^{73}Sr β-delayed proton emission and the structure of ^{73}Rb

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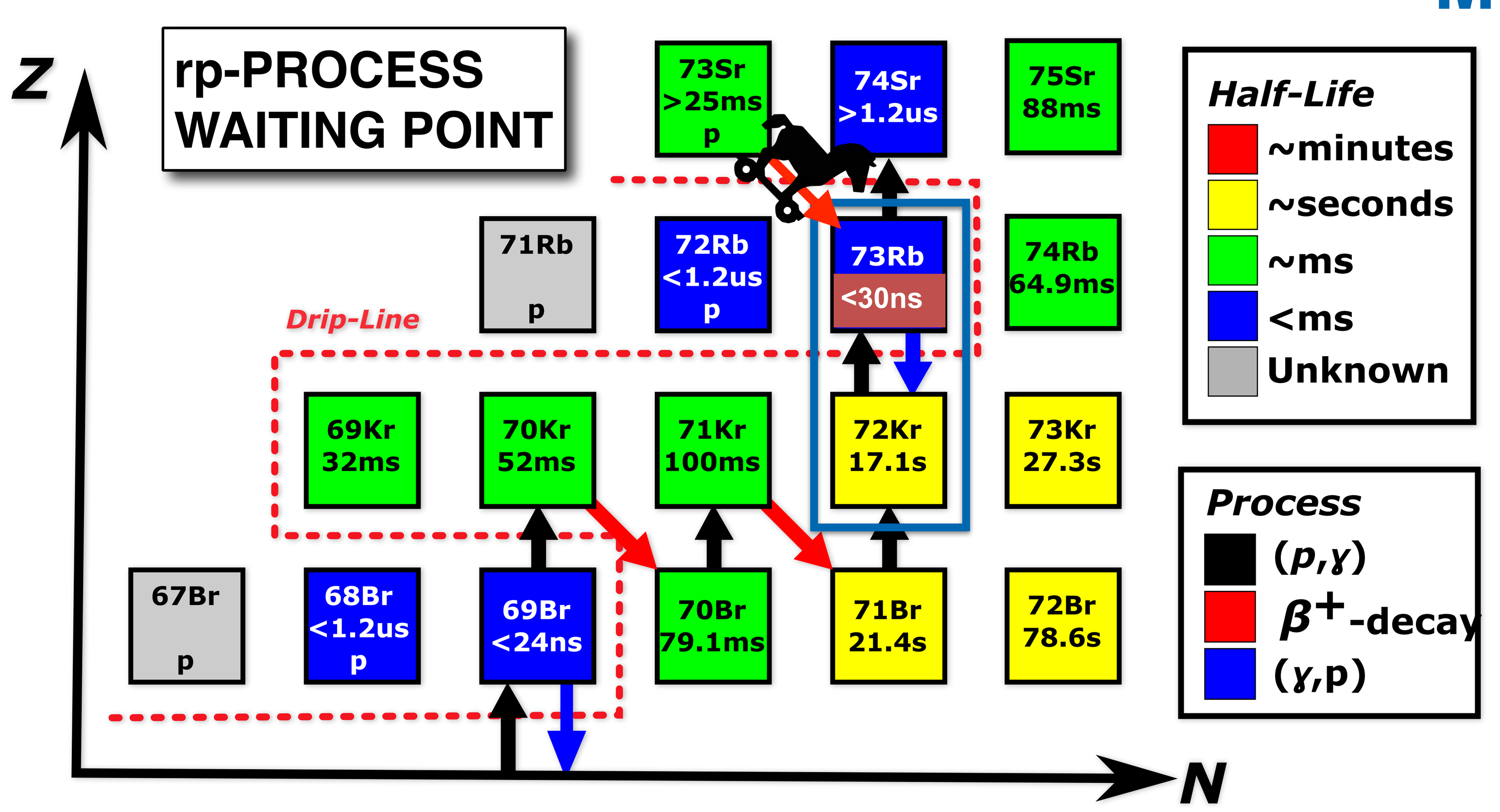
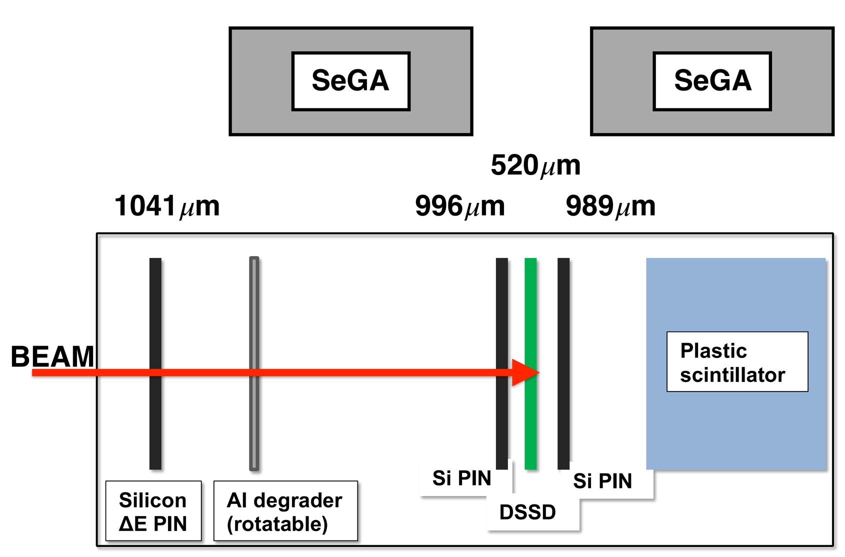
Motivation

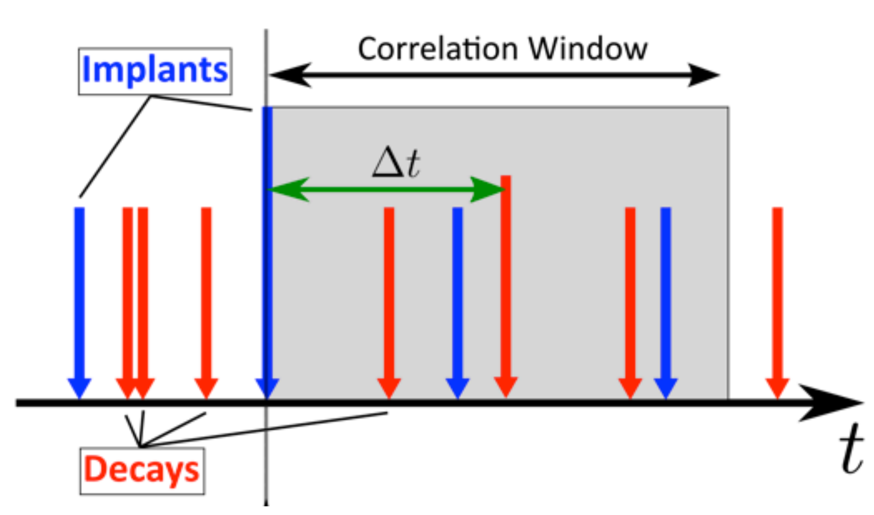


- Studied ^{73}Sr beta-delayed proton emission to understand role of ^{72}Kr waiting point in rapid-proton capture process (rp-process).
- Unable to measure short-lived ^{73}Rb directly in fragmentation experiments .
- Used "Trojan Horse" method to populate ^{73}Rb through beta-decay of ^{73}Sr and study proton emission in implantation-decay experiment.
- Goal: *Measure ^{73}Rb separation energy (presented below)*
- Discovered significant branching of ^{73}Rb*(IAS) decay, which is only explained by spin assignment $J^{\pi} = 5/2^-$, ***suggesting isobaric-spin symmetry breaking***!

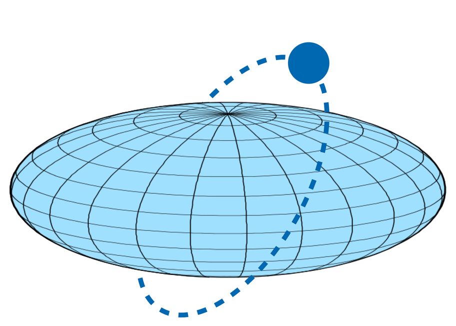
Experimental Method

- The experiment was performed at the NSCL using the Beta Counting Station surrounded by SeGA.
- Used a ^{92}Mo primary beam to create ^{73}Sr secondary beam.
  - ^{73}Sr beam purified a factor of 4500 by Radio Frequency Fragment Separator (RFFS).
- Ions implanted into a DSSD detector for spatial correlations of implantation and decay events.
- Data were collected using the digital data acquisition system (DDAS) allowing for offline determination of correlations and waveform analysis.





Gamow Coupled-Channel Analysis



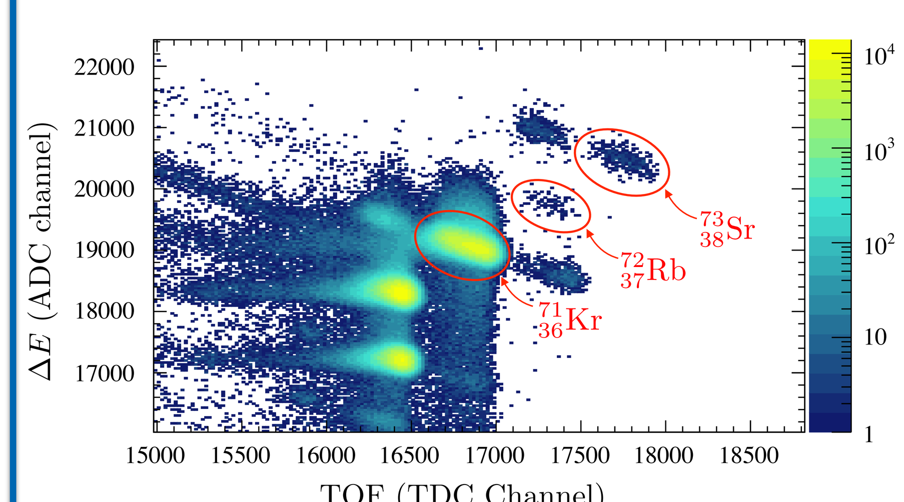
Deformed core (^{72}Kr) + valence proton

A=73 mass region has complicated deformation so calculations were done for different deformations and spin assignments.

$J^{\pi}=5/2^-$ is best solution!

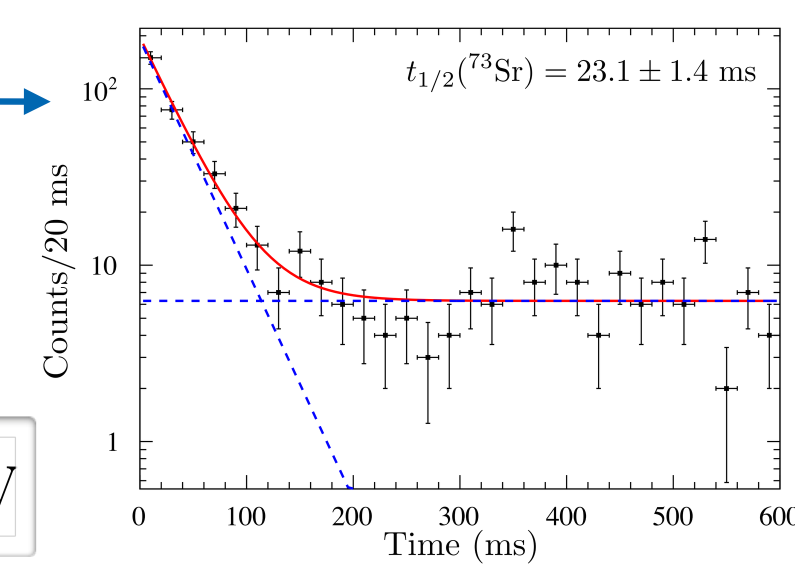
Transitions	Γ_p (keV)	Branching	Configurations
$5/2^- \to$ g.s. band (oblate) ^{72}Kr-$\beta_2 = -0.34$	1.75	49.56% 0^+ 49.54% 2^+ 1.05% 4^+	51.37%$(f_{5/2}, 0^+)$ 34.99%$(f_{5/2}, 2^+)$ 6.15%$(p_{1/2}, 2^+)$ 6.32%$(f_{5/2}, 4^+)$
$1/2^- \to$ g.s. band (oblate)	39.78	99.56% 0^+ 0.37% 2^+ 0.07% 4^+	78.84%$(p_{1/2}, 0^+)$ 19.79%$(f_{5/2}, 2^+)$ 0.98%$(p_{3/2}, 2^+)$ 0.40%$(h_{9/2}, 4^+)$
$5/2^- \to$ g.s. band (prolate) ^{73}Br-$\beta_2 = 0.4$	7.27	8.20% 0^+ 90.50% 2^+ 1.21% 4^+	23.10%$(f_{5/2}, 0^+)$ 40.69%$(p_{1/2}, 2^+)$ 20.17%$(f_{5/2}, 2^+)$ 10.81%$(f_{5/2}, 4^+)$
$1/2^- \to$ g.s. band (prolate)	30.47	98.54% 0^+ 0.81% 2^+ 0.63% 4^+	52.26%$(p_{1/2}, 0^+)$ 42.80%$(f_{5/2}, 2^+)$ 2.58%$(p_{3/2}, 2^+)$ 1.87%$(h_{9/2}, 4^+)$

Experimental Analysis

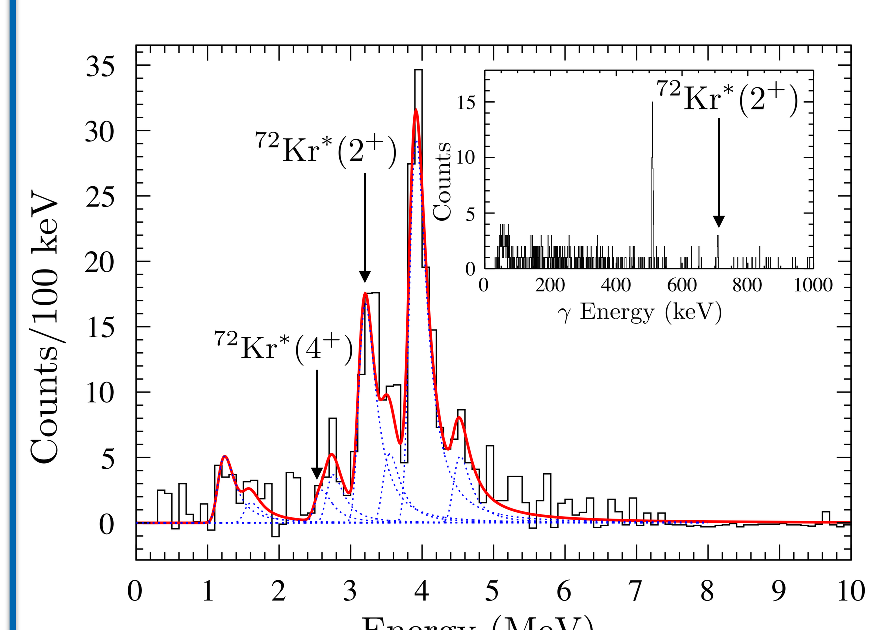


PID done with energy loss from first Si PIN in stack, and time-of-flight (TOF) between A1900 scintillator and second Si PIN in the stack. ^{73}Sr is well separated.

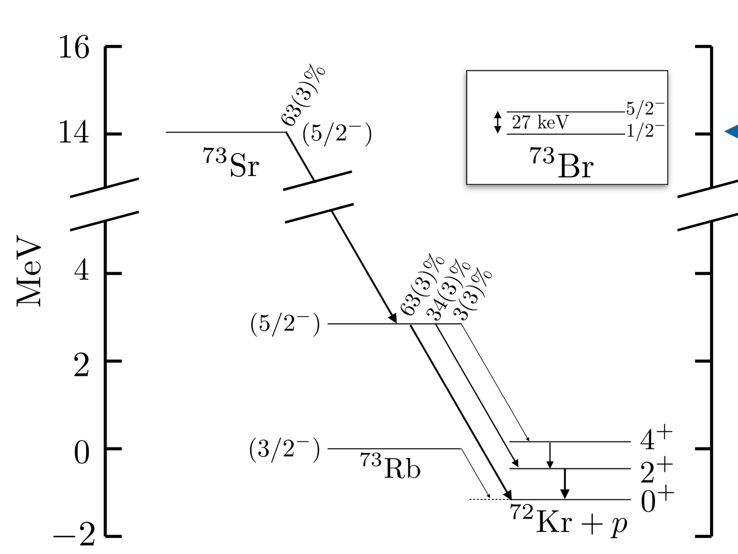
Correlated time between implantation and decay events of ^{73}Sr. First direct measurement of ^{73}Sr halflife.



$$^{73}\mathrm{Rb}\ S(p) = -1160^{+150}_{-30}\ \mathrm{keV}$$



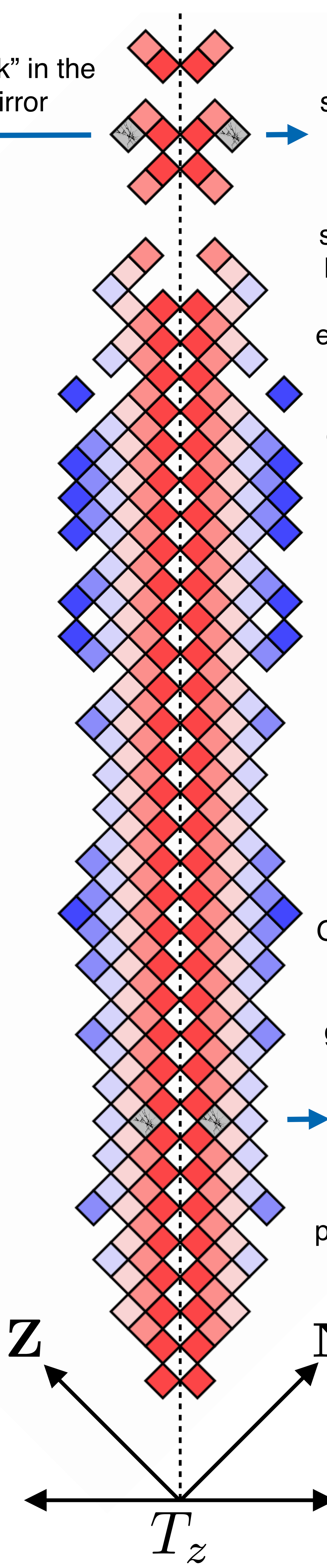
Energy spectrum of β+proton decay events detected in the DSSD. The observation of 709 keV γ rays correlated with the decays confirm branching to ^{72}Kr*(2^+).



Branching explained by Gamow Coupled-Channel calculations (courtesy Simin Wang). Small admixture of $p_{1/2}$ orbital (from deformation) allows for significant branching to ^{72}Kr*(2^+).

Mirror Chart

"Crack" in the mirror



Isobaric-spin symmetry breaking observed not well explained by Thomas-Ehrman shift, where loosely bound or unbound valence protons experience different forces based on their orbital configuration. The T_z=3/2 mirror pair ^{73}Sr and ^{73}Br are particle bound.

Only other isobaric-spin symmetry breaking between ground states is in A=16, T_z=1 mirror pair. This is well explained by Thomas-Ehrman shift since ^{16}N is particle bound while ^{16}F is not.

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