17a-C4-5

Nuclear Reaction by Laser Induced Proton Recollision

RIKEN Center for Advanced Photonics ○Katsumi Midorikawa and Erik Lötstedt

E-mail: kmidori@riken.jp

Laser induced electron recollision, where an electron is first liberated from an atom or molecule by an intense laser field, and then accelerated by the same field so that it returns close to the core with a high kinetic energy, is a central concept in strong-field physics [1]. Given that a lot of interesting atomic and molecular physics has been investigated with recolliding electrons, it is natural to try to extend the recollision scheme to heavier particles such as protons. If we could make a proton recollide with another nucleus at a kinetic energy of around 1 MeV or above, various nuclear reactions could be triggered, with attosecond temporal control of the collision event.

Here, nuclear reactions induced by proton recollision with a nearby nucleus are studied in a setup where a neutral molecule is exposed to an extremely intense, few-cycle laser pulse. At the rising edge of the laser pulse, all electrons in the molecule are first ejected by field ionization, resulting in a molecule consisting of the bare nuclei only. A proton in the bare molecule is subsequently accelerated by the laser field in such a way that it recollides with a nearby, heavier nucleus, with a kinetic energy high enough to induce a nuclear reaction. As a specific example, the probability of triggering the $^{15}N(p, \alpha)^{12}C$ reaction by exposing either a ^{15}NH molecule or a $^{15}NH_3$ molecule to an intense laser pulse is calculated using the classical trajectory Monte Carlo method. We show that the proton recollision process can be controlled both by varying the carrier-envelope phase of the laser field and by the degree of molecular orientation [1]. We also find that the magnetic field of the laser pulse plays a crucial role in the recollision dynamics.

References

[1] P. Corkum, Phys. Rev. Lett. **71**, 1994 (1994).

[1] Erik Lötstedt and Katsumi Midorikawa, Phys. Rev. Lett. **112**, 093001 (2014).

© 2014 年　応用物理学会