The Hartree-Fock based random phase approximation (HF-RPA) provides a good microscopic description of the nuclear compressional modes. The most special of these compressional modes is the isoscalar giant monopole resonance (ISGMR) also referred to as the breathing mode. The centroid energy $E_c$ of the ISGMR enables one to determine the value of nuclear matter incompressibility coefficient $K_{nn}$ which plays an important role in understanding a wide variety of phenomena ranging from heavy-ion collision to supernova explosions. Recent experimental data for the $E_c$ in heavy nuclei have rather small uncertainties (~0.1 – 0.3 MeV). Since, the uncertainty $\delta E_c$ associated with $E_c$ is approximately related to the uncertainty $\delta K_{nn}$ by,

$$\frac{\delta K_{nn}}{K_{nn}} = 2 \frac{\delta E_c}{E_c},$$

the value of $\delta K_{nn}$ is only about 10 MeV, for $K_{nn} = 250$ MeV and $E_c = 14.17 \pm 0.28$ MeV for the $^{208}$Pb nucleus. However, most of the HF-RPA calculations as employed for the determination of $E_c$ are plagued by the lack of self-consistency [1]. Self-consistency is violated due to the neglect of the spin-orbit and Coulomb terms in the particle-hole (p-h) interaction used in the RPA calculations. Furthermore, some of the RPA calculations are performed in the TJ (isospin) scheme. So, it is of utmost importance that in order to determine an accurate value of $K_{nn}$ one must have an accurate knowledge of the effects of violations of self-consistency on the centroid energy of the ISGMR. We may also point out that modifying the p-h interaction in an adhoc manner in such a way that the spurious state associated with the center of mass motion appears at zero energy [2] does not restore the self-consistency.

We have investigated in detail the effects of the violations of the self-consistency in the HF-RPA calculation of ISGMR energy [3]. In particular, we consider the self-consistency violations caused by ignoring the spin-orbit and Coulomb terms in the p-h interaction and by carrying out the RPA calculations in the TJ scheme. We performed the HF-RPA calculations for the ISGMR energies for several nuclei with the SGII Skyrme interaction and demonstrated that ignoring the spin-orbit term in the p-h interaction gives rise to a spurious enhancement in the values of ISGMR energies for spin unsaturated nuclei. On contrary, neglect of the Coulomb term in the p-h interaction and performing the RPA calculations in the TJ scheme underestimates the ISGMR energies. Finally, we calculated the ISGMR energies for the $^{90}$Zr and $^{208}$Pb nuclei for the five different Skyrme interactions SGII, SkM*, SLy4, SK255 and SK272 and show that in these nuclei, widely used to extract the value of $K_{nn}$, the various elements contributing to the self-consistency violations tend to counterbalance their effects leading to an uncertainty of about 0.1 – 0.4 MeV in the values of the ISGMR energies. These uncertainties are quite acceptable in view of the accuracy of the experimental data for the ISGMR energies currently available.