Low-lying level structure of ^{56}Cu and its implications to the rp process

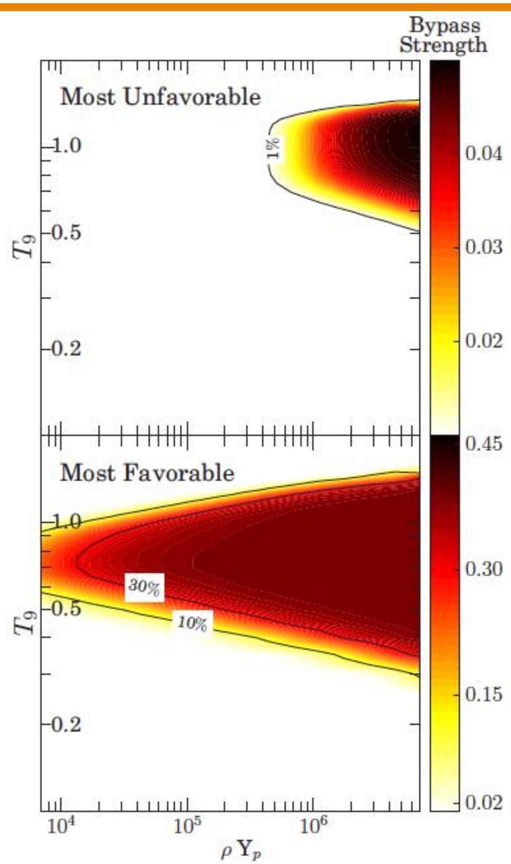

FIG. 7. Phase space diagram showing the region where the bypass may be effective, demonstrating the impact of the remaining nuclear physics uncertainties. The color and contours indicate the strength of the bypass. The most unfavorable (left) and most favorable (right) conditions are chosen to demonstrate the full range of the uncertainties.

The low-lying energy levels of proton-rich ^{56}Cu have been extracted using in-beam γ-ray spectroscopy with the state-of-the-art γ-ray tracking array GRETINA in conjunction with the S800 spectrograph at the National Superconducting Cyclotron Laboratory at Michigan State University. Excited states in ^{56}Cu serve as resonances in the ^{55}Ni(p,γ)^{56}Cu reaction, which is a part of the rp process in type-I X-ray bursts. To resolve existing ambiguities in the reaction *Q*-value, a more localized isobaric multiplet mass equation (IMME) fit is used, resulting in Q = 639 ± 82 keV. We derive the first experimentally constrained thermonuclear reaction rate for ^{55}Ni(p,γ)^{56}Cu. We find that, with this new rate, the rp process may bypass the ^{56}Ni waiting point via the ^{55}Ni(p,γ) reaction for typical X-ray burst conditions with a branching of up to ∼40%. We also identify additional nuclear physics uncertainties that need to be addressed before drawing final conclusions about the rp-process reaction flow in the ^{56}Ni region.

W.-J. Ong *et al.*, Phys. Rev. C **95**, 055806 (2017)