A new, fast method to estimate sublimation entropy and dissociation constants from molecular crystal data

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One of the main problems in prediction of binding free energy (or dissociation constants) consists in a correct evaluation of binding entropy. Such an evaluation can be done from molecular dynamics, but this requires a huge computational time. We have developed an alternative approach which allows a fast calculation of the binding entropy. This approach is based on an evaluation of the mean range of those molecular movements that are restricted in the bound molecule, but are not restricted in its "free" state. As a model, we considered the reversible dissociation of small organic molecules from their molecular crystals to vapor, which allows us to calculate and compare with experiment their sublimation entropies and then their dissociation constants. The range of the movements of molecules in the bound (in-crystal) state can be calculated from known geometrical parameters of the molecules and experimental data on the pressure of their saturated vapor and their sublimation enthalpy. At first, we have calculated the range of movements in individual crystals, and then the averaged range was used for calculation of sublimation entropies and, combined with the rapidly obtainable binding enthalpies, for calculation of dissociation constants. The results of these calculations are in close agreement with the corresponding experimental values. This work has been supported by the Russian Science Foundation Grant No. 14-24-00157.