Pramāṇa – J. Phys., Vol. 28, No. 4, April 1987, pp. 325–334. © Printed in India.

Equivalent potentials for a nonsymmetric non-local interaction

G C SETT, U LAHA and B TALUKDAR
Department of Physics, Visva-Bharati, Santiniketan 731 235, India

MS received 4 November 1986

Abstract. Scattering formalisms which incorporate antisymmetrization of the projectile with respect to identical particles in the target result in a nonsymmetric non-local interaction. Such an interaction constraints the relative wavefunctions to be orthogonal to redundant states forbidden by the Pauli principle. Concentrating on the nonsymmetric non-local kernel of Saito we try to visualize the mechanisms by which a potential can ensure the required orthogonality. We achieve this by replacing the Saito kernel by an effective symmetric non-local potential. The constructed symmetric potential is found to be phase-equivalent only but not off-shell equivalent to the original kernel. This difference in the off-shell behaviour is attributed to the dynamical origin simulating the redundant states. In close analogy with one of our recent works we also derive an energy-momentum dependent equivalent to the local potential. Our solution of the pseudo inverse problem is exact and provides a basis for writing the phase—and quasiphase—equations. We present numerical results in support of this.

Keywords. Equivalent potentials; radial wavefunction; non-local interaction; Saito potential; phase method.

PACS Nos 25·10; 25·60; 25·70

1. Introduction

The resonating group method (RGM) (Wildermuth *et al* 1966) represents a microscopic theory for the description of the interaction between nucleon clusters or composite nuclei. As an approximation to RGM, Saito (1969) introduced the orthogonality condition model (OCM). In OCM, non-symmetric non-local potentials occur which constraint the relative wave functions to be orthogonal to redundant states forbidden by the Pauli principle. The essential feature for maintaining orthogonality provides for extra nodes in the scattering wave functions (Krasnopol'skii and Kukulin 1975). An important aspect of Saito's theory is that the redundant states appear in the model potentials. For example, the s-wave Saito potential in the presence of one redundant state $v_1(r)$ is given by

$$V(r,r') = v_1(r)\,v_1(r')\frac{\mathrm{d}^2}{\mathrm{d}r'^2}. \tag{1}$$

Here $v_1(r)$ is represented by a normalized function (Okai *et al* 1972)

$$v_1(r) = (4a^3)^{1/2}\, r \exp(-ar), \tag{2}$$

with $a = 2\,\mathrm{fm}^{-1}$. It has been observed (Englefield *et al* 1974) that the potential in