Probing the Optical Conductivity of Trapped Charge-Neutral Quantum Gases

Z. Wu\(^1\), E. Taylor\(^2\), and E. Zaremba\(^3\)

\(^1\)University of Aarhus, DK-8000, Aarhus, Denmark
\(^2\)McMaster University, L8S 4M1, Hamilton, Canada
\(^3\)Queen’s University, K7L 3N6, Kingston, Canada
Contact Email: zaremba@sparky.phy.queensu.ca

Using a linear response formulation, we study the centre-of-mass response of a harmonically trapped gas to a small amplitude, time-dependent displacement of the trap. We show that the response to this kind of excitation is directly related to the global optical conductivity. Thus, a measurement of the time-dependent centre-of-mass dynamics of the cloud provides information about the complex global conductivity tensor of the many-body system. For systems with pure harmonic confinement, the response is prescribed by the generalized Kohn theorem and is independent of interactions and quantum statistics.

However, non-trivial responses arise when the harmonicity of the system is compromised by the presence of an additional external potential. We demonstrate the usefulness of this scheme by calculating the optical conductivity of bosonic atoms in a one-dimensional optical lattice. In the Mott-insulating phase, there is clear evidence of an optical Mott gap, providing a proof-of-principle demonstration that our proposal should be able to give considerable information about the excitations in strongly-correlated quantum gases [1].

References