Modified effective range theory for electron and positron scattering on nitrogen and carbon dioxide

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Synopsis Modified effective range theory has been applied to differential cross sections in the low energy range for electron scattering on N_2 and positron scattering on CO_2. The comparison with experimental data supports the our previous hypothesis on the importance of the *s*-wave in the low-energy shape resonance in N_2.

Applications of the modified effective range theory for electron and positron scattering on atoms and molecules have been prospected fifty years ago, or so [1]. However, only recently a new way of determining MERT phase shifts through solving the Schrödinger equation via Mathieu functions allowed to expand the applicability of MERT in positron scattering up to a few eV range [2].

In recent paper [3] we have applied MERT to inverting the total cross sections in N_2 in the low energy range. Using the potential obtained at higher energies, the shape resonance appears in the total cross section at a few eV. The agreement with the experimental total cross sections is the best if the resonance is assumed to be due to the *s*-wave phase-shift changes. This would contrast with the well-approved attributing this shape resonance to the Π_g configuration, see ref. [3]. However, we also observed that the invertion procedure is highly sensible on small uncertainties of the experimental total cross sections.

Presently, we apply the MERT approach to differential cross sections for electron – N_2 and positron – CO_2 scattering. As seen from figure 1, assuming the *s*-wave resonance the agreement with the experimental data is fairly good (better than assuming the resonance in the *p*-wave or *d*-wave channels). The agreement can be improved by slightly modifying the first three phase shifts. This in turn modifies the obtained MERT potential. The rigorous procedure of inverting differential cross sections through MERT procedure is under development.

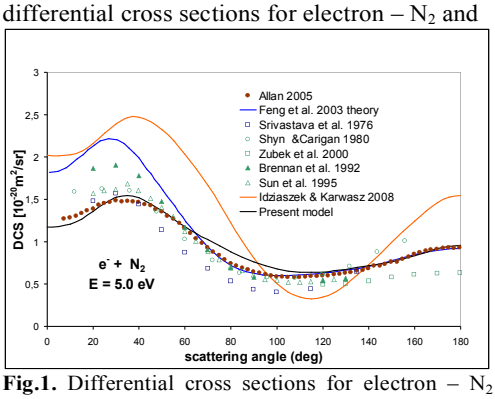
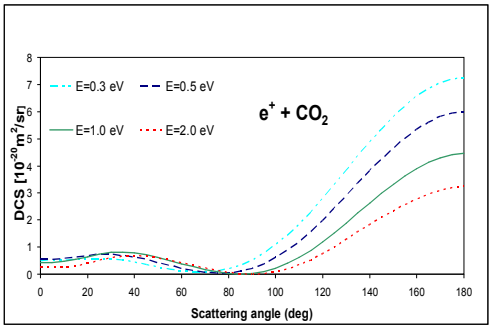


Fig.1. Differential cross sections for electron – N_2 scattering at 5 eV.

Total cross sections for positron scattering on CO_2 recently obtained in Trento laboratory are higher than earlier experiments. However, the discrepancy is relatively lower than in the case of N_2 [4]. We explained the N_2 difference by the angular resolution error in earlier measurements. As seen from the fig. 2, the positron – CO_2 scattering is rather back-ward-centered, therefore the angular resolution error should be relatively lower.



References

[1] O'Malley T F, Rosenberg L and Spruch L 1962 *Phys. Rev.* **125** 1300
[2] Idziaszek Z and Karwasz G P 2006 *Phys. Rev. A* **73** 064701
[3] Idziaszek Z and Karwasz G P 2008 *Eur. J. Phys. D* **51** 347
[4] Karwasz G P, Pliszka D, Brusa R S 2006 *Nucl. Inst. Meth.* *B* **247** 68

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