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Discovery of ^{40}Mg and ^{42}Al[1]

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Although very neutron rich nuclei do not exist on earth due to their short lifetimes, they do exist in the cosmos where conditions are met that can produce them. This is the case in the crust of accreting neutron stars, where the high gravitational pressure causes electron capture reactions that form neutron rich nuclei up to the drip line. They also can be formed and detected in the laboratory. The neutron rich nuclei ^{40}Mg and ^{42}Al have now been observed for the first time.[2] While ^{40}Mg has long been predicted by many leading nuclear models to be particle bound, the odd-odd neighbor ^{42}Al was believed to be unbound until now. The discovery was made at the National Superconducting Cyclotron Laboratory, where a primary beam of ^{48}Ca was fragmented on a tungsten target and the very rarely formed isotopes of ^{40}Mg and ^{42}Al, among others, were separated and identified in flight using a two-stage fragment separator. The findings in the laboratory have a direct impact on our knowledge about the cosmos, for these isotopes now have to be included in the composition of the crust of accreting neutron stars. This might have an effect on the crust heating which influences the rate of X-ray superbursts,[3] for which only recently data has become available. The new discoveries are also consequential for theoretical mass predictions, where the uncertainties are still too large for astrophysical applications. Current global mass models differ significantly in the prediction of the neutron drip line in this region. The comparison of the observed isotopes—especially the odd-odd ^{42}Al—to established theoretical model calculations suggests that the drip line lies further out to heavier isotopes.

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[2]Baumann et al. Nature 449 (2007) 1022.

[3]H. Schatz, K. E. Rehm, Nucl. Phys. A 777 (2006) 601.