Return to Michael by **Friday 8.12.2006** *at noon! The discussion is* **Monday 11.12** *at 10:15 in FYS2*

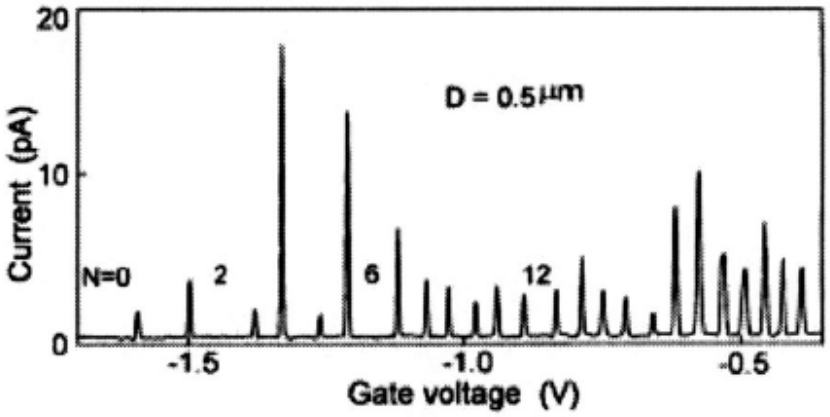
1. *Box potential model* Assume a box of constant volume and dimensions (a, a, b). The potential inside of the box is zero and infinite outside. Find the ratios a/b that minimize the energy if you pack two or three electrons into this box. Which configuration do you expect a Na_3 cluster to adopt according to this model (Na has one valence electron) ? **(3 points)**

2. *Simple model for quantum dots.* Show that the eigenenergies of a two-dimensional harmonic potential are $\varepsilon_l = \hbar\omega(l+1)$, and degeneracies $d_l = l+1$ with $l = 0, 1, 2, \ldots$ (Hint: Show that the Hamiltonian separates into a sum of two one-dimensional Hamiltonians and use the energies of one-dimensional harmonic oscillator.)

In the capacitive model of a quantum dot the addition energy is

$$\Delta_2(N) = \varepsilon_{N+1} - \varepsilon_N + e^2/C,$$

where ε_N is the energy of the single-electron level occupied by the Nth electron and e^2/C is the capacitive charging energy. Use the simple model of a quantum dot where the non-interacting electrons occupy the levels of the two-dimensional harmonic oscillator, and plot the addition energies $\Delta_2(N)$ as a function of electron number N, for N=1...13. For simplicity use units where $\hbar\omega = e = 1$ and $C = N$, thus assume that the capacitance increases with the electron number. Compare your plot with the experimental one (from Tarucha *et al.* Phys. Rev. Lett. **77** (1996) 3613):



What are the qualitative differences and similarities?
(**3 points**)