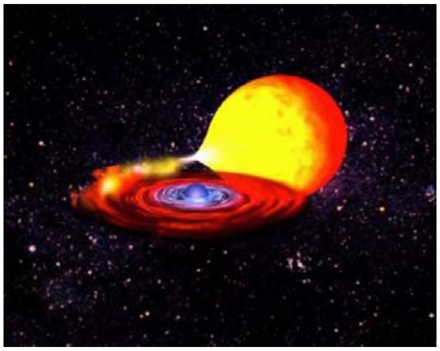
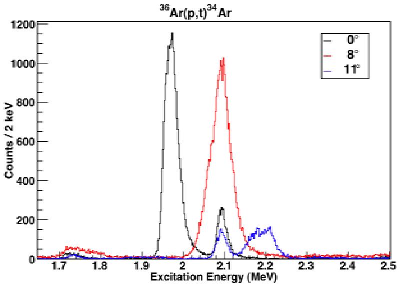
Understanding X-ray Bursts



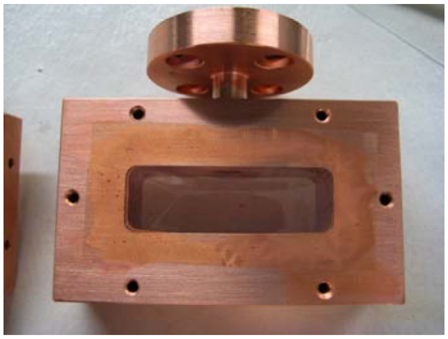
X-ray bursts are some of the most energetic events observed in the cosmos. It is thought that X-ray bursts are the thermonuclear explosions occurring near the surface of accreting neutron stars. The material accreted from the companion star is funneled to the surface of the neutron stars. The extreme density found near the surface of the neutron star provides the environment for explosive Hydrogen and Helium burning.

To understand the mechanism responsible for producing X-ray bursts, it is necessary to determine the reaction rates of the nuclear processes that occur during these events. We have performed a series of (p,t) reactions at the Research Center for Nuclear Physics (RCNP) in Osaka, Japan, in order to measure the energy of the excited states in the radioactive nuclei ^{30}S, ^{34}Ar and ^{38}Ca. Using the Grand Raiden spectrometer and the dispersion matching technique, we were able to measure up to 12 MeV in excitation energy with errors on the order of 10 keV. Many of the states were observed for the first time. This data will allow, also for the first time, the reaction rate calculations involving these nuclei to be based on experimental measurements. The reaction rates based on these measurements will be used to test the current reaction rate calculations that are based on the statistical model.

With a better understanding of the mechanism governing the explosive X-ray bursts, it is possible to determine the final abundance distribution following a burst, and therefore the abundance distribution that falls back onto the neutron star crust. This information is vital for the correct interpretation of the astronomical observations of neutron stars and to determine the physics occurring on their surfaces.



^{36}Ar(p,t)^{34}Ar data taken from three spectrometer angles (0, 8 and 11 degrees) are shown. The large peak seen in each spectra is a background peak coming from ^{12}C contamination on the target. Analyzing all three data sets allow for the unambiguous identification of the ^{34}Ar peak at 2.1 MeV, a peak that is completely covered by background in the 8 degree specta.



Picture of the gas cell used to perform the ^{36}Ar(p,t)^{34}Ar measurement. Thin (6 micron) Aramide foils were used as cell windows. This represents the first time an extended target was used with dispersion matched beam for a transfer reaction. The states in ^{34}Ar were determined with errors on the order of 10 keV

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