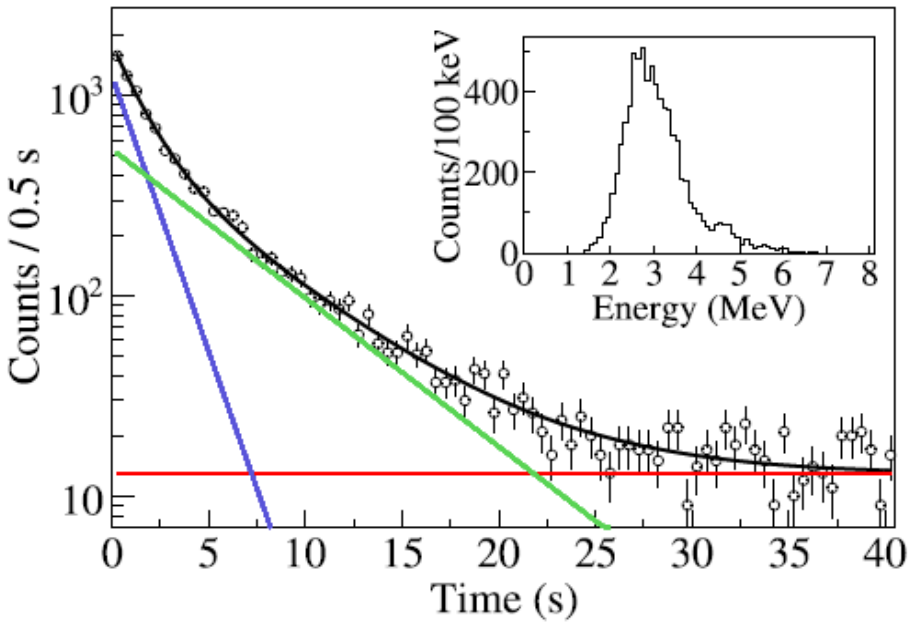
Rapid proton capture waiting points revisited: ^{97}Cd found to have long lived excited state

X-ray bursts are frequently observed by space based X-ray observatories – about 90 sources are known in the Galaxy and many burst at least once a day. Its the nuclear reactions in the rapid proton capture process that power type I X-ray bursts. To model burst light curves the lifetimes of so called waiting points (isotopes that have to decay before the reaction sequence can proceed) have to be known.

The beta decay half-life one of these waiting points, ^{97}Cd, had been measured before. However, a JINA led experiment at the National Superconducting Cyclotron Laboratory at Michigan State University has now discovered that ^{97}Cd has a long lived excited state, as so called isomer, corresponding to a very high spin of the nucleus. This isomer has long been predicted by theory and had since been searched. The experiment provided first evidence for the existence of this isomer and was able to disentangle the decays of ground and isomeric states. It was found that they actually decay with different half-lives: the ground state decays faster with a half-life of 1.1s while the isomeric state is longer lived with a half-life of 3.8s. Previous experiments measured a mixture of the decays. However, in X-ray bursts ^{97}Cd is believed to exist mostly in its ground state – therefore, models have to be corrected and the shorter 1.1s half-life now has to be implemented.

The experiment also found a probability for a proton to be emitted in the decay to be substantial – 12% for the ground state, and 25% for the isomeric state. However, these probabilities are not high enough to sufficiently enhance the production of ^{96}Ru, which is the end-product of the decay of ^{97}Cd when a proton is emitted. ^{96}Ru is found in unexplained large quantities on Earth and X-ray bursts were considered one possible source. When implementing the new data together with the previous JINA measurements of ^{96}Cd in X-ray burst models it is now clear that X-ray bursts are not a viable candidate for explaining the origin of ^{96}Ru.



Decay curve of ^{97}Cd. The data points are well fitted when using the sum (black) of the short lived ground state decay (blue) and the longer lived isomeric decay (green) together with some background (red). The inset shows the energy distribution of the emitted protons.

Publication: G. Lorusso et al., Phys. Lett. B 699 (2011) 141
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