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Research on He^- Ion Beam Generation Technology for Tandem Accelerators and Experimental Optimization

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To address the negative ion injection requirements of tandem accelerators, this study proposes a He^- ion beam generation technology based on a dual charge-exchange mechanism. Given the technical bottleneck caused by the negative electron affinity of ground-state helium atoms, which prevents direct He^- ion production, an innovative cascade charge-exchange pathway ($He^+ \rightarrow He^0 \rightarrow He^-$) is adopted. A self-designed metallic cesium vapor charge-exchange cell is developed, incorporating a thermal equilibrium temperature field model to optimize the operational temperature range, thereby ensuring stable cesium vapor density and enabling long-term stable operation of the charge-exchange medium. Experimental validation was conducted at the Ion Source Experimental Platform of the China Institute of Atomic Energy. This research provides a reliable solution for generating MeV-level He ion beams in tandem accelerators, and the parameter optimization methodology holds universal reference value for heavy-element negative ion beam production.

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