Dynamical Phase Diagram of Ultracold Josephson Junctions

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In Josephson junctions with ultracold atoms, the Josephson current can be driven by a chemical potential difference across the junction, which can be present due to nonlinear interactions and for a non-zero population imbalance $z(t)$ between the two wells. Depending on the value of the initial imbalance z_0, different dynamical regimes could be found. In fact, if z_0 is smaller than a critical value z_{cr}, the system enters the 'plasma' regime. When z_0 instead exceeds z_{cr}, different experimental studies observed a transition either to self-trapping [1] or to a dissipative regime [2]. These findings raise the interesting question of what distinguishes between such transitions/regimes and whether a particular experimental set-up could be found that would allow for all three regimes to be observed.

In this talk, we provide a complete study of the phase diagram emerging in a three-dimensional Josephson junction composed of two Bose-Einstein condensates of molecules of 6Li, which are coupled through a barrier [3-4]. In particular, we show the presence of all three dynamical regimes upon careful control of the barrier height, width and z_0. Moreover, our work connects the role of the barrier, vortex rings and associated acoustic emission with different regimes of the superfluid dynamics across the junction.

References

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