

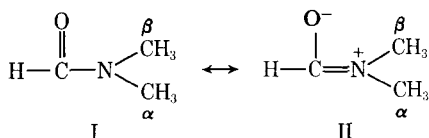
# Conformational Preference in *N,N*-Dimethyl-9-carboxamido-9,10-dimethylacridane Determined by NMR Spectroscopy

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**Abstract** □ The NMR spectrum of *N,N*-dimethyl-9-carboxamido-9,10-dimethylacridane at ambient 41° revealed a chemical shift difference of 42 c.p.s. between the two amide methyl groups. At higher temperatures the peaks of the methyl groups moved toward each other, and finally, at 96° coalesced into a single peak. It was concluded that the amide moiety exists in a preferred conformation whereby the methyl group that is *trans* to the carbonyl oxygen is conformationally oriented over the aromatic system.

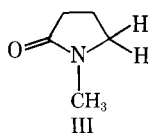
**Keyphrases** □ Conformation preference—*N,N*-dimethyl-9-carboxamido-9,10-dimethylacridane □ Proton resonance spectroscopy—*N,N*-dimethyl-9-carboxamido-9,10-dimethylacridane □ NMR spectroscopy—structure

It is well known that the methyl groups of *N,N*-dimethylformamide (I) are magnetically nonequivalent (1, 2). This has been attributed to the restricted rotation about the C—N bond as a result of the large contribution of II to the actual structure of the molecule.



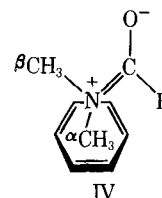
## THEORETICAL

The  $\alpha$ (*trans*)- and  $\beta$ (*cis*)-methyl group resonances at 60 Mc.p.s. occur at 2.95 and 2.80  $\delta$ , respectively, representing a chemical shift difference of about 10 c.p.s. (1). Hatton and Richards (3) on the basis of the difference in the coupling constants between the aldehydic proton and the two methyl groups assigned the higher field peak to the  $\beta$ -methyl group. Further evidence supporting this conclusion is found in the NMR spectrum of 1-methyl-2-pyrrolidone (III) in which unequivocal assignments can be made (4); the methyl group that occurs *cis* to the carbonyl oxygen appears considerably upfield (30 c.p.s.) to the *trans* methylene protons.



Hatton and Richards also studied the effect of different concentrations of solvents on the NMR spectra of dimethylformamide and dimethylacetamide, and found that the addition of aromatic solvents caused the relative chemical shifts of the two amide methyl groups to change sign.<sup>1</sup> This observation was attributed to complex formation between the amide and the aromatic solvents. These complexes may be represented by Structure IV<sup>2</sup> in which the  $\alpha$ -

methyl group is oriented over the center of the aromatic ring. As a result of the diamagnetic anisotropic influence of the ring, the  $\alpha$ -methyl group experiences a shielding effect greater than the  $\beta$ -methyl group which is near the edge of the ring.



The authors have observed a similar shielding effect with *N,N*-dimethyl-9-carboxamido-9,10-dimethylacridane (V). However, in this compound it appears that the diamagnetic anisotropic effect is the result of internal complex formation between the aromatic system and the carboxamido moiety. The spectrum of V at 41° (ambient) exhibits peaks at 7.18  $\delta$  (center of the aromatic multiplet,

8 H); 3.46  $\delta$  (singlet, 10-CH<sub>3</sub>, 3 H); 3.08  $\delta$  (singlet, —C—N—, 3 H);

2.38  $\delta$  (singlet, —C—N—CH<sub>3</sub>); and 1.62  $\delta$  (singlet, 9-CH<sub>3</sub>). The chemical shift difference between the two amide methyl groups amounts to 42 c.p.s. This is rather unusual when one considers that *N,N*-dimethylformamide displays a difference of only 10 c.p.s.<sup>3</sup> Even in the conformationally rigid 1-methyl-2-pyrrolidone (III), the chemical shift difference between the methyl and methylene protons is just 30 c.p.s. (4).<sup>3</sup>

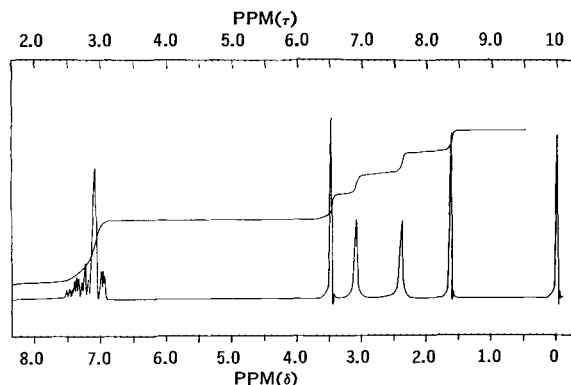
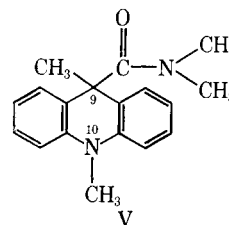


Figure 1—NMR spectrum of *N,N*-dimethyl-9-carboxamido-9,10-dimethylacridane (V) at 41° (ambient).

<sup>1</sup> At room temperature and in the absence of aromatic solvents the  $\alpha$ -methyl group resonance peak is downfield to that of the  $\beta$ -methyl group, but the relative positions of these resonance peaks become reversed in the presence of certain concentrations of aromatic solvents.

<sup>2</sup> Adapted from Hatton and Richards (3).

<sup>3</sup> Recorded at 60 Mc.p.s. in CDCl<sub>3</sub>.

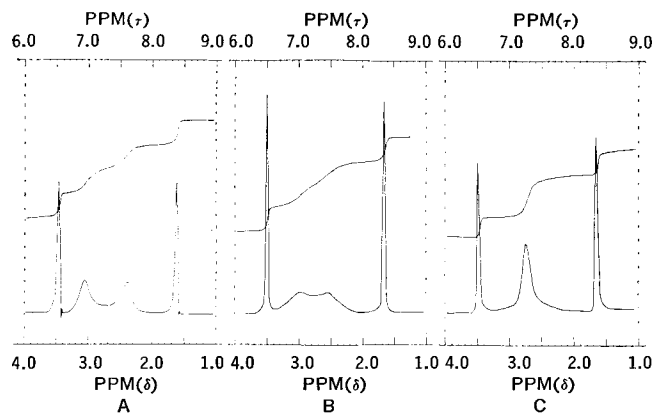


Figure 2—NMR spectrum of *N,N*-dimethyl-9-carboxamido-9,10-dimethylacridane (V) at various temperatures. Key: A, 52°; B, 78°; C, 96°.

In view of the surprisingly large separation of the resonance peaks of the amide methyl groups of V, some doubt existed as to the validity of assigning the peaks at 3.05 and 2.35  $\delta$  to these methyl groups. In order to prove the validity of these assignments it was necessary to record the spectrum of V at various temperatures (Figs. 1 and 2). As expected, the two inner peaks broadened with an increase in temperature, and at 96° they coalesced into a single peak, behavior which is analogous to that of *N,N*-dimethylformamide at elevated temperatures (1, 2). This phenomenon may be attributed to the effect of temperature on the rate of rotation about the C—N bond. As the temperature increases the rate of rotation also increases, and the differences in the chemical environments of the two methyl groups begin to average out, until finally, a rate is reached at which the methyl groups become magnetically equivalent.

The question now arises as to the reason for the wide separation of these peaks. Note that one methyl peak (Fig. 1) occurs about 30 c.p.s. upfield from the mean position (2.93, 175.8 c.p.s.) of the methyl peaks in dimethylformamide (5); whereas the other methyl peak is only 12 c.p.s. downfield from this position. This spacing strongly suggests that one of the methyl groups of V is conformationally oriented over the aromatic system and, consequently, is highly shielded by the diamagnetic anisotropic effect of both rings. Inspection of molecular models shows that only the  $\alpha$ -methyl (*trans*) group can be so oriented. This situation is analogous to the effect described earlier in this paper of aromatic solvents on the

relative positions of the methyl peaks in dimethylformamide and dimethylacetamide. Like IV, the  $\alpha$ -methyl group is located in the shielding portion of the induced currents of the rings. This strong shielding influence of both rings causes the resonance peak of the  $\alpha$ -methyl group to shift upfield to that of the  $\beta$ -methyl group.

## EXPERIMENTAL

*N,N*-Dimethyl-9-carboxamido-9,10-dimethylacridane was synthesized according to the procedure of Digenis (6).

The proton resonance spectra were obtained on a NMR spectrometer (Varian A-60A) by using 10% deuteriochloroform solutions in sealed tubes. Chemical shifts are reported as  $\delta$  using TMS as internal standard.

Temperatures were calibrated with ethylene glycol according to established procedures (7).

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