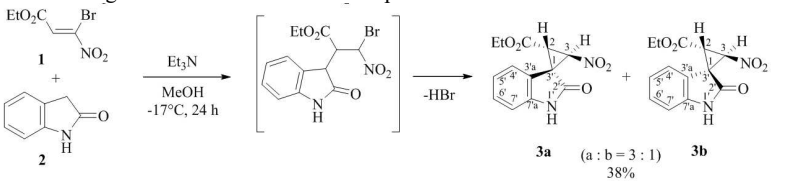
Determination of the spirocyclopropanoxindole fine structure using NMR spectroscopy

Mikhalap M. V., Pelipko V. V., Gomonov K. A., Makarenko S. V.
Herzen State Pedagogical University of Russia, Laboratory of nitro compounds, Center of collective use at the Faculty of Chemistry "Instrumental methods for the study of nitro compounds, coordination, biologically active substances and nanostructured substances" 48 Moyka River Embankment, Saint Petersburg 191186, Russia
E-mail: kohrgpu@yandex.ru

Alkyl 3-bromo-3-nitroacrylates, as Michael acceptors, form carbo- and heterocyclic structures in reactions with CH-acids [1, 2]. A study of the interaction of ethyl 3-bromo-3-nitroacrylate **1** with 1,3-dihydro-2*H*-indol-2-one 2 showed that the reaction ends with the formation of a mixture of regioisomeric spirocyclopropaneoxindoles 3a, b, which is reflected by a double set of signals in the ^{1}H and ^{13}C NMR spectra.



The rigidly fixed structure of these spirocyclopropaneoxindoles 3a, b makes them interesting objects for structural studies using 2D NMR spectroscopy experiments.

In the ^{1}H NMR spectrum of the mixture of spirocyclopropaneoxindoles 3a, b (Fig. 1), the H^{2} protons signals appear as doublets at 3.85 (a), 3.78 (b) ppm, and the H^{3} protons signals appear as doublets at 5.32 (a), 5.30 (b) ppm. In turn, the signals of the amino groups ($H^{1'}$) protons appear as broadened singlets at 8.73 (a), 8.95 (b) ppm. The vicinal *J*-coupling between methine protons of the cyclopropane ring observed in the ^{1}H NMR spectrum $^{3}JH^{2}H^{3}$ = 6.07 (a), 6.14 (b) Hz indicates their *trans*-configuration, which is consistent with the literature data [3].

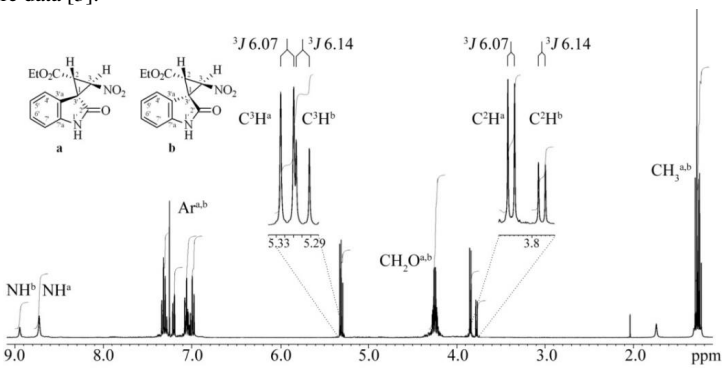


*Figure 1. ^{1}H NMR spectrum of isomers **3a, b** ($CDCl_3$)*

This assignment of signals in the ^{1}H NMR spectrum is confirmed by the results of the study these substances by the ^{1}H-^{1}H NOESY NMR method. The results of ^{1}H-^{1}H NOESY

(obtained with a variable value mix. time) of the isomer mixture, demonstrate NOE correlations of the protons $C^2H/C^{4'}H$ for isomer a and $C^3H/C^{4'}H$ for isomer b (Fig. 2).

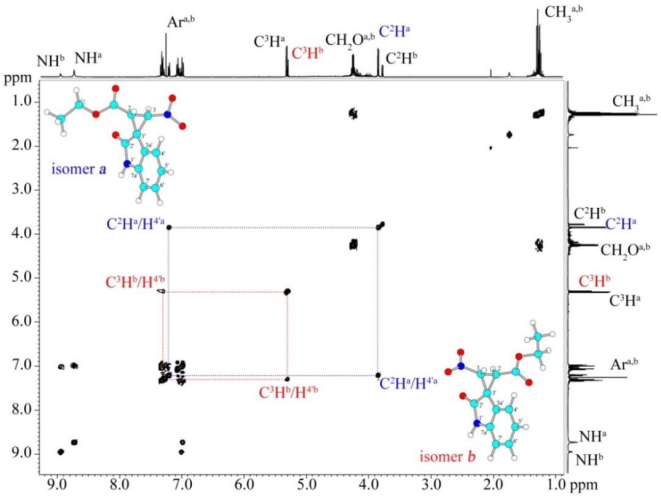


*Figure 2. ^1H-^1H NOESY spectrum of isomers **3a, b** ($CDCl_3$) with their models*

The assignment of signals in the ^{13}C NMR spectra for both isomers was carried out on the results of the ^1H-^{13}C HMQC and ^1H-^{13}C HMBC NMR experiments. Unprotonated carbon atoms were assigned based on ^1H-^{13}C HMBC NMR experiment. Thus, spectrum of the mixture of two isomers 3a, b showed cross-peaks between protons H^3, H^2, $H^{5'}$, $H^{1'}$ and carbon atom $C^{3a'}$ (121.7 (a), 122.6 (b) ppm), protons $H^{4'}$, $H^{6'}$, $H^{1'}$ and carbon atom $C^{7a'}$ (141.9 (a), 141.7 (b) ppm), proton $H^{1'}$ with spiro carbon $C^{3'}$ (40.0 (a), 39.2 (b) ppm). Cross peaks of methylene protons with the ester carbonyl carbon atom (163.4 (a), 165.0 (b) ppm) are also observed.

Thus, based on the 2D NMR spectroscopy experiments results, the fine structure of two isomers of spirocyclopropaneoxindoles was determined, and the signals of their protons and carbon atoms were assigned.

The studies were carried out in the Center of collective use at the Faculty of Chemistry of the Herzen State Pedagogical University of Russia on the Jeol ECX-400A spectrometer (Royal Probe) at 399.78 (^1H) and 100.53 (^{13}C) MHz with standard experimental settings. The residual signals of a non-deuterated solvent (for ^1H nuclei) or the signals of a deuterated solvent (for ^{13}C nuclei) were used as a standard.

References

1. V. V. Pelipko, R. I. Baichurin, K. A. Lyssenko, E. V. Kondrashov, S. V. Makarenko – Mendeleev Commun., 33, 451-454 (2023).
2. V. V. Pelipko, R. I. Baichurin, K. A. Lyssenko, V. V. Dotsenko, S. V. Makarenko – Mendeleev Commun., 32, 454-456 (2022).
3. A. J. Gordon, R. A. Ford. The Chemist's Companion. New York: Wiley, 1972.