STRANGENESS IN THE LIÈGE INTRANUCLEAR CASCADE MODEL

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Introduction: INCL (the Liège Intra Nuclear Cascade model) is a code simulating the intra-nuclear hadronic cascade taking place during nuclear spallation reactions. Those reactions happen when a light projectile (a hadron or a light nucleus) collide a nucleus target with kinetic energy from tens MeV to a few GeV. A previous version of INCL simulated spallation process for energies in the range ~100 MeV to ~2 GeV with the presence of three particle types: nucleons, pions and Deltas. However, the involved energies in particle accelerators and cosmic rays can be much higher. Then the energy capabilities of the latest version of INCL were extended up to roughly 15 GeV by adding the dominant channel: multiple pion emission(1). The version presented here includes a new degree of freedom: strangeness. The goal is both an improvement of INCL in the high energy region (from 2 GeV to 15 GeV) as well as the possibility to study new domains like the kaon physics or the hyper-nucleus physics.

Materials and methods: Strangeness implementation in INCL required new ingredients: characteristics of the new particles (K, Λ, Σ), additional reaction cross sections, angular distributions, momenta and charge repartition of the outcome particles. This information is based as far as possible on experimental data, but hypotheses are often necessary (e.g. isospin symmetry) to overcome the lack of data and sometimes models have been used also. It is worth to note that strange particles are produced through resonances, but, like in the Bertini model of Geant4, only the decay products of those resonances are taken into account in INCL. The reason rests first on the short lifetimes of those resonances (their transport is then considered negligible), second on some overlapping of the large widths and thirdly on the numerous not well known needed characteristics related to the resonances.

Results: Our first results was compared to experimental data and to the LAQGSM results(2) in the case of kaon physics. The forward K^+ production in p (2.3 GeV) + ^{12}C collisions, shown in Fig. 1, shows that INCL is competitive with LAQGSM in the region where experimental data exist. Both models are able to fit those latter. In Figure 2 are plotted the K^+ invariant production cross sections in p (3.5 GeV) + ^{197}Au collisions. Here again INCL gives rather good results. These preliminary results are very encouraging, and the next step is to do complete benchmark on the available experimental measurements in order to define more precisely the reliability of our model.

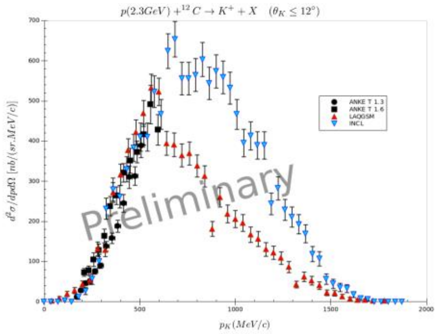

Figure 1. Forward K^+ production cross section in p (2.3 GeV) + ^{12}C collision. Experimental data (black bullets), LAQGSM and INCL results (red and blue triangles).

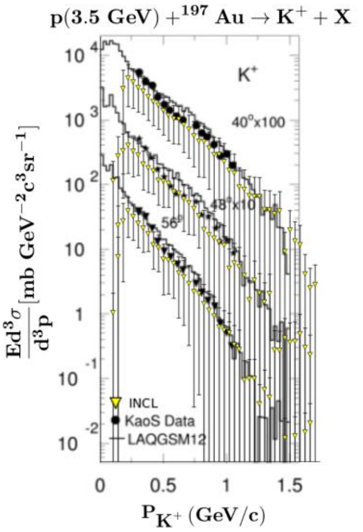

Figure 2. K^+ invariant production cross sections at θ=40°, 48° and 56° in p (3.5 GeV) + ^{197}Au collision. Black bullets (exp. data), solid lines and yellow triangles (LAQGSM and INCL results).

Conclusion: The new version of INCL is now able to simulate spallation reaction implying strangeness with relatively good predictions in kaons physics. In a near future, work on hypernucleus deexcitation will allow access to the hypernucleus physics.

References:

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