NUCLEAR INSTRUMENTS AND METHODS 146 (1977) 325; © NORTH-HOLLAND PUBLISHING CO.
ISSN 0029-554X

FIELD DESCRIPTION OF INELASTIC SCATTERING

G. G. DUSSEL*, E. E. MAQUEDA* and R. P. J. PERAZZO*

C.N.E.A., Dpto. Fisica Nuclear, Av. Libertador 8250, Buenos Aires, Argentina

The generalization of the nuclear field theory[1]) to include continuum states can shed new light on the properties of the coupling between scattering (projectile) and nuclear (target) coordinates.

We start by considering a Hamiltonian containing a two-body interaction V with vertices involving both scattering ($\alpha, \beta, ...$) and bound valence ($i, j, ...$) orbitals. The latter may be assumed to contain all the Hartree–Fock contributions while the former are solutions of an average distorting (optical) potential. Out of all the vertices of V, we will consider those that involve one continuum fermion line in both the initial and final states and two bound fermion lines. All other possible terms of V are relevant to the inelastic scattering only through their contributions to the optical potential. The effect of the terms under consideration, as seen from either the target or the (structureless) projectile systems, is that of an external one-body operator

$$\sum_{\alpha\beta} v_{\alpha\beta} a_\alpha^+ a_\beta = \sum_{ij} w_{ij} a_i^+ a_j = \sum_{\alpha\beta} \sum_{ij} V_{i\alpha, j\beta} a_i^+ a_j a_\alpha^+ a_\beta . \tag{1}$$

Within the field theoretical language the operator (1), acting on a product (fermion–boson) space, has a fermion and a collective part. This coupling Hamiltonian is expressed as

$$\sum_{\alpha\beta} a_\alpha^+ a_\beta \Big(\sum V_{i\alpha, j\beta} a_i^+ a_j + \sum_{\substack{i>\varepsilon_F \\ j<\varepsilon_F}} V_{i\alpha, j\beta} \times \times \{\lambda_{ij} + \mu_{ij}\} \Gamma_n^+ + \text{h.c.}\Big) . \tag{2}$$

Use has been made of the forward (λ) and backward (μ) RPA amplitudes. The operator Γ_n^+ creates the nth collective (RPA) mode.

The present treatment, when compared with the current theories[2]) of inelastic scattering, show the following differences:

1) the coupling is derived from a two-body microscopic interaction and not from the dependence of the nuclear radius on the deformation parameters;
2) terms that are not linear in the collective variables do not occur in the coupling Hamiltonian;
3) within a phenomenological treatment an additional fermionic term should be included in the calculation of the matrix elements of the transition operator;
4) if a microscopic analysis or inelastic scattering is attempted, formula (2) contains fermion–boson vertices that allow to bring into consideration collective degrees of freedom.

References

1) D. R. Bes, G. G. Dussel, R. A. Broglia, R. J. Liotta and B. R. Mottelson, Phys. Lett. **52B** (1974) 253.
2) P. E. Hodgson, *Nuclear reactions and nuclear structure* (Clarendon Press, Oxford, 1971) ch. 13 and references therein.

* Fellow of the Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Argentina.