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Chaos and Pairing

It is well known that pairing plays an important role in low-lying nuclear states, and that chaos plays an important role for highly excited states, as e.g. in the neutron resonance region. In the talk we shall discuss how these two parts combine.
In the nuclear ground-state region the mean field, deformed or spherical, provides a good approximation. The mean field then determines the dynamics of the system, and the connection classical/quantum chaos is well established. We show how the BCS pairing gaps respond differently on the dynamics of the mean field, and provide unique features through the gap fluctuations.

For the interacting many-body problem, where the two-body interaction is explicitly accounted for, chaos is usually found to appear with increasing excitation energy. This is understood as an effect of the two-body interaction, that plays a larger and larger role with increasing excitation energy. What happens if the two-body interaction is of pairing type? Will there be a transition to chaos for sufficiently large pairing strength? This is discussed based on a simple model system, that mimics a gas of ultracold fermionic atoms in a 2D confinement, subject to an attractive interaction of delta-type. It is found that with increasing strength of the pairing interaction, several chaos-like facets set in, although the system never becomes fully chaotic. For larger pairing strength the dynamics is found to revert, and the system becomes more and more regular as the interaction strength increases. We discuss differences in wave-functions emerging from a complex many-body system with a generic two-body interaction (as the nuclear shell model or even a random interaction), and from a many-body system with a pairing (delta) interaction.

Primary author: Prof. ÅBERG, Sven (Lund University)

Presenter: Prof. ÅBERG, Sven (Lund University)