Summary and Conclusion

The GDR built on excited states is used today as one of the major experimental probes in studying the evolution of the nuclear shape as a function of temperature and spin. The shape of such hot and rotating nuclei can be determined experimentally by observing the GDR cross sections and relating them to the magnitude of the nuclear deformation. This evaluation is possible by performing single or double Lorentzian fit to the experimental data. The deformations obtained in this way can be compared with those obtained theoretically. However as discussed in chapter 3, theoretically the GDR comprises five components out of which some are degenerate and hence single or double Lorentzian fit to the data may not explain the exact situation. Thus it is better to generate the GDR cross sections theoretically and then compare the theoretical cross sections with the experimental data so as to conjecture the nuclear shape. In this way the GDR cross sections of cold nuclei are well understood. For axially deformed nuclei at ground states, there will be only two components in the theoretical curve and a double Lorentzian fit to experimental data can explain the nuclear shape to a very good extent. In the case of hot nuclei, from the discussion of fluctuations in the previous section it is clear that the connection between nuclear shape and the observed GDR cross section is less direct than it is for the
ground state. Hence for hot nuclei, to study the shape evolution, the better option is to compare the theoretical and experimental GDR cross sections rather than comparing the deformations directly.

The theoretical investigations in this direction comprise three components namely 1) a model for nuclear shape calculations which gives the nuclear shape at any given temperature and spin 2) a model which relates the nuclear shape at any given shape and spin to the GDR cross section and 3) a formalism which takes care of fluctuations at finite temperatures and modifies the GDR cross sections accordingly. The formalism regarding the above three components are discussed in the the chapters 1, 2 and 3 respectively. Several modifications and extensions made in the formalism are discussed therein.

In chapter 4 we have discussed our results for the nuclei $^{45}Sc$, $^{59}Cu$, $^{90}Zr$, $^{92}Mo$, $^{120}Sn$, $^{160,166}Er$, $^{194}Hg$ and $^{208}Pb$. For all the above mentioned nuclei the spin distribution at finite excitations has been extracted quite unambiguously. In most of these cases our theoretical results match with the experimental data to a good extent. These results are obtained without assuming the ground state width and without adjusting the parameters of the power law used to describe the GDR width.

Shape transitions such as spherical to noncollective oblate deformation due to spin have been explained in the case of $^{90}Zr$ using the GDR curves. Transitions from strongly deformed collective prolate shape to spherical shape due to both the spin and temperature has been explained in the $^{160,166}Er$ isotopes.

No conclusive evidences for the occurrence of the phenomenon like motional narrowing has been identified. Our calculations do not suggest the saturation of the width at high excitations. The dependence of the width on the angular
momentum for heavier isotopes is found to be less.

The results of the Landau theory and the microscopic evaluation for fluctuation calculation agree to a very good extent. Hence the discrepancies in fit using the Landau theory, in certain cases, do not arise due to the lack of proper parameterization. Hence any formalism which tries to improve the parameterization may not change the results significantly.

GDR has been found to be an effective probe to detect Jacobi transition. We have identified the zirconium region as the very fertile region to detect Jacobi transition. At lower temperatures the Jacobi transition leads to hyperdeformation in proton-rich zirconium isotopes. Even though the Jacobi transition survives higher temperatures, it does not lead to hyperdeformation.