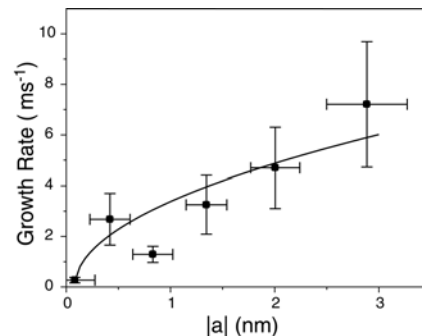


Amplification of Local Instabilities in a Bose-Einstein Condensate with Attractive Interactions

Our current understanding of the collapse of Bose-Einstein condensates (BECs) with attractive interactions is incomplete. Previous experiment studied very small condensates where the attractive mean field energy μ was comparable to or less than the $\hbar\omega$ level spacing of the harmonic trapping potential. We have studied the collapse of large sodium condensates far in the Thomas-Fermi regime ($|\mu| \gg \hbar\omega$), where the spatial profile of the condensate is relatively homogeneous [1]. Much of the dynamics of such a system is then described by local phenomena. When the interactions become attractive, Yurovsky predicted that local instabilities with momentum on the order of the (imaginary) speed of sound will undergo exponential growth [2].

By seeding the condensate with phonons (using optical imprinting) we observed the exponential growth of such excitations when the scattering length was suddenly switched negative. The scattering length could be varied by changing the magnetic field near a Feshbach resonance. For our parameters, this quantum evaporation process becomes comparable or faster than the global collapse even without seeding.



Growth rate of excitations in a BEC with scattering length $a < 0$. The rate increases with the magnitude of the negative scattering length $|a|$. The solid line shows a best fit to the theoretical prediction.

1. J.K. Chin, J.M. Vogels, and W. Ketterle, *Amplification of Local Instabilities in a Bose-Einstein Condensate with Attractive Interactions*, Phys. Rev. Lett. **90**, 160405 (2003).
2. V.A. Yurovsky, *Quantum effects on dynamics of instabilities in Bose-Einstein condensates*, Phys. Rev. A **65**, 033605 (2002).