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First Evidence of Interference effects in the ionization of N_2 molecule

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Synopsis We will present an experimental and theoretical investigation of triple differential cross sections for electron-impact ionization of nitrogen molecules at intermediate energies. A discussion of interference effects contained in the theoretical and experimental interference factors will be presented.

Double slit experiments with light depict the fundamentally probabilistic nature of quantum mechanical phenomena. The interference effects for quantum particles can be seen in triple differential cross sections (TDCSs) for electron impact ionization of diatomic molecules. Observation of such effects helps provide a detailed understanding of collision-induced reactions. The existence of Young-type interference patterns was recently observed in the ionization of diatomic molecules [1-2] and theoretically supported by calculations obtained using a molecular distorted-wave model. Evidence for double-slit interference effects was recently found for electron-H_2 scattering [3-5]. Although there have been several experimental attempts to find double-slit interference effects for electron-N_2 scattering, no experimental evidence had been found in prior work [6-8].

The I-factor, which is the ratio of molecular and atomic cross sections, represents a better test for interference than looking directly at the TDCS since it is not clear how interference effects will be manifested directly in the cross sections. In this work, we report a study looking for evidence of Young's double–slit interference in (e,2e) ionization of N_2 ($3\sigma_g$) by looking at the I-factor which, in this case, is the ratio of the molecular N_2 cross sections divided by the atomic nitrogen N cross sections [9]. Similar to the H_2 study, we do not have experimental data for ionization of atomic N. In this case, we use theoretical N cross sections calculated in the M3DW (molecular 3-body distorted wave) approximation as the denominator for both experiment and theory (as has been routinely done for heavy particle scattering [1,2]).

We compared experimental and theoretical (e,2e) cross sections and I-factors for intermediate energy electron-impact ionization of the N_2 molecule in the scattering plane. We found reasonably good agreement between the theoretical M3DW TDCS results and experiment. We will discuss the evidence for Young's double–slit interference in (e,2e) ionization of N_2 ($3\sigma_g$) at intermediate energies by looking at the I-factor during the conference.

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