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Synopsis If coherent superpositions such as the symmetry eigenstates *gerade* and *ungerade* are in turn coherently superimposed, localization occurs. This effect is studied by the intensities of the Doppler components of electrons emitted from dissociating fragments of superexcited O_2. The measurements show clear evidence for such coherent localization.

Homonuclear diatomic molecules are inversion symmetric systems which form eigenstates of the parity operator known as *gerade* and *ungerade* states. These states are non-local superpositions of charge distributions on both nuclear sites of the molecule with a phase shift of 0 and π, respectively. Due to this intrinsic character a coherent superposition of these states generates a localized state either on the left or on the right side. Such a coherent superposition of two parity eigenstates with different symmetries occurs on top of the broad $3s\sigma$ shape resonance of O_2 because the narrow $3s\sigma$ Rydberg excitation is sitting just near its maximum. This gives rise to interference causing coherent localization of the emitter position of the autoionizing electron. As a result of this localization in an electron-ion coincidence experiment the two Doppler components of the corresponding electron have unequal intensities. The so called wrong component where the red-shifted electron moves along with the ion has only half of the intensity of the right component where the blue-shifted electron moves along with the ion. This unexpected experimental result could be confirmed by a numerical simulation which takes known values of the decay life time, the splitting of the excited symmetry states and the conical intersection of the corresponding potential curves into account. The result is in very good agreement with the measurements.

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