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**Quasi-bound state lifetimes and classical periodic orbits in HOCl**

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— We use a discrete variable representation together with reaction matrix theory to calculate the quasi-bound states of a Chlorine atom scattering off a diatomic molecule of Hydrogen and Oxygen. The lifetimes of these quasi-bound states are found to vary over six orders of magnitude in a very small energy window. By examining Husimi distributions for various quasi-bound states we show that the longest-lived quasi- bound states are anchored by an island of stability surrounding a stable periodic orbit in the otherwise chaotic classical phase space. This stable periodic orbit, which corresponds to Chlorine rotating around the HO molecule, is responsible for the very long lifetimes of these quasi-bound states.

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