Optically Active Aromatic Chromophores. III.[1] A Remote Optically Active Phenyl Ring

Sir:

The question of whether a monosubstituted benzene ring could exhibit optical activity was answered recently by observations of weak Cotton effects in the ORD curves of several benzene derivatives having a phenyl group directly at or one carbon removed from the asymmetric center.[2] The relatively weak Cotton effects observed in the 260-mμ region are associated with the symmetry-forbidden $\pi-\pi^*$ transition of the aromatic ring. Moscowitz and co-workers[2a] pointed out that previous failures to observe aromatic Cotton effects in open-chain benzene derivatives were not a question of kind but of degree of optical activity.

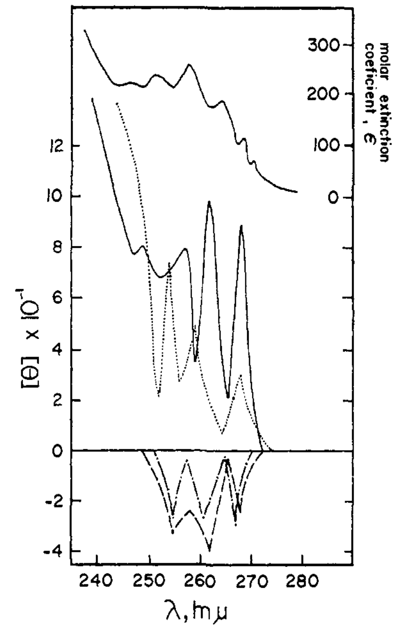
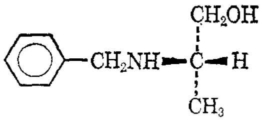


Figure 1. Isotropic absorption spectrum of L-(+)-2-(N-benzylamino)propanol-1, (+)-**1**, in heptane solution. Circular dichroism spectra of (+)-**1**, in ——— heptane, ······ acetonitrile, —·— 0.1 *N* HCl, and - - - - 95% ethanol-5% 0.1 *N* HCl solution.

We wish to present evidence for an optically active monosubstituted benzene ring which is separated from the asymmetric center by two atoms, one of them a heteroatom. In addition, the data bear on the current problem of correlation of absolute configuration with the sign of an appropriate Cotton effect in open-chain systems.

The isotropic absorption spectrum and circular dichroism spectra of L-(+)-2-(N-benzylamino)propanol-1, (+)-**1**, in four solvents are shown in Figure 1.



(+)-1

In all solvents examined[3] a Cotton effect was observed in the CD spectrum in the 260-mμ region, corresponding to a band containing fine structure in the isotropic absorption spectrum. Although this aromatic Cotton effect is quite weak,[4] it is readily discernible in the CD spectrum because of the absence of background effects such as are found in ORD measurements.

The 260-mμ Cotton effect in the CD spectrum of (+)-**1** is positive in the case of the free amine (acetonitrile and heptane solutions) and, as expected, the magnitude is increased on going to the more nonpolar solvent (Figure 1). However, in the case of the hydrochloride the sign of the Cotton effect is inverted.

Introduction of a formal positive charge on nitrogen is not expected to result in inversion of the Cotton effect based on pH-dependence studies of the CD spectra of open-chain amines.[5]

On the basis of CD studies of open-chain systems,[6] the inversion of the aromatic Cotton effect of (+)-**1** is most consistently interpreted as due to a shift in the conformational equilibrium of this freely rotating system upon protonation of the nitrogen atom.[7] The observed Cotton effect is the resultant of the Cotton effects associated with each rotameric species in solution. Every conformation possesses a contribution to the observed Cotton effect which varies in sign and in amplitude from conformer to conformer. Thus, the measured Cotton effect is sensitive to the relative proportions of rotamers present.[8]

The solvent-dependent Cotton effect found in this work illustrates that caution must be used in the important work of correlating absolute configuration with the sign of an appropriate Cotton effect in conformationally mobile systems.

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[1] Part II: L. Verbit, S. Mitsui, and Y. Senda, *Tetrahedron*, 22, 753 (1966).

[2] (a) A. Moscowitz, A. Rosenberg, and A. E. Hansen, *J. Am. Chem. Soc.*, 87, 1813 (1965); (b) L. Verbit, *ibid.*, 87, 1617 (1965); (c) ref 1.

[3] Other solvents used but not reported due to space limitation were water, 1,2-dimethoxyethane, and absolute ethanol. The aromatic Cotton effect in the 260-mμ region was positive in these solvents.

[4] A JASCO Model ORD/UV/CD-5 instrument with a sensitivity of 2×10^{-5} ΔA in the CD mode was used.

[5] L. Verbit and P. J. Heffron, 152nd National Meeting of the American Chemical Society, New York, N. Y., Sept 1966, Abstract C167.

[6] Reference 5, Abstract S169.

[7] An alternative explanation for the observed inversion of sign is the mixing of a nitrogen transition with a transition of the aromatic ring. Such mixing would be much less important in the σ-bonded protonated nitrogen. Variable-temperature and nitrogen-substitution experiments are planned in order to obtain more direct evidence of the origin of the Cotton effect inversion.

[8] W. S. Briggs and C. Djerassi, *Tetrahedron*, 21, 3455 (1965).

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Chemical Shifts of Boron-11 in Icosahedral Carboranes

Sir:

In view of the difficulties in applying the general theory[1] of chemical shifts to large molecules, we have

[1] R. M. Stevens, R. M. Pitzer, and W. N. Lipscomb, *J. Chem. Phys.*, 38, 550 (1963).