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ELASTIC AND INELASTIC COLLISIONS BETWEEN ATOMS AND IONS WITH IDENTICAL NUCLEI

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For the homonuclear collisions the oscillations of the differential cross section due to the interference of the scattering amplitudes $f(\vartheta)$ and $f(\pi-\vartheta)$ (ϑ — scattering angle in the barycentric system) can be observed. These oscillations occur in both atom-atom and atom-ion [1] collisions and for elastic as well as for inelastic processes. The scattering angle $\theta=\frac{\pi}{2}$ corresponds to the zero interference band. In this case both amplitudes are equal and the position of the cross section extremum does not depend on energy so that the observation at this angle is especially favorable. For the final state corresponding to the g-state of the quasimolecule we obtain at $\theta=\frac{\pi}{2}$ the maximum cross section for nuclei with zero spins; for the u-states we have the minimum value equal to zero. There are similar relation for nuclei with even spin and inverse relation for nuclei with odd spin. For higher spins these features are not so well pronounced due to the averaging over the various orientations of nuclear spins. In the laboratory system the angle $\vartheta=\frac{\pi}{4}$ corresponds to $\theta=\frac{\pi}{2}$ for elastic scattering, smaller angles ν correspond to inelastic processes.

Under favorable conditions and for energies about 1 keV the separation between the interference maxima amounts to several degrees. The coincidence method where after scattering both particles are detected is especially convenient for such observations.

The calculations of the scattering amplitude phase can be made by means of semiclassical method using its various generalizations for inelastic processes.

It will be of interest to note that the semiclassical method for two identical charged particles gives the phase equal to that obtained by correct quantum mechanical calculations, so that the wellknown Mott formula follows from the calculations of classical action along the Coloumb hyperbolic trajectory.

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