STRUCTURE-PROPERTY RELATIONSHIP IN SUBSTITUTED BENZENES: MULTIFIDELITY METHODS TO QUANTIFY AND UNDERSTAND INTERACTIONS AMONG SUBSTITUENTS ON THE BENZENE RING

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Derivatives of benzene bearing electron-withdrawing or electron attracting substituents occupy a prominent position in synthetic organic chemistry, food chemistry, pharmaceutical science, energetic materials research, and, ultimately, in chemical thermodynamics [1]. A classical challenge in physical organic chemistry is the quantitative assessment of steric versus electronic interactions between neighboring groups in aromatic systems or the effect of the introduction of one or more groups into the aromatic ring as both can significantly alter its properties [2]. Whereas electron-donating groups make the benzene ring more reactive towards electrophilic aromatic substitution, while electron-withdrawing groups make it less reactive [3], being the extent of reactivity be assessed by determining their thermodynamic parameters.

A comprehensive study of the thermodynamic properties of methyl-, mono- and dinitro-substituted benzoic acids was carried out using various methods: thermogravimetry (under both isothermal and non-isothermal conditions), differential scanning calorimetry, combustion calorimetry, and transpiration method. In addition, complementary quantum chemical (high-fidelity) and empirical (low-fidelity) methods were employed to cross-validate the results obtained. This multifidelity approach is essential for the benchmarking of thermodynamic properties.

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