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技术及应用

千兆电子伏重离子加速器——兰州冷却储存环

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摘要 能量达千兆电子伏的兰州重离子加速器冷却储存环HIRFL-CSR，是一个集加速、累积、电子冷却及内外靶实验于一体的多功能双冷却储存环同步加速器系统，由主环CSRm和实验环CSRe构成，并以兰州重离子回旋加速器系统HIRFL作注入器。CSR将重离子束的能量从兆电子伏提高到千兆电子伏，同时利用空心电子束冷却技术将束流的动量分散及发射度降低1~2个数量级，并提供多种类的高电荷态重离子束以及放射性次级束(RIBs)，以开展更高精度的物理实验及更广范围的应用研究。兰州冷却储存环于2006年建成并投入运行，实现了剥离注入与多圈注入、空心电子束对重离子束的冷却与累积、变谐波宽能区同步加速、等时性环型谱仪、RIBs的产生与收集以及重离子束的快慢引出，并实现了高能重离子束的空心电子束冷却，使得重离子束的动量分散降低到10^{-5}量级，而发射度收缩到0.1 πmm•mrad以下。同时，完成了短寿命近滴线核素的高分辨质量测量物理实验及高能重离子束深层治癌的临床应用实验。

关键词 冷却储存环 累积 电子冷却 放射性次级束 重离子治癌

分类号

Heavy Ion Synchrotron and Cooler-Storage-Ring in Lanzhou

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Abstract

The heavy-ion synchrotron complex HIRFL-CSR is a new cooler-storage-ring system in Lanzhou; it consists of a main ring (CSRm) and an experimental ring (CSRe). The existing cyclotron facility HIRFL is used as its injector system. The heavy-ion beams from cyclotron with the energy of 7-25 MeV/u will be first injected into CSRm, accompanying with the cooling-accumulation and acceleration, finally extracted slowly with the energy of 500-1 000 MeV/u for external-target experiments, or extracted fast with the energy of 200-700 MeV/u to produce radioactive ion beams (RIBs) or high *Z* beams at the primary target of the beam line, and those secondary beams will be accepted and stored in CSRe for internal-target experiments. The HIRFL-CSR project was finished in 2006, and up to now all the commissioning activities and several experiments were made, including the stripping injection, multi-turn injection, cooling accumulation with hollow electron beam, ramping in the wide energy range with difference RF harmonic number, fast and slow extraction from CSRm, isochronous mode of CSRe, e-cooling for C-ion with the energy of 400 MeV/u, and the experiments of the RIBs mass-measurement in CSRe and the C-ion cancer therapy.

Key words cooler-storage-ring _ accumulation _ e-cooling _ radioactive ion beams _ heavy-ion cancer therapy

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