Observation of Ultra-fast transitions in A~50 Mass Region following the $^{20}Ne + ^{40}Ca$ reaction @150 MeV.

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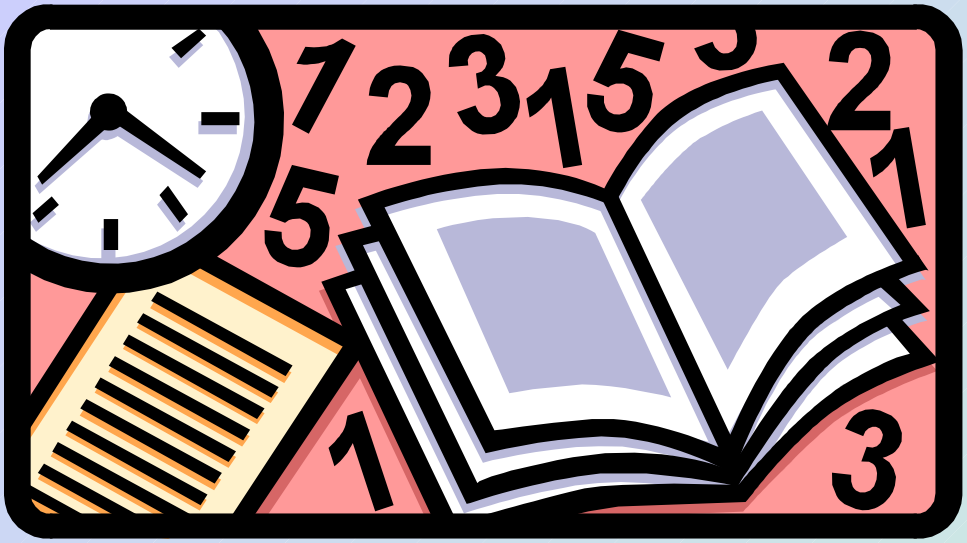
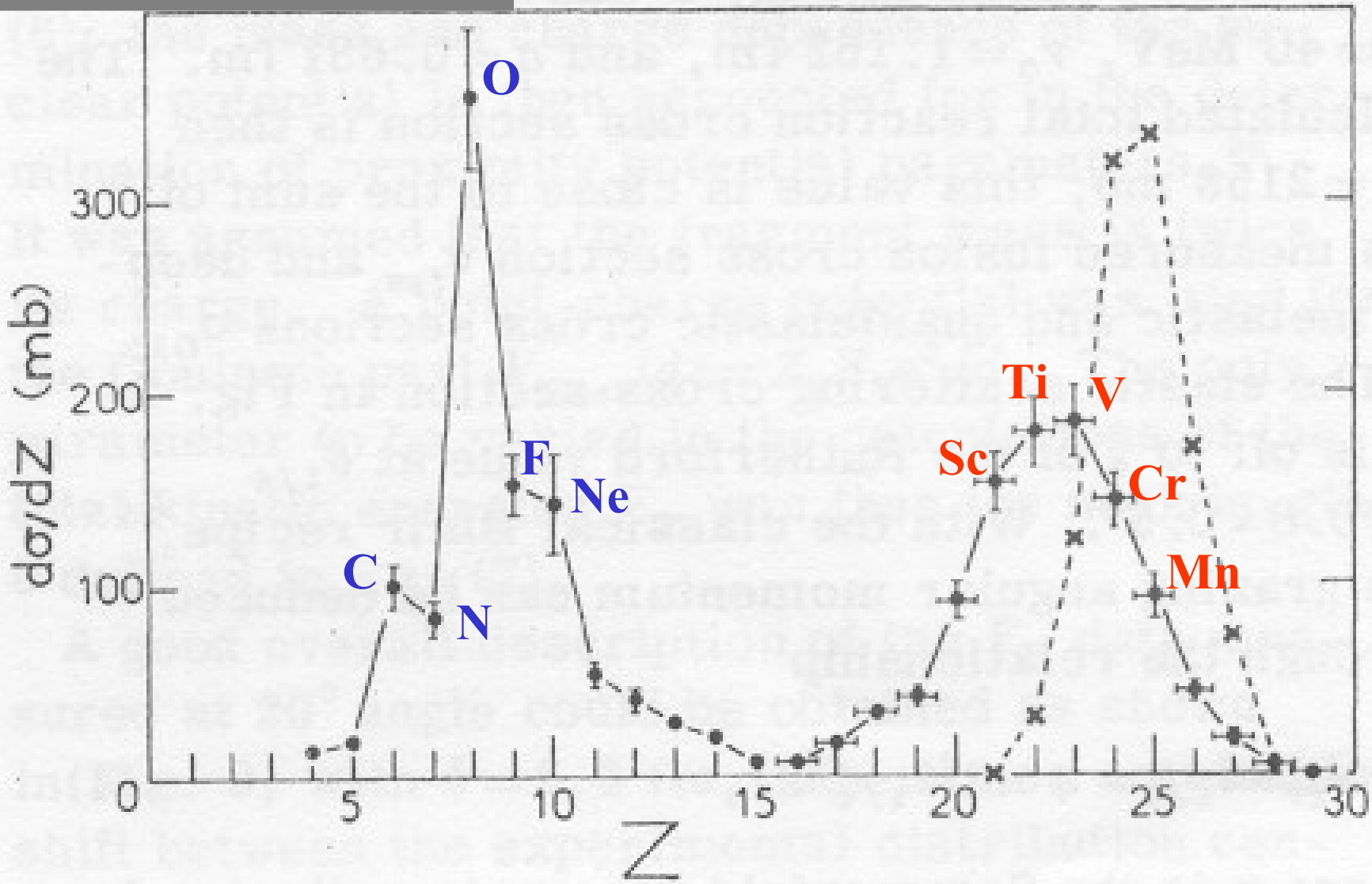


Cross-section measurements for the $^{20}Ne + ^{40}Ca$ reaction @ 150 MeV, were reported by Nguyen Van Sen *et al.* in PRC 22, (1980) 2424.

$^{20}Ne + {}^{40}Ca$ @ 150 MeV

[PRC22 (1980) 2424



The Full line → Measured Data

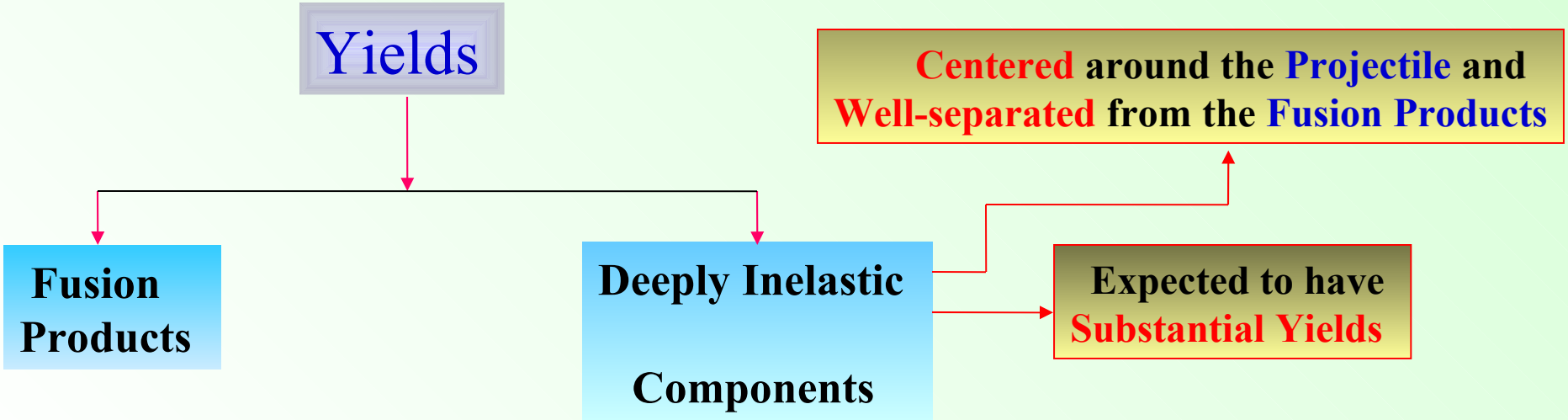
Dashed Line → Evaporation Residue Distribution Calculated with ALICE Code

Not only Fusion ….But Deeply Inelastic Reactions are equally dominant.

Simple Classical calculations predict that

@ 151 MeV,

Fusion Cross section ~ **(1/2)** of The Total Reaction Cross section



Physics Motivation ????

Most of the Populated Nuclei

are $f_{7/2}$ – shell nuclei → (Proton Number between the Magic Numbers 20 and 28)

Middle of the Shell $f_{7/2}$ → **Characterized by Large Deformation near the Ground state**

Moving away towards the End of the Shell $f_{7/2}$ → **The Collective Behaviour is replaced by Single - Particle Effects.**

With Increasing Excitation Energy

Single – particle Degrees of freedom and the Collective ones Compete to produce…….

→ **Band Termination**
→ **Shape Changes**
→ **Backbending Effects**

Earlier Difficulties in the study of the $f_{7/2}$ – shell Nuclei through Fusion-evaporation Reactions….

Investigation of High-spin states undergoes Experimental Difficulties due to……

Low Angular Momentum transferred via Heavy-Ion Fusion-evaporation reaction Because of the small masses of the Reaction Partners

Low Coulomb Barrier leads to a large number of Competing Reaction Channels with Evaporation of Charged Particles

Solution :

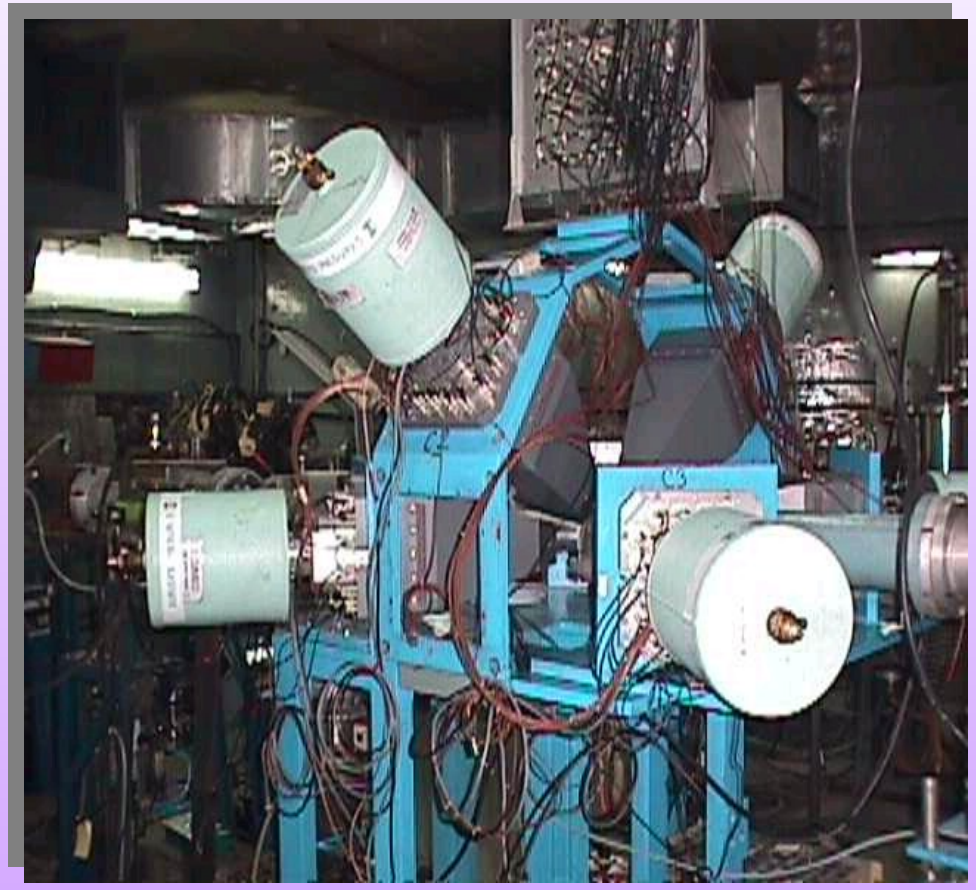
Moderately Large Gamma – ray Arrays and non-equilibrated reaction mechanism to populate & investigate higher angular momentum states in these nuclei.

…….We Opted for

Indian National Gamma Array

(Then at VECC,Calcutta, INDIA)

Array of Six Clovers



- Mounting Structure
  - Vertical Ring
    - Supports Six Clovers
  - Median Plane
    - Supports Four Clovers
- Present Set-up
  - Two at 40^0 Forward
  - Two at 90^0
  - Two at 125^0 Backward

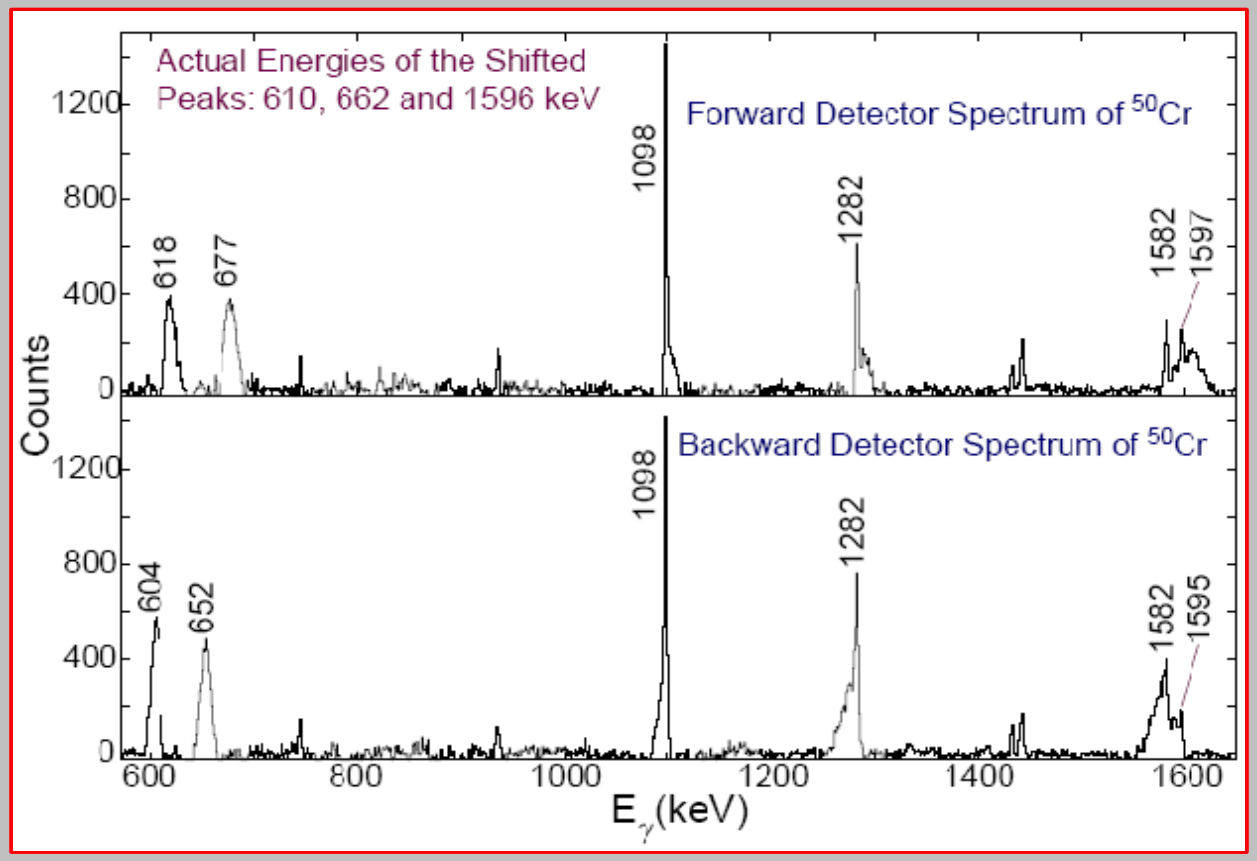
Electronics & DAQ System

- **Integrated Electronics Modules(from NSC) for Clover Detectors were used.**
- **Data Acquisition was done using a CAMAC-based multi-parameter system "LAMPS".**
- **E_γ, T_γ and RF- Gamma were recorded.**
- **The entire electronics & DAQ were housed in the cave.**

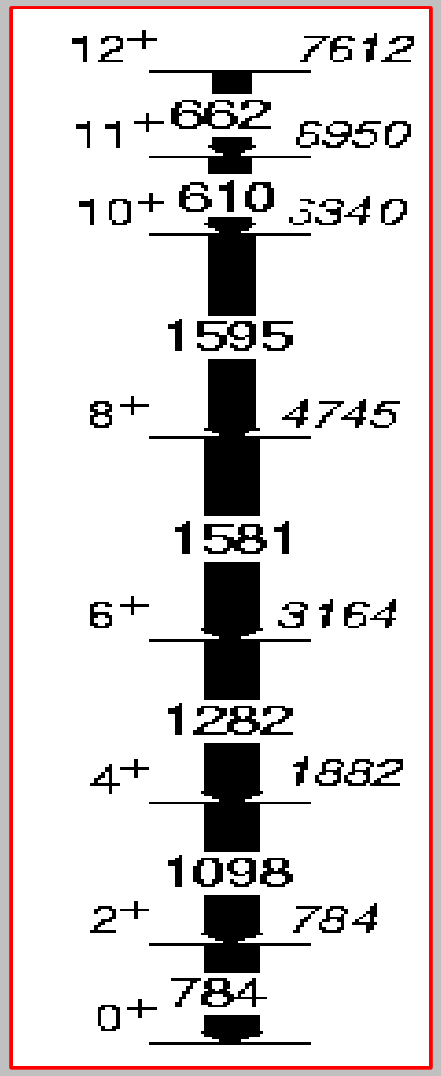
Experimental details

Beam :	**^{20}Ne with 6^{+} charged state**
Beam Current :	**~1 nA**
Target Chamber:	**A compact uniformly thick Al chamber with conical entrance and exit ports**
Target :	**Natural Ca sandwiched between two mylar films Front Mylar thickness ~ 4 μm Backing Mylar thickness ~ 25 μm**
Target Thickness:	**5mg/cm^2**
Event Rate :	**~ 2.5k/sec**
Events Recorded:	**~80 Million Gamma-Gamma Coincidence Events were Recorded.**

Fast Transitions in ^{50}Cr



Representative Gated γ Spectrum
(**Fingerprint** of a Nucleus !!!!!)

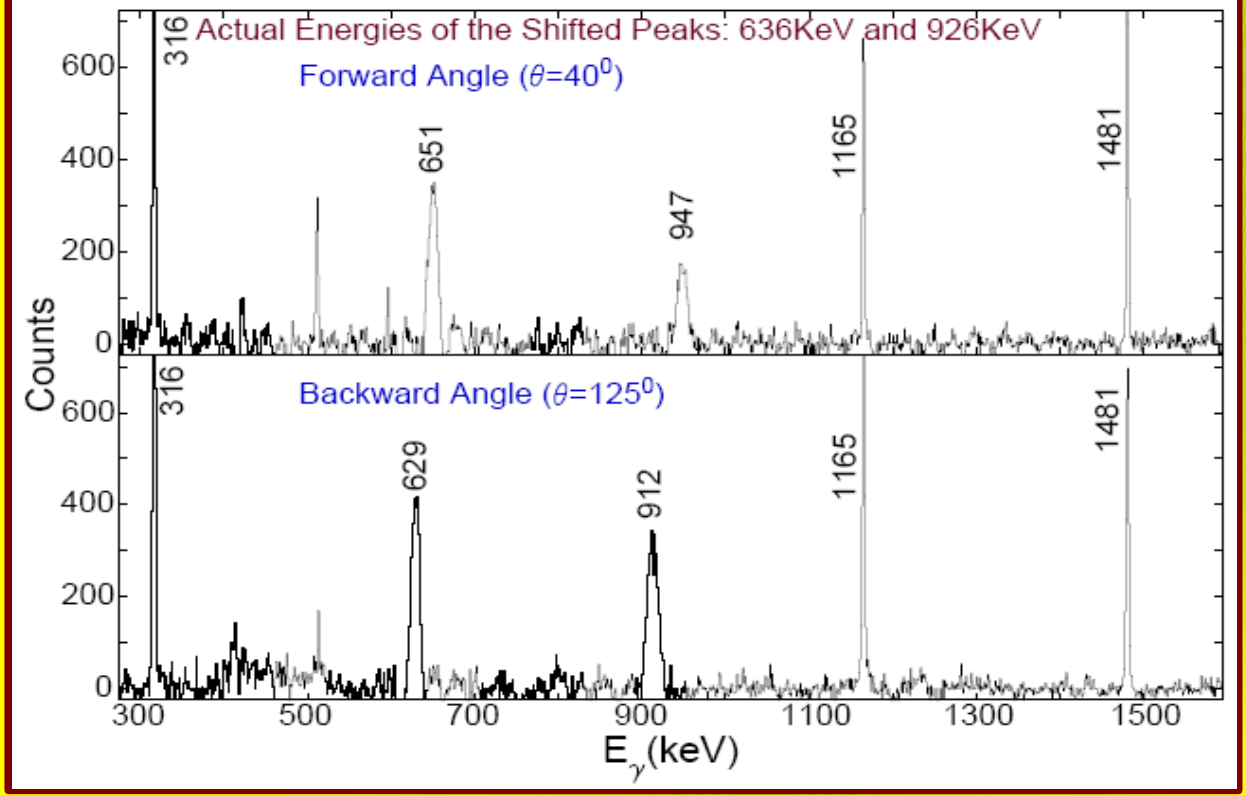


Partial Level Scheme of ^{50}Cr

Huge Doppler Shift in Transitions above $15/2^-$ level in ^{51}Cr !!!!

Nuclear Level Lifetime << Stopping time of the Recoil

Gamma-rays are emitted in flight



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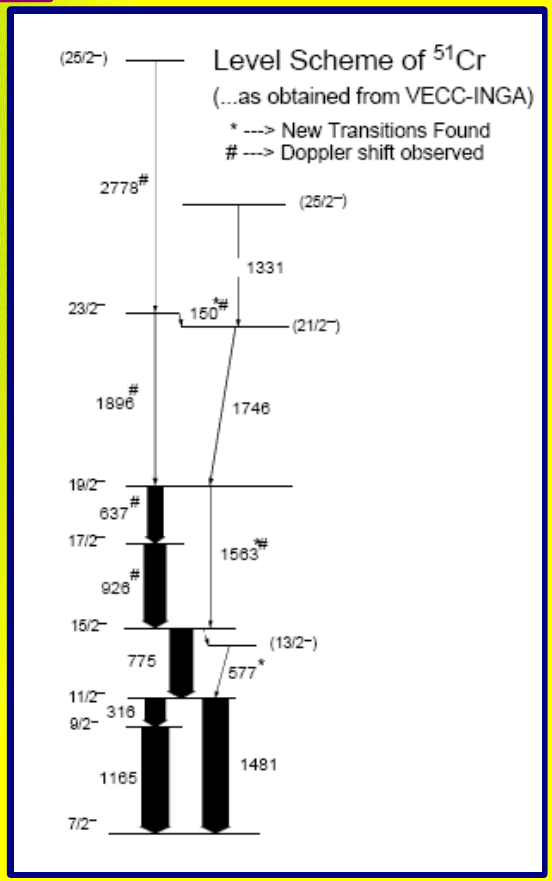


Partial Level Scheme of ^{51}Cr

Turned towards the Calculation of Fractional Doppler Shift

....A Measurement of Nuclear Level Lifetime

Shifted γ–Energy

Detector Angle

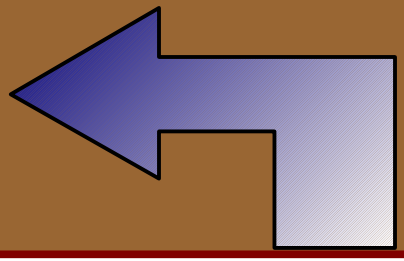
$$E_s \approx E_0\left(1+\frac{v}{c}\cos\theta\right)$$

Actual Un-shifted γ–Energy

$$F(\tau) = \frac{v_{av}}{v_0} = \frac{1}{v_0\tau}\int_0^\infty v(t)\exp\left(-\frac{t}{\tau}\right)dt$$

Fractional Doppler Shift

Our Aim:



To measure Experimental F(τ)

To simulate Theoretical F(τ)

To extract Effective Lifetime after comparing them

To extract Mean Lifetime of the Nuclear Levels after applying the Feeding correction

Difficulties:

1> Thick Target

2> Different Reaction Mechanisms

2> Angular spreading

Solution:

Development of a new Monte Carlo Algorithm:

1> Optimized for two media

2> Incorporates the idea of cross-section distribution over the thickness of the target

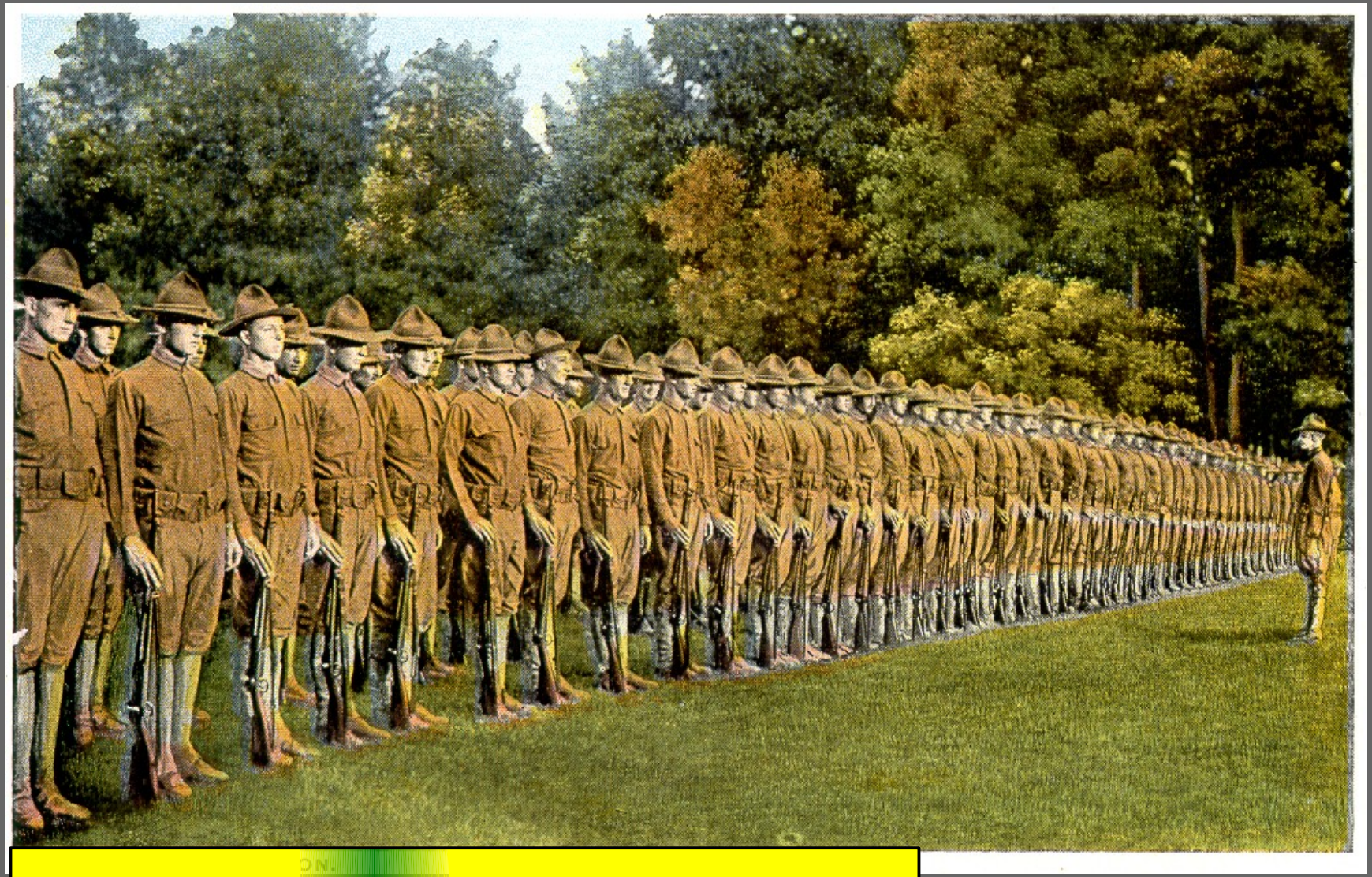
3> Takes care of Angular straggling

@ Mean Lifetime values of ^{51}Cr and ^{49}V have been Extracted after comparing the algorithm and method with the Precise DSAM measurement of ^{50}Cr

@ Shell Model Calculation are being applied to interpret the results.

@ Search for Ultra-fast transition in A~50 region is On...

Progress Report



Thanks for your Kind Attention !!!!