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Feshbach molecules and repulsively bound atom pairs in optical lattices GREGOR THALHAMMER, KLAUS WINKLER, FLORIAN LANG, RUDOLF GRIMM, JOHANNES HECKER DENSCHLAG, Institute for Experimental Physics, University of Innsbruck, Austria — Three dimensional optical lattices represent an interesting environment for fundamental research with ultracold atoms. We have prepared atomic Fock states in an optical lattice where individual sites are either empty or filled with two ^{87}Rb atoms in the vibrational ground state of the lattice. With the help of a Feshbach resonance we are able to reversibly convert the pairs of atoms into Feshbach molecules with almost unit efficiency. We observe long molecular lifetimes because the lattice shields the trapped molecules from collisions and thus overcomes the problem of inelastic decay by vibrational quenching. Aside from the conversion into molecules, the atomic pairs themselves are very interesting to study because they exhibit counterintuitive and paradoxical behavior. Even though the two atoms in a lattice site effectively repel each other and each individual atom can quickly hop between lattice sites, pairs of atoms do not separate but form a metastable bound state. This can be explained by a strong restriction in phase space due to the lattice which forbids shedding of the repulsive potential energy of the pair. We have investigated the properties and stability of these strange two-body bound states.

Gregor Thalhammer
Insitut for Experimental Physics, University of Innsbruck,
Technikerstr. 25/IV, 6020 Innsbruck, Austria

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