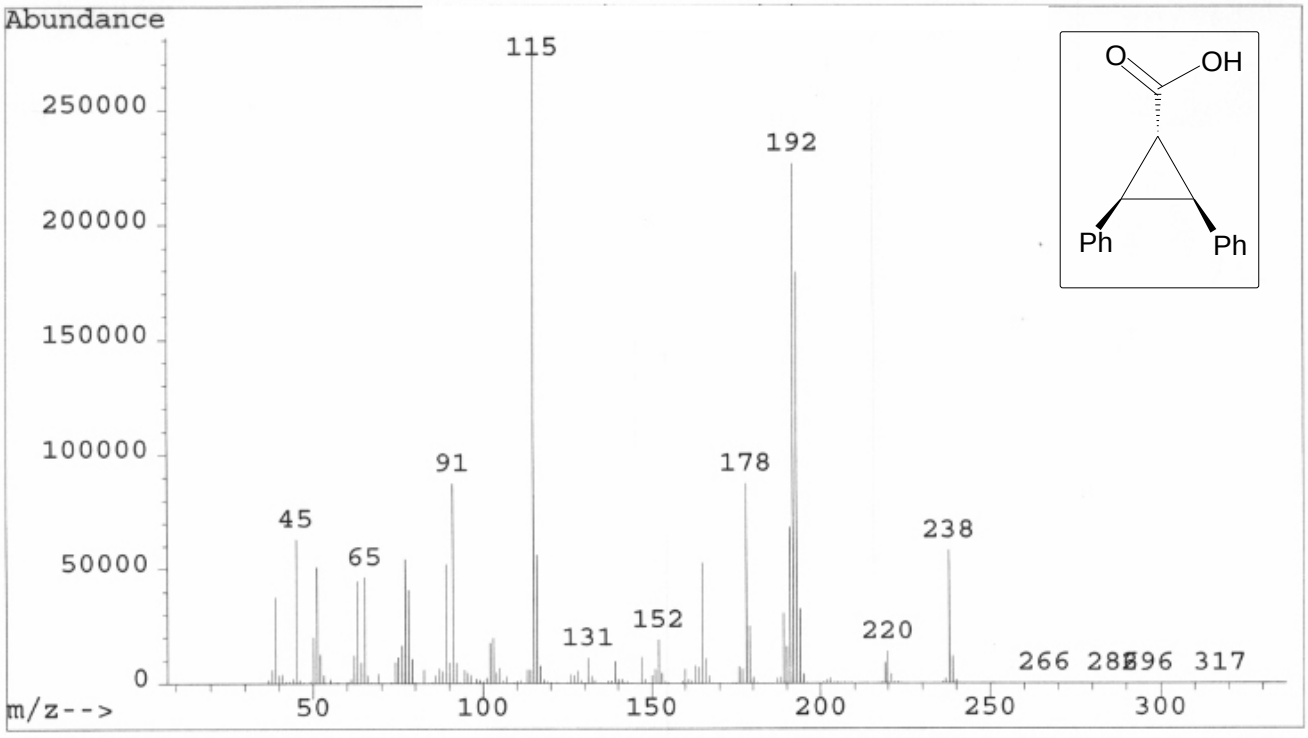


Figure - **4**: GC/MS : 2β,3β-diphenylcyclopropane-1α-carboxylic acid

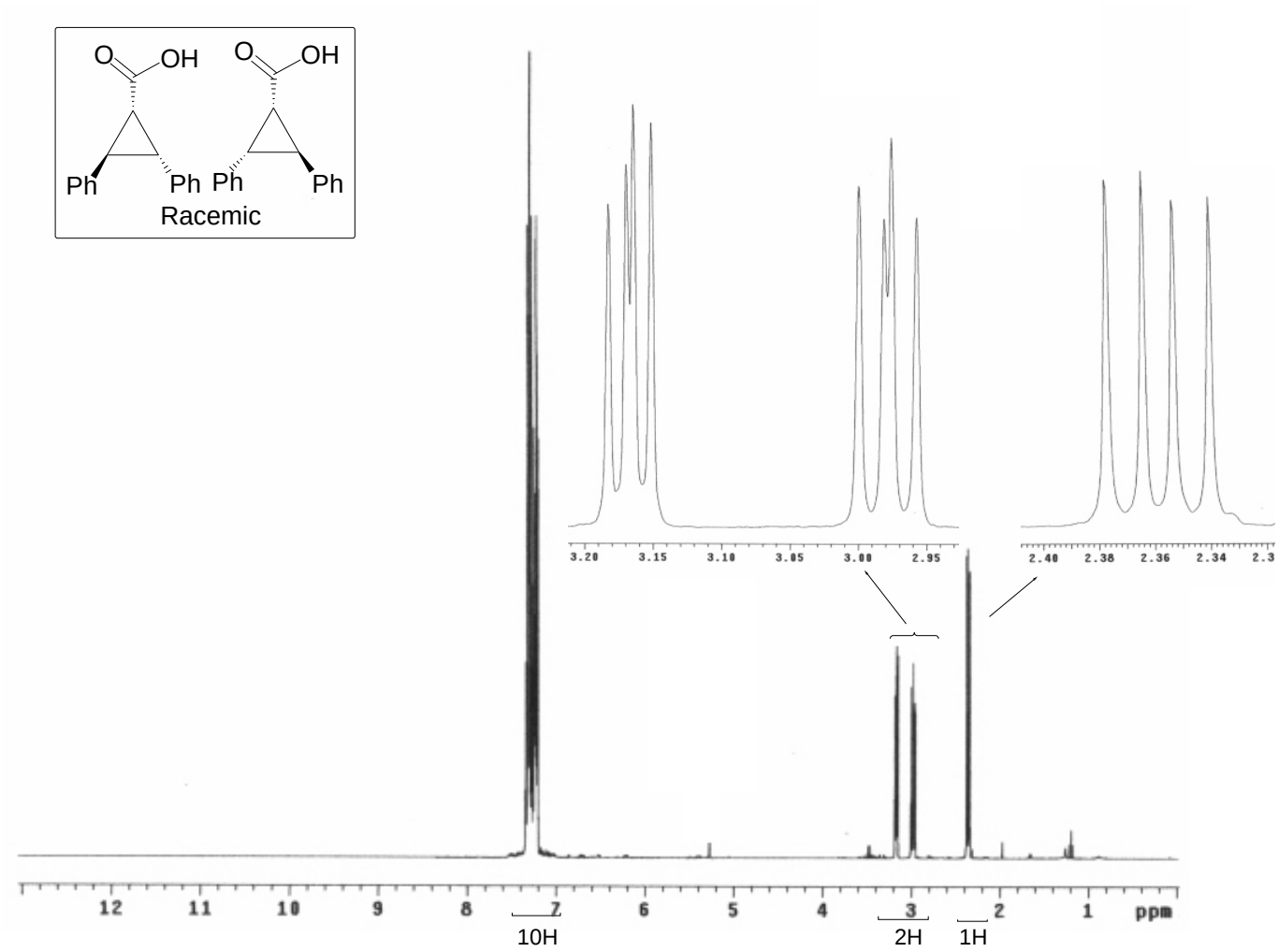
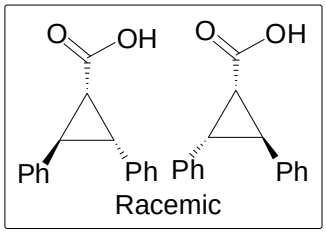


Figure - **5**: ^{1}H-NMR ($CDCl_3$, 400MHz) : (racemic) 2,3-diphenylcyclopropane-1-carboxylic acid



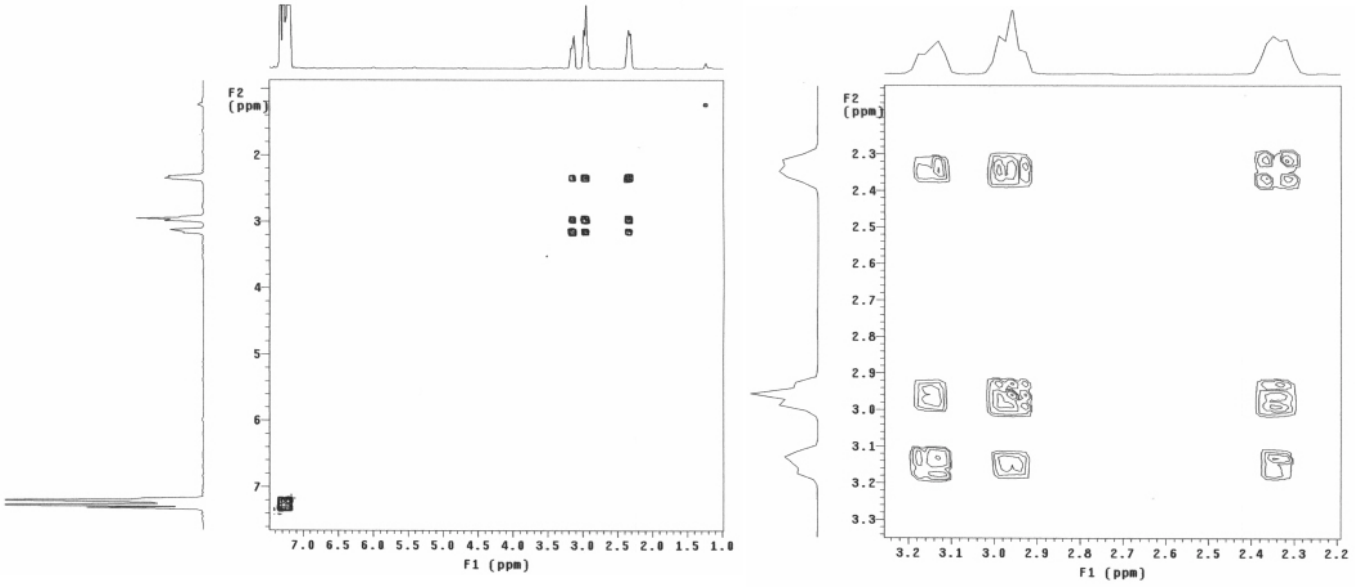


Figure - **6**: ^{1}H-^{1}H COSY ($CDCl_3$, 400MHz) : (racemic) 2,3-diphenylcyclopropane-1-carboxylic acid

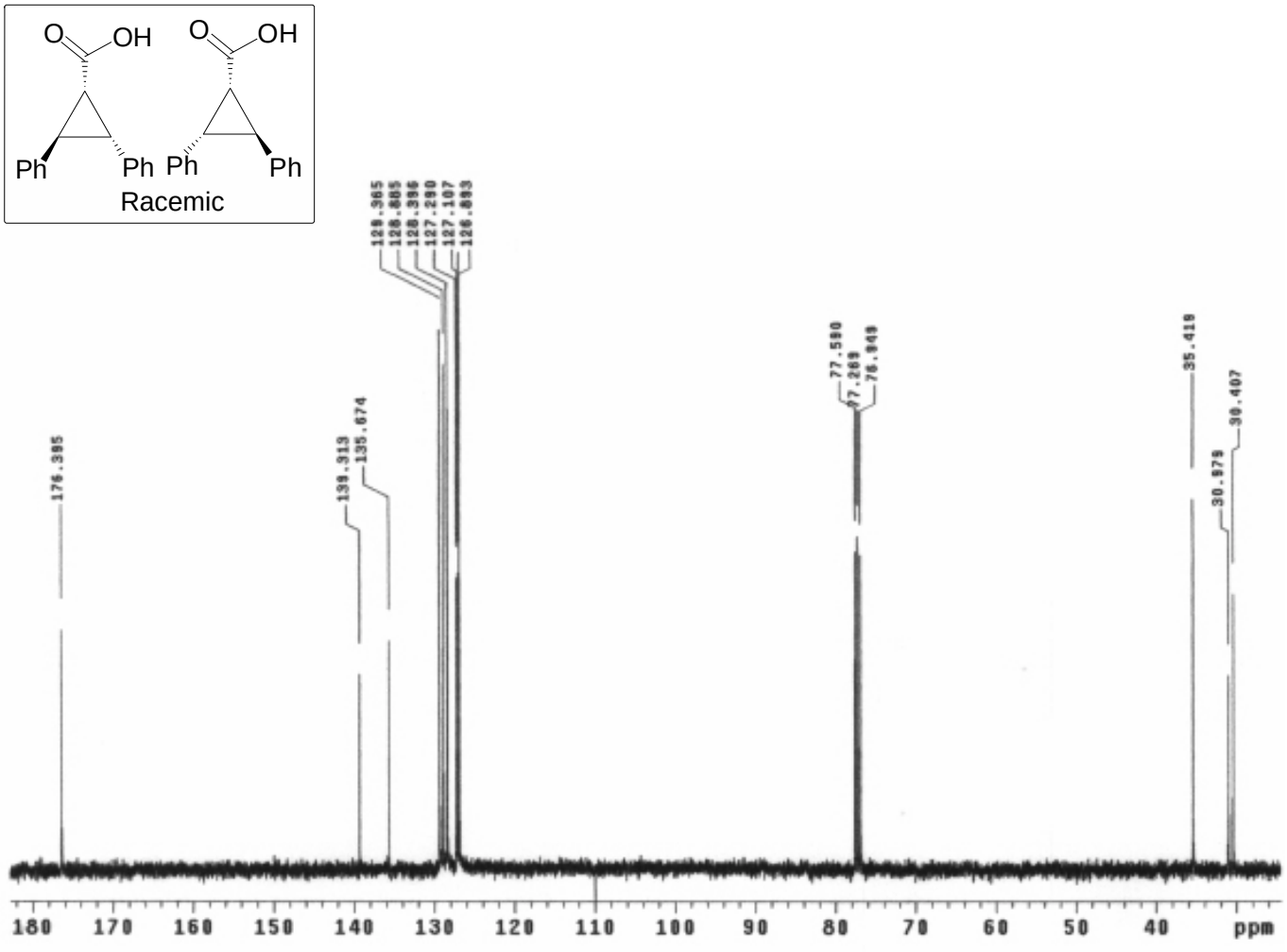


Figure - **7**: ^{13}C - NMR ($CDCl_3$, 400MHz) : (racemic) 2,3-diphenylcyclopropane-1-carboxylic acid

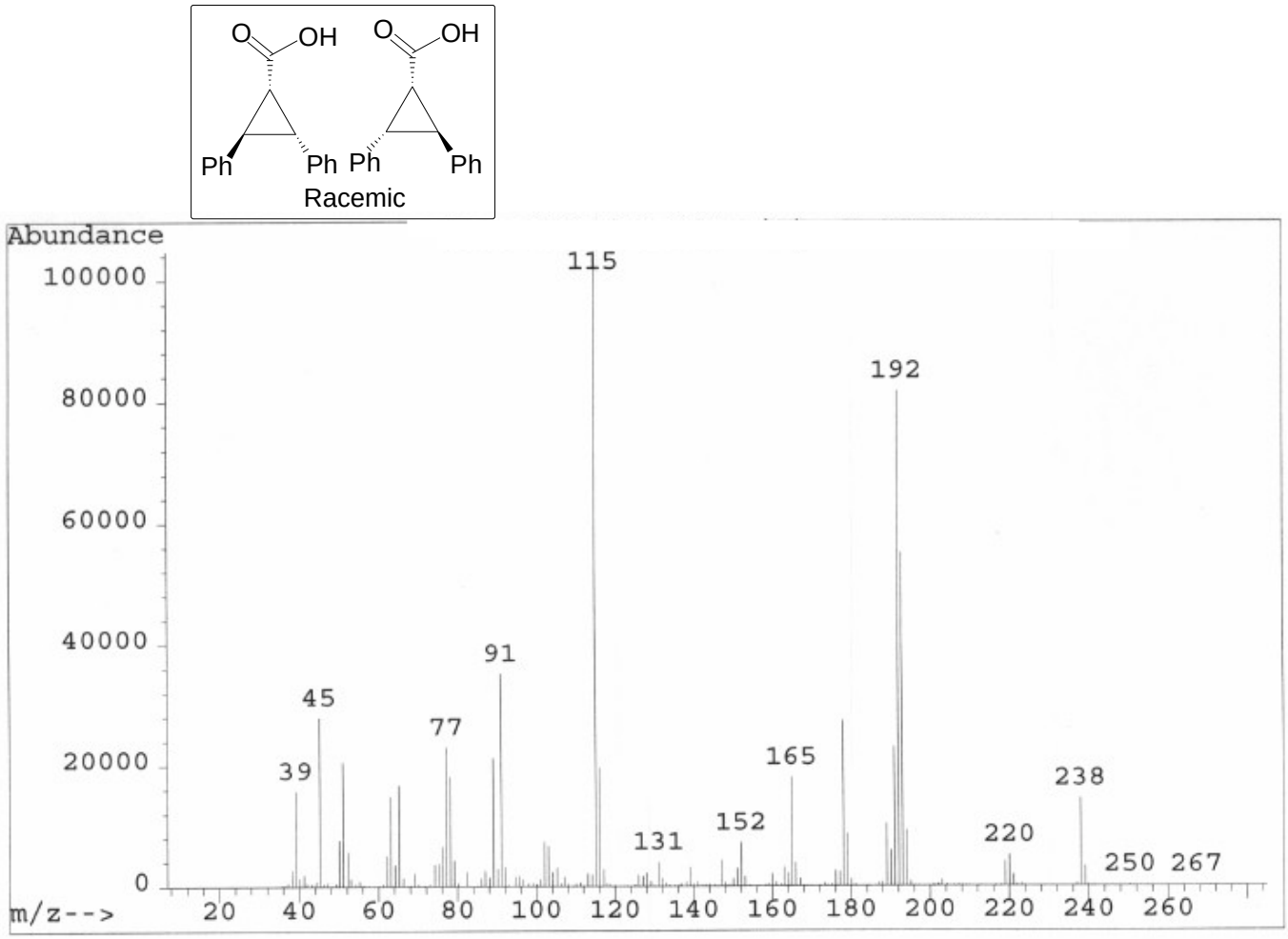


Figure - **8**: GC/MS : (racemic) 2,3-diphenylcyclopropane-1-carboxylic acid

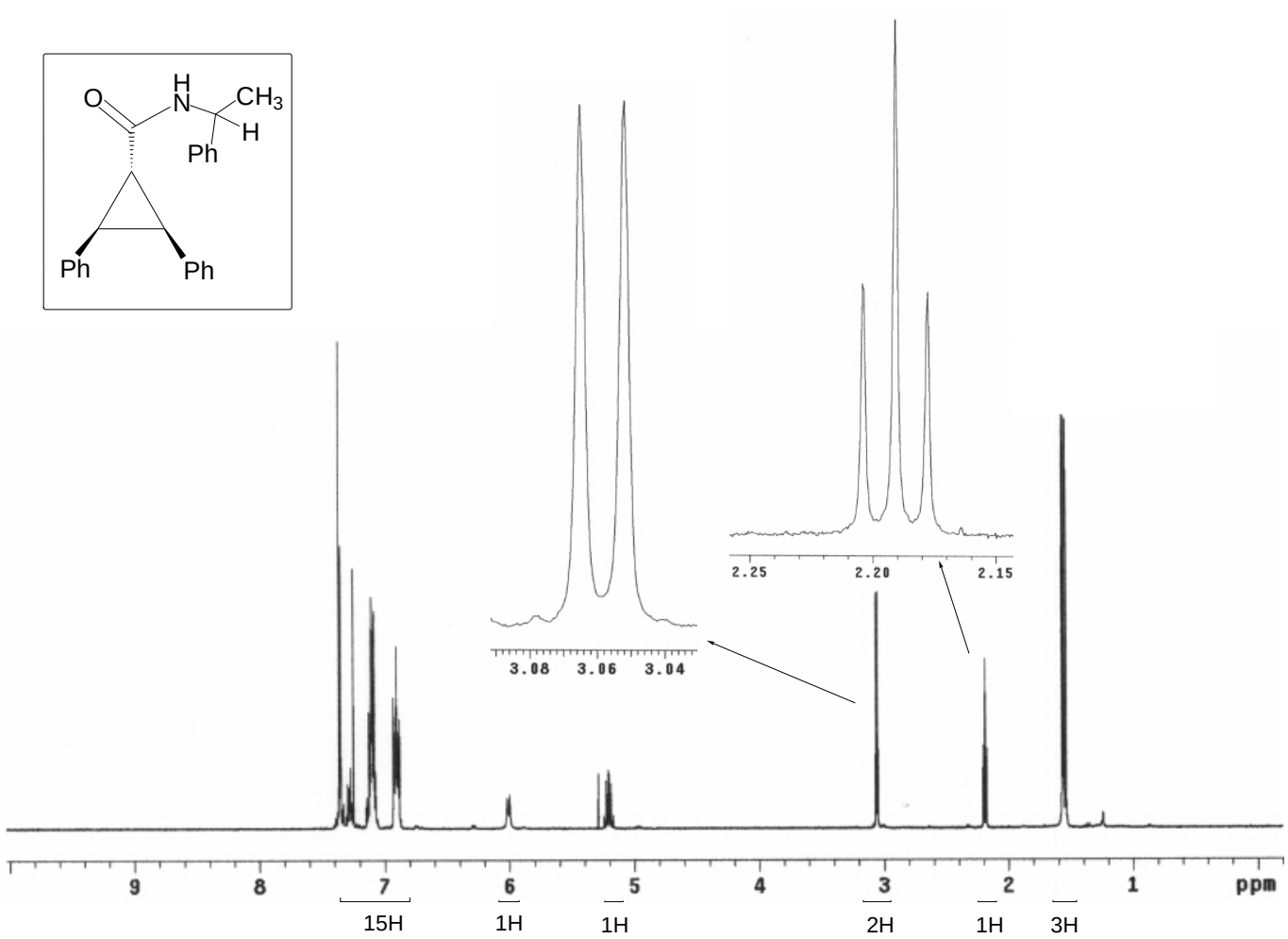


Figure - **9**: ^{1}H -NMR ($CDCl_3$,400MHz) 1-phenylethylamide of 2β,3β-diphenylcyclopropane-1α-carboxylic acid

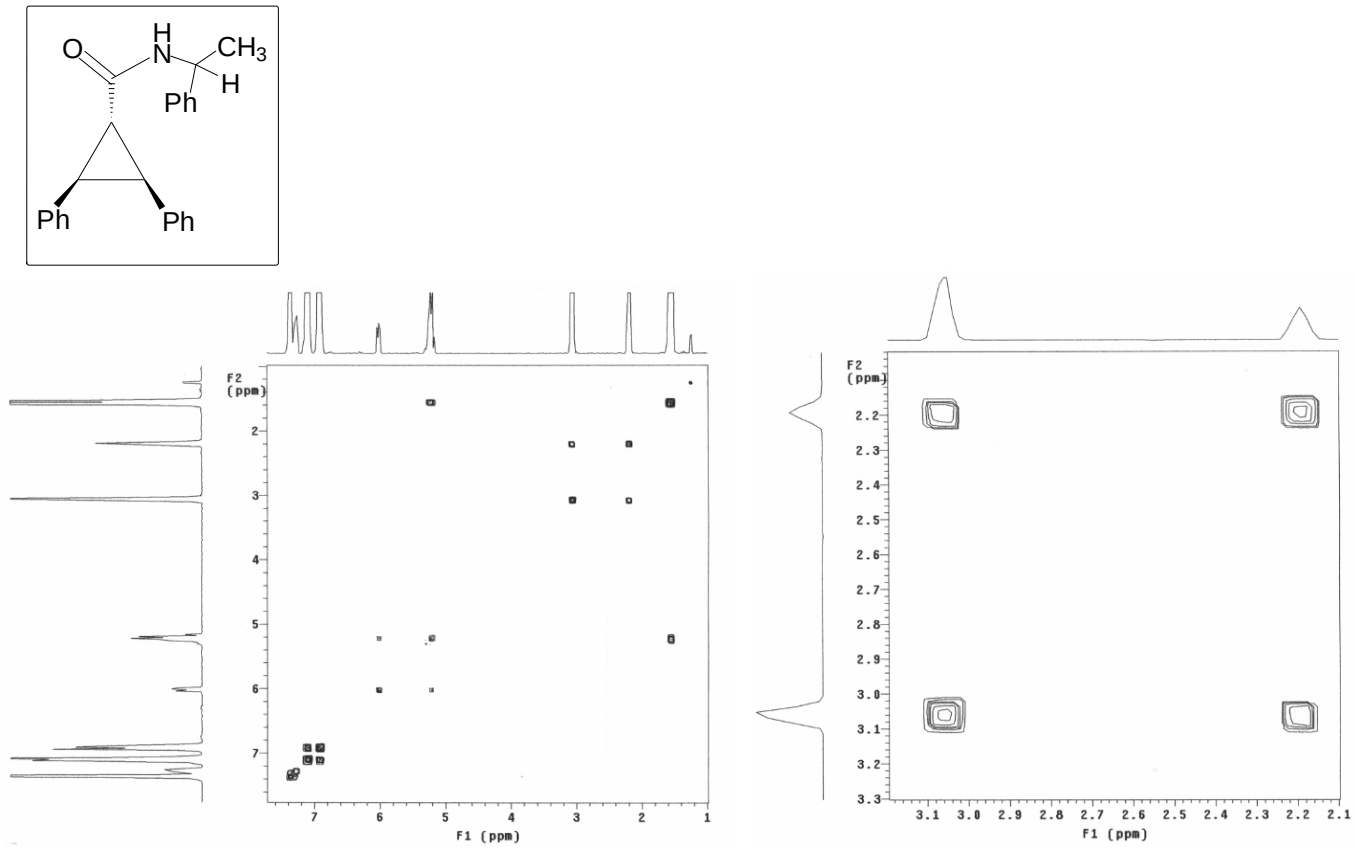


Figure - **10**:
^{1}H -^{1}H COSY ($CDCl_3$,400MHz) 1-phenylethylamide of 2β,3β-diphenylcyclopropane-1α-carboxylic acid

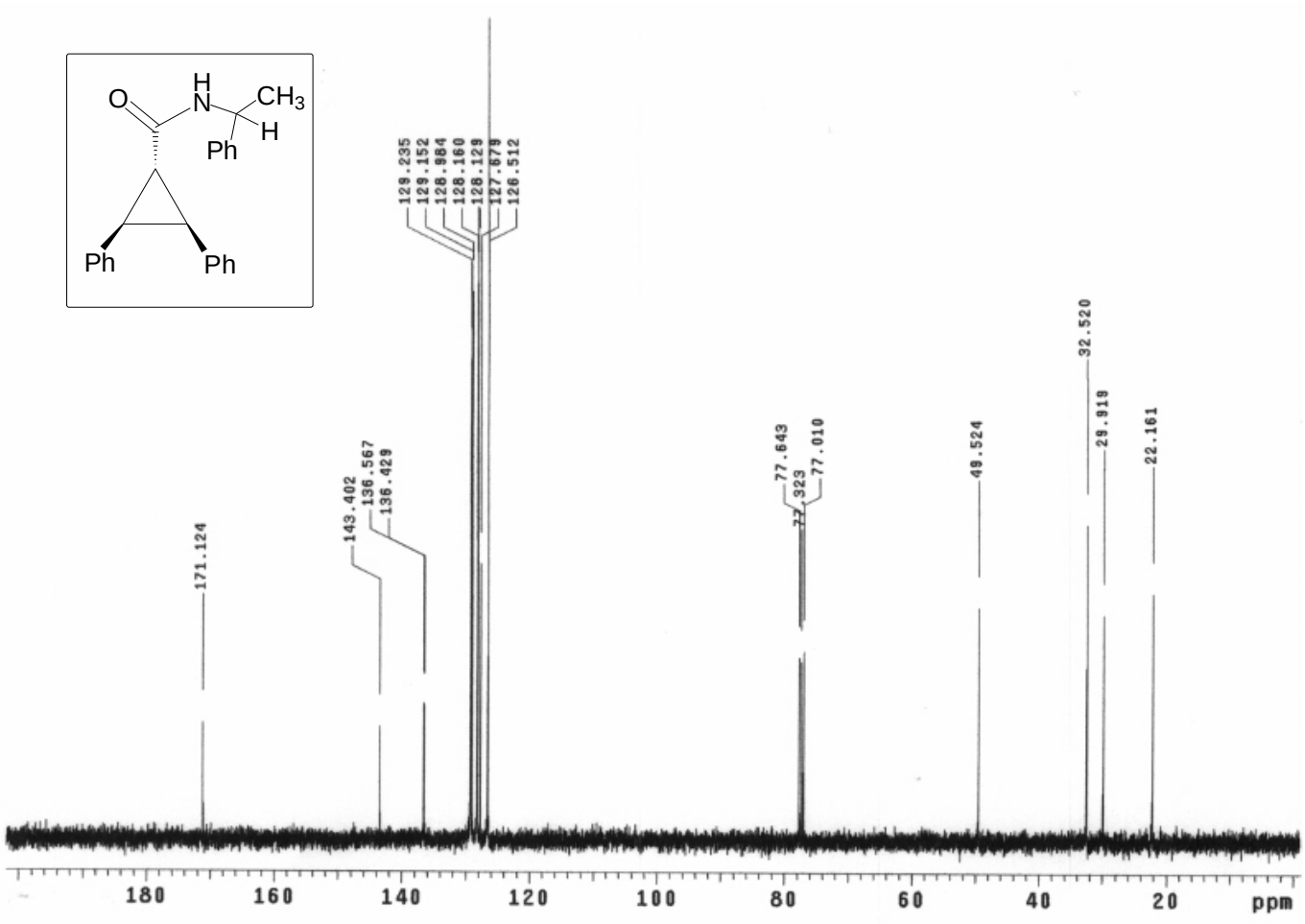


Figure - **11**: ^{13}C -NMR ($CDCl_3$,400MHz) 1-phenylethylamide of 2β,3β-diphenylcyclopropane-1α-carboxylic acid

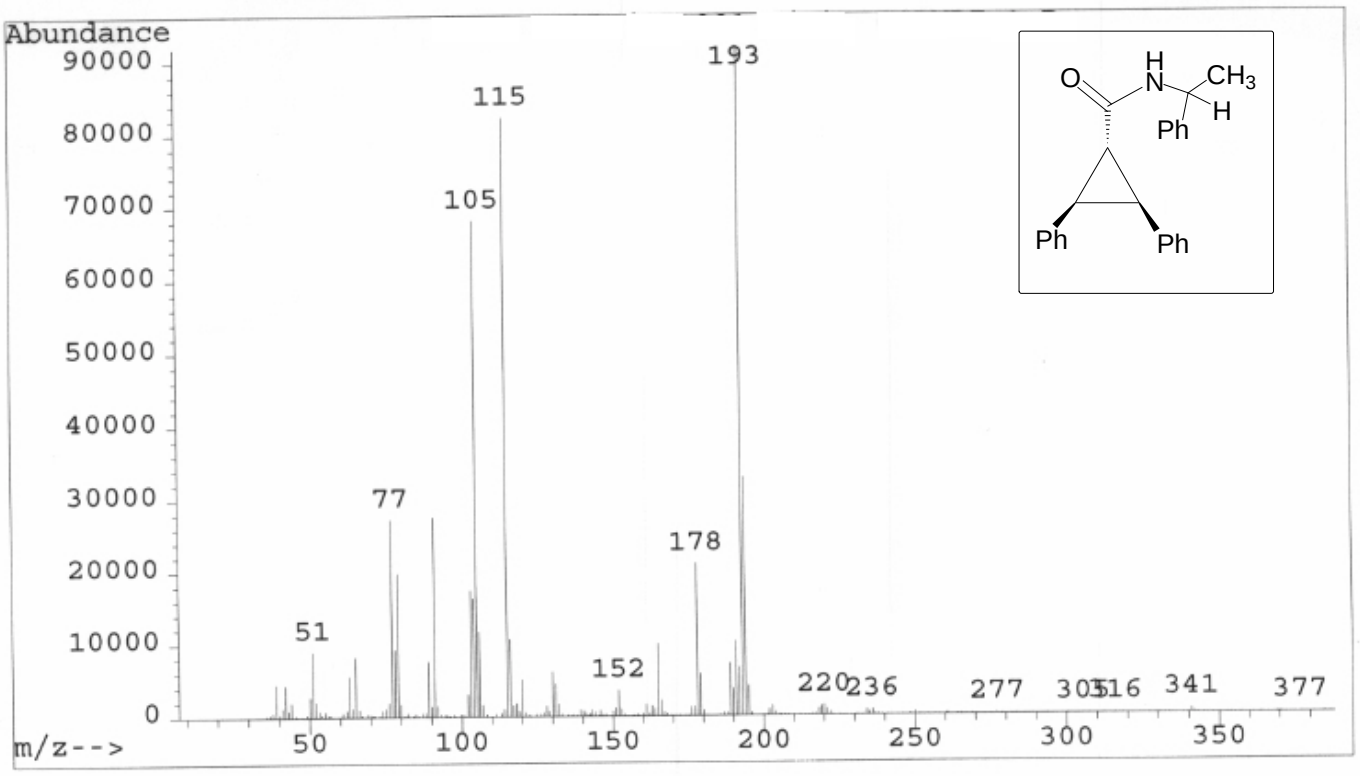


Figure - **12**: GC/MS : 1-phenylethyl amide of 2β,3β-diphenylcyclopropane-1α-carboxylic acid

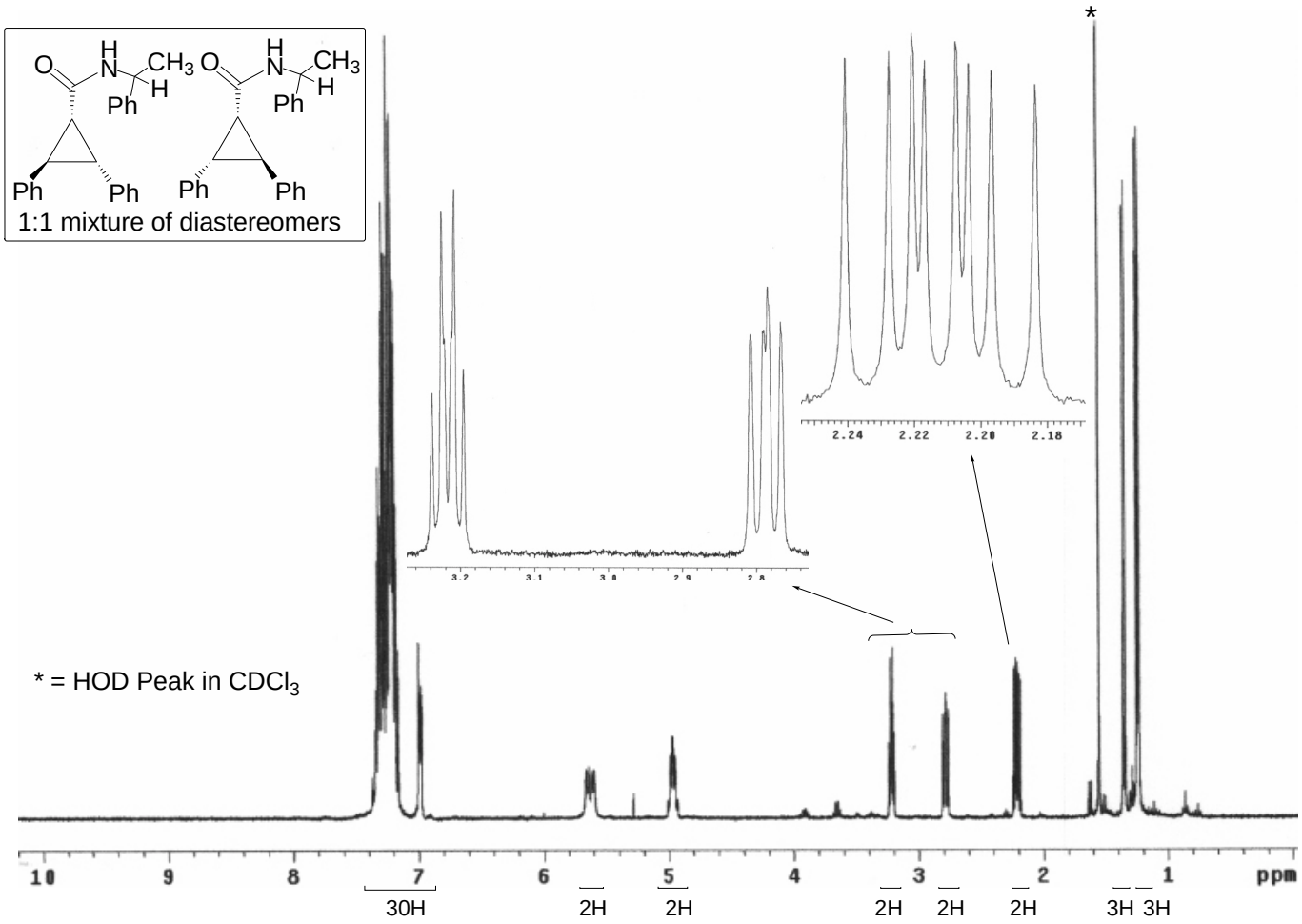
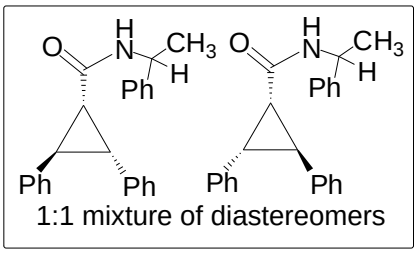
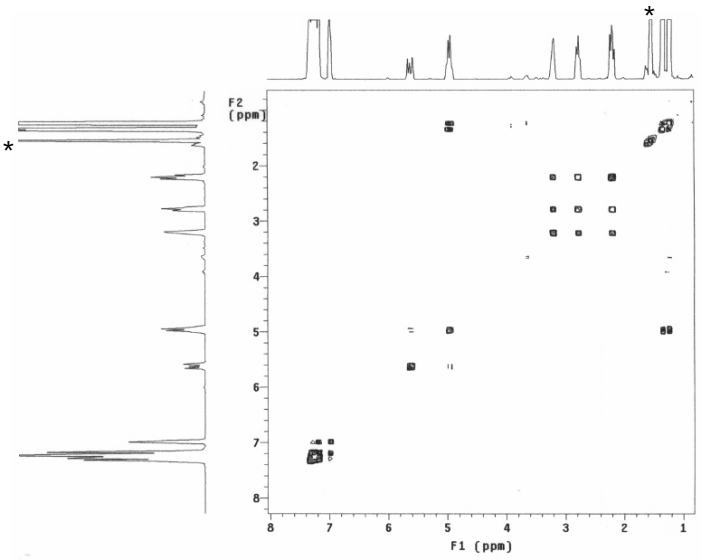
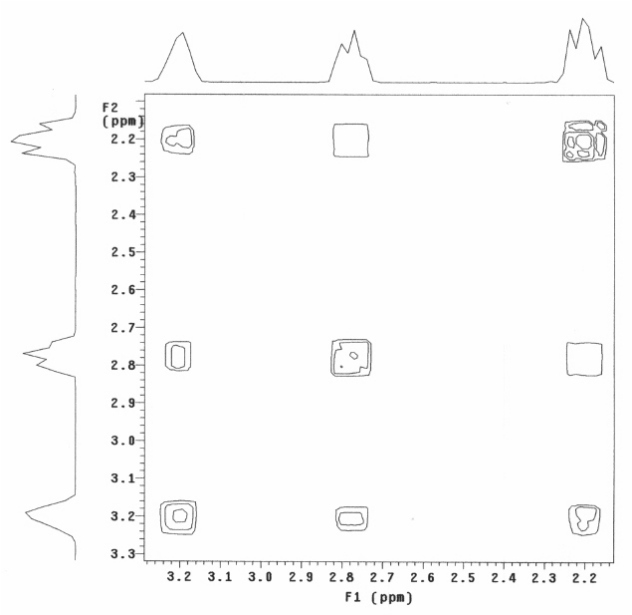


Figure - **13**: ^{1}H-NMR :1-phenylethylamide of (racemic)-2,3-diphenylcyclopropane-1-carboxylic acid



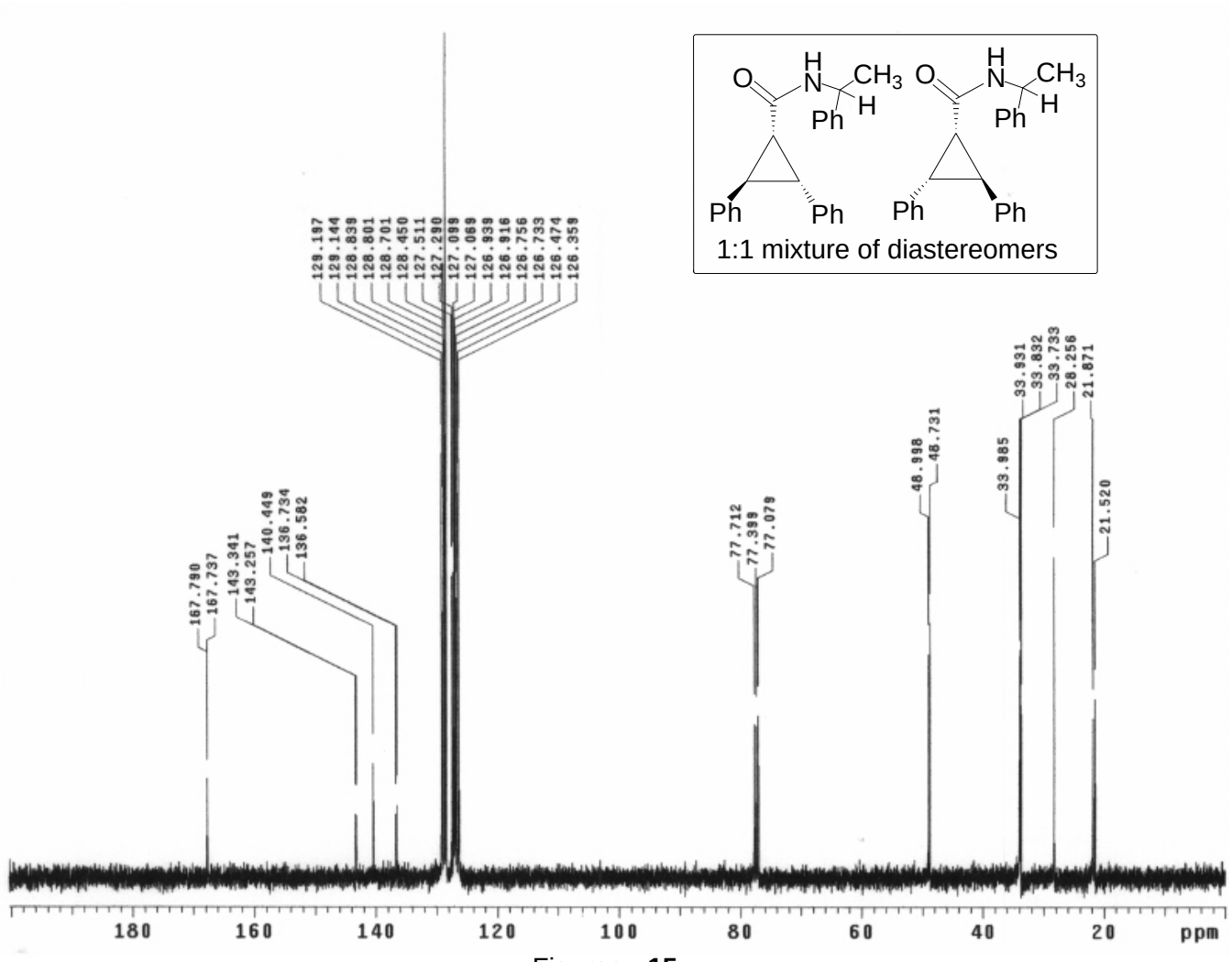


* = HOD Peak in $CDCl_3$



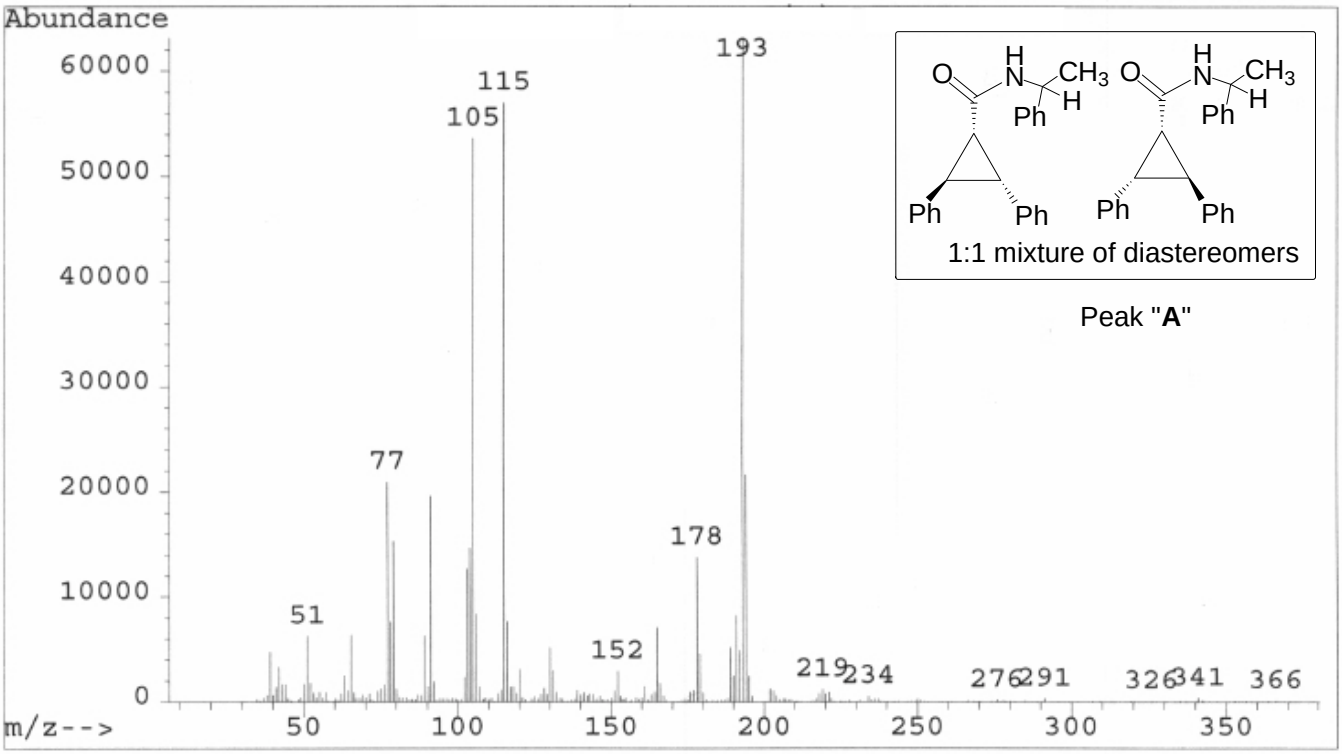
Cross peaks of cyclopropane protons

Figure - **14**: ^{1}H-^{1}H COSY :1-phenylethylamide of (racemic)-2,3-diphenylcyclopropane-1-carboxylic acid



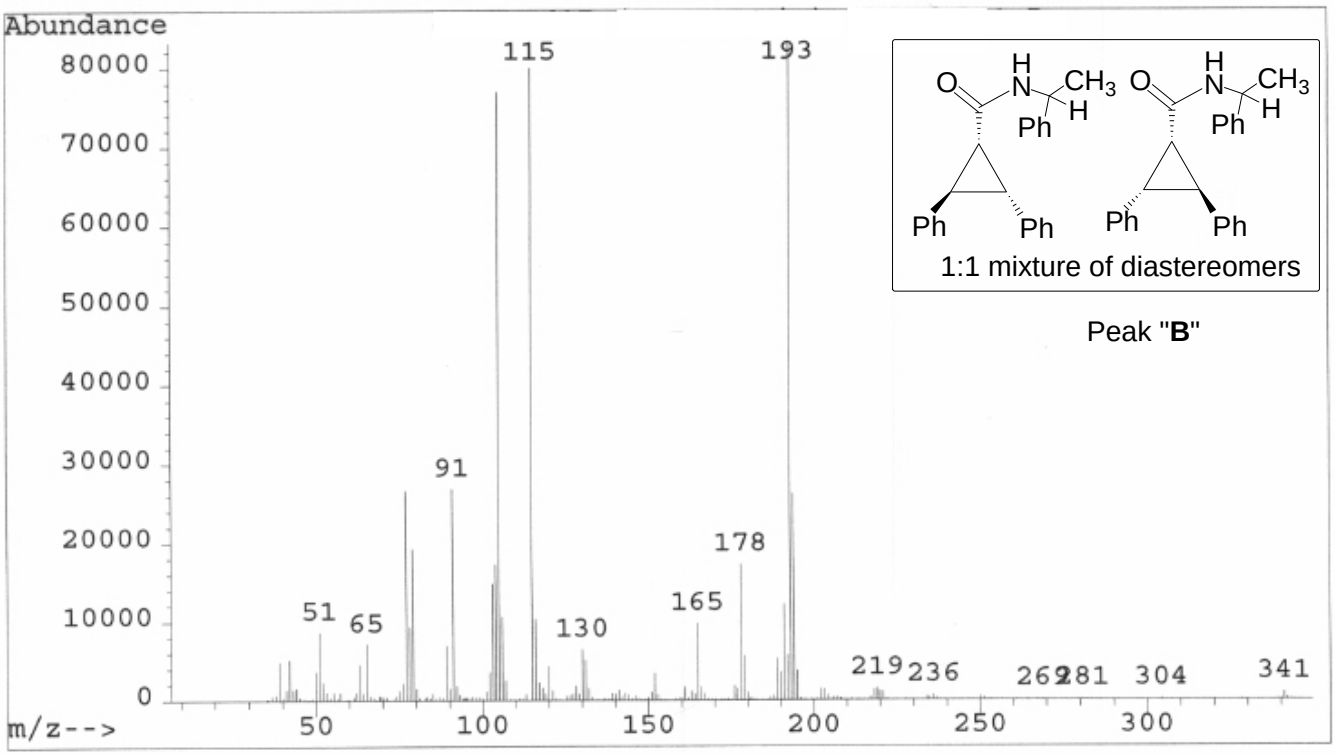
Figuree - **15**:

^{13}C-NMR (CDCl3, 400MHz) 1-phenylethylamide of (racemic)-2,3-diphenylcyclopropane-1-carboxylic acid



Peak "**A**" - The first of the two diasteromeric peaks that elutes out of the GC/MS column (RTX-5 column)

Figure - **16**: GC/MS : 1-phenylethylamide of (racemic)-2,3-diphenylcyclopropane-1-carboxylic acid



Peak "**B**" - The second diasteromeric peak that elutes out of the GC/MS column (RTX-5 column)

Figure - **17**: GC/MS : 1-phenylethylamide of (racemic)-2,3-diphenylcyclopropane-1-carboxylic acid

The chiral auxiliary approach - direct (quartz) irradiation:

Compounds (**1a** - **1j**, 2-3 mg) were dissolved in 0.5 mL of dichloromethane followed by the addition of 15 mL of hexane. MY (M=Li^+, Na^+, and K^+) zeolite (300 mg) activated at 500 ^oC was added with stirring. The slurry was stirred for 12 h, filtered and washed thoroughly with fresh hexane (supernatant was analyzed for the absence of the reactant). The zeolite was dried under

vacuum (2 x 10^{-3} torr) at 60 ^{o}C for 10-12 h. The sample was transferred into a quartz test-tube inside a dry box and fresh anhydrous hexane was added, the test-tube stoppered with a rubber septum and wrapped with parafilm. The slurry was then irradiated (unfiltered output from a 450W medium pressure mercury lamp with a quartz jacket), filtered and washed again with fresh hexane (analysis of the supernatant showed that no products or reactant were present). The reactant and the photoproducts were extracted from the zeolite by stirring with acetonitrile. The extract was concentrated and analyzed by GC (SE-30 column; Shimadzu 17-A Gas Chromatograph; shimadzu CR501 chromatopac integrator).

Characterization of photo-products by comparison of retention times with authentic samples-verification of diastereoselectivity:

The authentic samples were injected in the GC or HPLC and verified with the retention times of the photo-products. Figure-**18** shows the comparison of retention times of the authentic sample and LiY(dry) reaction of the amide **1b**. The retention times confirm the photo-products.

Figure-19a shows photo-products of **1b** injected on a GC (SE-30 column, Shimadzu GC). The de was found to be 83%. The same sample was then analyzed using HPLC after a micro-column (chiralpak AD-RH) and the de was found to be the same (figure-**19b**). This suggests that there are no hidden peaks inside the *trans*- photo-products.

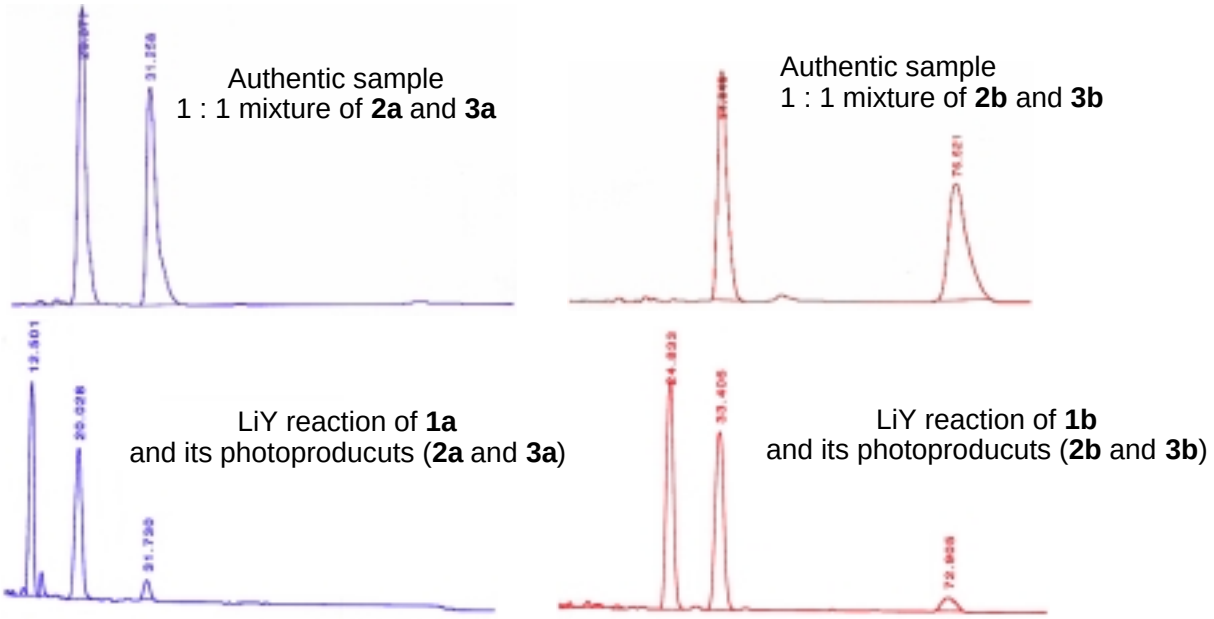


Figure-18: The HPLC trace of the LiY reaction and its authentic sample for verification of its photo-products.

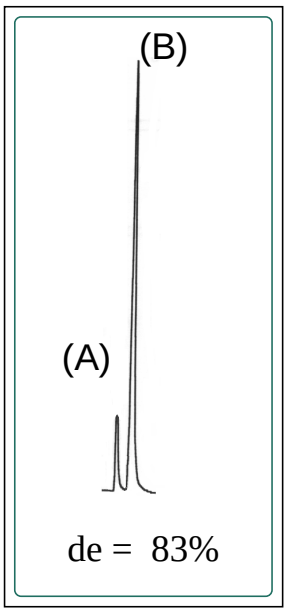
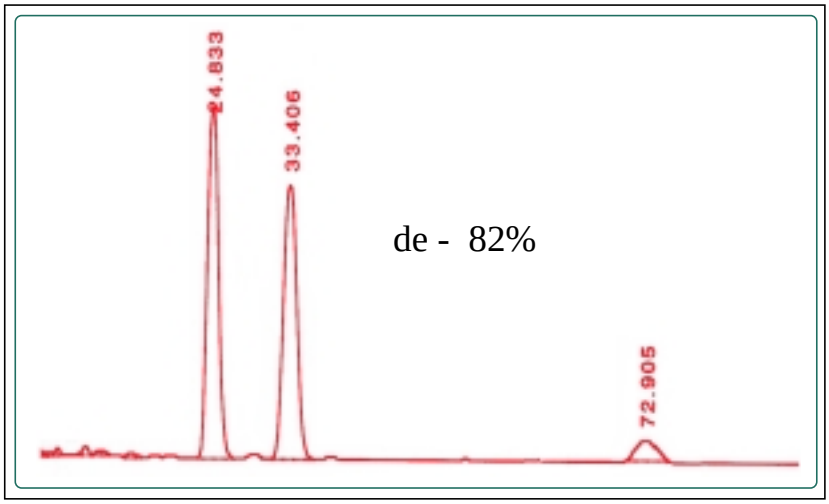


Photo-products **2b** and **2c**

Figure-**19a**



Peak @ 24.833 = compound **1b**
Peak @ 33.406 & 72.905 = photo-products **2b** and **2c**

Figure-**19b**

Figure-19: Analysis of photo-products of **1b** on an achiral stationary phase (SE-30 column - figure-**19a**) and on a chiral stationary phase (Chiralpak AD-RH - figure-**19b**)