NUCLEAR PROTON-PROTON ELASTIC SCATTERING VIA THE TROJAN HORSE METHOD

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The Trojan Horse Method (THM) is a powerful indirect technique to study charged particle two-body reactions at sub-Coulomb energies [1,2]. As known, it makes it possible to extract their cross sections down to the relevant energies without experiencing Coulomb suppression. For this reason, since a couple of decades it is successfully applied to rearrangement reactions of astrophysical interest. Recently, we have investigate the suppression of the Coulomb amplitude when the THM is applied to scattering processes. This was done by considering the $p-p$ scattering at low energy, the simplest case where the Coulomb suppression can be observed. Proton-proton cross section was extensively studied in the past. Its energy trend appears to be very similar to that of n-n or p-n systems (1/E behaviour) except at lower proton relative energies, where a deep minimum shows up ($E_{pp} = 191.2$ keV, $\theta_{cm} = 90^o$). This minimum is interpreted as being the signature of the interference between nuclear and Coulomb scattering amplitudes. Therefore, if one considers that a non sizable Coulomb amplitude would make the minimum in the $p-p$ cross section to disappear, the strong interference pattern offers an unique possibility to validate the THM suppression of Coulomb amplitude for scattering.
This has been realized by measuring the $p-p$ elastic scattering within the region of the minimum through the $^2H(p,pp)n$ reaction at 4.8 and 5 MeV in the quasi-free (QF) kinematics regime [3,4]. The THM p-p cross-section was extracted in the framework of the Plane Wave Impulse Approximation [5] down to $E_{lab} = 80$ keV, and compared with the direct p-p behaviour. No minimum shows up in the THM data, whose trend appears to be smooth, much similar to that of the n-n or n-p cross-section. A detailed formalism was developed to build-up the expression of the theoretical half-off-shell $p-p$ cross section, whose behaviour agrees with the THM data, given the fact that in its expression the Coulomb amplitude is negligible with respect to the nuclear one. These results will be presented and the suppression of Coulomb effects in the THM due to the off-shell character of the transferred proton will be discussed.

References

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