Topics for bachelor thesis
Summer semester 2015

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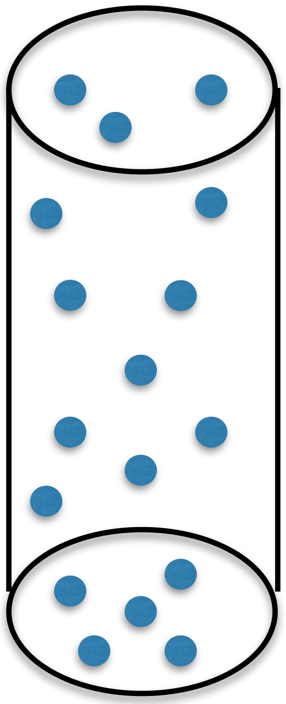
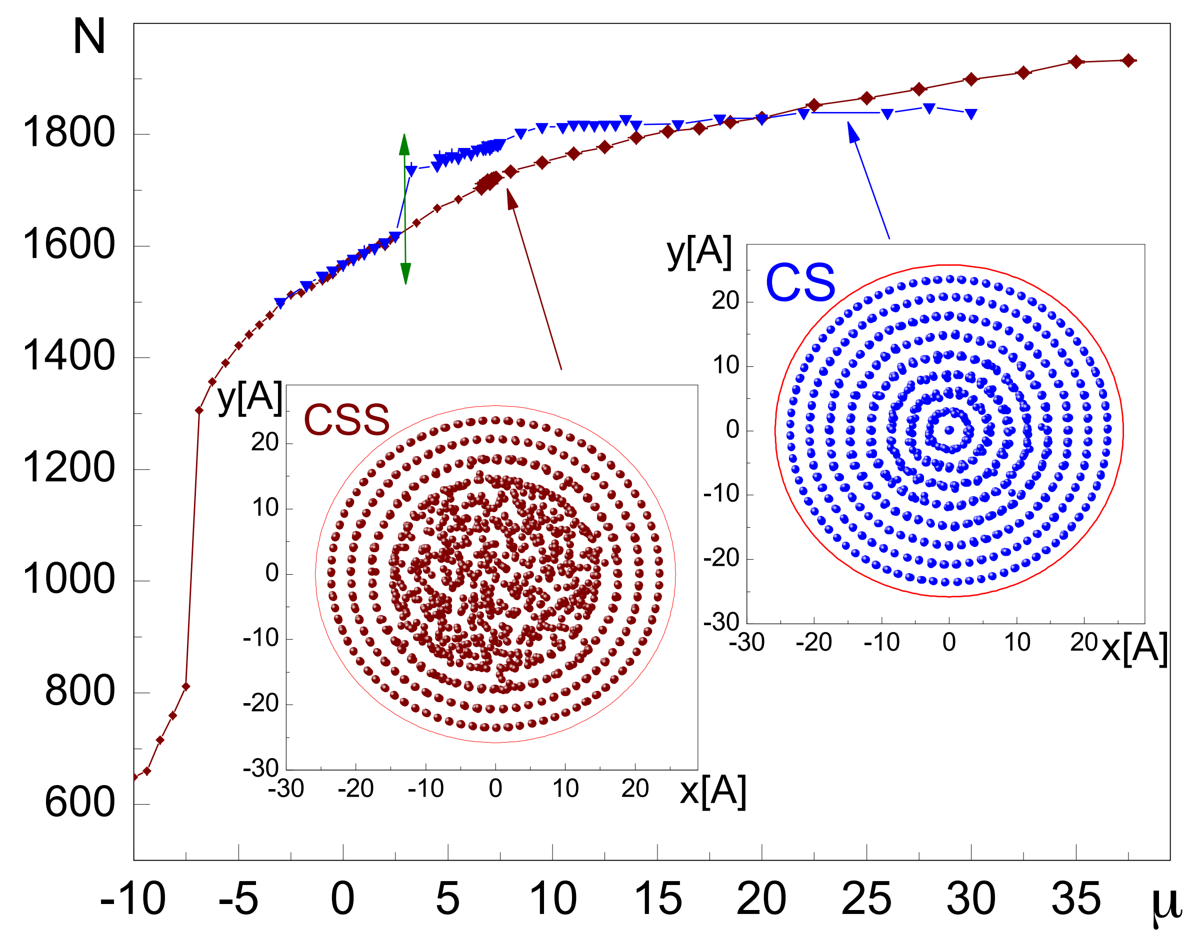
Topic nr 1: classical analysis of Helium in a nanopore





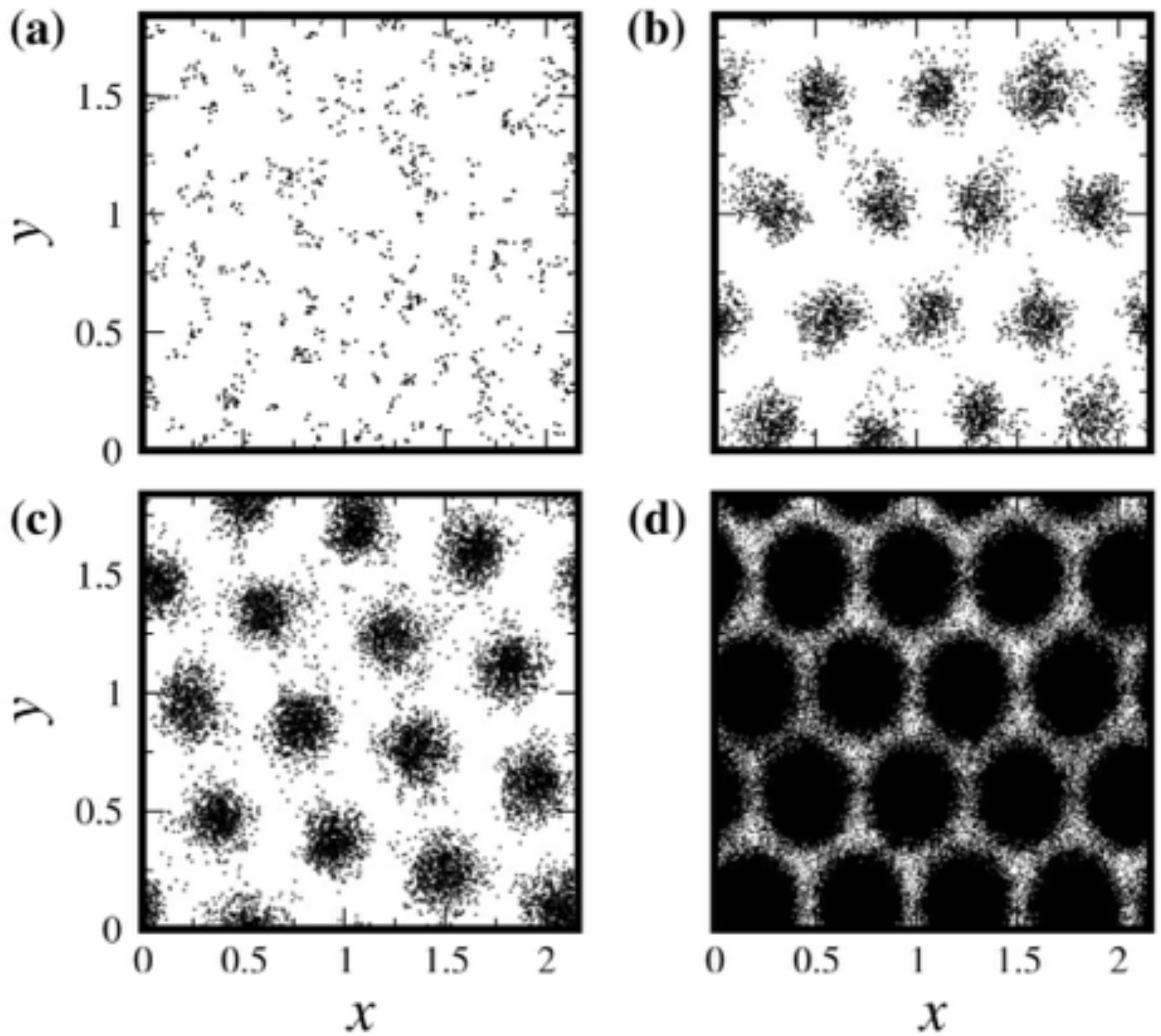
crucial for understanding: topological defect (disclination with Frank index n=1)

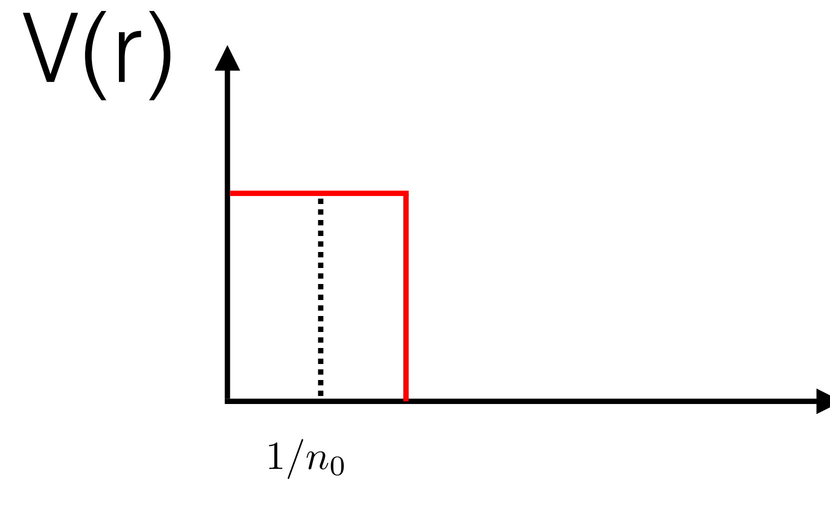
can this be understood at the classical level?

Ref: Lode Pollet and Anatoly B. Kuklov Phys. Rev. Lett. 113, 045301 (2014)

contact person: Tobias Pfeffer

Topic nr 2: Gross-Pitaevskii equation with finite range potential



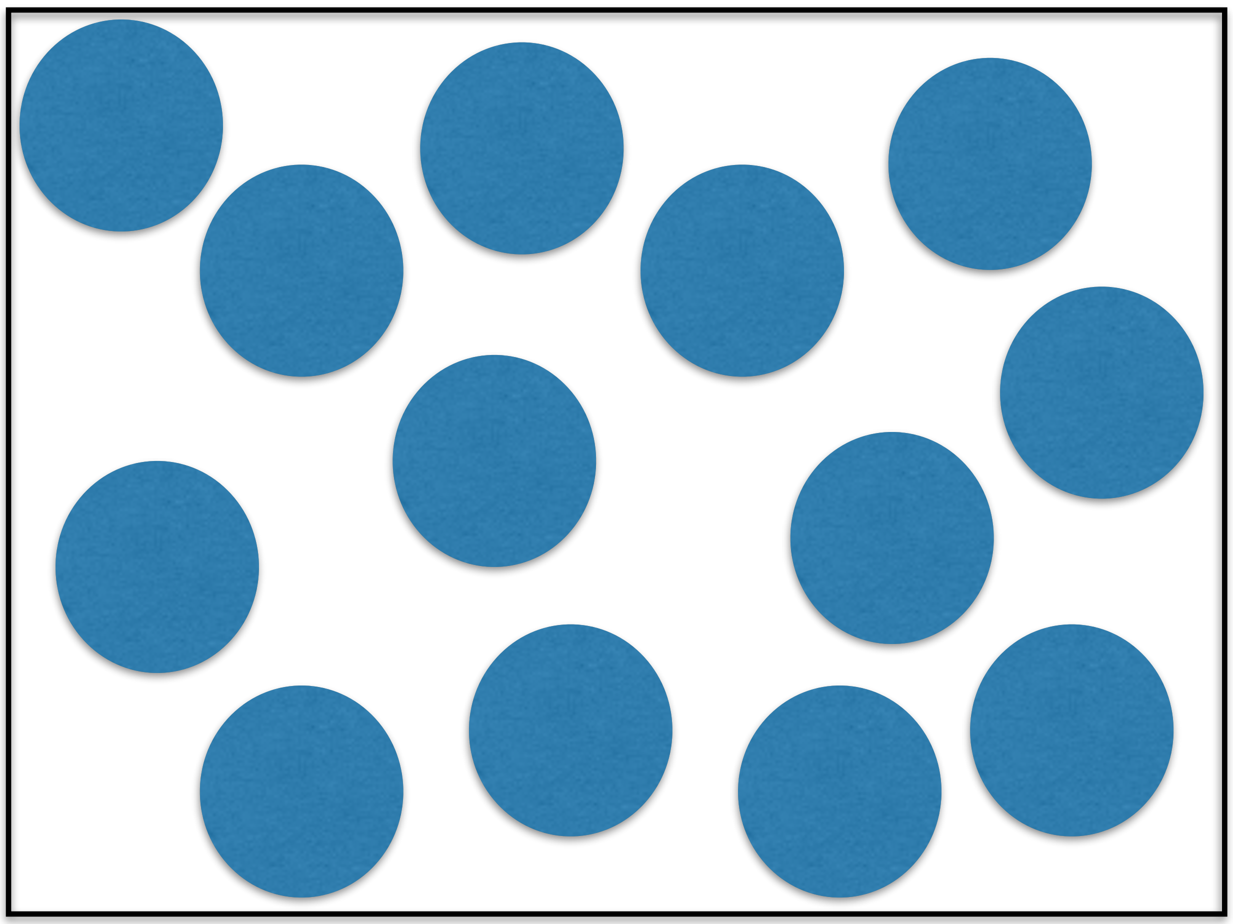


Can the formation of clusters and the coherence between them seen with a single field ψ ?

Ref: F. Cinti, P. Jain, M. Boninsegni, A. Micheli, P. Zoller, and G. Pupillo, Phys. Rev. Lett. 105, 135301 (2010)

contact person: Dario Hügel

Topic nr 3:classical Monte Carlo study of hard spheres



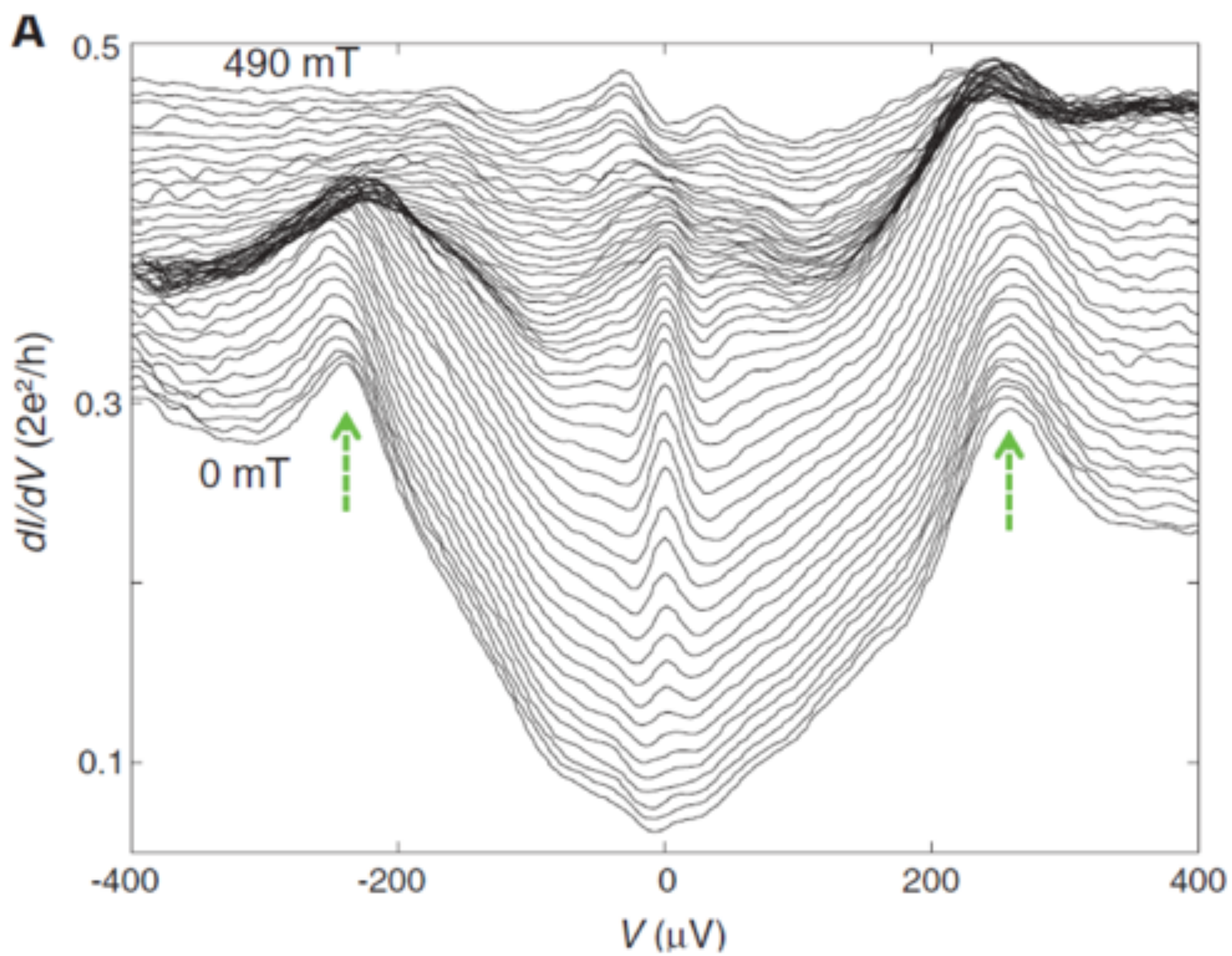
equation of state for
hard spheres in a box.
observe the jamming
transition at high density

Ref: W. Krauth, Statistical Mechanics: Algorithms and Computations, Oxford University Press

contact person: Peter Kroiß

Topic nr 4:literature study of Majorana zero modes

$$\gamma = \gamma^\dagger\,,\, \gamma^2 = 1\,,\, [H, \gamma] = 0$$



Have experiments observed a MZM, or are other explanations possible?

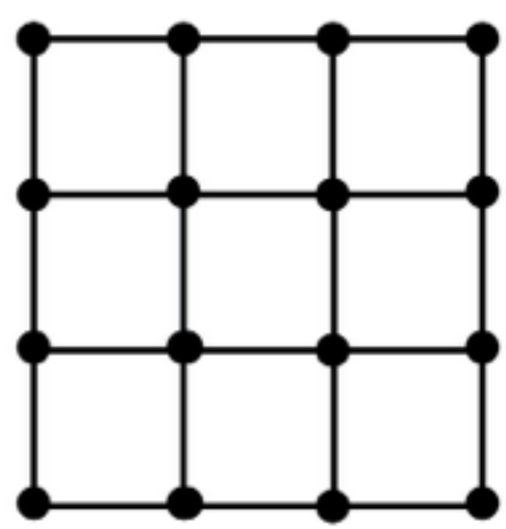
What are the impacts for topological quantum computing?

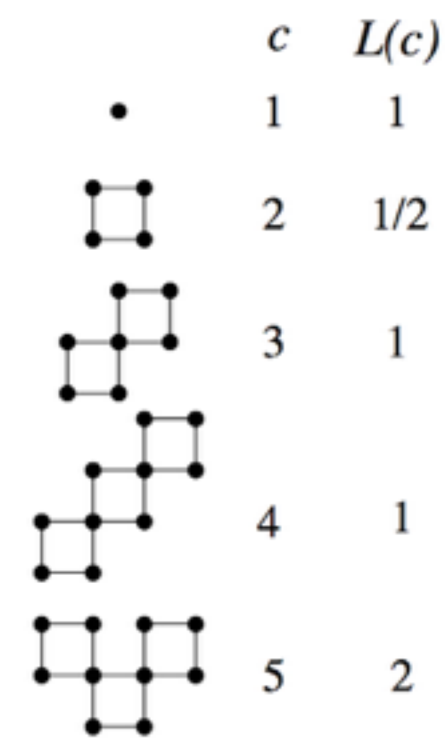
Ref: S. Das Sarma, M. Freedman, C. Nayak http://arxiv.org/abs/1501.02813

Topic nr 5: numerical linked cluster expansion

$$P(\mathcal{L})/N = \sum_c L(c) \times W_P(c)$$

$$W_P(c) = P(c) - \sum_{s \subset c} W_P(s)$$





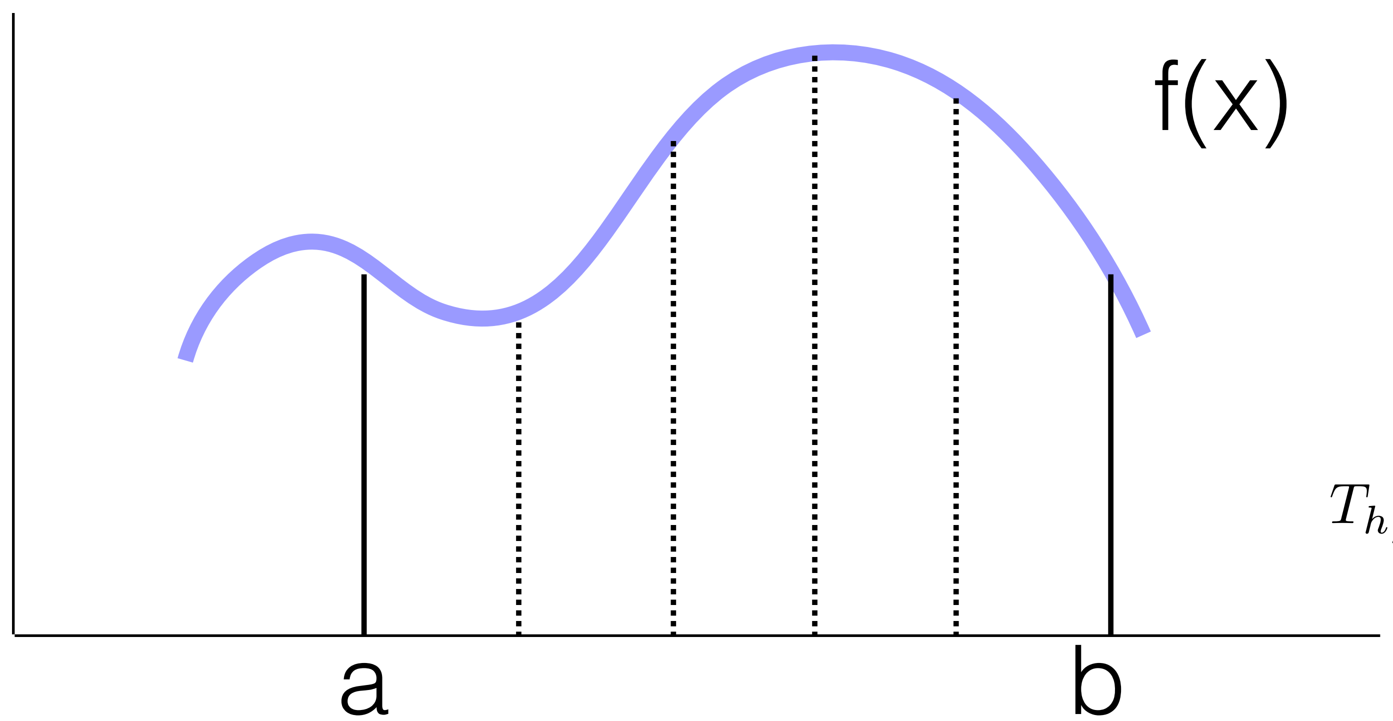
goal: understand and implement this method
(exact diagonalization + finite size analysis)

Ref: M. Rigol, T. Bryant, R.Singh, Phys. Rev. E 75, 061118 (2007)

Ref: B. Tang, E. Khatami, M. Rigol, http://arxiv.org/abs/1207.3366

contact person: Stephen Inglis

Topic nr 6: Romberg integration method



trapezoidal rule

$$\int_a^b f(x)dx = T_h + Ch^2 + \mathcal{O}(h^4)$$

half step size

$$\int_a^b f(x)dx = T_{h/2} + C(h/2)^2 + \mathcal{O}(h^4)$$

$$T_{h/2} = \frac{h}{4}[f_0 + 2f_{1/2} + 2f_1 + \ldots + 2f_{n-1/2} + f_n]$$

combine and cancel
leading error term

$$\int_a^b f(x)dx = \frac{4}{3}T_{h/2} - \frac{1}{3}T_h + \mathcal{O}(h^4)$$

can be repeated iteratively and converges very first + gives an idea of the systematic error

Question: if H = T +V with [T,V] ≠ 0, can Romberg integration still give an advantage?

contact person: Tobias Pfeffer