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Structure and field-induced dynamics of small helium clusters

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Small helium clusters are peculiar few body quantum systems. The helium dimer has a single weakly bound state of a huge spatial extent. About 80% of its probability distribution resides in the classically forbidden tunneling region [1]. This is why such objects are termed “quantum halos”. The helium trimer has two bound states, excited one of which is of Efimov nature [2]. We utilize laser-triggered Coulomb explosion imaging for measuring spatial probability distributions of these quantum objects. Application of an additional laser pulse in a pump-probe manner allows us to observe the structural response dynamics of small helium clusters upon interaction with a strong laser field on a picosecond time scale.

The results of our experimental approach on He₂ [3] and He₃ will be discussed.

[1] S. Zeller et al., PNAS 113(51), 14651 (2016). DOI: 10.1073/pnas.1610688113

[2] M. Kunitski et al., Science 348(6234), 551 (2015). DOI: 10.1126/science.aaa5601

[3] M. Kunitski et al., Nature Physics 17(2), 174 (2021). DOI: 10.1038/s41567-020-01081-3

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