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Investigation of the Dynamical Dipole Mode in the $^{40,48}Ca+^{152,144}Sm$ fusion-evaporation and fission reactions at 11 MeV/nucleon

C. Parascandolo[1], D. Pierroutsakou[2], C. Agodi[3], R. Alba[3], V. Baran[3,4], A. Boiano[2], M. Colonna[3], R. Coniglione[3], E. De Filippo[5], A. Del Zoppo[3], M. Di Toro[6,3], U. Emanuele[7], F. Farinon[8], A. Guglielmetti[9], M. La Commara[10,2] , C. Maiolino[3], B. Martin[10,2], C. Mazzocchi[9], M. Mazzocco[1], C. Rizzo[6,3], M. Romoli[2], M. Sandoli[10,2], D. Santonocito[3], C. Signorini[1], R. Silvestri[10,2], F. Soramel[1], E. Strano[1], D. Torresi[1], A. Trifirò[7] and M. Trimarchi[7]

[1] *Dipartimento di Fisica e Astronomia, Università di Padova and INFN - Padova, Italy* [2] *INFN - Napoli, Napoli, Italy* [3] *INFN - Laboratori Nazionali del Sud, Catania, Italy* [4] *University of Bucharest, Bucharest and NIPNE-HH, Magurele, Romania* [5] *INFN - Catania, Catania, Italy* [6] *Dipartimento di Fisica e Astronomia, Università di Catania, Catania, Italy* [7] *INFN Gruppo Collegato di Messina and Università di Messina , Messina, Italy* [8] *GSI, Darmstadt, Germany* [9] *Dipartimento di Fisica, Università di Milano and INFN - Milano, Milano, Italy* [10] *Dipartimento di Fisica, Università di Napoli, Napoli, Italy*

Contact email: *concetta.parascandolo@pd.infn.it*

The *Dynamical Dipole mode (DD)* is a large amplitude collective oscillation of protons against neutrons of the di-nuclear system, formed in charge asymmetric heavy-ion collisions. It decays emitting prompt dipole γ-rays [1-3] and gives information about the dynamics of dissipative reactions. From a theoretical point of view, the DD γ yield should increase as a function of the entrance channel charge asymmetry, becoming maximum for reactions employing exotic nuclei where large N/Z ratios can be reached. A large yield could allow to probe the density dependence of the symmetry energy in the Equation of State at sub-saturation densities, where the DD is active [4]. Furthermore, the DD radiation could be of interest for the synthesis of super-heavy elements in hot fusion reactions as it cools down the formed nucleus on the fusion path through emission of prompt γ-rays. However, by comparing the few existing data in the mass region A~ 130, taken at different beam energies and for different entrance channel N/Z asymmetries, with theoretical calculations we conclude that many aspects should still be clarified.

By performing time-dependent Hartree-Fock calculations it was predicted in [5] that the DD γ yield decreases in collisions involving heavy mass ions since reactions with small nuclei are less damped than those involving heavier ones. To verify such a prediction we investigated the DD in fusion-evaporation and fission reactions in a mass region never studied before. The ^{192}Pb compound nucleus was formed in the ^{40}Ca + ^{152}Sm and ^{48}Ca +^{144}Sm reactions at E_{lab} = 440 MeV and 485 MeV, respectively, by using the same method described in our previous works [2]. The experiment was performed at Laboratori Nazionali del Sud (LNS, Italy), by using the $^{40-48}Ca$ pulsed beams provided by the Superconducting Cyclotron. The γ-rays and the light charged particles were detected by using the MEDEA apparatus [6], made of 180 BaF_2 scintillators. The heavy reaction fragments were detected by position sensitive Parallel Plate Avalanche Counters placed symmetrically around the beam direction in order to investigate the DD in both fusion-evaporation and fission events. Preliminary results of the analysis were presented in [7]. γ-ray spectra and angular distributions extracted for central collisions evidence that the DD survives in reactions involving heavier nuclei than those studied before, with a yield of $(8\pm1)*10^{-5}sr^{-1}$ for evaporation and $(10\pm3)*10^{-5}sr^{-1}$ for fission. These results will be compared with those found at different mass regions for fusion-evaporation events and with theoretical calculations performed within a BNV transport model, based on a collective bremsstrahlung analysis of the entrance channel reaction dynamics. Ideas about future experimentation on the DD study by employing also radioactive beams will be discussed.

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