Multinucleon transfer and fragmentation processes in deep-inelastic collisions of the ^{197}Au + ^{197}Au system at an energy of 23A MeV

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Collisions of the very heavy nonfusing nuclear system ^{197}Au+^{197}Au were studied in detail at an energy of 23A MeV. The experiment was performed at the INFN Laboratori Nazionali del Sud (LNS) in Catania, Italy. For detection and identification of the reaction products the Charged Heavy Ion Mass and Energy Resolving Array (CHIMERA) arranged in 4π geometry was used.

Events with two, three and four heavy fragments in the final state were observed. Analysis is concentrated on a class of deep inelastic ternary reactions in which one observes a target-like fragment (TLF) in addition to two other heavy fragments from the projectile-like fragment (PLF) break-up. It is demonstrated that in the case of asymmetric PLF partitions the lighter of the two fragments is emitted in a process that shows characteristics of prompt emission of "intermediate mass fragments" from the projectile-target interaction zone (neck). The mass numbers of fragments emitted from the neck side cover a much wider range than in typical neck-fragmentation reactions at intermediate energies, indicating that the decaying system evidently keeps a memory of the neck configuration even when the PLF and TLF are no longer in close proximity. Emission of heavy fragments (with atomic masses up to 60 mass units) from the neck region was studied in detail for the first time. The time elapsing from the scission of the binary PLF + TLF system to the secondary scission of the PLF was estimated to be about 230 fm/c, independent of the total kinetic energy loss. In addition to the dynamical neck fragmentation (non equilibrated) statistical (equilibrated) decay of the primary fragment was also observed.

More symmetric PLF divisions occur in both equilibrated and non equilibrated sequential processes. Dynamical symmetric PLF break-up also keeps a memory of the first reaction step. In this case all three fragments are emitted collinearly along the PLF-TLF separation axis. The contribution of statistical processes increases with increasing symmetry of the PLF break-up.

The data are interpreted in terms of a dynamical model of deep inelastic collisions. It was concluded that the ternary reactions occur in semiperipheral collisions, in a range of angular momenta in the entrance channel corresponding to about 0.55-0.75 of the maximum L value for grazing collisions. It was shown that ^{197}Au+^{197}Au collisions at an energy of 23A MeV lead predominantely to tranfer of only a few nucleons between the target and projectile nuclei. Multinucleon transfer reactions are also observed, but with significantly lower cross sections.