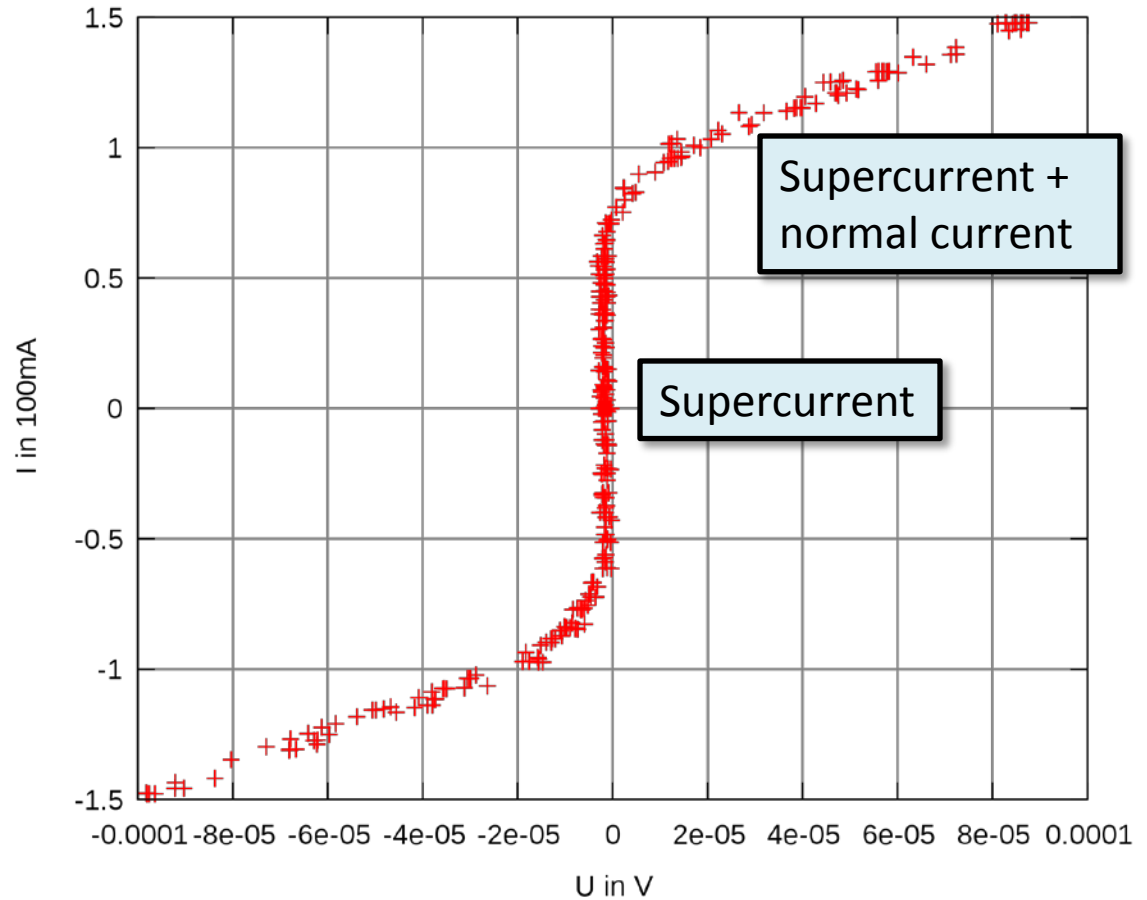


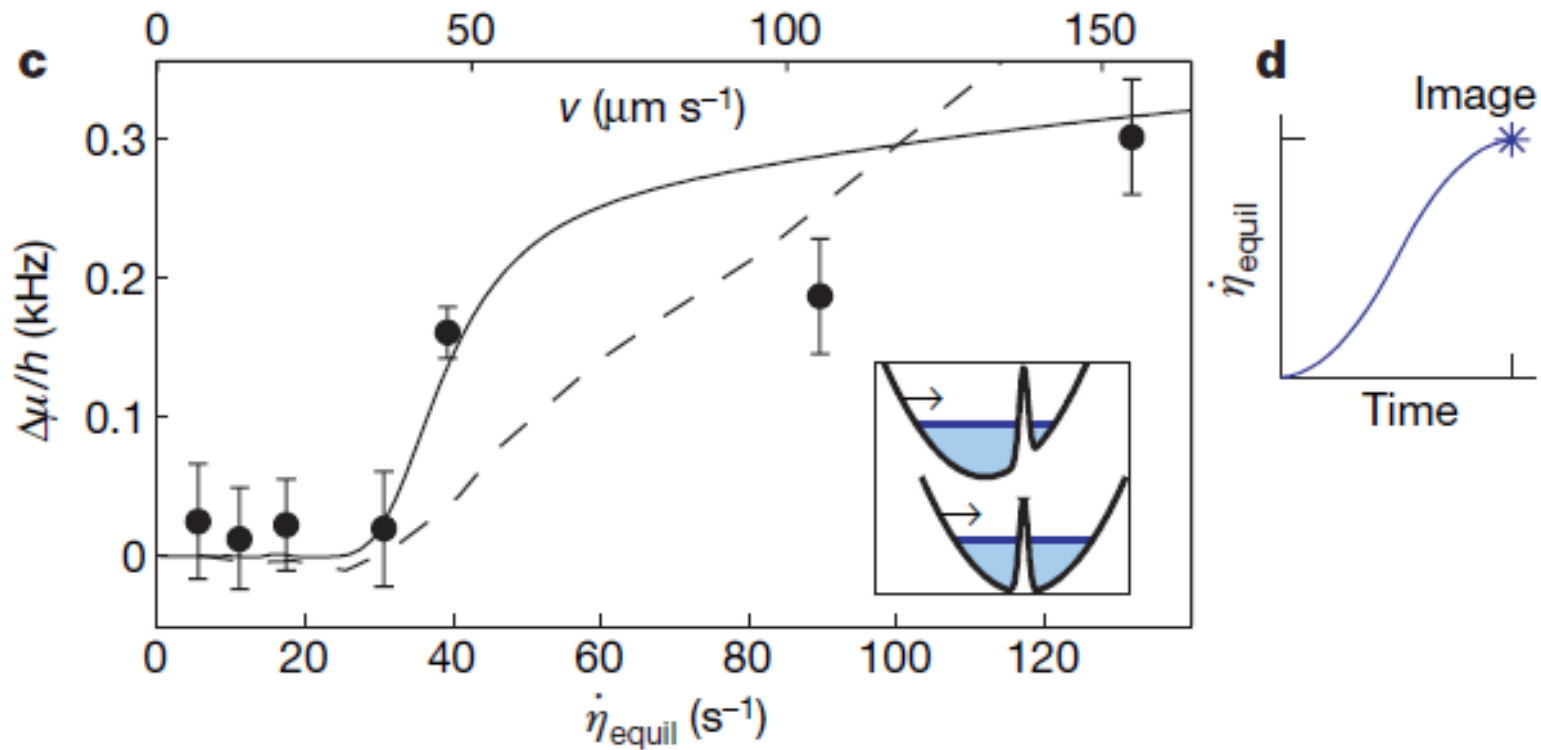
d.c. Josephson Effect

$$I_{\text{SC}} = -I_J \sin(\Phi)$$

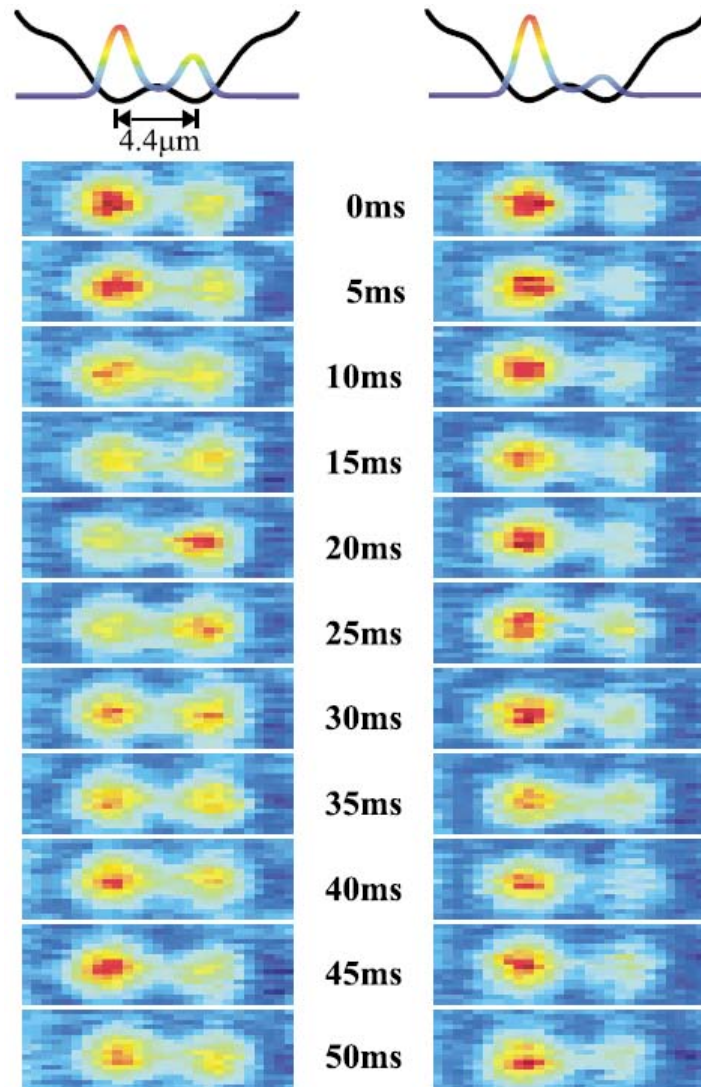
$$\rightarrow |I_{\text{SC}}| < I_J$$



d.c. Josephson Effect

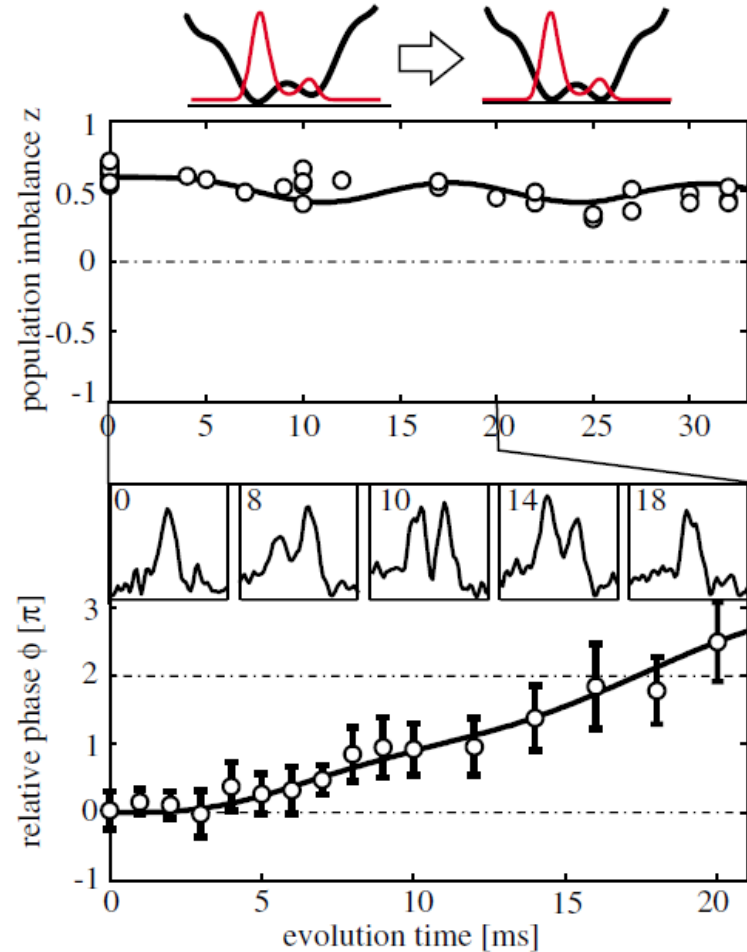
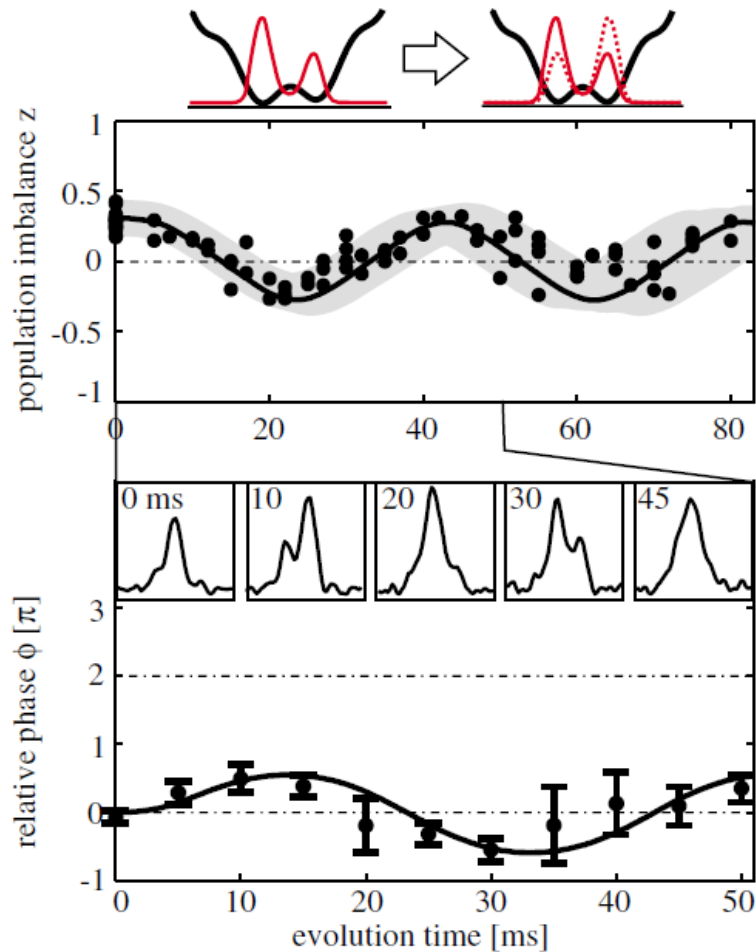


Plasma oscillations and self-trapping



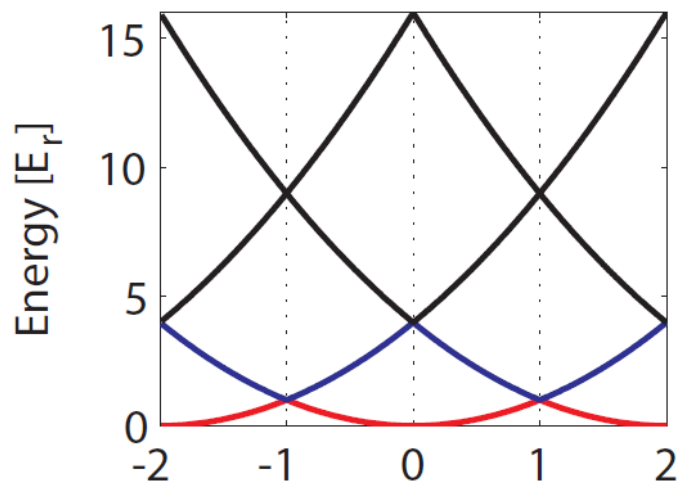
from M. Albiez et.al. PRL **95**, 010402 (2005)

Plasma oscillations and self-trapping

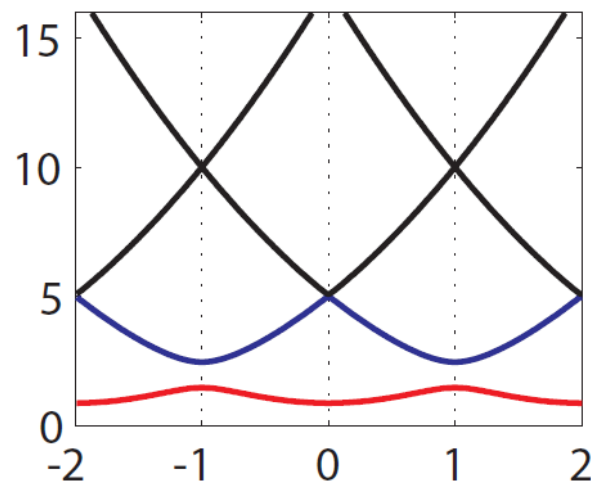


Bloch wave energies

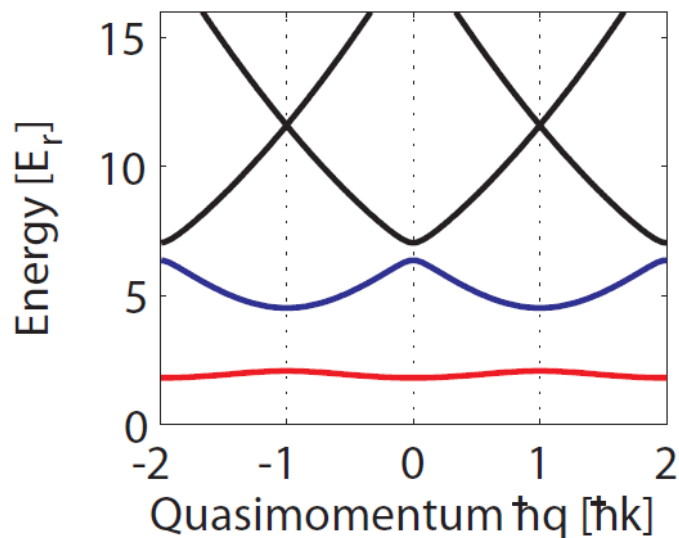
$$V_0=0 E_r$$



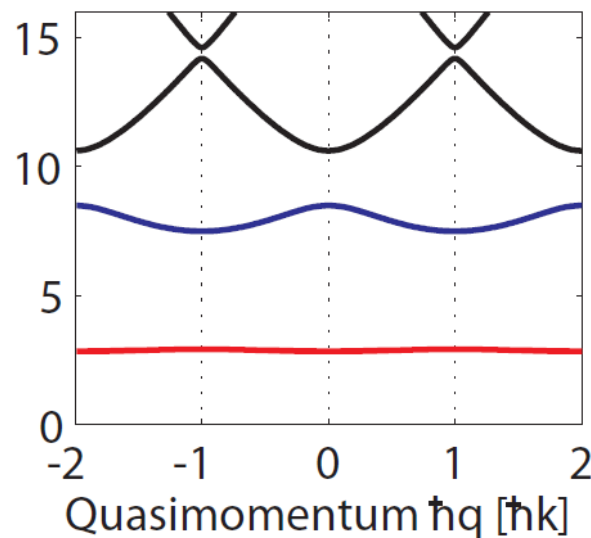
$$V_0=2 E_r$$



$$V_0=5 E_r$$



$$V_0=10 E_r$$



Bloch wave composition

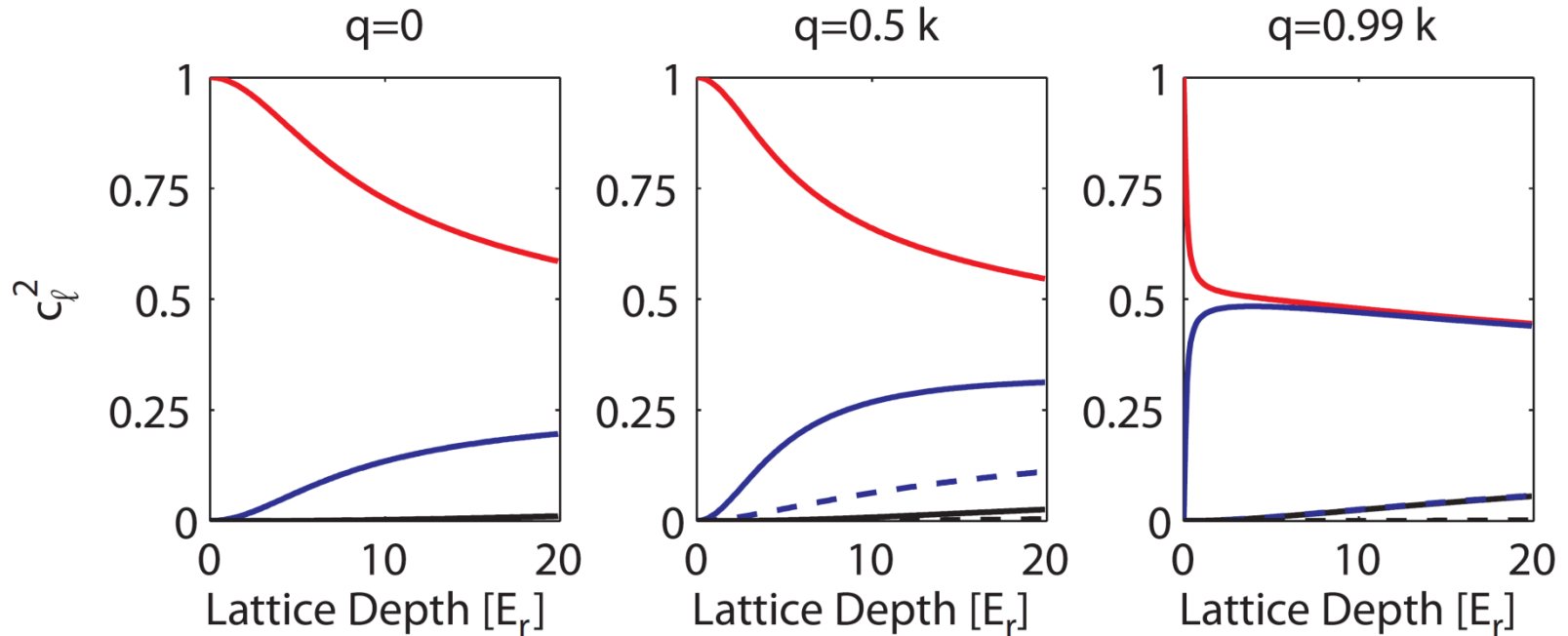
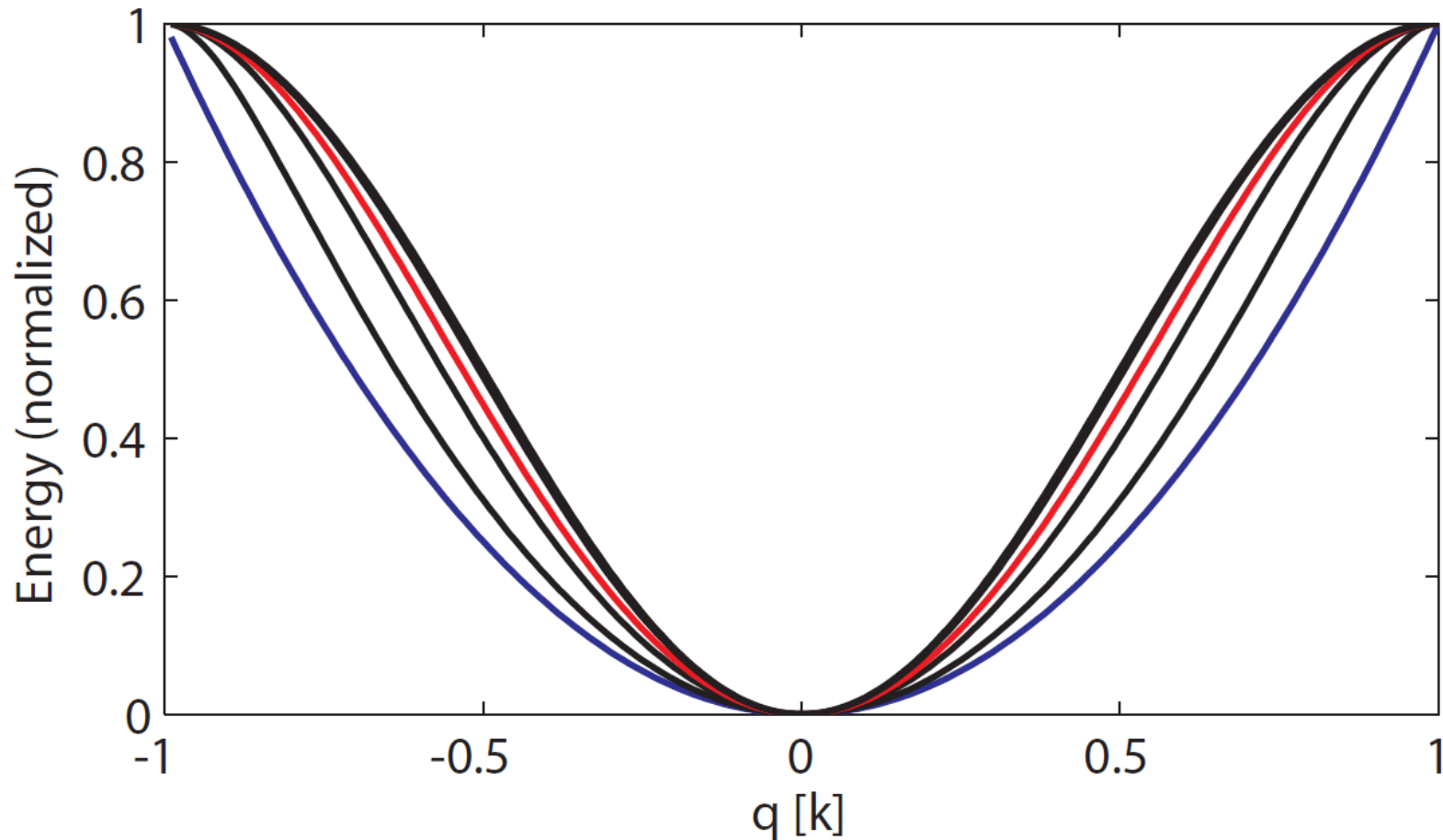


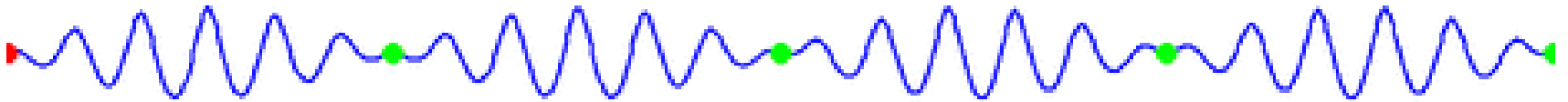
Figure 5.9.: Composition of Bloch waves: for three different quasimomenta $\hbar q$ the weight of the corresponding plane waves is shown as a function of lattice depth. The red lines denote the real space momentum $p = \hbar q$, blue (black) denote $p = \hbar(q + 2k)$, ($p = \hbar(q + 4k)$) and the dashed lines denote $p = \hbar(q - 2k)$, ($p = \hbar(q - 4k)$). At zero lattice depth the Bloch waves are identical to plane waves with momentum $p = \hbar q$.

Dispersion relation: From free space to tight binding

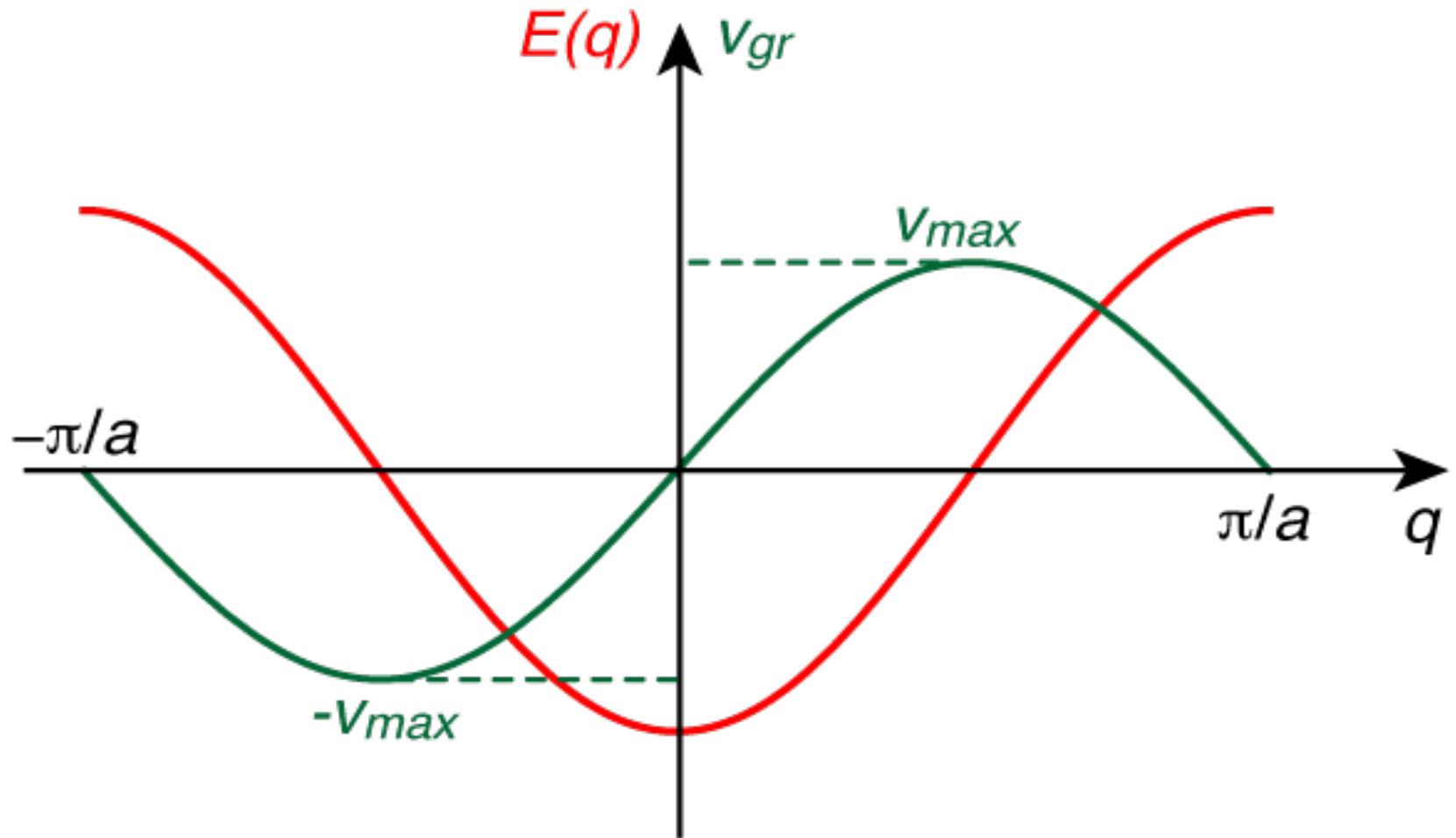


Lattice Depth: 0Er, 1Er, 3Er, 5Er, 10Er, 100Er

Group velocity vs. Phase velocity



Group velocities



Bloch Oscillations

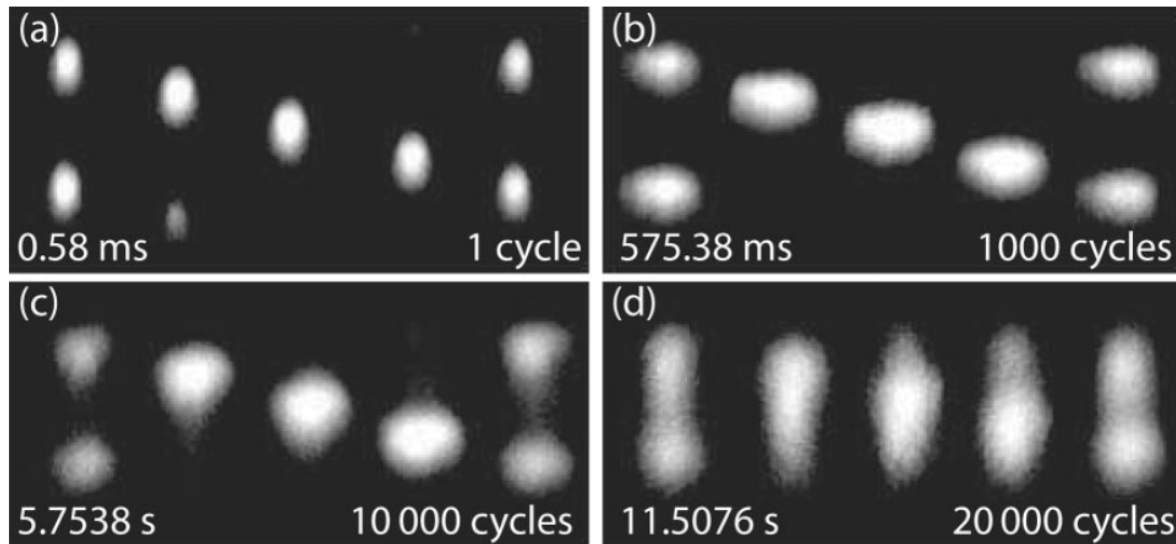


FIG. 1. Long-lived Bloch oscillations for a noninteracting BEC with Cs atoms in the vertical lattice under the influence of gravity. Each picture shows one Bloch cycle in successive time-of-flight absorption images corresponding to the momentum distribution at the time of release from the lattice. Displayed are the first (a), the 1000th (b), the 10 000th (c), and the 20 000th (d) Bloch cycle for minimal interaction near the zero crossing for the scattering length.

Bloch Oscillations

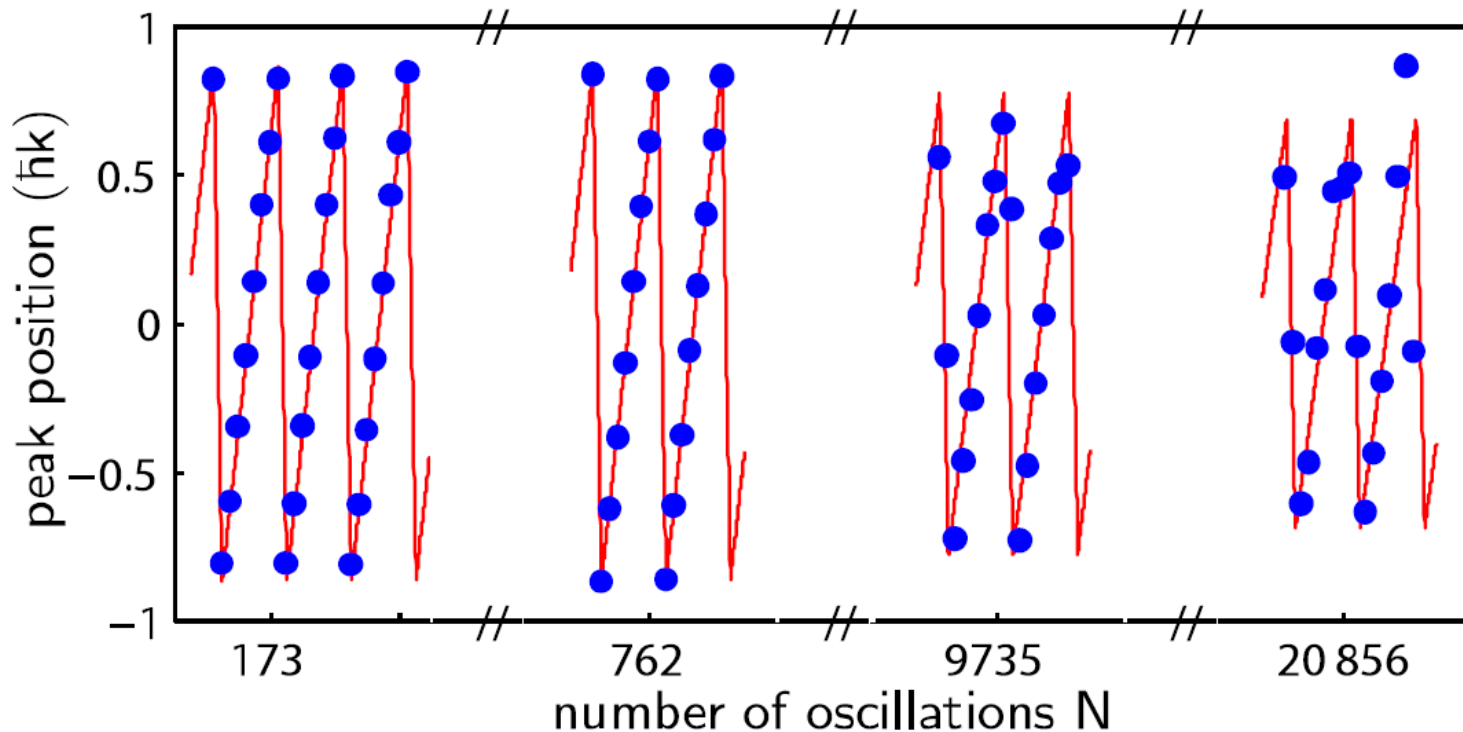


FIG. 2 (color online). Position of the strongest peak in the momentum distribution as a function of the number N of Bloch oscillations (dots). More than 20 000 cycles can be followed with high contrast. A fit to the data (solid curve) yields a Bloch period of $0.575\,380\,7(5)$ ms.

Wannier Functions

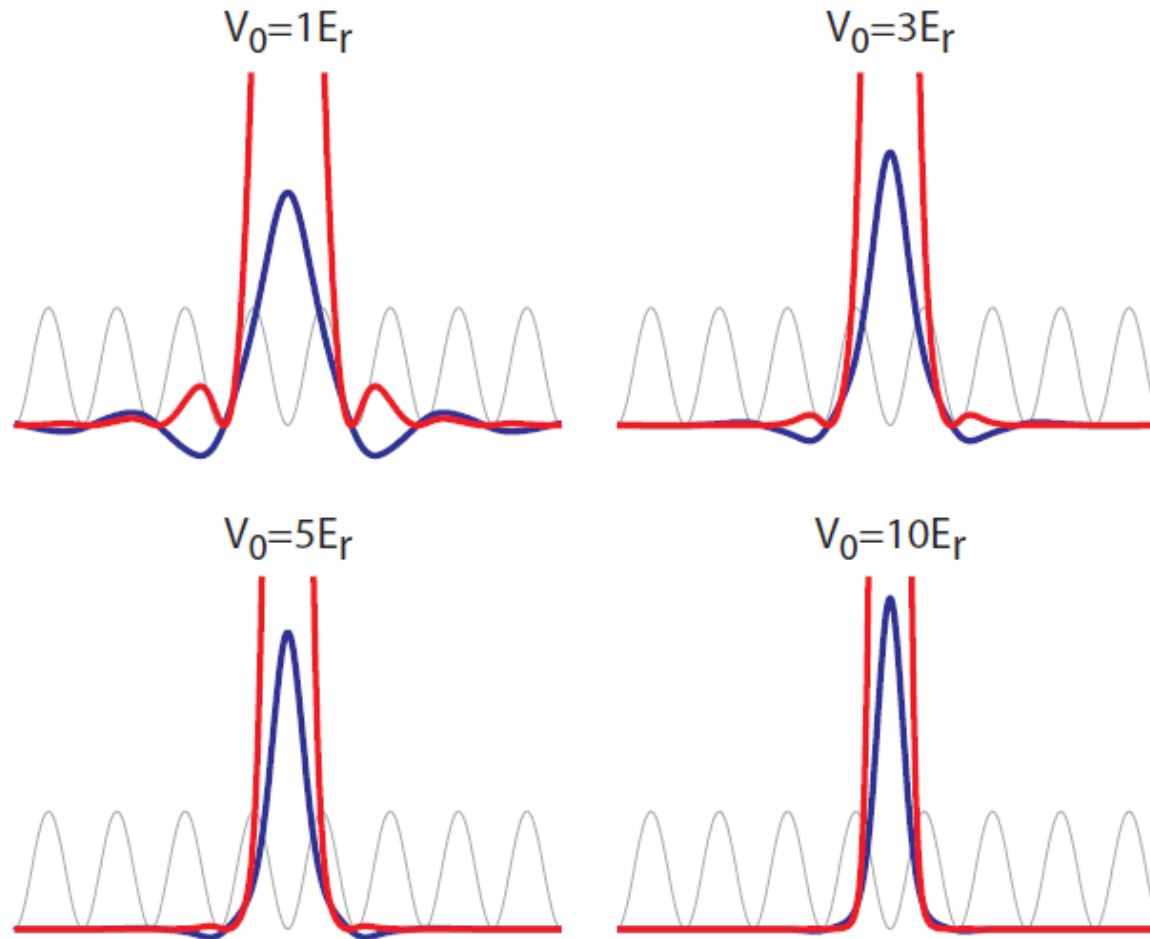


Figure 5.10.: Wannier functions for different lattice depths. The Wannier functions w are plotted in blue together with the resulting density $|w|^2$ in red and the lattice potential is given schematically in gray.

