John Waczak Quantum Mechanics Homework 3 **Question 3**

a)

Title: "Quantum ground state and single-phonon control of a mechanical resonator"
Author: A. D. O'Connell1 , M. Hofheinz1 , M. Ansmann1 , Radoslaw C. Bialczak1 , M. Lenander1 , Erik Lucero1 , M. Neeley1 , D. Sank1 , H. Wang1 , M. Weides1 , J. Wenner1 , John M. Martinis1 & A. N. Cleland1

Title: "Sideband cooling of micromechanical motion to the quantum ground state"
Author: J. D. Teufel1 , T. Donner2,3, Dale Li1 , J. W. Harlow2,3, M. S. Allman1,3, K. Cicak1 , A. J. Sirois1,3, J. D. Whittaker1,3, K. W. Lehnert2,3 & R. W. Simmonds1

b)

In class we talked about the classical limit of quantum mechanics i.e. that the correspondence principle means for high energy states, quantum mechanical systems approach their classical counterparts. Thus for objects on macroscopic scales that have massive energies compared to the quantum ground state it is very difficult to observe QHO behavior. The first paper uses cryogenic refrigeration to cool the mechanical mode to it's quantum ground level where measurements are made by what they call a "quantum drum". They were able to demonstrate controllable quantum excitations (phonons) in the resonator. In the second paper, by embedding a membrane into a superconducting circuit. Both of these papers illustrate that quantum mechanics of larger mass systems is now becoming a reality. This relates to the QHO because in both cases, the researchers used classical resonators cooled down to their quantum ground states.