ABSTRACT

In this thesis work, we calculate parity non-conserving electric dipole transition amplitudes of the hyperfine components for the transitions between the ground and first excited states of $^{137}Ba^{+}$ and $^{87}Sr^{+}$. The results are presented to extract the constants associated with nuclear spin dependent amplitudes from the ongoing and proposed experimental measurements. Here the sum-over-states approach is considered, where dominant part of the sum is calculated using relativistic and highly correlated coupled-cluster theory. The remaining part of the sum is calculated using core polarization correction on top of the Dirac-Fock approximation. To calibrate our program, especially for the relativistic coupled-cluster wavefunctions near to the nuclear region, hyperfine A constants and B/Q values of a series of Na-like systems are calculated. Here these systems are considered from Na to V^{12+}. Also, the calculated hyperfine results of the Na-like ions have important applications in nuclear quadrupole moment estimations and accurate line-profile analysis of astrophysically important transition lines. Study on the parity non-conserving electric dipole transition amplitudes is an effective approach to estimate nuclear anapole moments. The coupled-cluster theory is reformulated here to incorporate the unretarded Breit or the Gaunt interaction for these calculations. The implementation of this interaction is verified on the basis of some analytical results. In addition, we show some distinct features in electron-correlation trends with increasing ionization in the hyperfine constants for the 3^2D of the Na-like ions.

Key words: atomic transition, electron-correlation, Gaunt interaction, relativistic coupled-cluster theory, parity non-conservation, anapole moment, hyperfine constants, nuclear quadrupole moment.