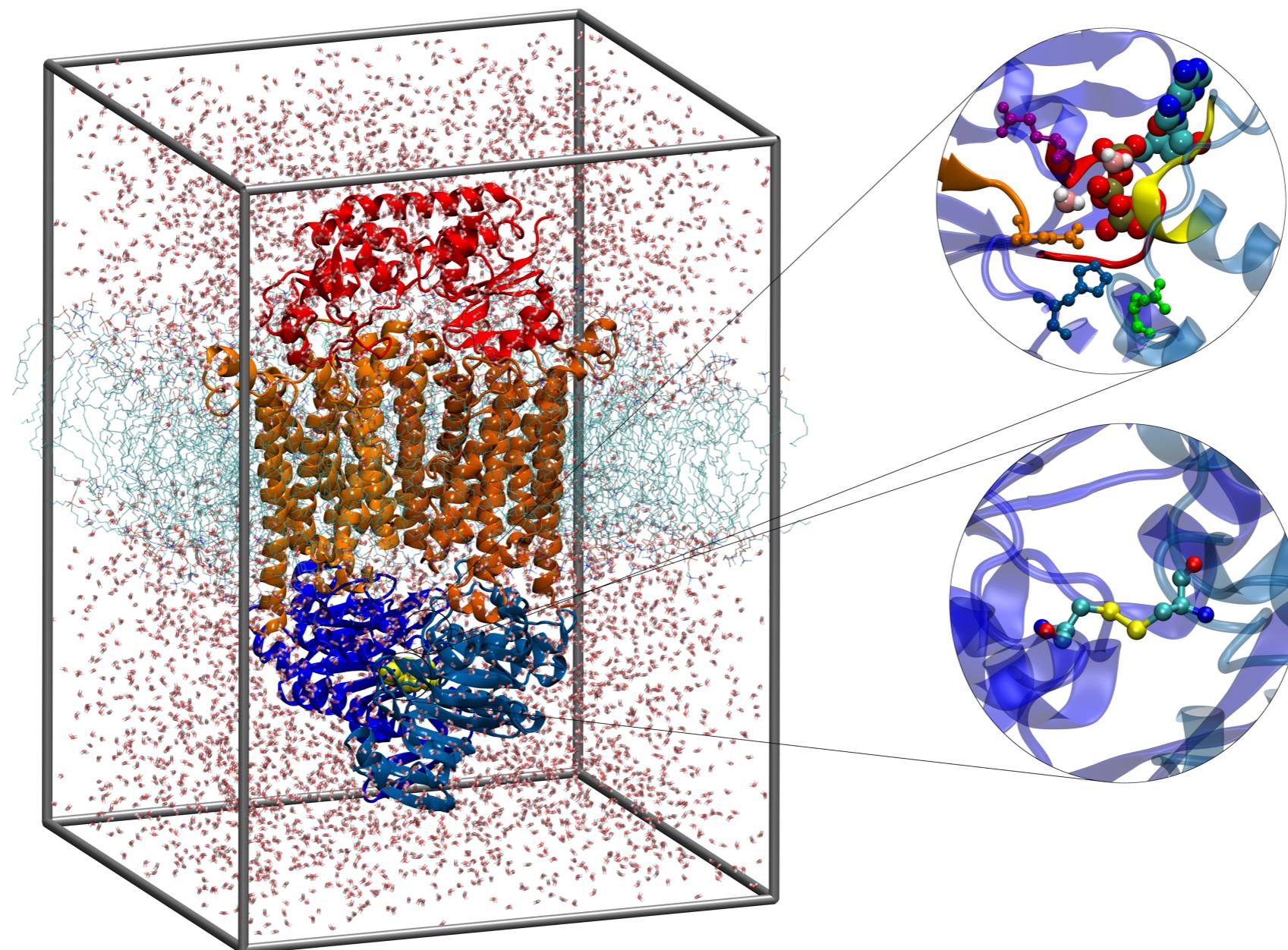


Free Energy Calculations of ATP hydrolysis in BtuCD-F via Thermodynamic Integration (TI)

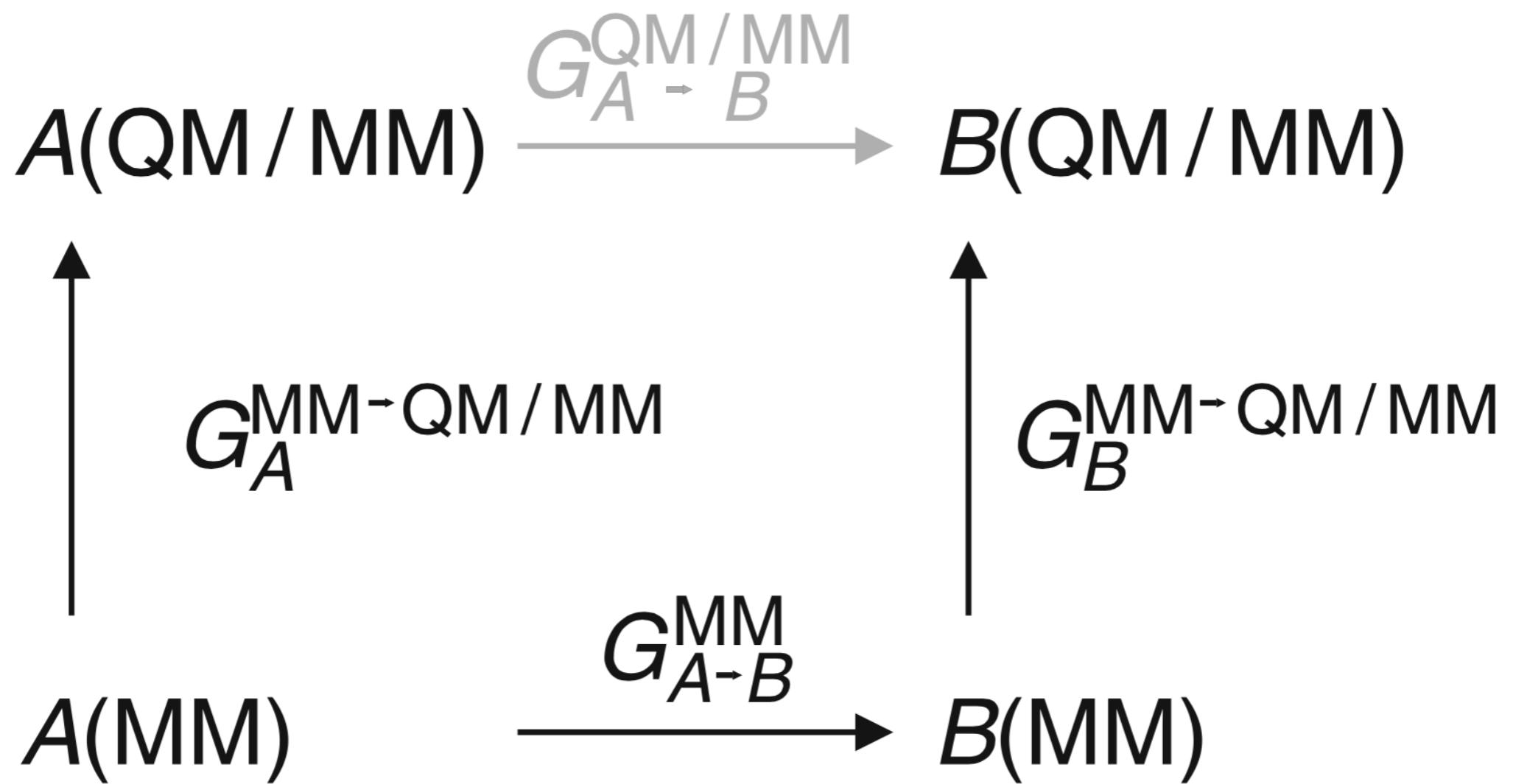
Marten Priess
Theoretical Chemistry
Ruhr University Bochum

The System: BtuCD-F

ATP binding cassette (ABC) transporter of *E.coli*



Free Energy Calculations Using the Thermodynamic Cycle

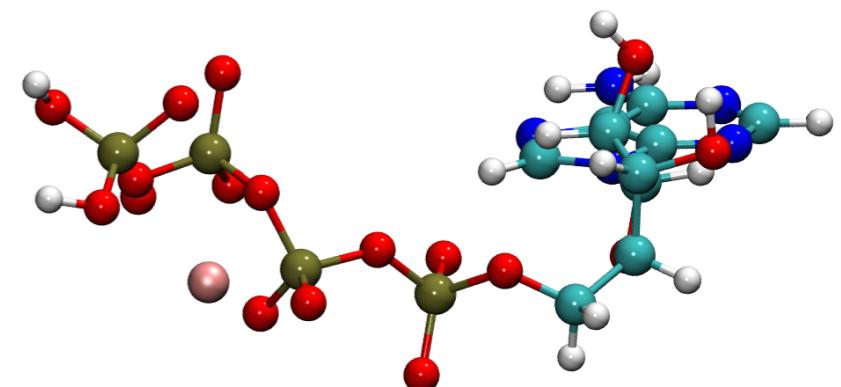


Adapted from: Gerrit Groenhof, *Introduction to QM/MM Simulations*

Getting ΔG_{A-B}^{MM}

- choose reaction coordinate: disappear of PO₃ group and appearing of H₂PO₄
- A state: ATP + H₂O , B state: ADP + H₂PO₄
- Choose certain points along reaction coordinate and sample
- Determine the free energy difference via

$$\Delta G_{A-B}^{MM} = \int_{\lambda=0}^{\lambda=1} \left\langle \frac{dH}{d\lambda} \right\rangle d\lambda$$

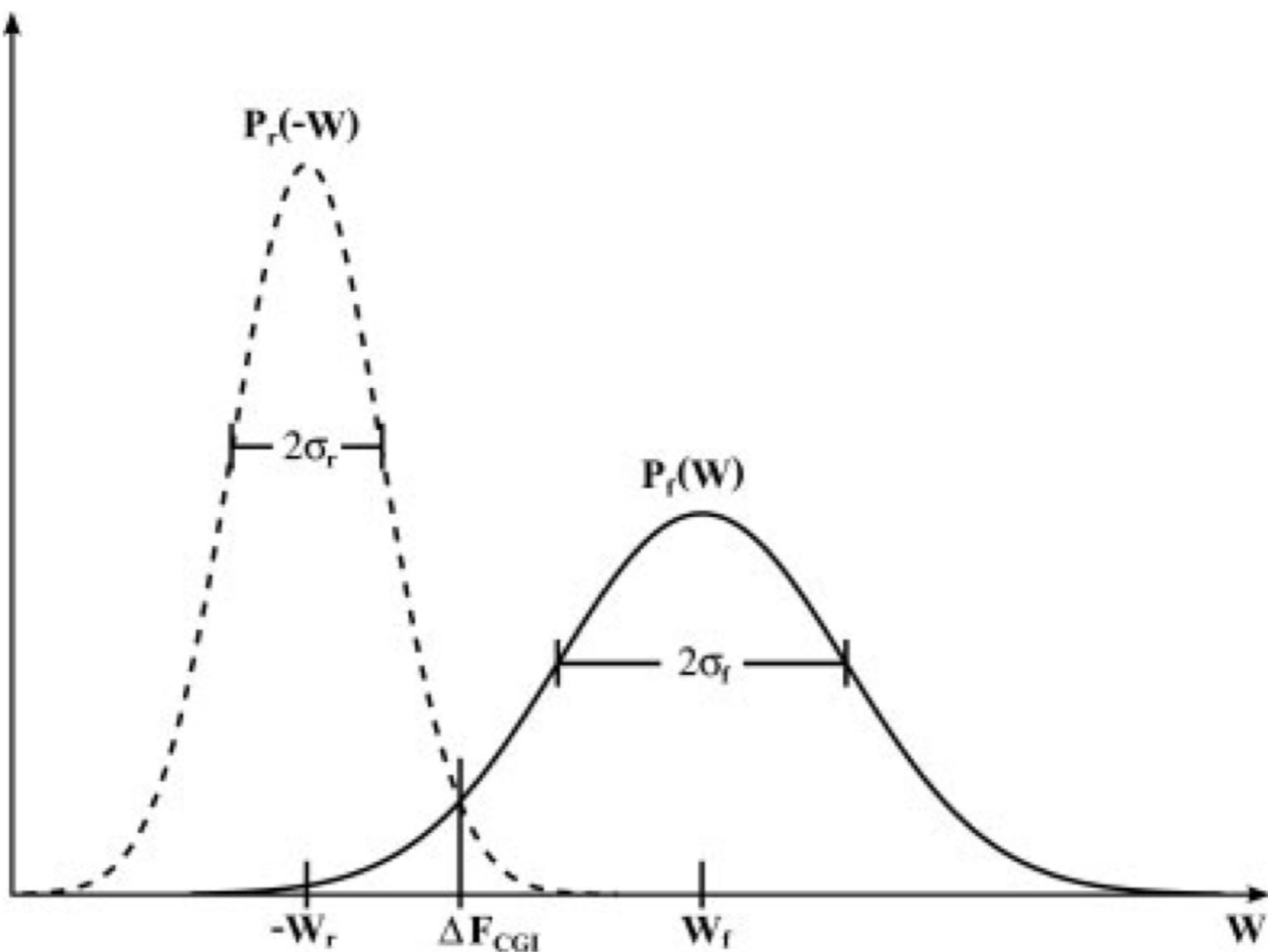


Getting $\Delta G_A^{MM \rightarrow QM-MM}$

- One can show that the free energy difference of bringing the A system from the MM description to the QM description is given by:

$$\Delta G_A^{MM \rightarrow QM-MM} = -\frac{1}{\beta} \ln \langle e^{-\beta \cdot (E_{QM-MM} - E_{MM})} \rangle$$

Future perspective: Crooks Gaussian Intersection (CGI) method with QM/MM simulations



Adapted from: Goette, Maik, and Helmut Grubmüller. "Journal of computational chemistry 30.3 (2009): 447-456.

Thank you very much!

Special thanks to Gerrit Groenhof