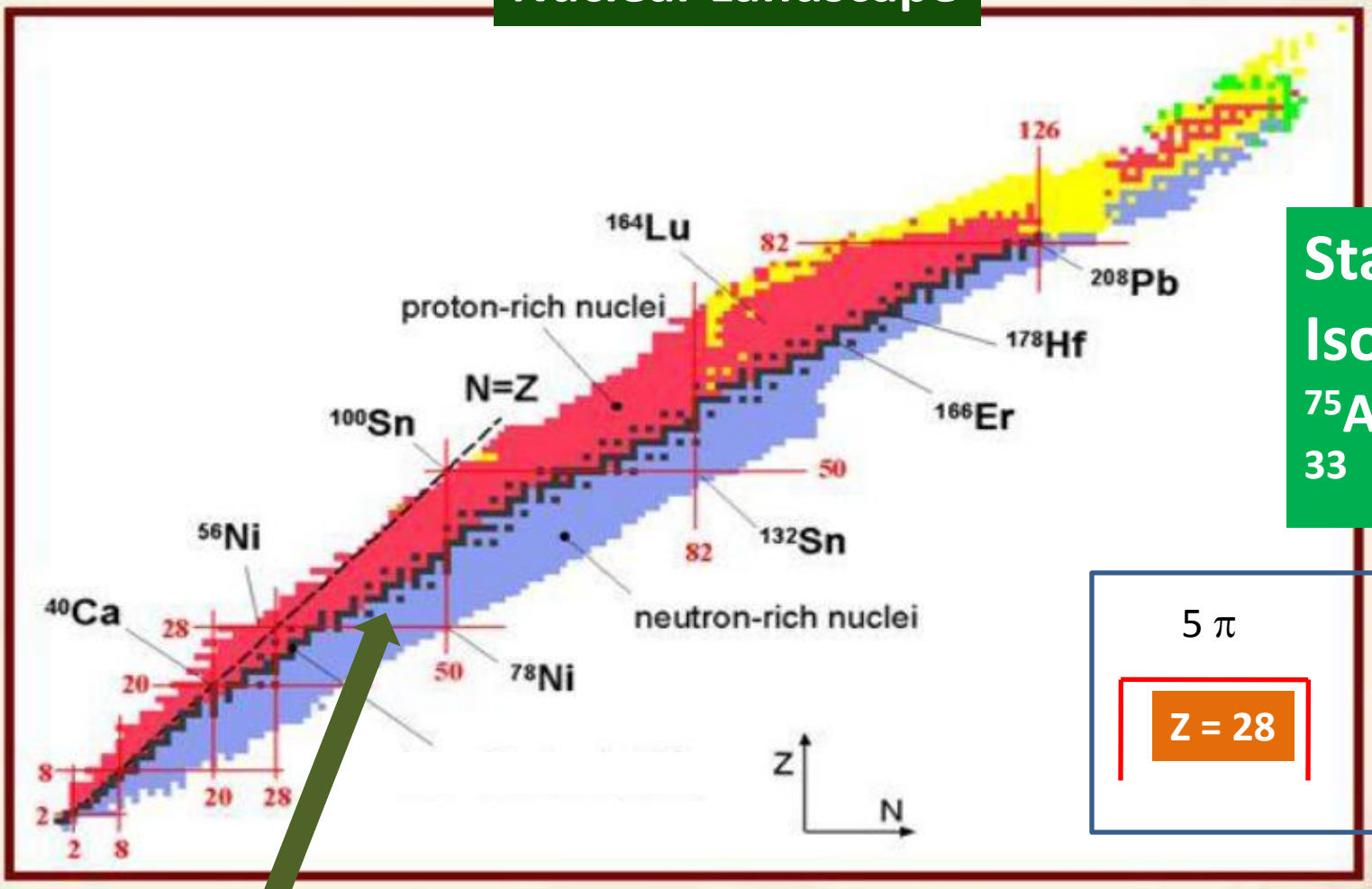
Onset of different excitation modes in the neutron-rich ^{78}As

Anagha Chakraborty
Department of Physics,
Sikhsha-Bhavana,
Visva-Bharati,
Santiniketan,
West Bengal – 731 235, India
anagha.chakraborty@visva-bharati.ac.in

Nuclear Landscape



Stable Isotope:
^{75}As
33 42

5 π

Z = 28

17 ν

N = 28

Our Interest:

^{78}As
33 45

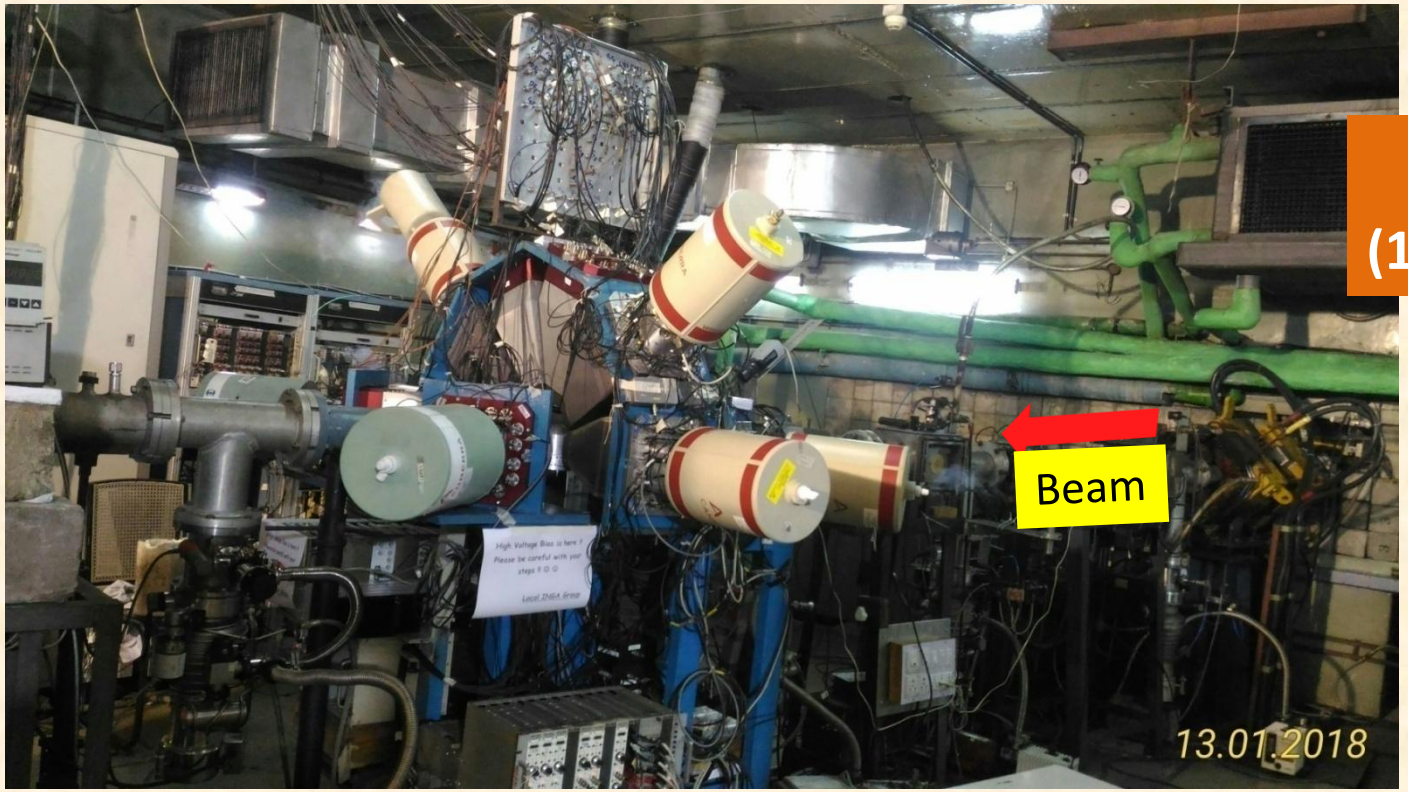
→ **Neutron rich ?**

Irregular → Regular

- ✓fpg-shell nucleus
- ✓mild collectivity
- ✓Limited number of valence nucleons outside ^{56}Ni core (^{56}Ni + 5π + 17ν)
- ✓Possible on set of band structure

Experimental Details

α @ 30 – 40 MeV + $^{76}Ge \rightarrow {}^{80}Se^*$



^{78}As
(1p1n channel)

Beam energy:
30 MeV
35 MeV
40 MeV

❖De-excited gamma rays were detected using the **Indian National Gamma Array** (**INGA**) @ VECC, Kolkata

❖The array was comprised of seven Clover detectors and one LEPS.

Detector Configuration:

4 Clover @ 90° 2 Clover @ 125° 1 Clover @ 40° 1 LEPS @ 40°

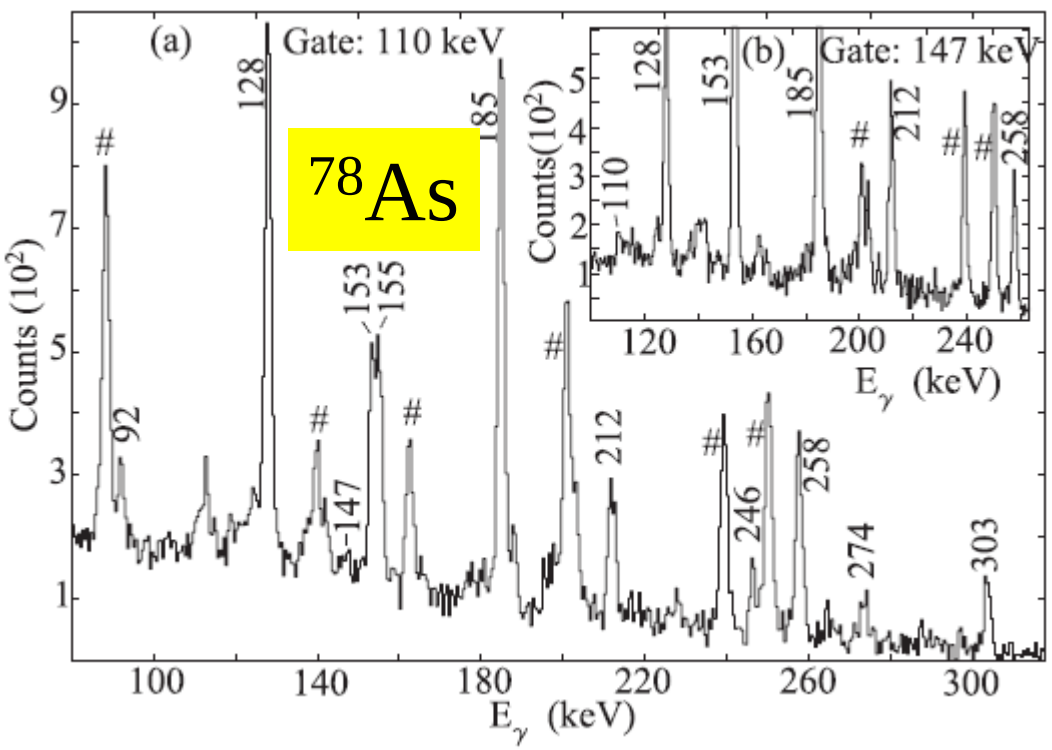
❖Digital DAQ developed by **UGC-DAE CSR, Kolkata** was used

S. Das *et al.*, Nucl. Instrum. Methods Phys. Res. A 893 (2018) 138

Experimental Results

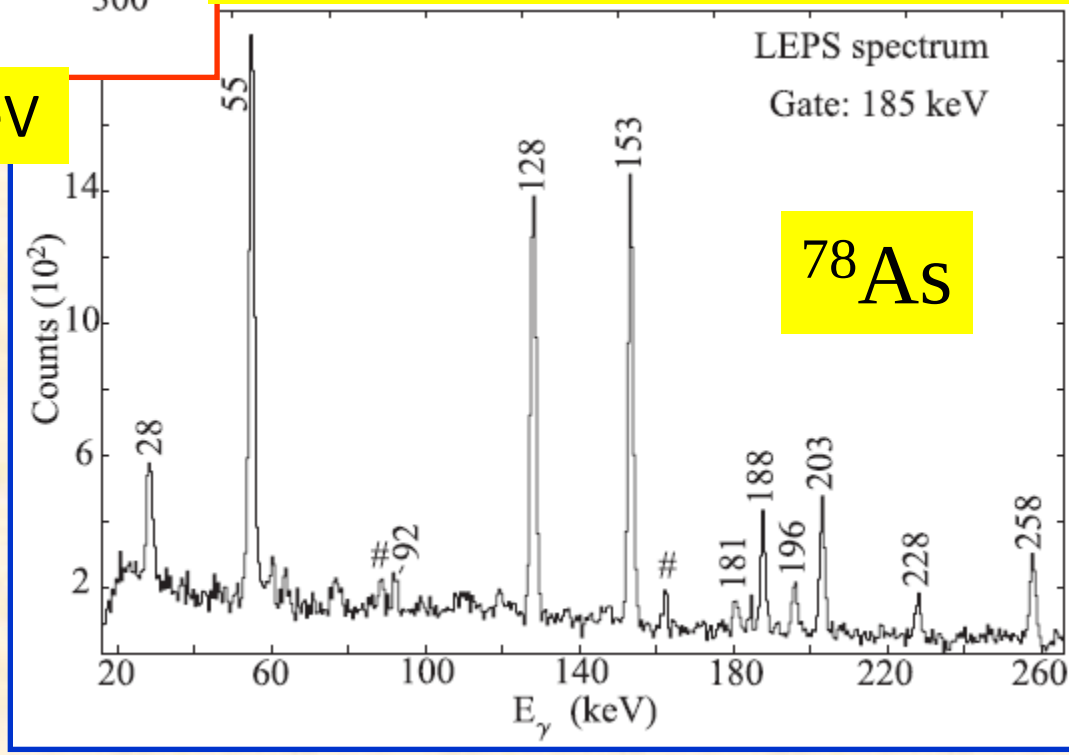
 # ^{77}Se
(populated through 3n channel)

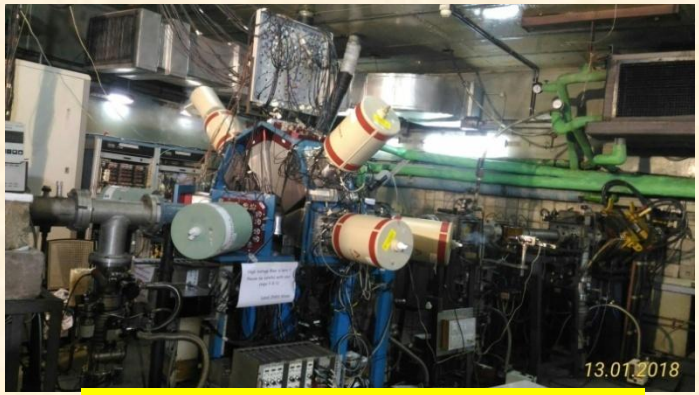
Peaks labeled by their energies belong to ^{78}As



Spectrum from Clover @ 35 MeV

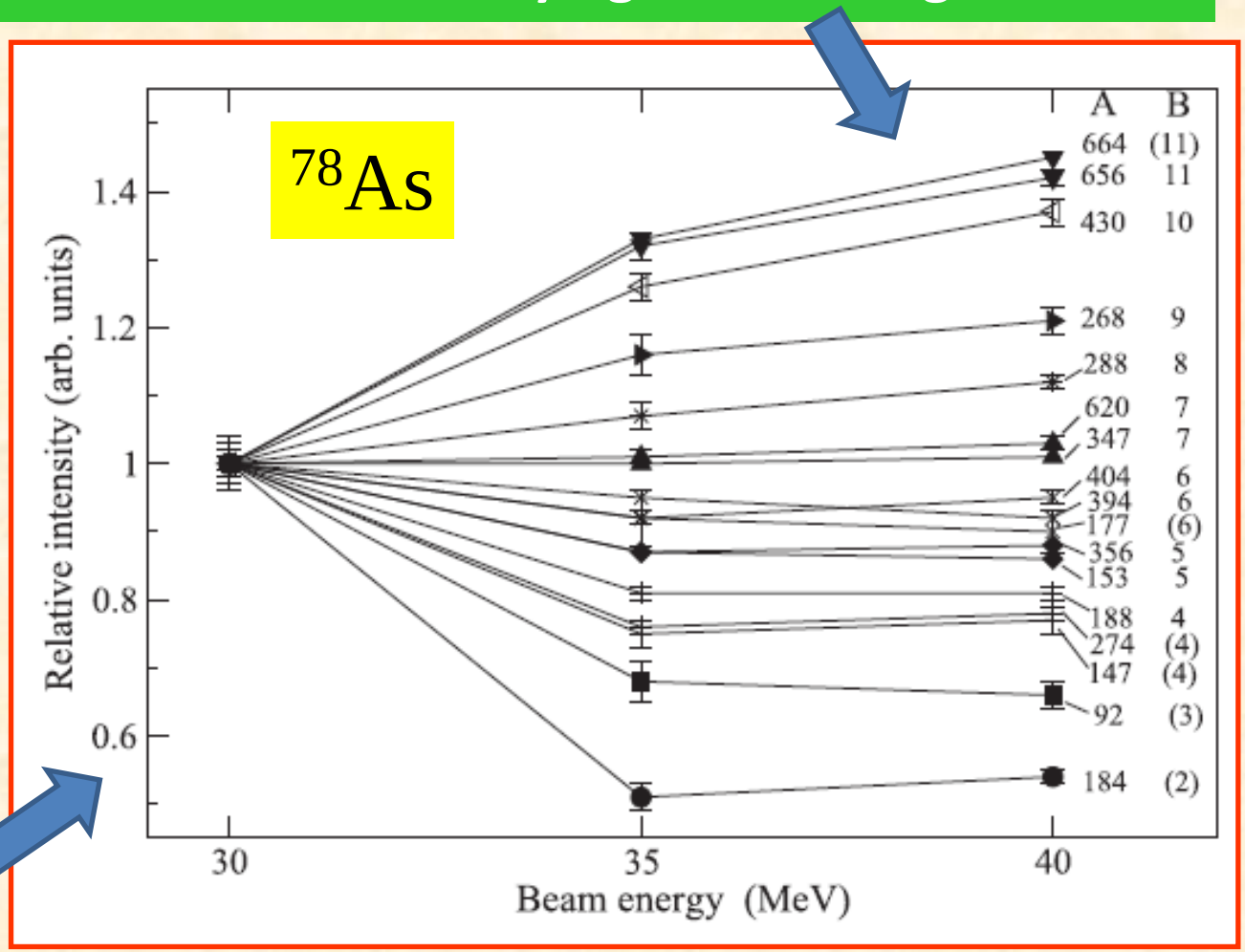
Spectrum from LEPS @ 40 MeV





INGA Spectrometer

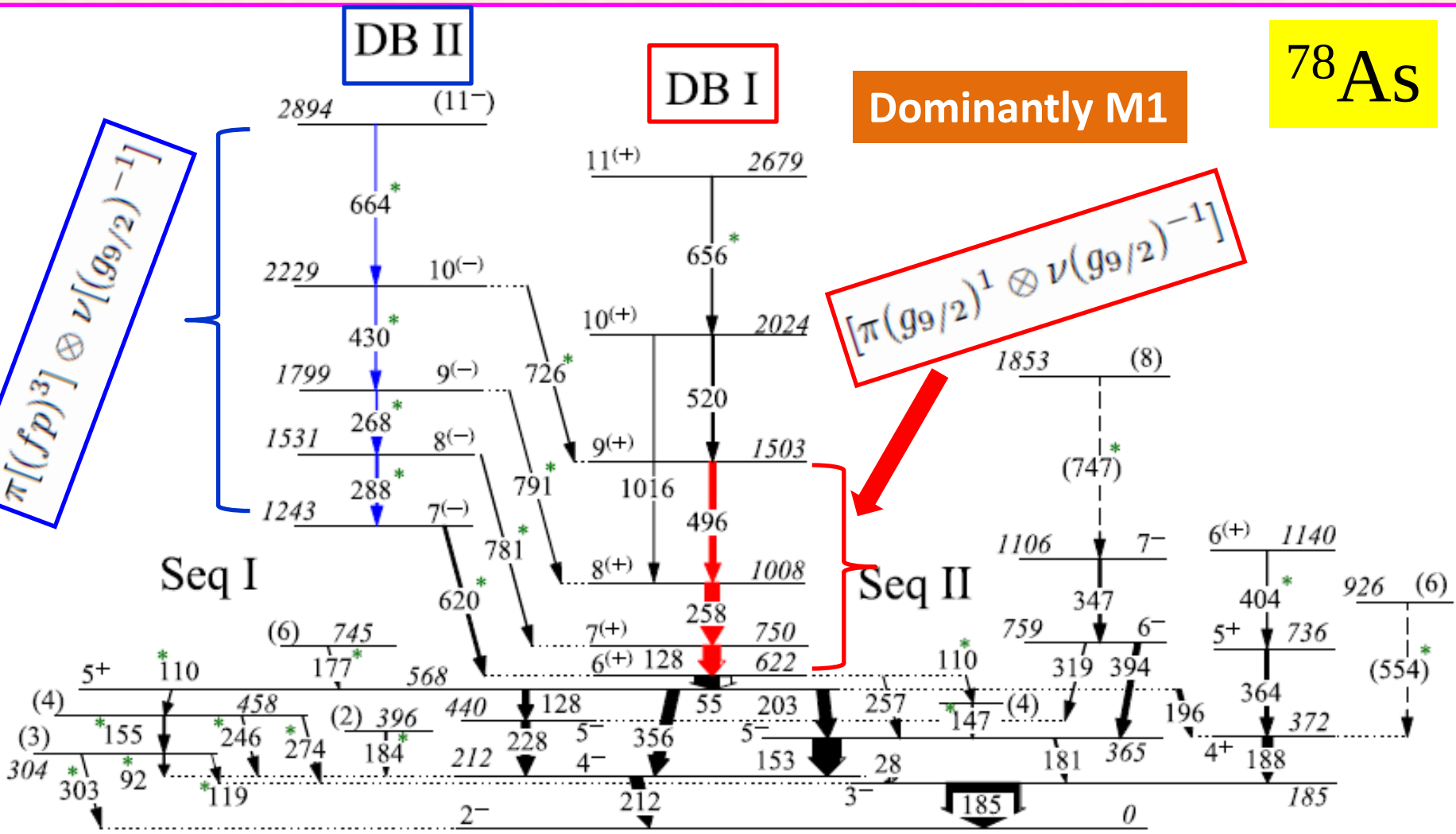
- Standard gamma ray spectroscopic techniques
- Spin-parity measurements: Coincidence Angular Correlation Measurement (DCO)
- Polarization asymmetry (Δ_{asym})
- Population pattern of the states at varying beam energies



Population Enhancement of higher spins at higher beam energies

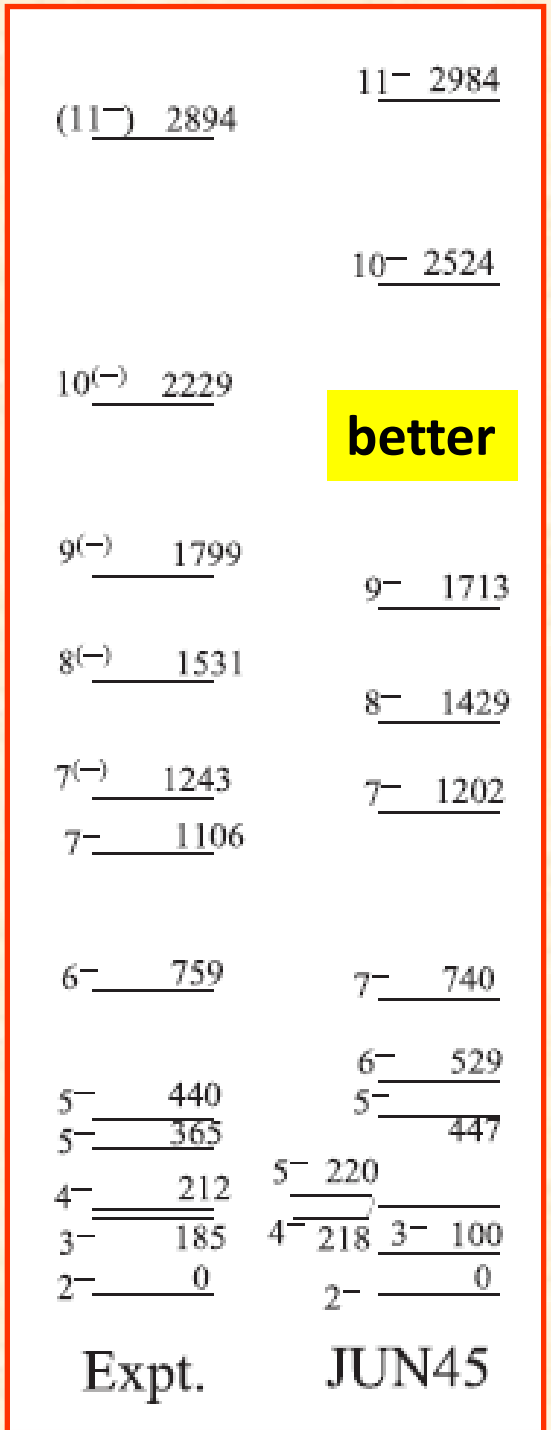
Proposed Level Scheme

* Newly placed transition



Seq I, Seq II: Irregular

DB I, DB II: Regular



better

^{78}As

5 π 17 ν

Z = 28 N = 28

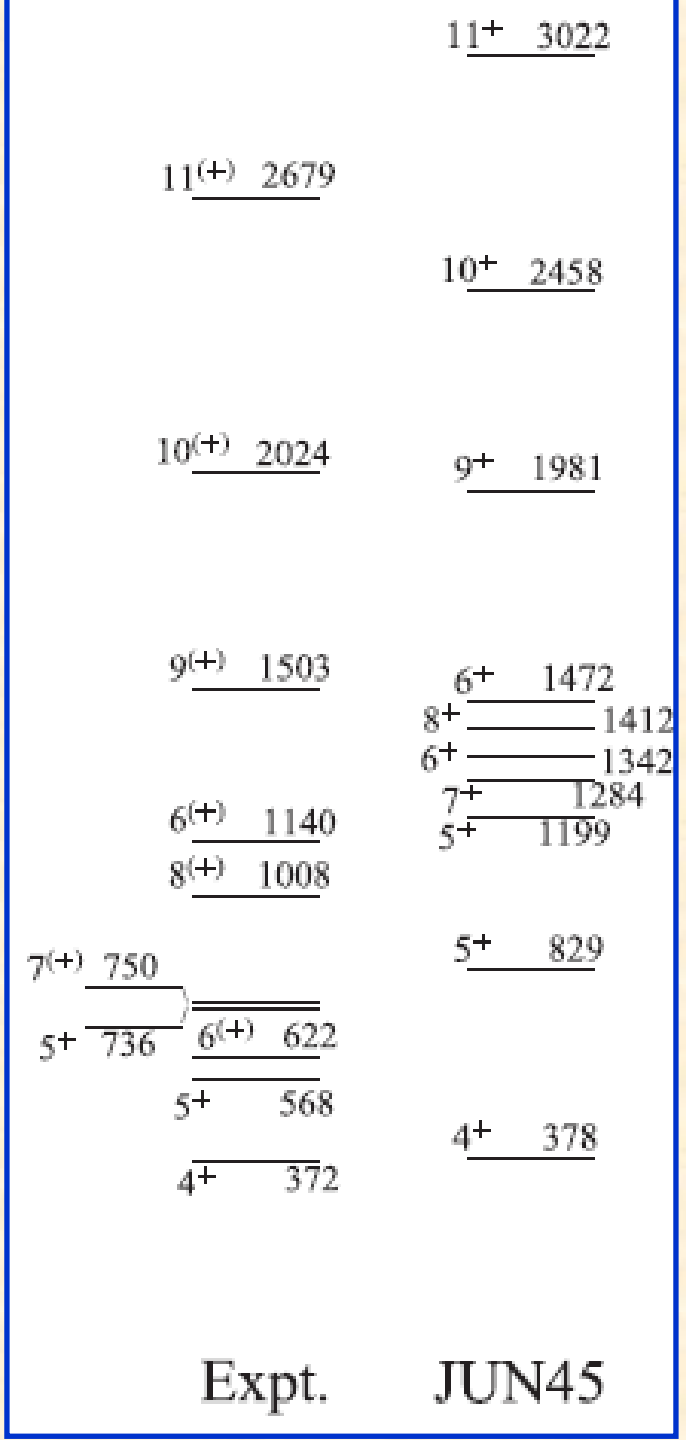
^{56}Ni core (^{56}Ni + 5π + 17ν)

✓NUSHELLX code

✓fpg-model space

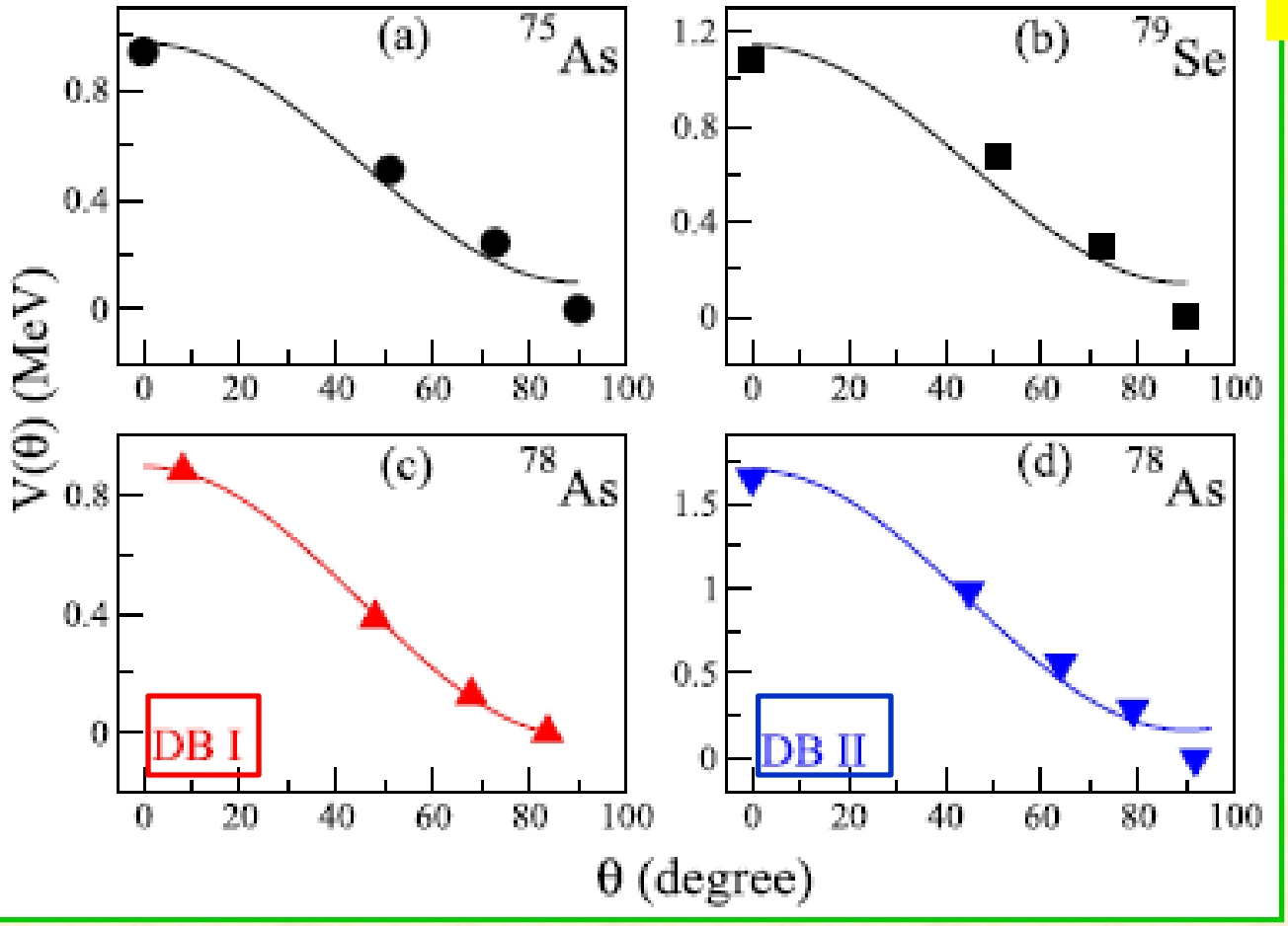
❖Negative parity states:
No role of $\pi(1g_{9/2})$

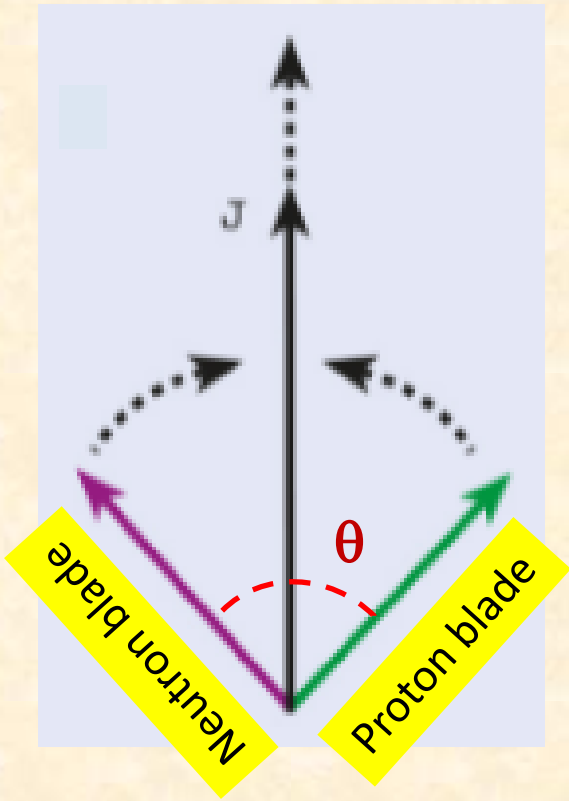
❖Positive parity states:
Occupancy in both
$\pi(1g_{9/2})$ & $\nu(1g_{9/2})$



Validity of Shears Mechanism

Semi-classical approach of Macchiavelli *et al.*, Phys. Rev. C 57 (1998) R1073



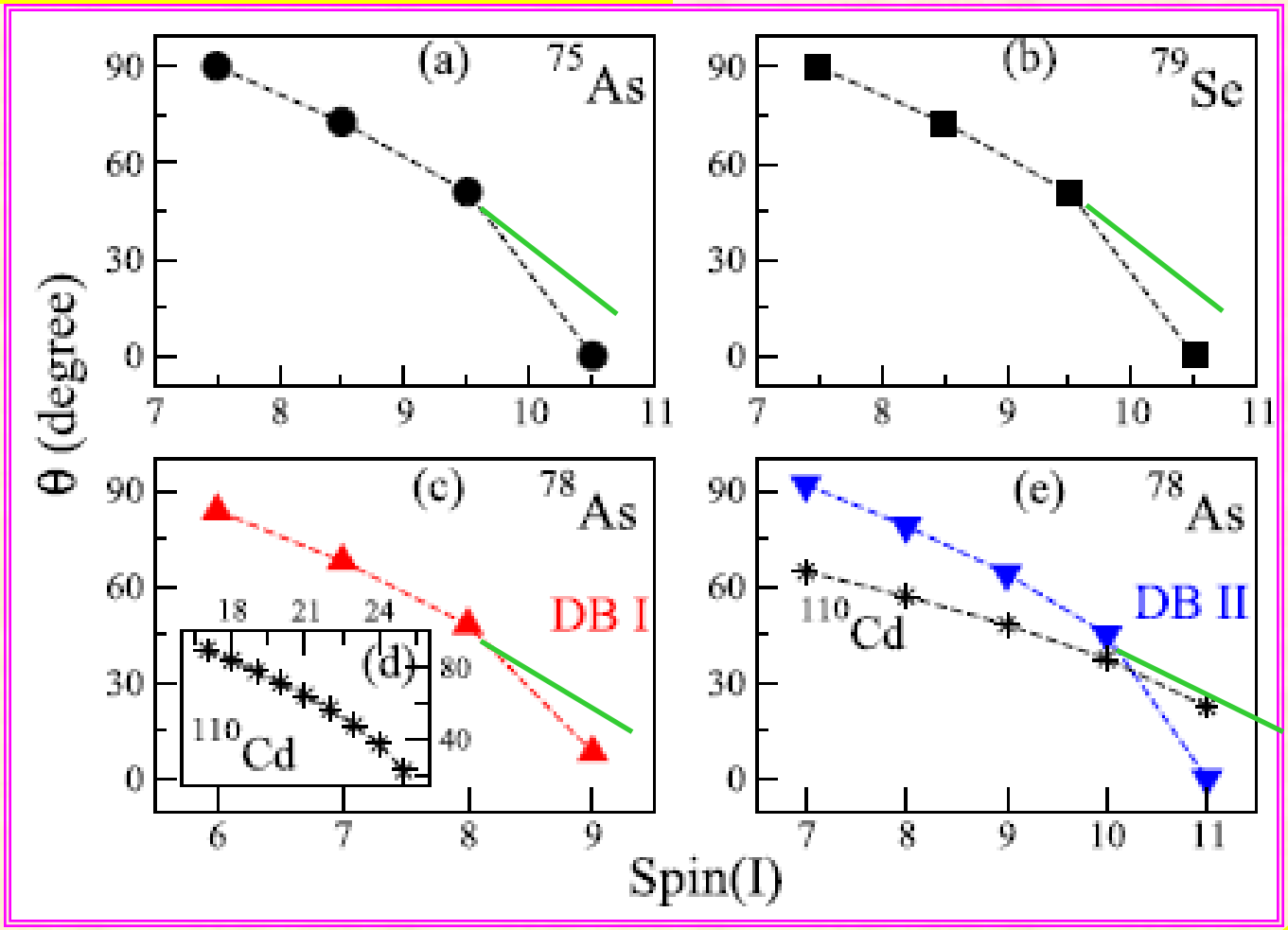


$$V(\theta) = V_0 + [(1/2) \times V_2(3cos^2(\theta) - 1)]$$

V_2: strength of interaction
θ: shears angle

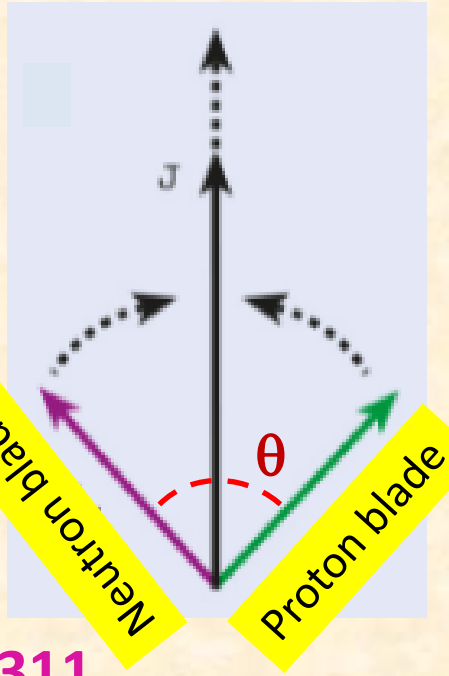
A. K. Mandal *et al.*, Phys. Rev. C 102 (2020) 064311

Scissor vs Stapler band



Neutron blade

Proton blade



^{75}**As**: Physics Letters B 766 (2017) 107

^{79}**Se**: Phys. Rev. C 100 (2019) 044318

^{110}**Cd:** Phys. Rev. Lett. 82 (1999) 3220

^{78}**As:** A. K. Mandal *et al.*, Phys. Rev. C 102 (2020) 064311

Summary

✓**Results from INGA @ VECC, Kolkata: ^{78}As**

Onset of different excitation modes in the neutron-rich ^{78}As

❖**Single particle excitations**
❖**Stapler-like mechanism**
(Regular M1 band structure)
Shears Mechanism

TABLE III. Experimental and theoretical $B(M1)/B(E2)$ values for the transitions belonging to DB-I and DB-II of ^{78}As.

	E_x (keV)	J^π	$B(M1)/B(E2)$(expt) $(\mu_N/eb)^2$	$B(M1)/B(E2)$(SM) $(\mu_N/eb)^2$
DB-I	1008	$8^{(+)}$	>31	101950
	1503	$9^{(+)}$	>26	772
DB-II	1799	$9^{(-)}$	>19	20
	2229	$10^{(-)}$	>6	4
	2894	(11^-)	>5	1

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Collaborators

Visva-Bharati, Santiniketan
B. Mukherjee
S. Rai
U.S. Ghosh
A. Dey
S. Biswas
K. Mandal
A.K. Mondal

Presidency Univ.
S. Rajbanshi

Univ. of Mumbai
R. Chakrabarti

BARC, Mumbai
S. Mukhopadhyay

BHU, Varanasi
V. Kumar
A. Kumar

TUNL, USA
Krishichayan

UGC-DAE CSR, Indore
A.K. Sinha

VECC, Kolkata
R. Banik
S. Bhattacharyya
S. Nandi
S. Bhattacharya
G. Mukherjee

UGC-DAE CSR, Kolkata
S. Chatterjee
S.K. Das
S. Samanta
R. Raut
S.S. Ghiugre

SINP, Kolkata
S. Ali
A. Goswami