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CALIF. PATENT GROUPMEASUREMENT OF DIFFERENTIAL SCATTERING OF $D_2-N_2^*$ D. H. Winicur, L. R. Martin,
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Although differential scattering cross sections have been reported for many alkali metal systems, only a few measurements have been made on non-alkali systems. We have measured the angular distribution of the differential scattering cross section of D_2-N_2 from 2 to 21 degrees (center-of-mass) and have observed small angle interference oscillations out to 16 degrees.

The molecular beam apparatus is discussed in detail elsewhere.^{1, 2} A brief description is given here. Two aerodynamically-accelerated molecular beams are crossed at 90 degrees--the decreased widths of the velocity distributions produced by the aerodynamic acceleration reduce the need for velocity selection. The primary beam, modulated by a rotating-wheel chopper, is detected with an Extranuclear Laboratories, Inc. quadrupole mass spectrometer mounted in a differentially pumped chamber which rotates about the scattering center in the plane of the two beams. The detector signal is amplified by a preamplifier mounted on the mass spectrometer and then by an ELI tuned amplifier and a PAR HR-8 lock-in amplifier.

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For the experiments reported here, the measured Mach number of the D_2 primary beam was approximately 9. The Mach number of the N_2 beam was estimated to be 6. The most probable relative velocity was 2.20×10^5 cm/sec (0.0876 eV). The density of scattered D_2 was measured as a function of laboratory scattering angle. A correction was made for the attenuation of the scattered beam at small angles and the data were converted to differential cross sections in center-of-mass coordinates $\left(\frac{d\sigma}{d\omega}, \theta\right)$. The results, in arbitrary units, are shown in Fig. 1.

A straight line was fitted to a log-log plot of $d\sigma/d\omega$ vs θ to obtain the average angular dependence of the cross section, $d\bar{\sigma}/d\omega$. The slope of this line indicates that $d\bar{\sigma}/d\omega \propto \theta^{-4.1}$ below 16 degrees. The measured cross sections are divided by $d\bar{\sigma}/d\omega$ to remove the steep angular dependence, allowing the interference extrema to be seen clearly. The results are shown in Fig. 2.

The data were compared to quantal cross sections calculated for a Lennard-Jones (12, 6) potential. The preliminary results of the comparison indicate that, (a) the observed deviation from $\theta^{-7/3}$ dependence of $d\bar{\sigma}/d\omega$ is at least partially the result of the averaging over the finite angular width of the detector entrance, and (b) the extrema may not be completely resolved in the region between 7 and 12 degrees. Additional experiments are in progress to improve the resolution of the extrema in this region.

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References

1. O. H. Crawford, Ph.D. Thesis, University of Illinois, 1966.
2. J. B. Cross, Ph.D. Thesis, University of Illinois, 1966.

Figure Captions

FIG. 1. Angular dependence of the differential collision cross section for an aerodynamically accelerated D_2 beam scattered by an aerodynamically accelerated crossed N_2 beam in center-of-mass coordinates. The most probable relative velocity is 2.20×10^5 cm/sec (0.0876 eV).

FIG. 2. Undulatory behavior of the differential cross section of a D_2 beam scattered by a crossed N_2 beam.