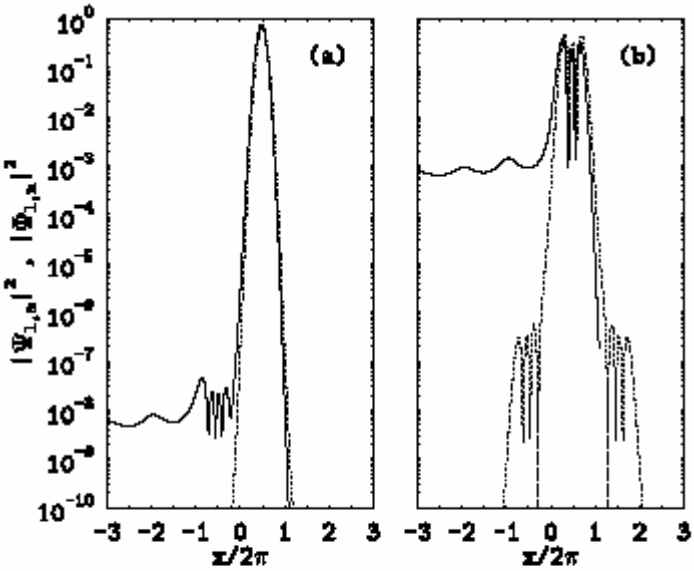
Observing W-S ladders and L-Z tunnelling:

The WS ladder is studied as follows. First a MOT is used to cool and trap the sodium atoms. Then the MOT is turned off and a far detuned standing wave is turned on. About 10% of the atoms are trapped in their lowest energy band. The standing waves are accelerated and after interacting with the standing waves the atoms drift freely in the dark after witch the near-resonant trapping beams are switched on again without the magnetic field gradient forming an optical molasses and the resulting fluorescent light is registered.
To observe the WS ladder, a phase modulating frequency is added to the accelerating optical potential. This AC field drives transitions between the two bands when resonance is matched.

Landau-Zener tunnelling to higher or lower bands, can be reduced or enhanced respectively by tuning the acceleration mentioned above. A spectrum is taken and gives Wannier-Stark splitting as a function of say frequency or acceleration. By measuring the fraction of atoms that remain in the accelerating frame as a function of the interaction time one can study LZ tunnelling.

A numerical result showing the large correlation in WS-states.



Dashed line – the localized quasistationary states $\Phi_{l,m}(x)$ constructed from the Bloch states with $l = 0$ (a) and $l = 2$ (b), the cell index is $m = 0$. Solid line – the ground and second excited metastable Wannier-Stark states $\Psi_{l,m}(x)$ for $F = 0.2$.