IV. INTERATOMIC FORCES*

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RESEARCH OBJECTIVES AND SUMMARY OF RESEARCH

1. Chemical Accelerator. A prototype apparatus has been constructed using neutral sodium atoms in a target beam and fast electrons as projectiles to test our plan for using recoil atoms from elastic scattering events to produce a beam of neutral atoms in the eV range. In DC tests of the recoil beam intensity we have seen signals of the expected intensity and with the expected variation of intensity with electron energy. We are now attempting to measure the time-of-flight of the recoil atoms using a pulsed electron gun. The detector system consists of a counting-type detector and a double-channel time-gated differential counter to obtain improved S/N ratio. Our objective is to apply this method to the measurement of excitation cross sections in the eV range.

2. Energy Levels of Hydrogen. By using the perturbation expansion

$$\psi = \psi^{(o)} + \psi^{(1)} + \ldots$$

$$E = E^{(o)} + E^{(1)} + \ldots,$$

the first perturbation equation of interest is

$$\left(H_o - E^{(o)}\right)\psi^{(1)} = \left(E^{(1)} - H_1\right)\psi^{(o)}.$$

We have solved this inhomogeneous equation exactly for the case wherein H_o is the Dirac Hamiltonian for an electron in a point Coulomb field, and H_1 is the term for the energy that is due to the interaction of the electron's magnetic moment with the magnetic moment of the nucleus. We have solutions for the 1S and 2S states, and the work is being extended to 2P levels. Using our more exact wave functions, we have calculated energy shifts in S levels which are due to the existence of a nuclear electric quadrupole moment. In order to eliminate infinities associated with the perturbation expansion, we are investigating the possibility of obtaining an exact solution to the problem. Thus far, we have obtained asymptotic forms that are valid near the origin, which are well-behaved.

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