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COLLISIONAL PROCESSES OF INTEREST IN MFE PLASMA RESEARCH

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INTRODUCTION

Research on our contract can be divided into two general topics: (1) H^- formation collision processes, and (2) the determination of scattering cross sections used to diagnose plasma properties. Research progress during the last two months is presented below.

H^- Formation

The scattering calculations for H^o + Cs and D^o + Cs elastic collisions have been completed using molecular interaction energies from pseudo-potential computations. The total cross sections are very large and are greater than 70×10^{-16} cm^2, even at 1,000 eV. We also find there is considerable scattering to large angles which is due to the $a^3\Sigma^+$ initial molecular state being highly repulsive. The calculated total cross sections, the 500 and 1000 eV differential cross sections, and the percent of scattering outside various angles are attached as Figs. 1 to 7. The numbers have also been sent to colleagues at LBL and ORNL, and given to our experimental section for inclusion in their modeling effort.

Diagnostic Reactions

During the last period we completed our work on product state distributions for electron capture collisions

$$A^{+q} + H \rightarrow A^{+q-1}(n\ell) + H^+ \quad .$$

A paper was written and submitted to Physical Review A for publication. When discussing this subject with Ralph Isler from ORNL at the Baton Rouge meeting, I found he had some special needs for his modeling work on impurity ion

concentrations in ISX that we did not cover in the paper. To help him, I ran the computer code and sent him calculated data for 25 keV/amu C^{+6} + H and 32.6 keV/amu O^{+8} + H collisions. He will send me his modeling results shortly.

I have been concerned that calculations of $n\ell$ product distributions, which are performed without the inclusion of any exterior fields, may not be valid for Tokamak studies. Thus, we have also been investigating the effect of a dc electric field on the cross sections. In our first application we employed a field of 20 V/cm, which according to Hogan from ORNL is approximately an order-of-magnitude larger than realized in present Tokamaks. To our relief, we observed no changes in the product state cross sections. We hope to investigate the effects of magnetic fields in the future.

Our work on collisions of protons and alphas with He and Li in the 100 keV/amu to 1 MeV/amu energy range is proceeding well. We have developed a four-body Monte Carlo code to follow both electrons on a He-like target. We now have cross sections for single and double ionization at 1 MeV/amu and are working to lower energies. The calculated values compare well to existing experimental data. We have sent an abstract describing the work to the ICPEAC committee.

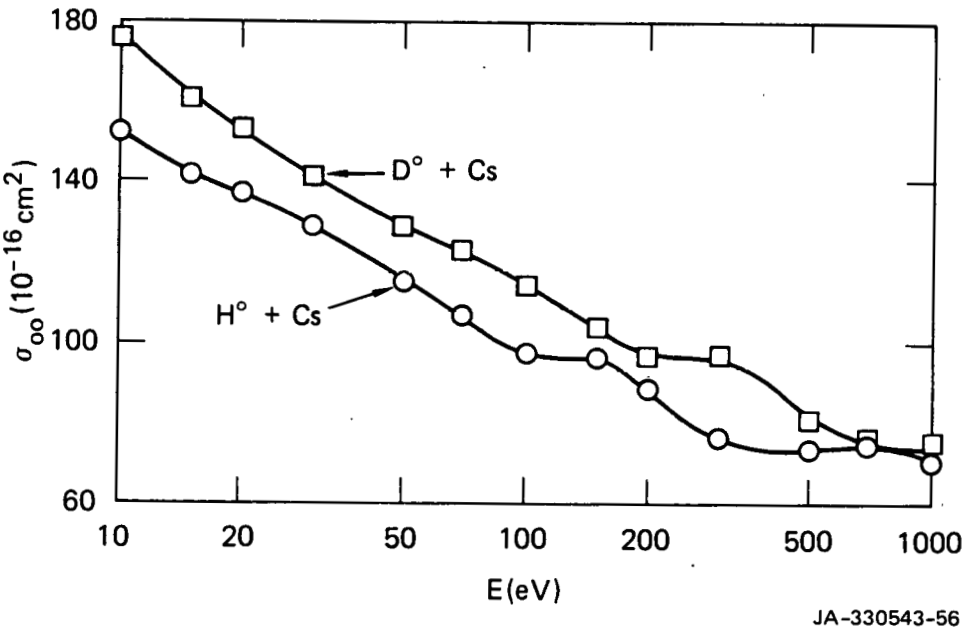

Figure 1. Total cross sections for the elastic scattering of H and D from a Cs target.

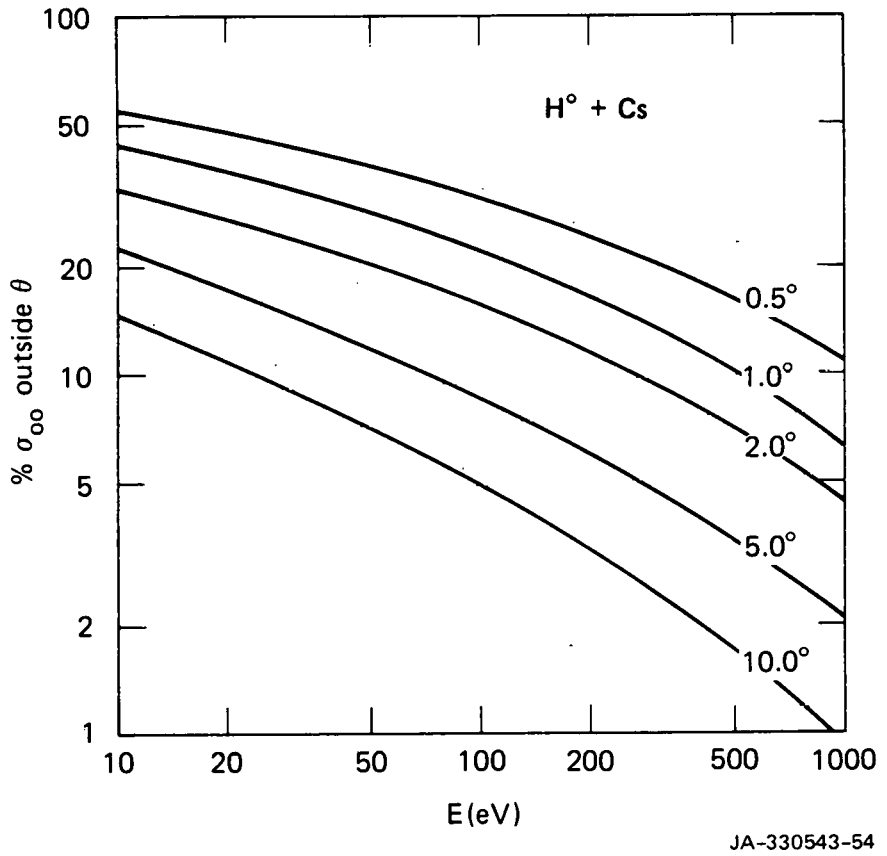

Figure 2. The percent of elastic cross sections outside various angles for H + Cs collisions.

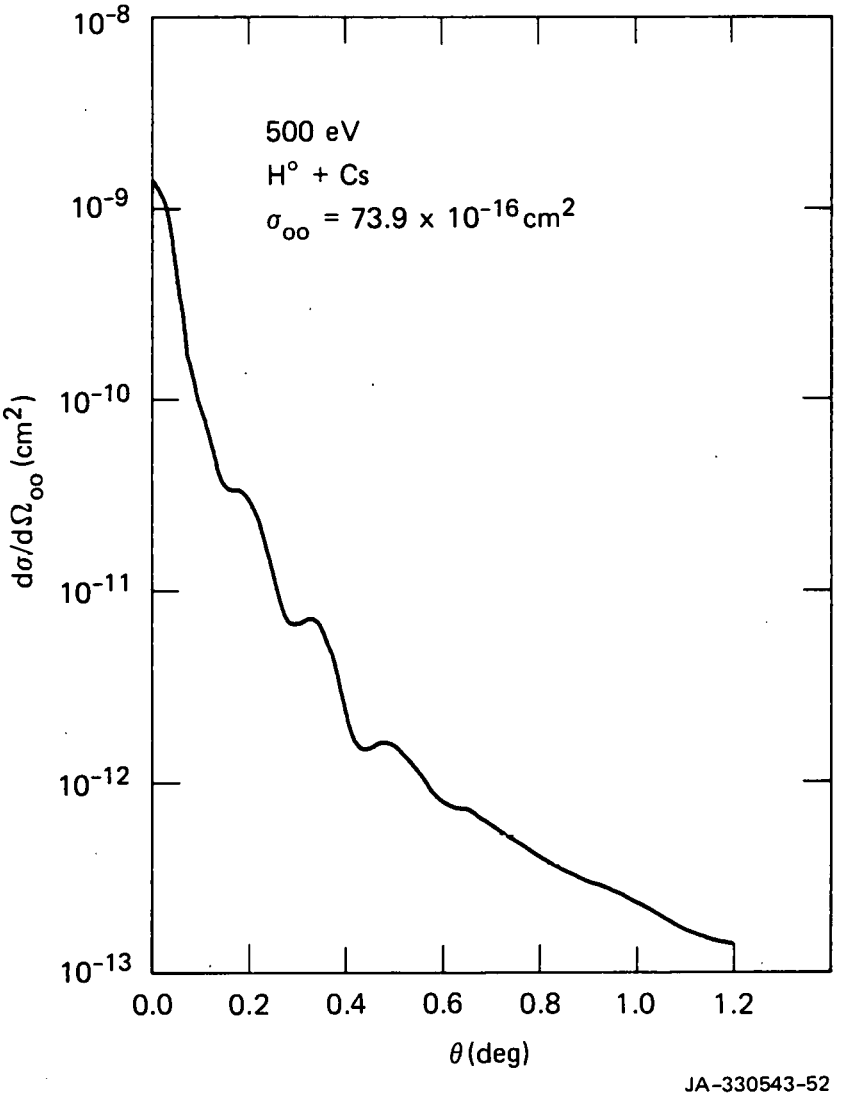

Figure 3. Differential cross section for 500 eV H + Cs collisions.

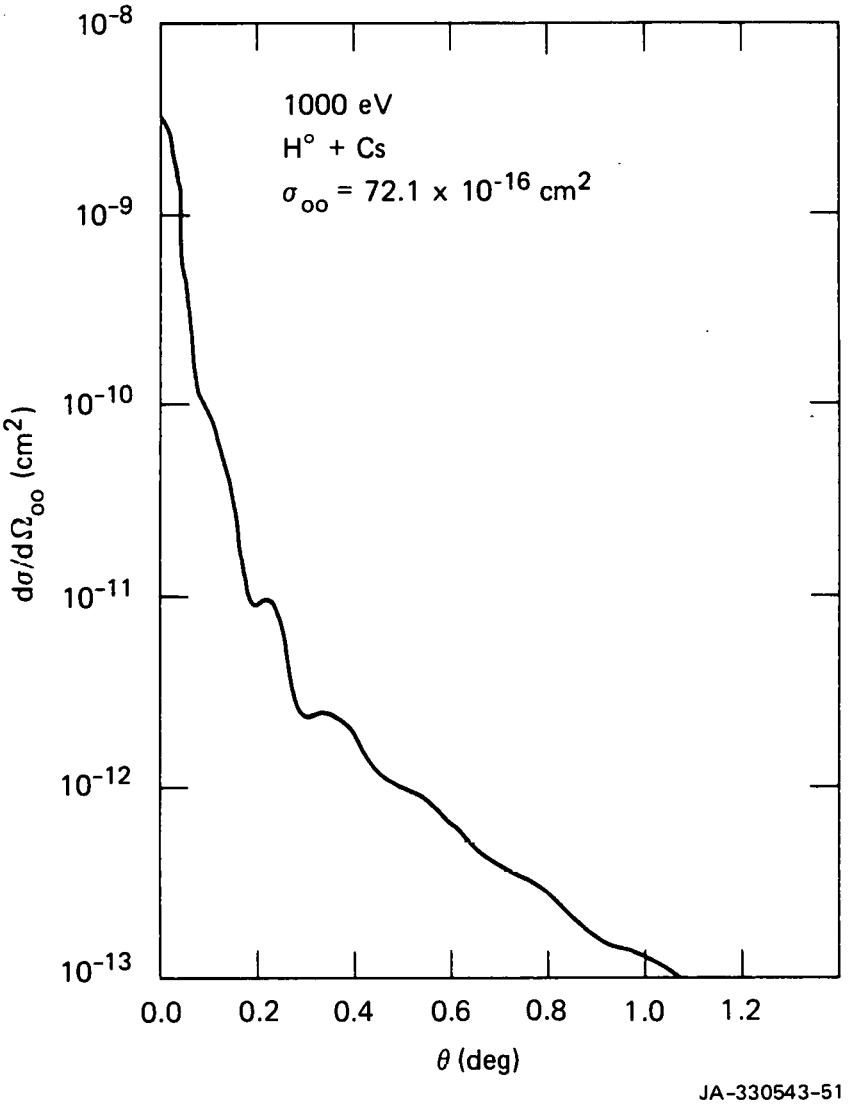

Figure 4. Differential cross section for 1000 eV H + Cs collisions.

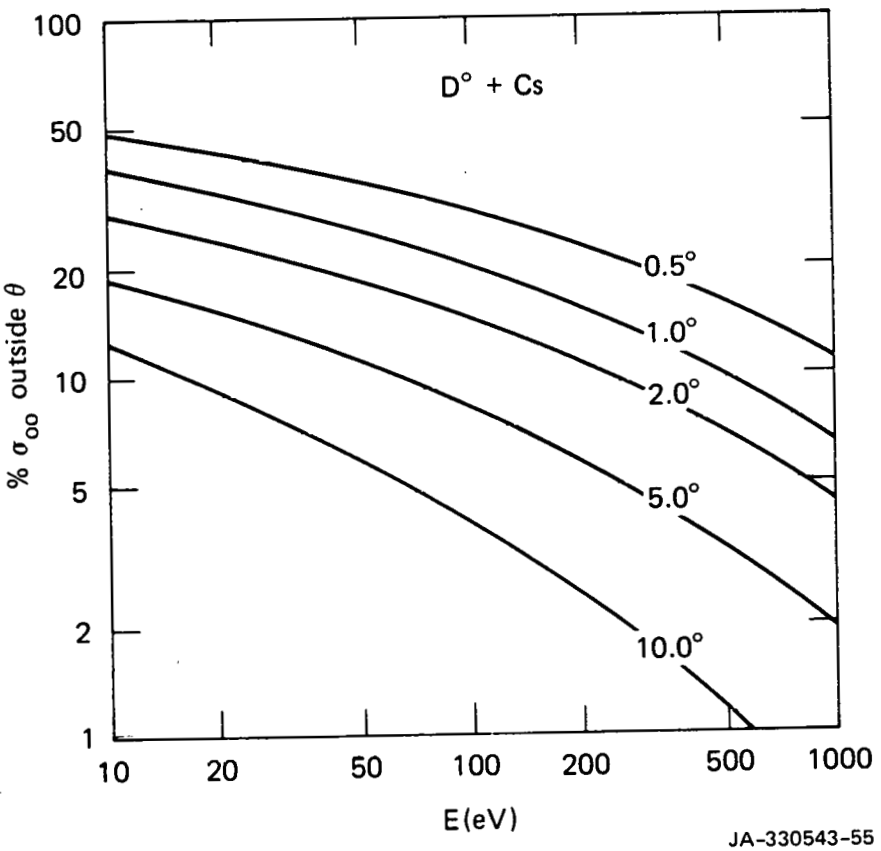

Figure 5. The percent of elastic cross section outside various angles for D + Cs collisions.

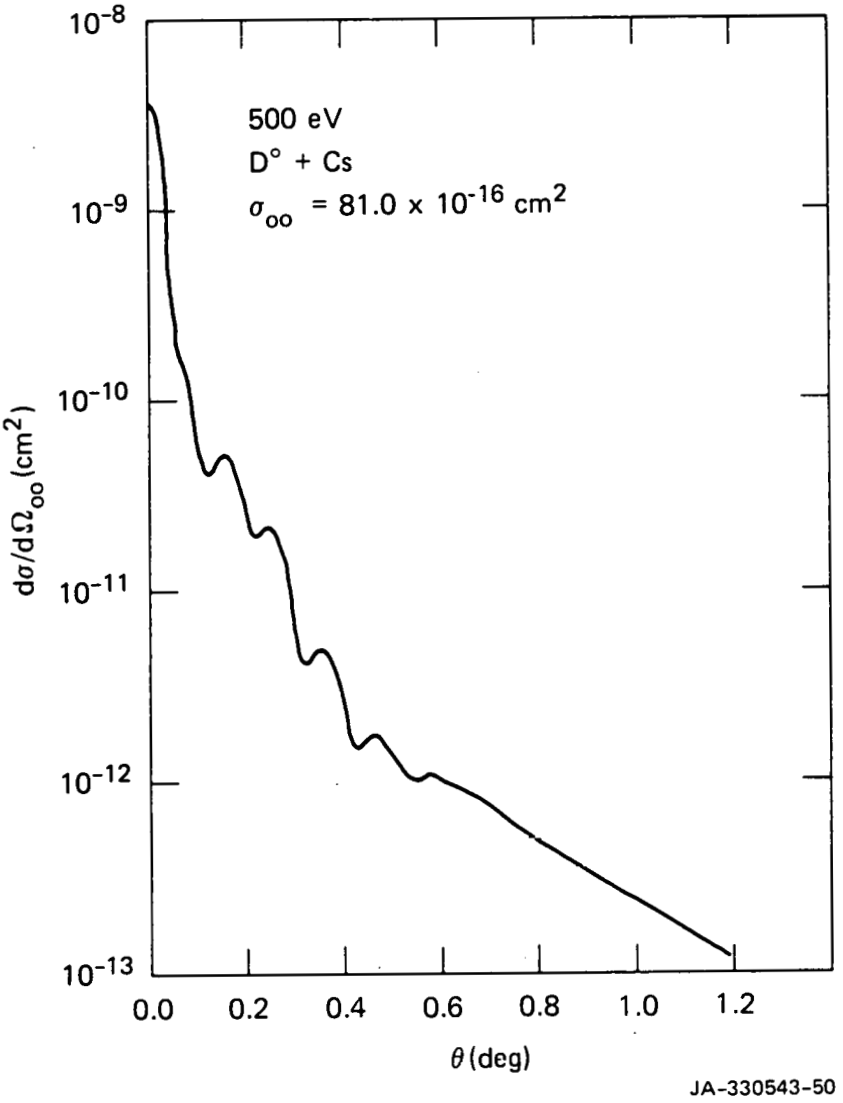

Figure 6. Differential cross section for 500 eV D + Cs collisions.

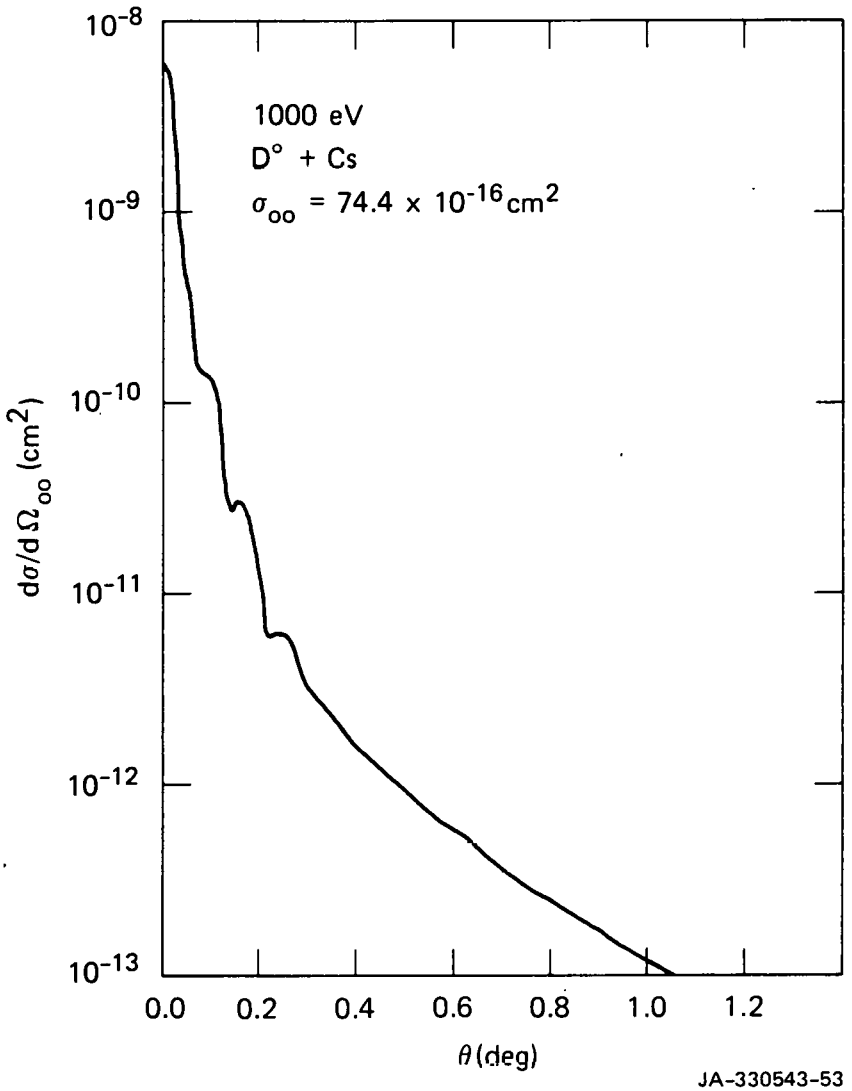

Figure 7. Differential cross section for 1000 eV H + Cs collisions.