Dispersive and Deflective Effect in Transverse Momentum Distribution of Fragments at Intermediate Energies

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In this study, transverse momentum (P_T) distribution of projectile-like fragments (PLFs), produced at intermediate energies E=95 and 290 MeV/u, are investigated based on systematic experimental results. At relativistic energies, the fragment momentum distribution shows an isotropic Gaussian shape, and the width can be successfully reproduced on the basis of the contribution of the Fermi momentum of nucleons in the fragmentation process. At intermediate energies, additional dispersion and deflection effects have been observed in P_T distribution of PLFs in previous experimental results. However, fragmentary measurements have prevented from disclosing further information on reaction processes and formulating the P_T distribution.

The obvious velocity dependence is observed in the width of P_T distribution of PLFs produced from Ar-beam and Be-target at E=95 MeV/u and the dependence is successfully reproduced by a simple formulation. According to a microscopic model calculation, observed velocity dependence is explained on the basis of the contribution of the impact parameter. At E=290 MeV/u, no significant velocity dependences are observed in P_T distribution. This result indicates that the collective process, which would cause the velocity dependence, is suppressed at higher energy. An orbital deflection effect has been observed in P_T distribution of PLFs, which were produced through few-nucleon removal reactions with heavy targets at E~100 MeV/u in earlier measurements. In our measurements with Ar- and Kr-beams and various targets (C, Al, Nb, Tb, and Au) at E=290 MeV/u, the deflection effect is successfully observed and the effect grows with target mass. In the case of 1-nucleon removal and exchange reactions, the evolutional behavior is consistently described by the orbital deflection with Coulomb potential and nuclear potential. In the case of multinucleon-removal reactions, P_T distribution is reproduced by practical formulation. Formulation, obtained in this study, enables a reliable characterization of the fragments, which would be applicable to various research fields involving, for example, radioactive nuclear beams.