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Solving the mystery of the missing superfluid shells: radio-frequency spectroscopy of a homogeneous Bose gas in an optical lattice yields a bimodal line shape KADEN HAZZARD, ERICH MUELLER, Cornell University — We show that near the Mott transition a uniform gas of bosons in an optical lattice should display a bimodal radio-frequency (RF) spectrum. This behavior is very different from the lineshapes in both the deep superfluid and deep Mott limit where we find a single sharp peak. The basic physics, known from studies of the single particle spectrum, is that the intermediate regime can be thought of as a Mott state with a few delocalized particles added. This yields two types of single particle excitations: a low energy "phonon" in the gas of delocalized particles, and a higher energy particle-hole excitation of the Mott state. RF photons couple to each of these excitations. We discuss the role of symmetries in the spectrum: in particular we describe how the vertex corrections are structured in order to satisfy the Ward identities which encode the relevant conservation laws. This may account for and suggest ways to circumvent the experimental difficulties in spectroscopically distinguishing the superfluid from the Mott insulating state.

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