Weakly Bound Quantum Many Body Systems: ^{3}He and Metal Atoms Attached to Clusters of ^{4}He

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The small well depth of the helium-helium interaction and the light mass of helium give rise to extreme floppyness and other quantum effects in helium clusters. Substituting ^{3}He for ^{4}He leads to systems with even less binding whose existence was predicted on the basis of quantum Monte Carlo calculations and confirmed only very recently in beam diffraction experiments.

Metal atoms have become popular probes for the investigation of bulk superfluid helium and helium clusters. Metal-helium potentials are generally even weaker than the helium pair potential. This situation raises the question about the nature of binding between helium clusters and single metal atoms: no binding, formation of a surface state or embedding into the interior.

Quantum Monte Carlo calculations for mixed clusters of ^{4}He and Li, Na, Cu, Ag, Ca atoms illustrate the two binding scenarios and indicate the possible existence of a peculiar surface embedded state. Variational calculations for alkali helium pairs give strong indications for the existence of extremely diffuse bound states which may be relevant for the cooling processes in atom traps.