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Chun C. Lin

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Department of Physics
University of Wisconsin-Madison
1150 University Ave., Madison, WI 53706

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)
The general objective of this research project is to study radiative transitions in atoms and molecules especially those relevant to infrared radiation. ~~For the 8/84-7/85 period our~~ major efforts include (i) determination of optical emission cross sections for atomic oxygen transitions produced by electron-impact dissociation of $O_2^{\circ}$, (ii) electron excitation from a metastable level to a higher level, (iii) excitation behaviors of Na atoms, (iv) production of excited N atoms by electron impact on $N_2^{\circ}$. Keywords:)

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Annual Technical Report: 1 August 1984 - 31 July 1985

Grant Number AFOSR-83-0312

Principal Investigator: Chun C. Lin

The general objective of this project is to study radiative transitions in atoms and molecules, particularly those which are relevant to infrared radiation. During the period of 1 August 1984-31 July 1985, our major efforts were in the following areas:

(i) Absolute optical emission cross sections have been measured for transitions in the wavelength range 3690-11300A originating from thirty-two terms of excited oxygen atoms produced by electron impact on oxygen molecules with incident electron energy up to 500 eV. The excitation functions show a broad peak at about 90 eV with a shoulder-like structure of varying degree near 35 eV. The observed threshold energy is very close to the energy defect of the dissociation process. Near the threshold, dissociative excitation through partly bound Rydberg states of the oxygen molecule is believed to be a major mechanism for producing the observed atomic-oxygen emission, whereas simultaneous ionization and excitation followed by dissociation becomes important at energies above 50 eV. Absolute optical emission cross sections for a series of atomic-oxygen transitions in the long-wave infrared region have been obtained.

(ii) We are working on an experiment to determine the cross section of electron-impact excitation of neon from the metastable level ($1s^2 2s^2 2p^5 3s\ ^3P_2$) to a higher level in the $1s^2 2s^2 2p^5 3p$ configuration. An electron beam with energy alternating between ~17 eV and ~5 eV is produced. During the 17-eV period the ground-state neon atoms are excited to the metastable level, and during the 5-eV period the neon atoms in the metastable level are excited to the $1s^2 2s^2 2p^5 3p$ levels. We have observed

neon $1s^2 2s^2 2p^5 3p \rightarrow 1s^2 2s^2 2p^5 3s$ emission which is most probably due to $Ne(1s^3 2s^2 2p^5 3p)$ atoms produced by the above two-step process, and are performing test experiments to confirm it.

(iii) In connection with our study of excitation of the $Ne(1s^2 2s^2 2p^5 3s)$ metastable atom to higher levels like $1s^2 2s^2 2p^5 n\ell$, we try to get some indications as to the behaviors of the 3s electron of the metastable atom under various collision conditions. The 3s electron is a "lone" electron in an outer shell and relatively loosely bound, so that it is in some way similar to the 3s electron in a ground-state Na atom ($1s^2 2s^2 2p^6 3s$). We have performed collision experiments of Na atoms with $H^+$, $H_2^+$, $H_3^+$, $H^-$ as projectile and measured the cross sections of exciting the Na(3s) atoms to Na(3d). These cross sections will give us information about the excitation behavior of the 3s electron under different perturbing fields produced by the projectiles.

(iv) Studies of production of excited nitrogen atoms in the $1s^2 2s^2 2p^2 n\ell$ states have been extended to n = 5, 6, ...,9. Excitation functions for optical emission of the $1s^2 2s^2 2p^5 n\ell \rightarrow 1s^2 2s^2 2p^5 n'\ell'$ lines have been measured and are compared with those for the lower-n states previously obtained in our laboratory.

Publications

"Electron Excitation Cross Sections for the Metastable and Resonant Levels of $Ne(2p^5 3s)$", Physical Review A, accepted for publication.

"Emission from Oxygen Atoms Produced by Electron-Impact Dissociative Excitation of Oxygen Molecules", Physical Review A, accepted for publication.