

# Spin-orbit Coupling in Deformed Harmonic Traps

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Recent experiments have realized single-particle spin-orbit coupling in cold atomic Bose and Fermi gases [1-3]. Here we study spin-orbit coupling of the Rashba type for cold fermionic systems that are held by a deformed harmonic trap. The deformation has strong influence on the spectrum of single-particle levels (see Fig. 1) which will in turn affect the many-body states of large systems [4]. We study the many-body instabilities of such systems using Hartree-Fock and BCS pairing theory including the full single-particle spectrum (and thus avoiding the local density approximation). Our results show that the combination of spin-orbit interaction and deformation can be used to experimentally tune collective and pairing modes.

[1] Lin Y-J, Jiminez-Garcia K and Spielman I B 2009 *Nature* **471** 83

[2] Wang P *et al.* 2012 *Phys. Rev. Lett.* **109** 095301

[3] Cheuk L *et al.* 2012 *Phys. Rev. Lett.* **109** 095302

[4] O. V. Marchukov, A. G. Volosniev, D. V. Fedorov, A. S. Jensen, and N. T. Zinner, *J. Phys. B* (in press), arXiv:1212.4051

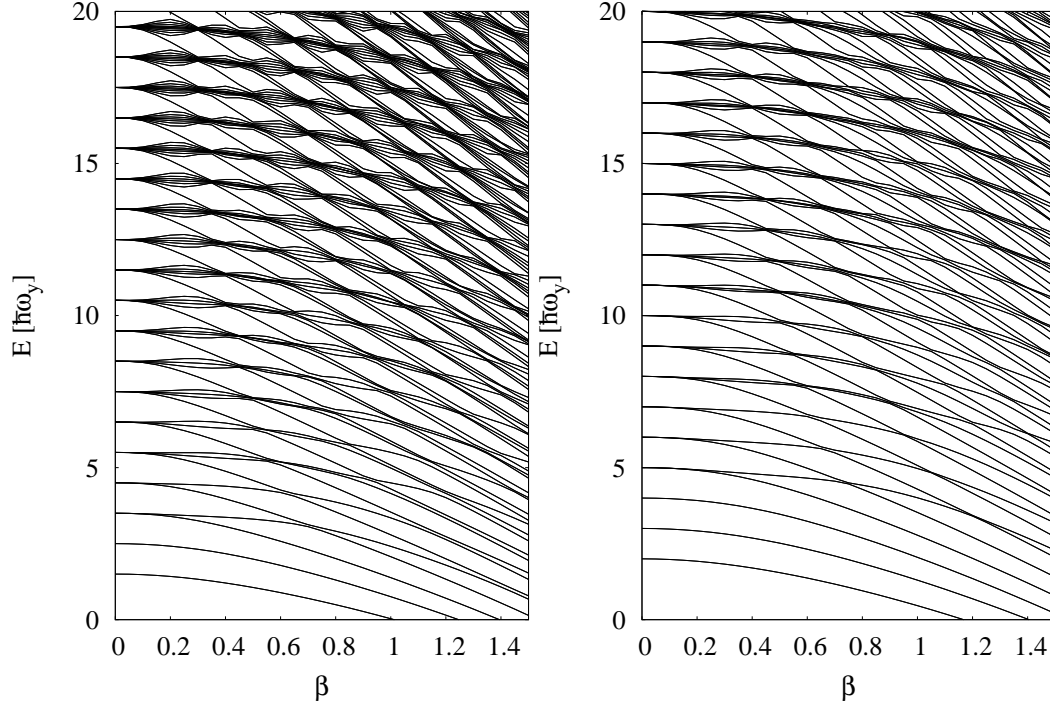


Figure 1: Energy as function of dimensionless spin-orbit coupling parameter  $\beta$  for the case where the oscillator potential,  $V(x, y) = \frac{1}{2}m(\omega_x^2 x^2 + \omega_y^2 y^2)$ , is deformed. The left panel has  $\gamma = \frac{\omega_x}{\omega_y} = 2$  and the right panel has  $\gamma = 3$ .

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