Topology and Control of Ultra-Cold Atoms with Radio-Frequency Fields

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We develop techniques for the analysis of wave packet dynamics in 2D and 3D. We use a Gaussian approximation to a wave-packet in a ring potential and show how the orientation of the wave-packet changes as it propagates around the ring. Further to this, a method to obtain corrections to the Gaussian wave-packet is obtained by transforming the Hamiltonian of the system to a local co-moving and rotating harmonic basis. The same methodology is also used to examine the creation of angular momentum of a wave packet by means of rotating an anisotropic potential, which is a technique being used to impart angular momentum to Bose-Einstein condensates. Finally, the different method of representing a wave-function by a swarm of Gaussian wave-packets is used to analyse the dynamics of expanding matter-wave rings and shell states.

The motivation of the work is the analysis of systems that may be used to make Sagnac interferometers [1–3] for rotation measurements, and the analysis of idealised shell states of a Bose-Einstein condensate. For the latter, experiments on the Cold Atom Laboratory, or CAL [4, 5]) have stimulated wide interest in the creation and physics of bubbles of quantum gas [6]. This includes the collapse and expansion of bubbles, vortices on closed surfaces, and vibration of the shell.

References

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