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Proxy-$SU(4)$ symmetry in A=60-90 region

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Abstract

Introduction of spin-isospin $SU(4)$ algebra in 1937 by Wigner [1] and the rotational $SU(3)$ algebra in 1958 by Elliott [2] are two most significant developments in nuclear structure physics. Following Elliott's seminal papers, $SU(3)$ appeared, for describing rotational structures, clustering etc., in many different extended versions such as pseudo-$SU(3)$ model, $Sp(6,R) \supset SU(3)$ scheme, $SU(3)$ in IBM, IBFM and IBFFM models, $SU(3)$ in FDSM, models for clustering in nuclei and so on [3]. Latest in this is the proxy-$SU(3)$ model introduced by Bonatsos, Casten, Martinou, Minkov and others [4]. Applications of the proxy-$SU(3)$ model to nuclei in A=60-90 region introduces proxy-$SU(4)$ symmetry. Shell model spaces with single particle (sp) orbits ${}^1p_{3/2}$, ${}^1p_{1/2}$, ${}^0f_{5/2}$ and ${}^0g_{9/2}$ are essential for these nuclei and also protons and neutrons in these region occupy the same sp orbits. With this and applying the "proxy scheme", the ${}^0g_{9/2}$ changes to ${}^0f_{7/2}$ giving the SGA $U(40) \supset [U(10) \supset G \supset SO(3)] \otimes [SU(4) \supset SU_S(2) \otimes SU_T(2)]$. With $G = SU(3)$, we have proxy-$SU(3)$ model that is described in detail in [4]. It is easy to see that the proxy-$SU(3)$ implies goodness of the $SU(4)$ symmetry appearing above, i.e. proxy-$SU(4)$ symmetry. Shell model calculations pointing out the need for ${}^0g_{9/2}$ orbit, ground state masses, shape changes and shape co-existence in A=60-90 region and GT distributions for example clearly show the importance of proxy-$SU(4)$ in this mass region. Besides presenting this evidence, new proxy schemes with $G = SU(5)$, $SU(4) \sim SO(6)$ and $SO(10)$ that are generated by good proxy-$SU(4)$ symmetry are described.

References

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