A Single Atom Antenna

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Synopsis Here we demonstrate the smallest possible implementation of an antenna-receiver complex which consists of a single (helium) atom acting as the antenna and a second (neon) atom acting as a receiver.

In radio technology antennas are used to efficiently collect energy from the electromagnetic field. In the optical regime nano-scale antennas have been developed [1] and in nature specialized antenna molecules efficiently collect the visible light for light harvesting. Schematically all these systems consist of the antenna itself which couples to the radiation field, a receiver which uses the energy and a route to transport the energy between them.

Here we demonstrate the smallest possible implementation of such an antenna-receiver complex which consists of a single (helium) atom acting as the antenna and a second (neon) atom acting as a receiver [2,3]. We investigate the ionization of HeNe from below the He 1s3p excitation to the He ionization threshold. We observe $HeNe^+$ ions with an enhancement by more than a factor of 60 when the He side (the antenna atom) of the antenna couples resonantly to the radiation field. The energy transfer occurs via Interatomic Coulombic Decay (ICD) [4]. The $HeNe^+$ ions are an experimental proof of a two-center resonant photoionization mechanism predicted by Najjari et al. [5]. Furthermore, our data provide electronic and vibrational state resolved decay widths of interatomic Coulombic decay in HeNe dimers. We find that the interatomic Coulombic decay lifetime strongly increases with increasing vibrational state.

The non-dissociating as well as the dissociating case (see Figure 1) will be discussed in detail.

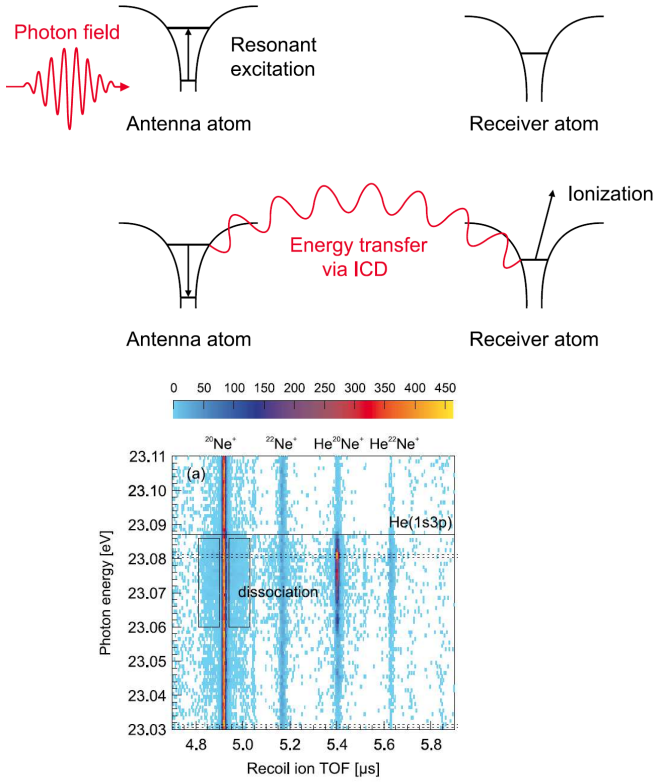

Figure 1. Schematic of the antenna mechanism and experimental results: Ion time of flight versus photon energy in the vicinity of the He(1s3p) resonance.

References

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