GENERAL PHYSICS

I. INTERATOMIC FORCES*

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RESEARCH OBJECTIVES

The study of chemical forces using the probe of atomic-beam methods has thus far been limited to a few reactions of low activation energy, because of the difficulty of obtaining sufficiently intense beams of neutral atoms with well-defined energies in the chemically important range 1-10 eV.

We have considered elastic collisions between fast electrons and a beam of neutral atoms as a method for accelerating the atoms to energies in the electron-volt range. Detailed calculations of the kinematics of such collisions show that a geometrical arrangement is possible that minimizes "first-order Doppler shift" in the energy of the accelerated beam induced by the initial velocity distribution of the target atoms. The calculated energy dispersion of the accelerated beam is of the order of 3.5% full width half-maximum (FWHM) for ^{39}K at 800°K, and 1.5% FWHM for ^{4}He at 100°K. The use of protons as bombarding particles may also be advantageous, depending on the properties of the proton beam.

The expected intensity of the accelerated beam is somewhat greater than that obtained in the recently developed sputtering source of Politiek and co-workers.[1]

The calculated characteristics of the beam show that it is suitable for measurements of (a) total cross section as a function of energy in the electron-volt range; (b) production of ionized products in collisions between neutral atoms; and (c) excitation functions for various optical transitions in collisions between neutral atoms. Other experiments such as the study of differential scattering in the reactive case may be possible, depending on the quality of the accelerated beam obtained in practice.

Existing vacuum equipment is being rebuilt so that a small-scale test of the new acceleration method may be performed. Intensities will be measured and time-of-flight methods will be used to analyze the velocity spectrum of the accelerated beam.

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References

1. J. Politiek, P. K. Rol, J. Los, and P. G. Ikelaar, Rev. Sci. Instr. 39, 1147 (1968).

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