Dynamical Phases of Spin Changing Collisions within a Spin-1 BEC

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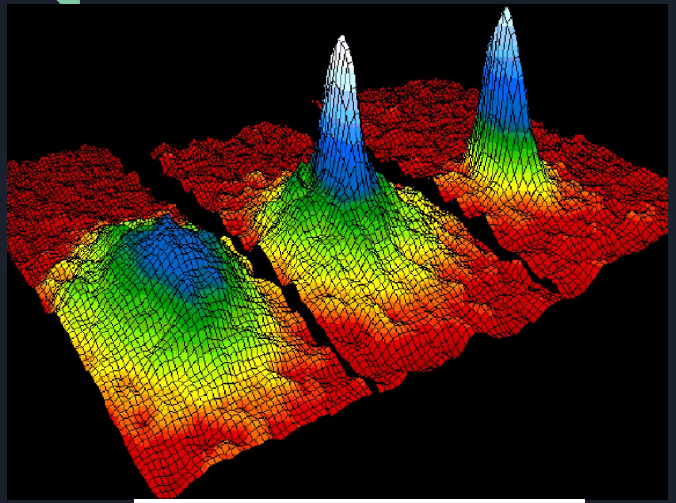
What is a Spin-1 BEC?



$$\lambda = \frac{h}{p} = \frac{h}{mv}$$

$$v_{RMS} = \sqrt{kT}$$

- BEC (Bose-Einstein Condensate) is a gas of atoms (often Na or Rb) cooled to a few nano-Kelvin
- Atoms' wavefunctions begin to overlap
- Spin-1 BEC means the atoms can have different spin states

What happens inside a Spin-1 BEC?

- Atoms within a Spin-1 BEC can have three different Zeeman states or spins (m = -1, 0, 1), and they can collide

- These collisions can be elastic (spin conserving) or inelastic (spin-changing)

Elastic: $0 + 0 \rightarrow 0 + 0$

Inelastic: $0 + 0 \rightarrow -1 + +1$

$\Sigma m_i = \Sigma m_f$

Understanding Collisions

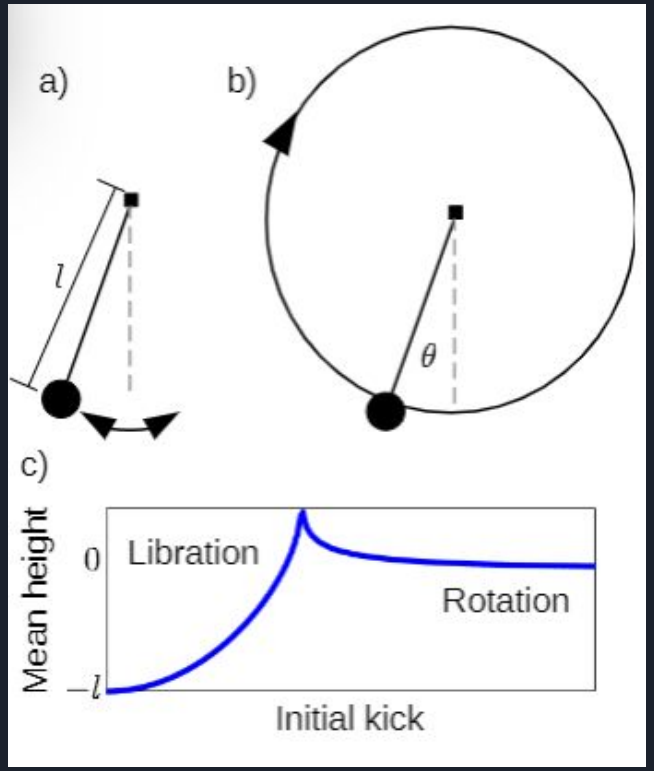
- The dynamics of these atomic collisions can be well described by a classical non-rigid pendulum

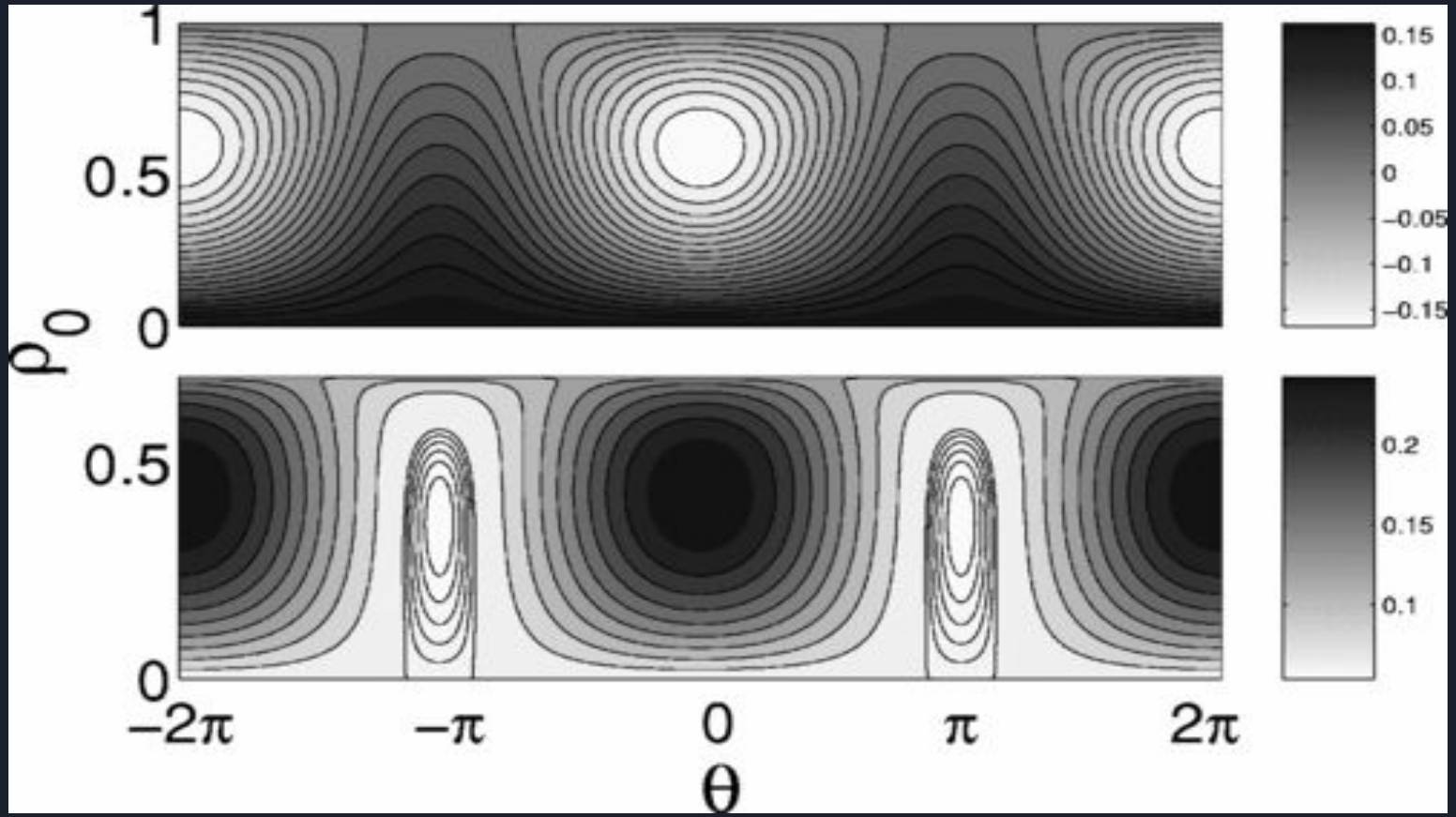
- Studying the classical dynamics of such a pendulum can give us information on the dynamical phases of the Spin-1 BEC

What are Dynamical Phases?

- Qualitatively distinct regimes of different behavior separated by a sharp transition

- Ex: A pendulum swinging back and forth




1
0.5
0
ρ_0
0.15
0.1
0.05
0
−0.05
−0.1
−0.15
0.5
0
0.2
0.15
0.1
−2π
−π
0
π
2π
θ

My Contribution

- I am looking at the microscopic Hamiltonian of the system, and by ignoring the quantum noise, the Hamiltonian simplifies down to only two variables (somewhat analogous to the pendulum's height and angle)

- I will then map this two dimensional Hamiltonian to a one dimensional potential well, and identify turning points, i.e. dynamical phases