Exploring Complex Phenomena using Ultracold Atoms in bichromatic lattices SHUMING LI, JILA, University of Colorado at Boulder, INDUBALA SATIJA, Department of Physics, George Mason University, CHARLES CLARK, Joint Quantum Institute, National Institute of Standards and Technology and University of Maryland, ANA REY, JILA, University of Colorado at Boulder — With an underlying common theme of competing length scales, we study the many-body Schrodinger equation in a quasiperiodic potential and discuss its connection with the Kolmogorov-Arnold Moser (KAM) problem of classical mechanics. We propose a possible visualization of such connection in experimentally accessible many-body observables. We demonstrate those observables not only are useful probes for the three characteristic phases of the problem: metallic, Anderson and band insulator phases but in addition exhibit fingerprints of non-linear phenomena such as *Arnold tongues*, *bifurcations* and *devil-stair* cases. Our numerical treatment is complemented with a perturbative analysis which provide insight on the underlying physics. The perturbation theory is particularly useful in illuminating the distinction between the Anderson insulator and the band insulator phases in terms of *paired sets of dimerized states*.

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