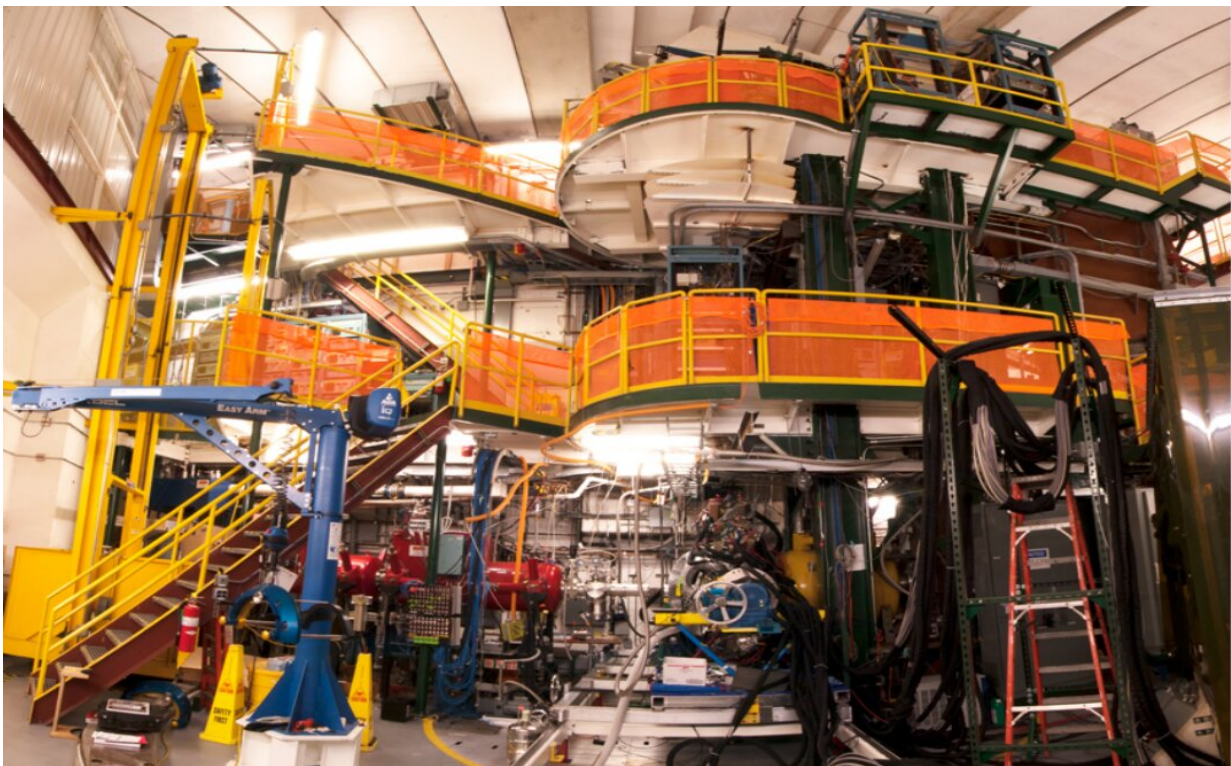


A new measurement of charge-exchange reaction helps to understand core-collapse supernovae

March 24 2020, by Zhang Nannan



The detector setup. Credit: S.Noji

Researchers from the Institute of Modern Physics of the Chinese Academy of Sciences, together with collaborators, have lately made progress in the study of the electron-capture rates of the ^{93}Nb by using

the charge-exchange reaction, which sheds light on core-collapse supernovae (CCSNe).

Some [massive stars](#) end their life as CCSNe, which is the most energetic and mysterious event in the universe. A large amounts of energy will be released during CCSNe and the whole galaxy can be lighted up. Decades of efforts have been devoted to understanding CCSNe while some open questions still remain.

Computer simulation is an important tool to help researchers understand the interior of CCSNe. One of the important physical inputs in CCSNe simulations is the electron-capture rate. Previous studies have shown that a group of neutron-rich nuclei in the N=50 region contribute most strongly in capturing electrons, hence reducing the electron fraction and changing the composition of the collapsing stars. However, electron-capture rates of neutron-rich nuclei cannot be directly studied in the terrestrial environment, for this kind of reaction is endothermic and just does not happen in the terrestrial environment.

In this work, researchers studied the electron-capture rates of the ^{93}Nb —in the vicinity of the above-mentioned N=50 region—by using the $^{93}\text{Nb}(t, ^3\text{He}+\gamma)$ charge-exchange reaction. The experiment was performed in the National Superconducting Cyclotron Laboratory in the Michigan State University. The high precision S800 spectrometer in combination with the Gamma-Ray Energy Tracking In-beam Nuclear Array, GRETINA, was used for the measurement.

The results show that the widely used approximation proposed by K. Langanke et al. for the calculation of electron-capture rates does not take into account the Pauli-blocking effects properly. It fails to predict the experimental electron-capture rates well and therefore, is unsuitable for calculating electron-capture rates in this region, especially in lower stellar density and temperatures.

The study was published in *Physical Review C*.

More information: B. Gao et al. Gamow-Teller transitions to Zr93 via the Nb93(t,He3+ γ) reaction at 115 MeV/u and its application to the stellar electron-capture rates, *Physical Review C* (2020). [DOI: 10.1103/PhysRevC.101.014308](https://doi.org/10.1103/PhysRevC.101.014308)

Provided by Chinese Academy of Sciences

Citation: A new measurement of charge-exchange reaction helps to understand core-collapse supernovae (2020, March 24) retrieved 26 April 2024 from <https://phys.org/news/2020-03-charge-exchange-reaction-core-collapse-supernovae.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.