Feshbach Resonance in a Tight-binding Model

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BACKGROUND

Feshbach Resonance (closely related to Fano resonance) occurs when a system describing the scattering of two particles (e.g atoms) at energy E (the open system) is coupled to another system (the closed system) where the two particles interact with a potential v(r) such that: 1) For large inter-particle separation r, v(r)>E, and 2) At small r, v(r) has a pocket that supports at least one bound-state.

In cold-atom physics the potential v(r) is tunable by a magnetic field and that affects the open channel scattering in in a dramatic way. A FR corresponds to a point where the s-wave scattering length a_s changes from -¥infty to +¥infty. This enables the experimentalists to transform a system of fermions interacting with weakly attractive potential into a condensed gas of Bose molecules, the so called BCS-BEC crossover.

THIS TALK

I formulate the two particle scattering problem for the coupled (open and closed) systems within a simple one dimensional tight-binding model and solve it analytically. The central result is a simple expression for the s-wave scattering phase-shift ¥delta(E). From this expression all the important observables of the scattering event are easily computed. The FR (identified as ¥delta(E=0)=¥pi/2) is driven by the strength of the coupling between the two systems, and conditions for its occurrence are analyzed. Some results are rather surprising, for example, FR may occur even if the potential v(r) in the closed system is repulsive (provided the coupling between the two systems is strong enough).