Supplementary Information for "Soft-Core Potentials in Thermodynamic Integration. Comparing One- and Two-Step Transformations"

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The autocorrelation function ($R(t)$) of $dV/d\lambda$ was defined as,

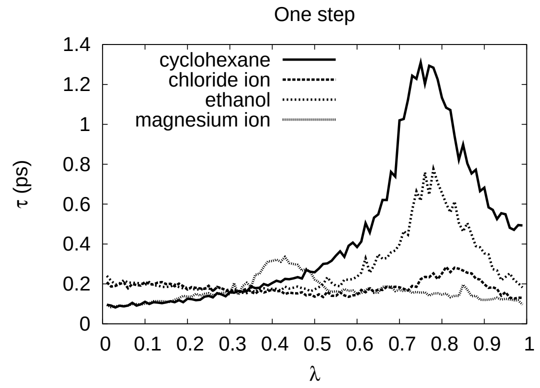
$$R(t) = \frac{1}{n-t}\sum_{i=1}^{n-t}[(dV/d\lambda)_i - < dV/d\lambda >] \cdot [(dV/d\lambda)_{i+t} - < dV/d\lambda >].$$

The time step is discrete and the gap between time steps was 0.002 ps. $R(t)$ was evaluated for continuous data points over the length of the simulation. Using $R(t)$, the correlation time(τ) of $dV/d\lambda$ was estimated using:

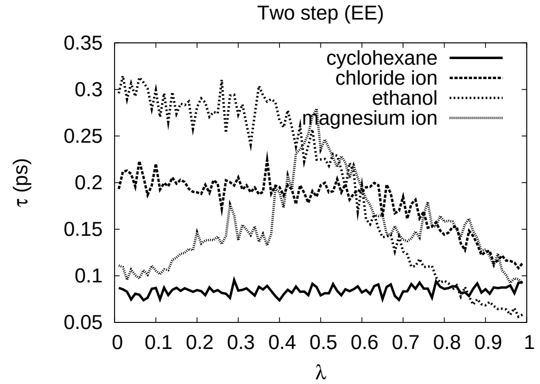
$$\tau = \int_0^\infty R(t)/R(0)dt \simeq \int_0^{1\mathrm{ps}} R(t)/R(0)dt + \int_{1\mathrm{ps}}^\infty e^{-t/\tau}dt = \int_0^{1\mathrm{ps}} R(t)/R(0)dt + \tau e^{-(1\mathrm{ps})/\tau}$$

Practically, the integration of $R(t)/R(0)$ was divided into two terms because we conservatively estimated that $R(t)$ would be reliable up to about one-thousandth of the full length of the data set. Beyond the cutoff time, $R(t)/R(0)$ was modelled as an single-decaying exponential function. The first term of the two was evaluated by numerical integration. The second term typically contributed little to τ. The results are shown in Figure 1.

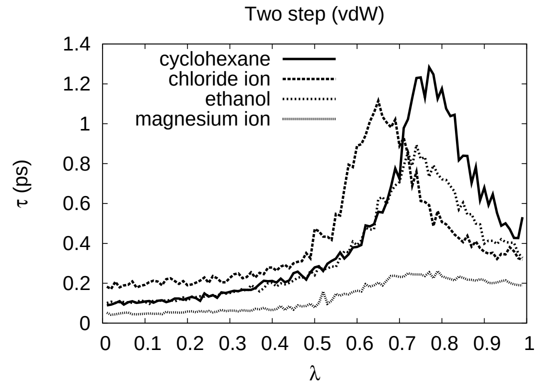
Figure 2 to 6 show free energies of solvation (ΔG^0_{Solv}), errors of the energies (σ_{SEM}) and curvature-values for the five test molecules. Results for all explored parameter variations of α_{LJ}, $\beta_C^{1/m}$ and m are displayed. From plots of these types usable parameter combination for new molecules could be determined, but such an assignment would not always be easy, as the plots show that even for simple molecules the relationship between the parameters and the estimated errors are very non-linear. Table 3 of the main text summarizes these data. Unit of energy is kcal/mol.



(a) One-step method



(b) Two-step method (electrostatic)



(c) Two-step method (vdw)

Figure 1: Dependency of the correlation time of $dV/d\lambda(\tau)$ on the coupling parameter thermodynamic integration λ. Optimal soft-core parameters as described in the main text were used in each case.

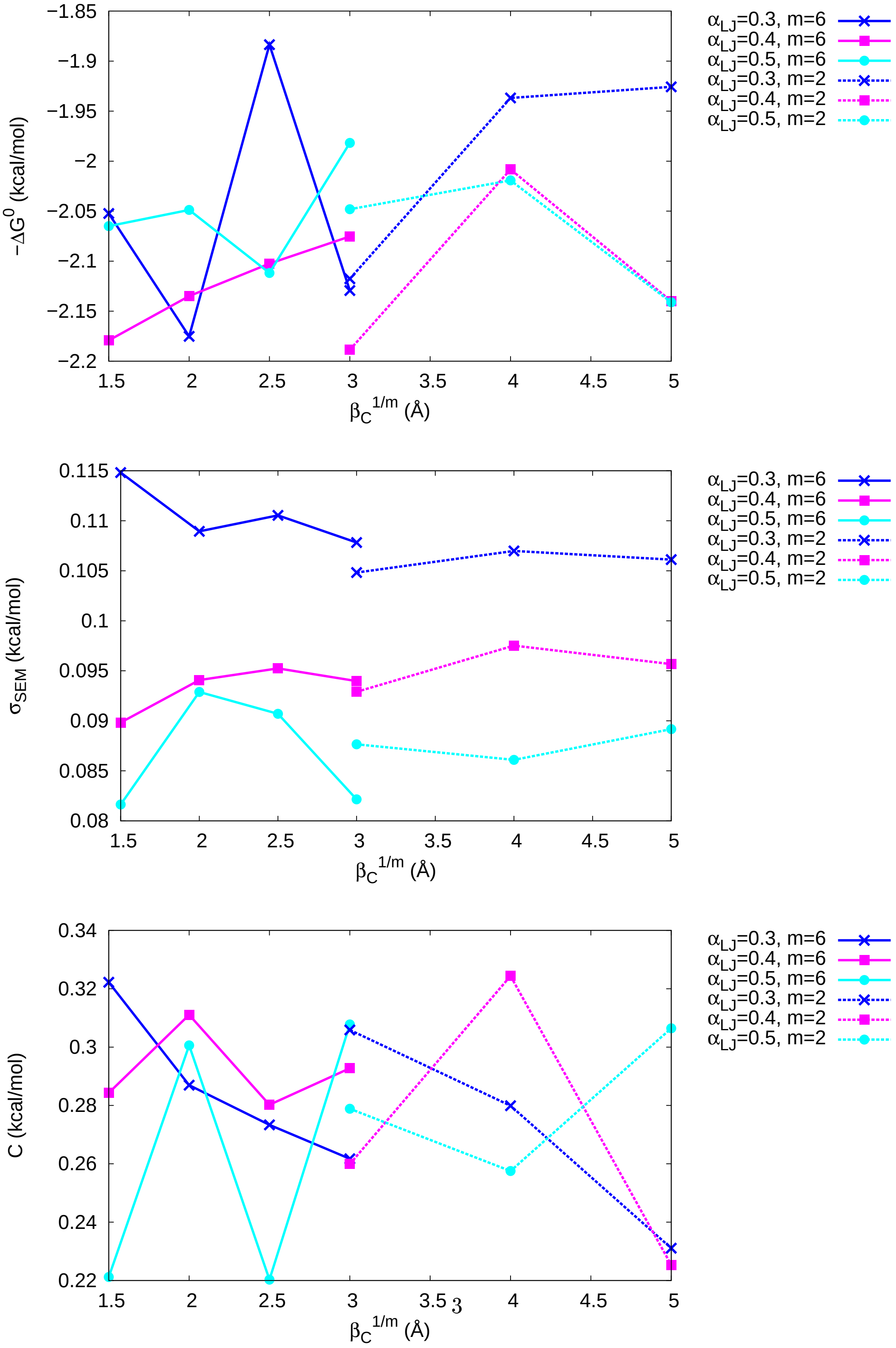


Figure 2: cyclohexane

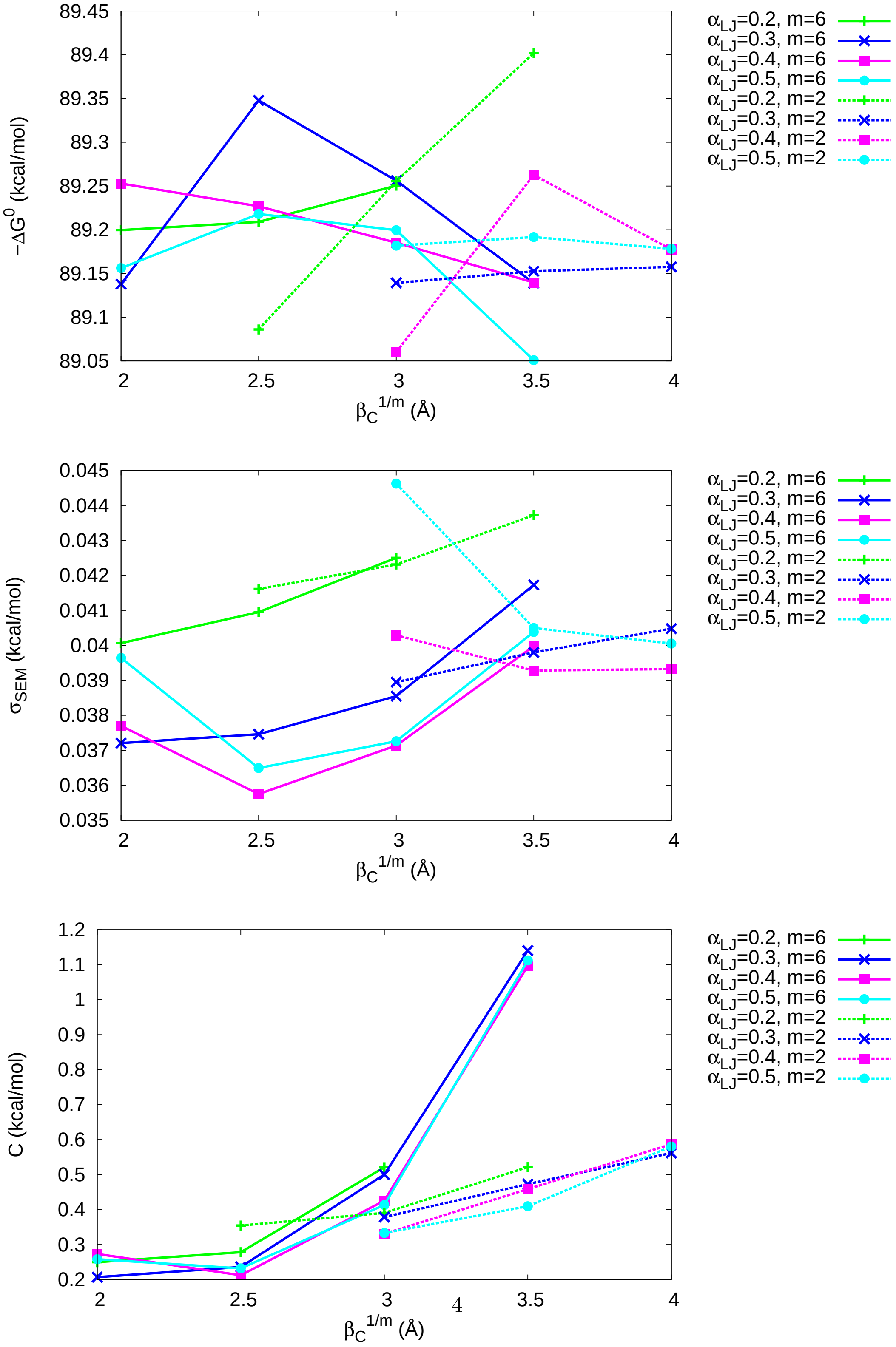


Figure 3: a chloride ion

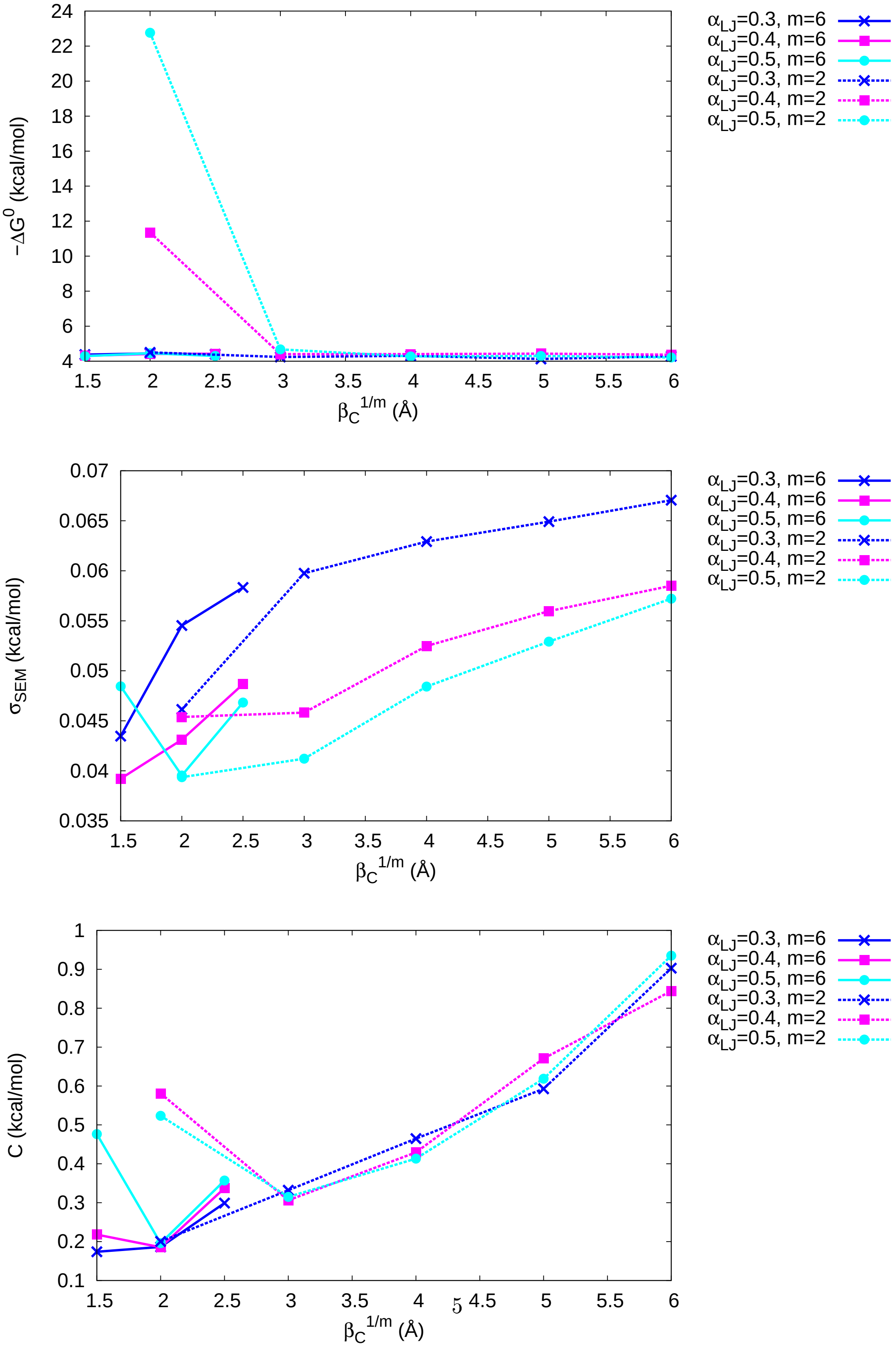


Figure 4: ethanol

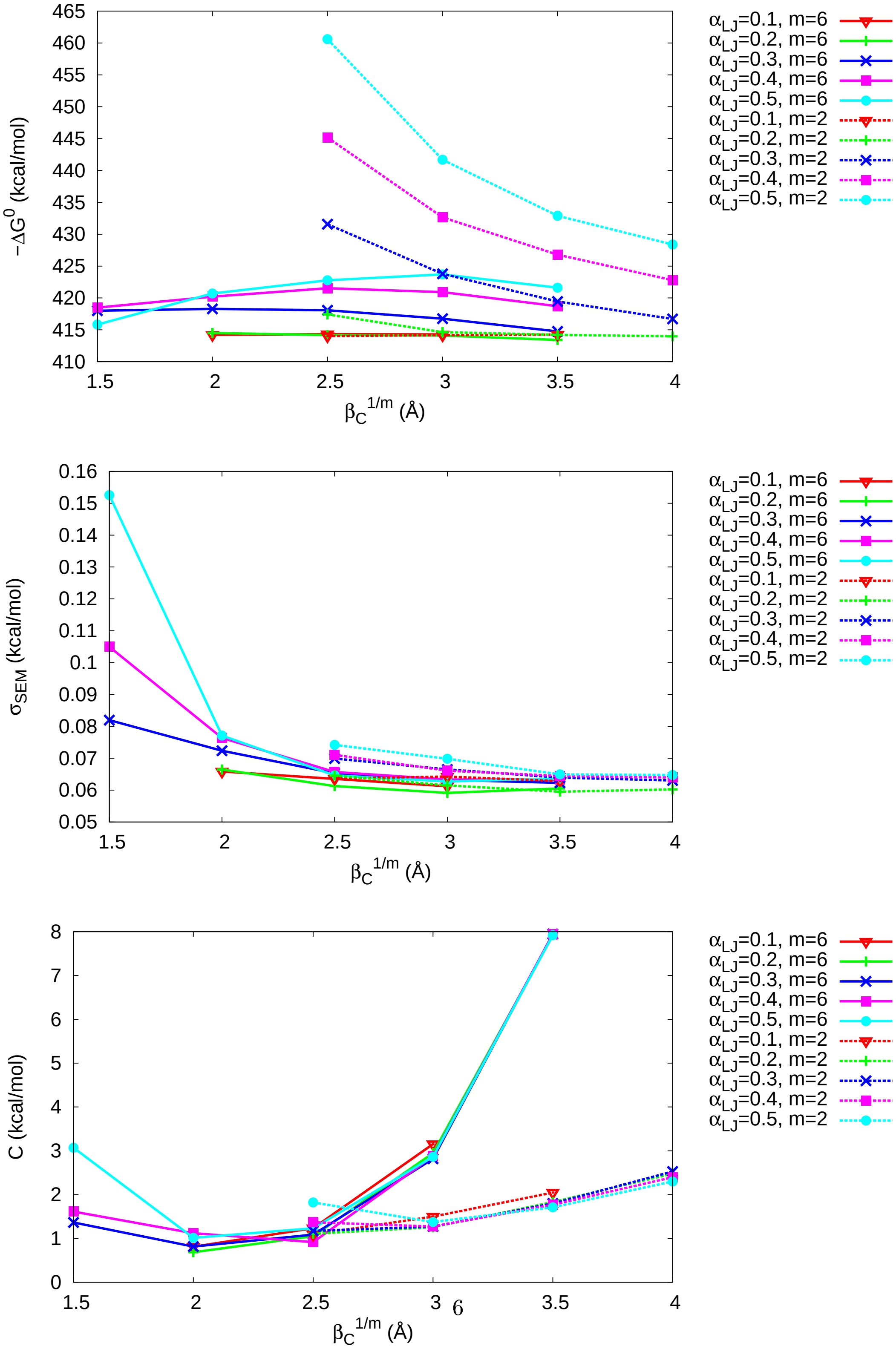


Figure 5: a magnesium ion

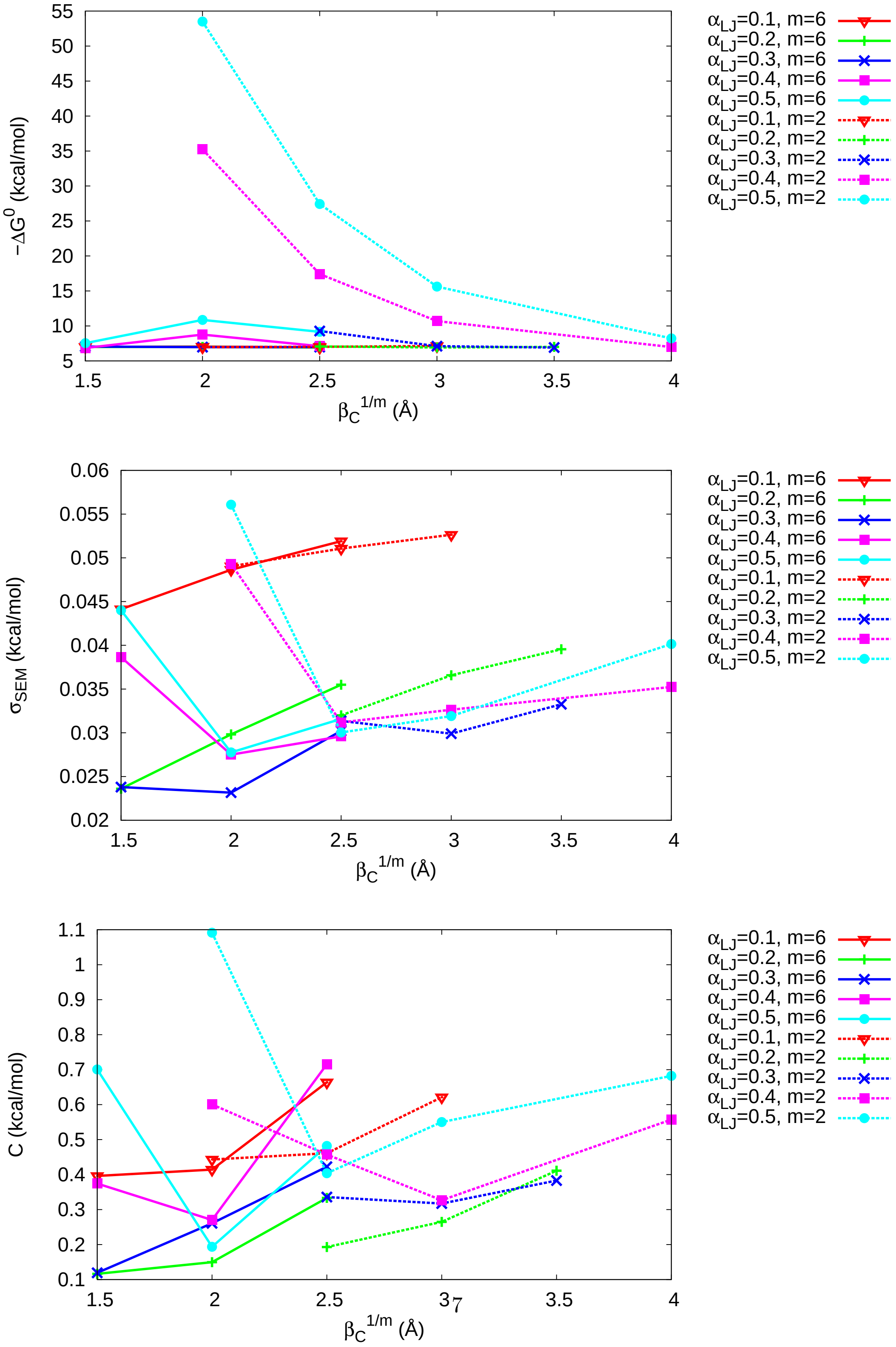


Figure 6: water