NUCLEAR THEORY, Vol. 37
eds. M. Gaidarov, N. Minkov, Heron Press, Sofia

The microscopic origin of the Interacting Boson Model

Andriana Martinou[1],

[1]Institute of Nuclear and Particle Physics, National Centre for Scientific Research "Demokritos", GR-15310 Aghia Paraskevi, Attiki, Greece

Abstract

Elliott in 1958 applied for the first time Algebras in Nuclear Physics [1]. In references [1–4] Elliott, Harvey and Wilsdon created the Shell Model $SU(3)$ symmetry (nowadays called the Elliott $SU(3)$ symmetry), which is the algebraic realization of the nuclear Shell Model [5, 6]. Specifically in Ref. [3] Elliott and Harvey proved that the Shell Model single-particle orbitals in the cartesian coordinate system generate a nuclear spectrum, which is organized in rotational bands identified by the band quantum number K.

Of special interest is the L-projection technique, accomplished in Ref. [2], through which, the familiar nuclear states (those we observe in the data) are being projected out of a single, leading, many-quanta wave function. The L-projection technique has also been accomplished by Vergados in 1968 [7], where he produced analytic expressions for the expansion coefficients. But this L-projection technique can be also accomplished through successive couplings of spherical tensors. Specifically since one harmonic oscillator quantum is a spherical tensor of rank 1, a symmetric pair of quanta is either a spherical tensor of rank 0 or of rank 2. It will be suggested that these spherical tensors of rank 0 and 2 (those which Elliott treated into the L-projection technique) can be the s and d bosons of the Interacting Boson Model in its $SU(3)$ limit [8]. In this way each Elliott $SU(3)$ irrep is mapped into a single $SU(3)$ irrep of the Interacting Boson Model; no spurious irreps appear.

If so, the Interacting Boson Model is linked with the Ellliott $SU(3)$ symmetry and invetably with the nuclear Shell Model. Specific examples will be given, out of which it will become clear that the leading state of the Elliott Model is a coherent state of Ginocchio and Kirson [9], with well defined and quite expected values of the deformation variables β, γ of the Bohr and Mottelson Model [10]. Thus, four major nuclear models are being connected: the Shell Model, the Elliott $SU(3)$, the Interacting Boson Model and the Bohr and Mottelson Model.

References

[1] J. P. Elliott, Proc. R. Soc. Lond. A, **245**(1240), 128-145 (1958)
[2] J. P. Elliott, Proc. R. Soc. Lond. A, **245**(1243), 562-581 (1958)
[3] J. P. Elliott and M. Harvey, Proc. R. Soc. Lond. A, **272**, 557-577 (1963)

[4] J. P. Elliott and C. E. Wiilsdon, Proc. R. Soc. Lond. A, **302**, 509-528 (1968)
[5] M. G. Mayer, Phys. Rev., **74**(3), 235-239 (1949)
[6] O. Haxel, J. Hans D. Jenssen and Hans E. Suess, Phys. Rev., **75**(11), 1766 (1949)
[7] J. D. Vergados, Nucl. Phys. A, **111**, 681-754 (1968)
[8] A. Arima and F. Iachello, Ann. Phys., **111**(1), 201-238 (1978)
[9] J. N. Ginocchio and M. W. Kirson, Nucl. Phys. A, **350**(1-2), 31-60 (1980)
[10] A. Bohr and B. R. Mottelson, Mat-fys Medd, **27**(16), 1-174 (1953)