CV of Dr Ashok Kumar

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Following are the areas of my Research Interest:

(i) Study of Nuclear Structure and lifetime measurements by RDM and DSAM:

The normal rotation in nuclei is associated with the presence of a significant electric quadrupole moment. As a result, one obtains enhanced electric quadrupole transitions connecting $\Delta I = 2$ levels in a rotational band. Regions of deformed nuclei where rotational motion is observed, are now well defined and generally lie between the magic numbers. Spherical nuclei are few and remain confined to the proximity of magic numbers. It was therefore very surprising when regular rotational-like features were seen in nuclei lying close to the magic numbers. These bands have been variously termed as the 'magnetic dipole', 'magnetic rotational' or, 'shears' band.

In the mass region $A \sim 130$, proton Fermi surface lies near the bottom of the $h11/2$ shell, while the neutron Fermi surface lies in the upper shell. A single particle in high-j orbital induces oblate shape ($\gamma = -60°$) and a single hole induces prolate shape ($\gamma = 0°$). Therefore, the different quasiparticle configurations can drive a nucleus to different shapes and sometimes shape coexistence may be observed in a nucleus. One of the important structures in this region is the observation of collective oblate bands. However, systematical signature inversion in odd-odd nuclei is also an interesting subject and this phenomenon is still not fully understood theoretically. The active proton orbitals for these nuclei are the unique parity intruder $h_{11/2}$, $d_{5/2}$, $g_{7/2}$ and the extruder $g_{9/2}$. Moreover, because of the different shape-driving effects for protons and neutrons, many of the nuclei in this region show triaxiality, which leads to chiral bands. At present our group is engaged in lifetime measurements and high spin structure of excited states in the two mass regions, Xe-Ba-Ce and A=170-190. For this purpose, we are using the 'plunger' device at Inter University Accelerator Centre (IUAC) New Delhi and. Lifetimes are extracted using the computer codes LIFETIME and LINESHAPE by J. C. Wells for RDM and DSAM measurements.

In nearly spherical nuclei the lowest-lying collective states are typically characterized as quadrupole and octupole vibrational modes. According to the vibrational model, phonons may act as building blocks of further vibrational structures. The coupling of the one phonon quadrupole and octupole excitations ($2^+_1 \otimes 3^-_1$) give rise to five negative-parity states, which would lie around the energy given by the sum of the single-phonon energies. Multiphonon structures have been widely identified in the Pd, Cd, Sn, and Te nuclei, It is well known that the non selectivity of level excitation provided by the *(n, nγ)* reaction at low neutron energies provides a sensitive method for studying low-lying states regardless of their structure. The population of levels by this reaction is limited only by the angular momentum that the scattered neutron brings into the system. Because the neutron energy can be kept close to the threshold for a particular excitation, this reaction eliminates the side-feeding effects from the population of higher-lying levels, which otherwise may affect the lifetime determination of the level of interest. These features lead to accurate transition strengths measurements.

(ii) ION BEAM Analysis: These techniques are based on the atomic and nuclear physics phenomena but have the applications as diverse as the semiconductor and corrosion industries as well as in metallurgical, environmental, archaeological, geological, material sciences, biological sciences, forensic samples and aerosol samples etc. In the Cyclotron laboratory, both the PIXE and PIGE measurements are being carried out simultaneously to detect the x-rays and γ-rays, respectively.

(iii) Study of PreScission and PostScission Charged Particle Emission in Heavy Ion Reactions:

During the course of the fission process, the nuclear system undergoes drastic shape changes. It is a dynamical process for which the nucleus needs time to deform up to scission. Neutrons and charged-particle (mainly proton and α-particle) emission take pla**ce** from various stages:

(i) From the fissioning compound nucleus (prescission)

(ii) from the accelerated fission fragments (postscission)

Pre-scission and postscission neutron and charged-particle emission spectra and multiplicities provide important information on the statistical and dynamical aspects of the fusion-fission process. It is observed that α-particle are also emitted very near the neck region in the fission process just before scission. This part of prescission α particles emitted near the neck region is termed as near-scission emission (NSE). The study of the dynamics of the shape evolution, and in particular the effect of dissipation, is crucial to our understanding the one-body or two-body nature of the nuclear viscosity. Nuclear viscosity has the effect of slowing down the fission process leading to fission lifetimes of the order of 10–100 $x10^{-21}$ s.

(iv) Study of Dynamical and Entrance Channel Effects using Light Particles:

Over the past few years, there has been a strong interest directed towards inferring the statistical properties of the hot rapidly rotating nuclei. Evaporative light charged particles from the compound nucleus have proved to be a powerful probe for the properties of the emitting nuclei such as the temperature, the effective emission barriers, and the spins. In the case of the composite nuclei at moderate energies and angular momenta, such as those produced with light-ion projectiles, the evaporation spectra are well explained in terms of the standard statistical model employing the optical model transmission coefficients. However, over the past decade, there have been several claims of serious discrepancies between the standard statistical model predictions and the experimental light charged-particle evaporation from heavy-ion fusion reactions. It has been known for a long time that dissipation influences the formation and decay of the compound nucleus in the heavy-ion reactions. One example of the process in which the dissipation plays a role is the mass transfer in the deep-inelastic collisions; a second example is the hindrance of fusion in certain very symmetric reactions first explained within the framework of the dissipative dynamical model by Swiatecki and co-workers. The hindrance of fusion due to the energy dissipation into internal degrees of freedom leads to a long compound nucleus formation times which might be comparable to the decay times and thus might have an important influence on the subsequent decay of the compound nucleus. The assumption of a very short formation time in the statistical model is one extreme of the general evolution process which in fact is a continuous relaxation process, leading to the composite system from the entrance channel to the equilibrated configuration. Recently some authors have suggested the possibility of the dynamical effects on the de-excitation processes.

In these experiments, we are using ΔE- E telescopes (Silicon surface barrier detectors).

For the detection of Neutrons we are using the organic liquid scintilatos (NE213) and time-of- technique to measure the energies of evaporated neutrons with Pulse Shape Discriminators (PSD)

(v) NOvA collaboration:

The NOvA (NuMI Off-axis ν_e Appearance) experiment is aimed to shed light on the nature's most elusive particles: neutrinos. Since the late 1990s, it is known that neutrinos come in three varieties: muon neutrinos, electron neutrinos and tau neutrinos. Scientists know that neutrinos oscillate, or change from one type to another. But this behavior is not predicted by the Standard Model of particle physics. Scientist have seen oscillations of muon neutrinos to tau neutrinos but have not seen muon neutrinos oscillating into electron neutrinos. Unknown factors that govern neutrino oscillations have significant implications for our understanding of the makeup of the universe. It is well established that neutrinos have some mass but at present we do not know the masses of the different neutrino types, nor do we know the neutrino mass hierarchy – that is, which kind of neutrino is the lightest and which is the heaviest. NOvA is working to better understand these strange particles through precision measurements of their oscillation properties. Physicists at NOvA hope to determine the mass hierarchy by comparing oscillations of a beam of muon neutrinos to oscillations of a beam of muon antineutrinos. Physicists theorize that the big bang created equal amounts of matter and antimatter. When corresponding particles of matter and antimatter meet, they annihilate one another. But somehow we're still here, and antimatter, for the most part, has vanished. In order to advance the theory that neutrinos tipped the balance between matter and antimatter, neutrino physicists need to observe CP violation in action. Researchers at Fermilab use the NuMI neutrino beam and neutrino detectors to study neutrino and antineutrino oscillation. If antineutrinos do not follow the same pattern as neutrinos when they change from one flavor to another, this is a signal of CP violation.

Research Publications in Referred International Journals

Communicated:

1. **High Spin structure in ^{139}Pm**
   Navneet Kaur, A. Kumar et al.
   EPJ (2018)

2. **Systematic study of fission time scales in fusion-fission reactions via neutron and alpha particle multiplicities**
   K. Kapoor, Chetan Sharma, A. Kumar et al.
   Phys. Rev. C (2018)

3. **Study of role of viscosity in fusion-fission dynamics via simultaneously measured neutron and alpha-particle multiplicities**
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72. Negative parity three-quasiparticle band in ^{127}I
S. Chakraborty, H.P. Sharma, S.S. Tiwary, C. Majumder, P. Banerjee, S. Ganguly, S. Kumar, A. Kumar, **A. Kumar**, R.P. Singh, and S. Muralithar
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71. Revised level structure in ^{127}Xe
S. Chakraborty, H. P. Sharma, S. S. Tiwary, C. Majumder, P. Banerjee, S. Ganguly, S. Rai, Pragati, Mayank, S. Kumar, S. S. Bhattacharjee, R. P. Singh, S. Muralithar, **A. Kumar** and R. Palit
EPL (Europhysics Letters), Volume 121, Number 4

70. Systematic study of ^{192,202,206,210}Po compound nuclei using neutron multiplicity as a probe
Communicated to PRC

69. Rotational band on a three-quasineutron isomer in ^{127}Xe

S. Chakraborty, H. P. Sharma, S. S. Tiwary, C. Majumder, P. Banerjee, S. Ganguly, S. Rai, Pragati, Swati Modi, P. Arumugam, Mayank, S. Kumar, R. Palit, **A. Kumar**, S. S. Bhattacharjee, R. P. Singh, and S. Muralithar

PRC (Accepted 19 April 2018)

68. Dependence of precipitation of trace elements on pH in standard water
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67. Standardisation of the ion beam facility at Chandigarh cyclotron for simulataneous PIXE and PESA analysis
Shivcharan Verm, P. Mohanty, Karn P. Singh and **A. Kumar**
NIM B 417, (2018) p-60

66. *K0S* Production from beryllium target using 120 GeV/c protons beam interactions at the MIPP experiment
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65. Study of fission time scale from pre-scission neutron and alpha multiplicities in $^{16}O+^{194}Pt$ Reaction
K. Kapoor, S.Verma, P. Sharma, R. Mahajan, N. Kaur, G. Kaur, H. Singh, R. Dubey, N. Saneesh, G. Mohanto, B. K. Nayak, A. Saxena, A. Jhingan, P. Sugathan, H.P. Sharma, S.K.Chamoli, I. Mukul, B.R. Behera, K.P. Singh and **A. Kumar**

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64. Study of nuclear fusion-fission dynamics in $^{16}O+^{194}Pt$ reaction
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