Wave-function renormalization effects in the time evolution of a Bose-Einstein condensate

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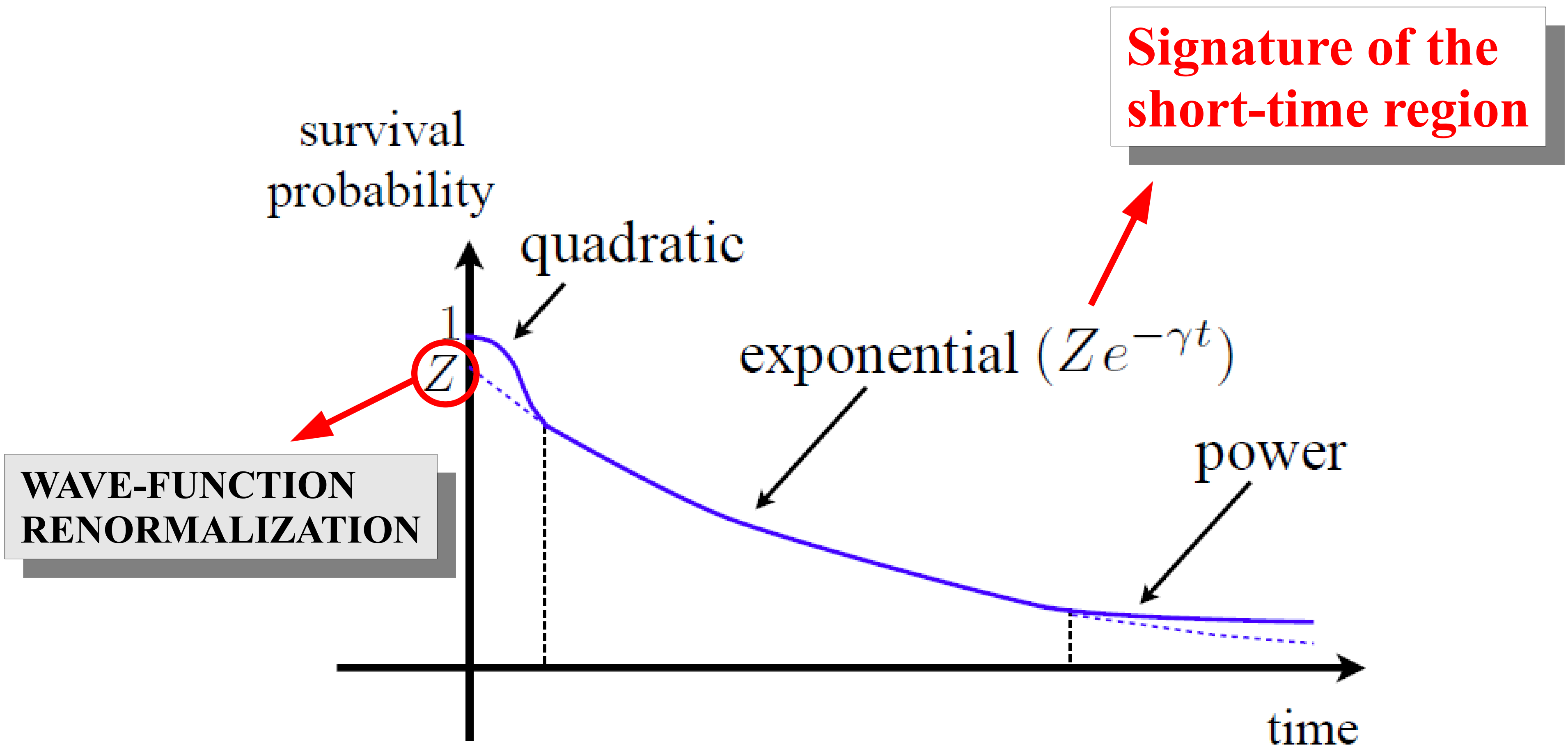
Decay of an unstable state

$P(t) \sim \exp(-\gamma t)$ only at **intermediate** times



Bose-Einstein condensates

A macroscopic number of particles is in the same single-particle quantum state

“Collective” wave function

$$\Psi_0(\boldsymbol{x}, t)$$

related to MACROSCOPIC OBSERVABLES (density, velocity,...)

Gross-Pitaevskii equation (nonlinear)

$$i\hbar \frac{\partial}{\partial t} \Psi_0(\boldsymbol{x}, t) = \left(\frac{-\hbar^2}{2m} \nabla^2 + V_{\text{ext}}(\boldsymbol{x}, t) + g \left| \Psi_0(\boldsymbol{x}, t) \right|^2 \right) \Psi_0(\boldsymbol{x}, t)$$

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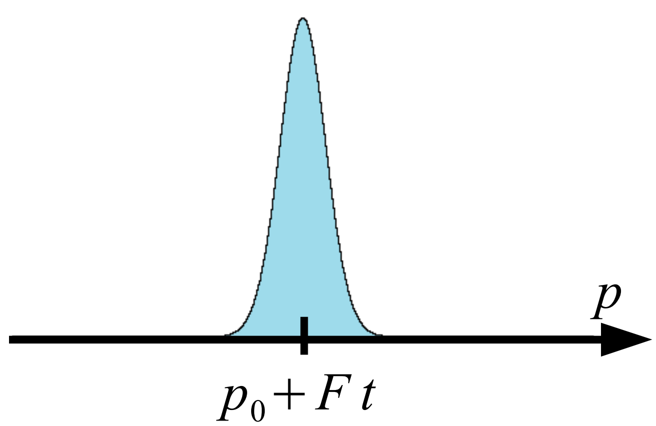
LINEAR REGIME: **Schrödinger equation**

Accelerated optical lattice

EXTERNAL POTENTIAL

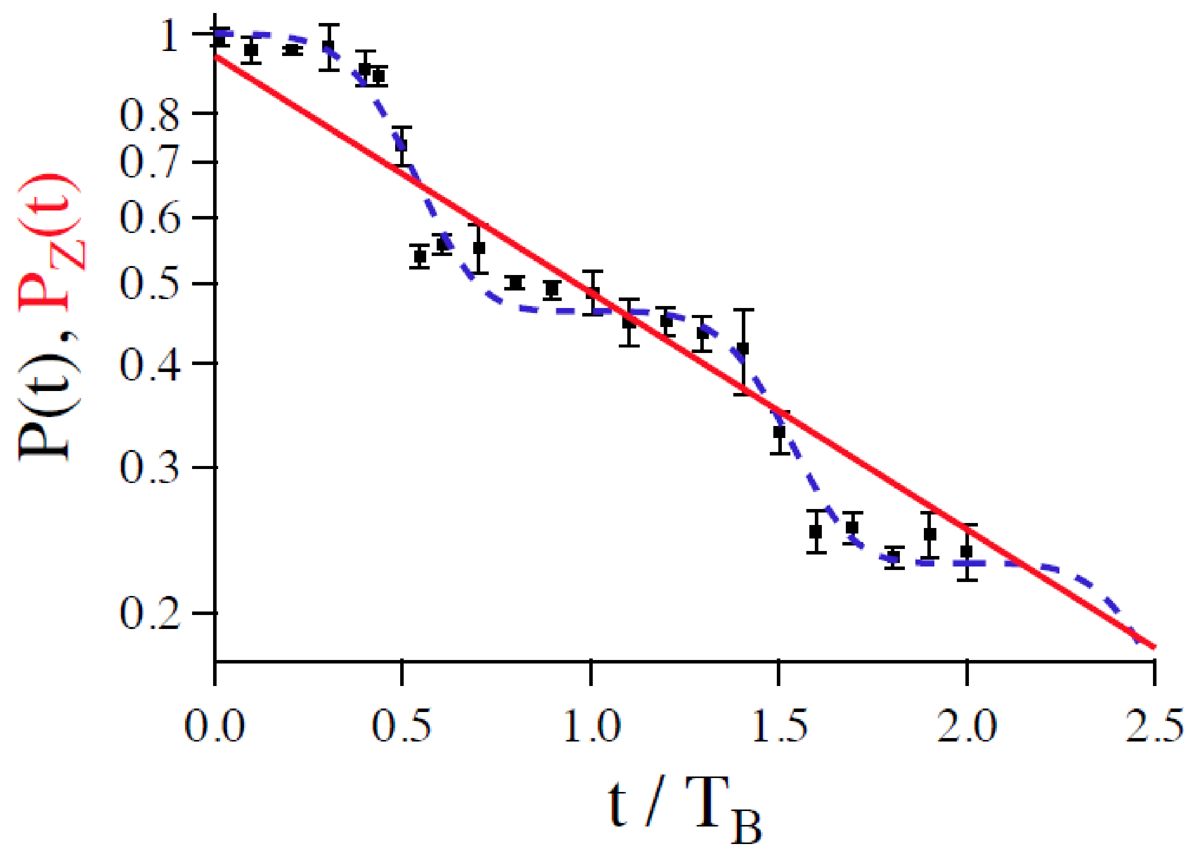
$$V(x) = \frac{V}{2}\cos\left(\frac{2\pi x}{d_L}\right) - F x$$

Narrow momentum distribution

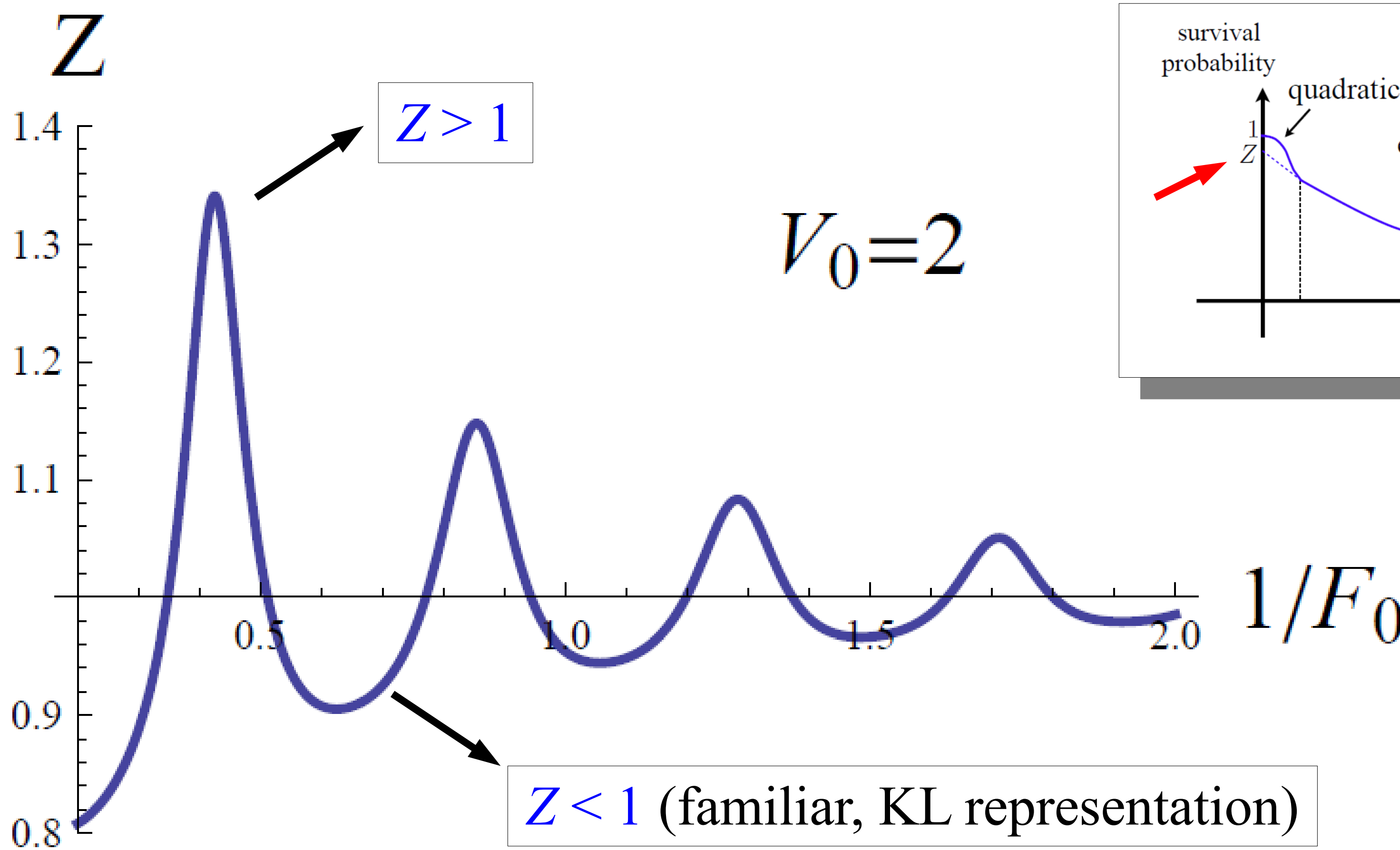


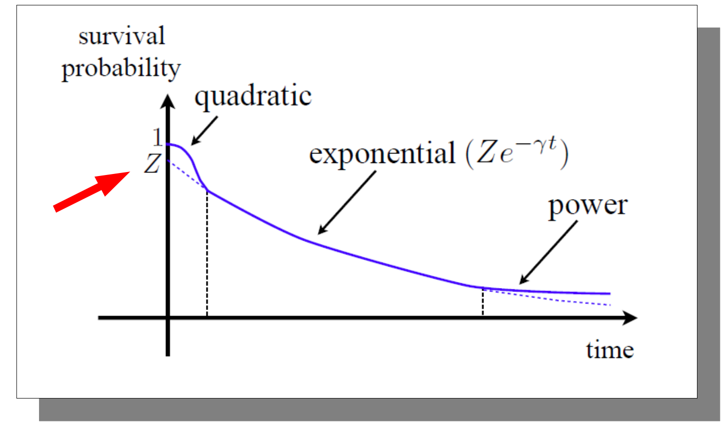
SURVIVAL PROBABILITY IN THE LOWEST BAND

Step-like structure for small V



Theoretical model...

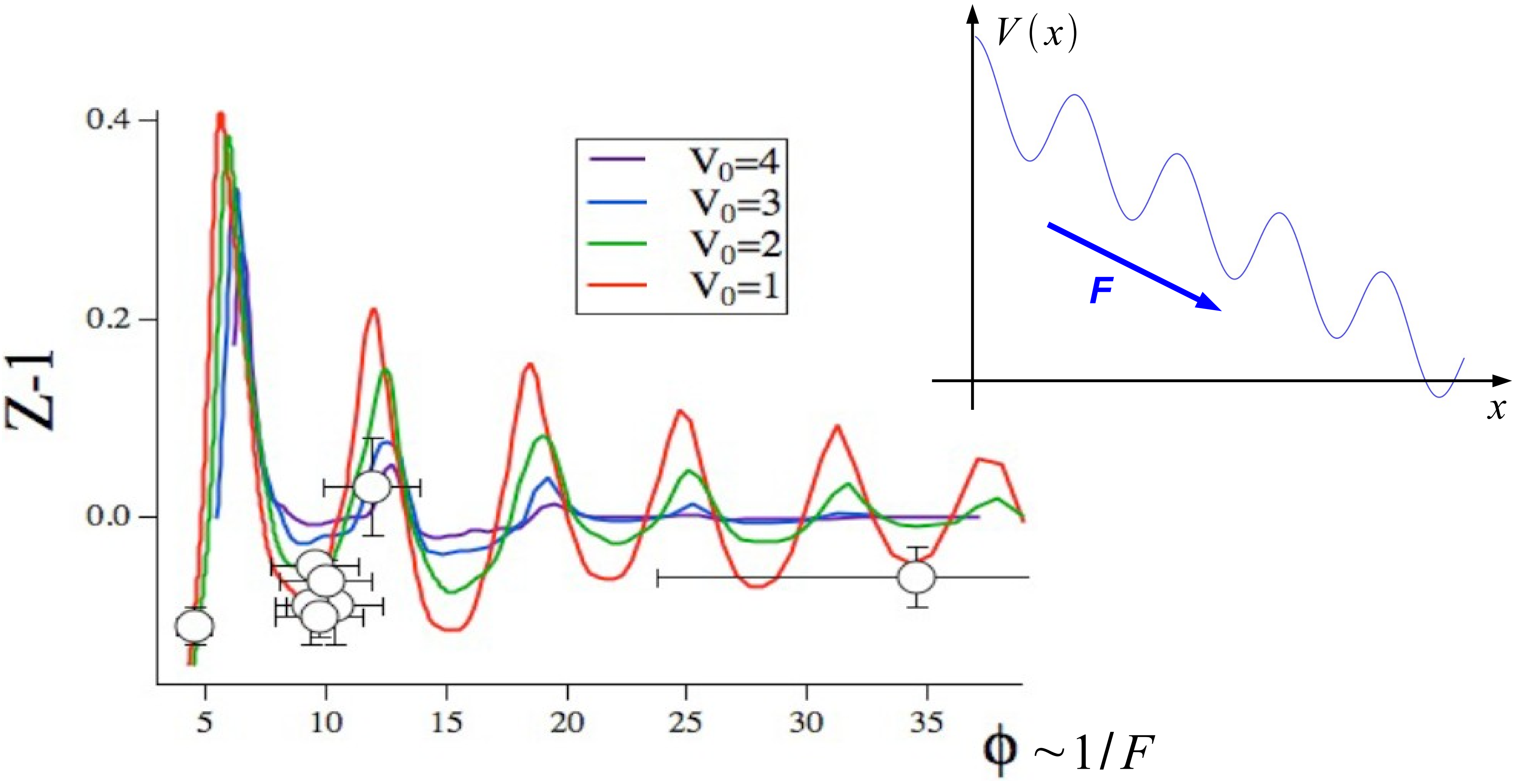




Based on a properly modified **Landau-Zener transition** scheme

$$P_{LZ}=\exp\left(-\frac{\pi}{16}\frac{m\,d_L^2\,V^2}{F}\right)$$

...and first experimental data



In collaboration with Pisa (E. Arimondo, D. Ciampini, O. Morsch, R. Mannella, H.Lignier) and Heidelberg (N. Lörch and S. Wimberger)