Ultra-high charge electron acceleration for intense nuclear excitation

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The laser plasma acceleration is not only suitable for advance accelerator, but also possess great potential for plasma exciter or collider. At present, main research topics focus on the quality improvement of accelerated electrons. On the other hand, the laser plasma accelerator also has extremely high electron charge which will produce high brightness gamma ray source and intense neutron source, resulting in powerful tool for nuclear physics research.

Recently, our team has carried out systematic studies on electron acceleration with large charge. For example, we used a solid target to realize relativistic electron acceleration of 100 nC [1] with very small divergence angle; And achieved stable acceleration of ~ 20 nC and electron energy of tens MeV in high-density gas targets through a novel efficient injection that the atom inner shell electrons are ionized and continuously injected into multiple plasma bubbles [2].

Based on new results of electron acceleration obtained, we have carried out the research of "laser-plasma exciter". Firstly, a high brightness neutron source [3] is obtained by driving a solid target with an electron beam. And then, using the nonlinear resonance of Kr clusters excited by intense laser, the 83Kr isomeric state is achieved experimentally with peak efficiency 2x10^15 p/s [4]. And also, with optimized high charge electron beam driven (γ,n) reaction, the peak flux of neutron source reaches to 10^21 n/cm^2/s, which is comparable to Supernova.

In order to carry out the experimental verification of laser "plasma exciter" and extremely strong field QED, we are constructing the "laboratory astrophysics research platform" (LAP) in Tsungdao Lee Institute, for the nuclear astrophysics research in relativistic.

References

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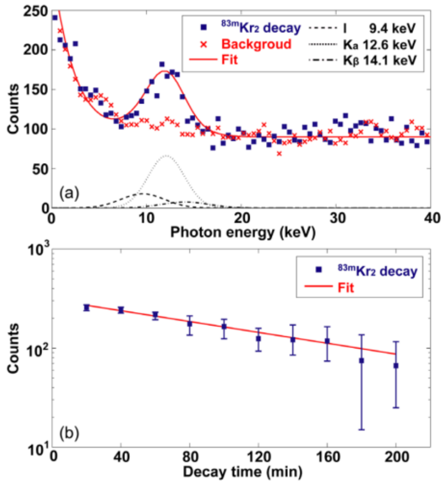
3. J. Feng *et al.*, HEDP 36, 100753(2020);
4. J. Feng *et al.*, PRL 128, 052501(2022)

Figures



Detected 83Kr isomeric state and decay characteristics