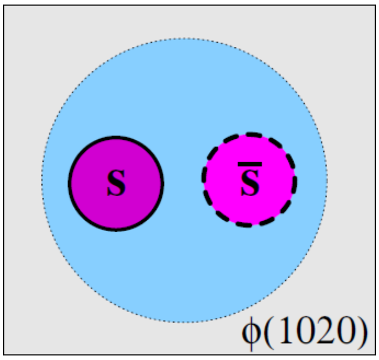
Study of hidden strangeness production in the NA61/SHINE experiment at CERN SPS

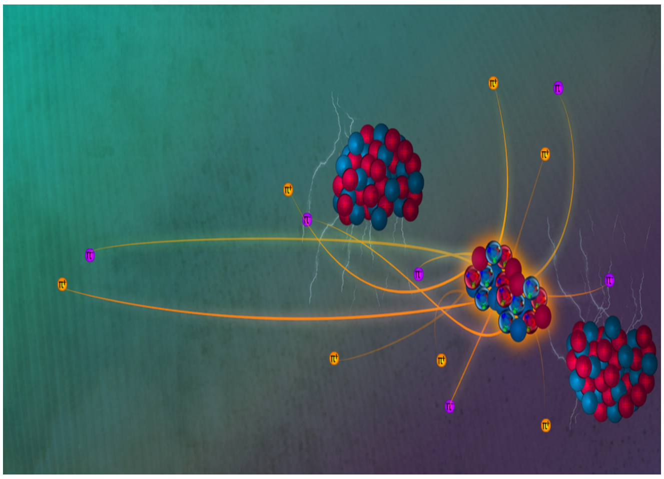
The aim of this project is the investigation of **high energy** collisions of atomic nuclei, that is, collisions in the energy range of at least a few GeV/nucleon (1 GeV = 10^9 eV). Such high energy collisions are being studied, among others, in the international experiment **NA61/SHINE** in the main high energy physics laboratory CERN near Geneva (the Principal Investigator has an *expert* status in this experiment). The project will supply new experimental information on production of the **ϕ(1020) meson** in collisions of argon and scandium nuclei (Ar+Sc), as well as xenon and lanthanum nuclei (Xe+La).



The ϕ meson, with its rest mass of 1020 MeV/c^2 has a very peculiar internal structure: it consists of one ***s*** quark with its non-zero *strangeness* quantum number, and of the corresponding anti-quark $\bar{s}$. The ***s*** and $\bar{s}$ do not exists in our „normal" every day matter, but they can be produced in high energy nuclear collisions.

The specific internal structure of the ϕ(1020) meson makes it an important probe of the nature of the system of the extremely hot and dense matter created in these collisions: in a „normal" environment of colliding protons and neutrons, the ϕ behaves as a „usual", non-strange particle, like, *e.g.*, a proton. However, if in the collision a phase transition to the **quark-gluon plasma** occurs, the production of the ϕ will reflect the enhanced production of strange quarks and anti-quarks in such a system.

The main aim of this project is to provide new data on the puzzling **collision energy dependence of the rapidity ("relativistic velocity") distribution** of ϕ mesons in nucleus-nucleus collisions. In heavy ion (lead-lead) reactions, **a very rapid increase** of the width of this distribution with increasing collision energy has been observed. No such rapid increase was observed for any other particle under study, nor for the ϕ in proton-proton collisions. As in lead-lead reactions, one expects a transition to the quark gluon plasma in the energy regime studied by NA61/SHINE, this phenomenon may be connected to the fundamental nature of the created system.



The study of the collision energy dependence of ϕ production for *smaller colliding nuclei*, planned in this project, will allow for an elucidation of this intriguing phenomenon. Argon-scandium as well as xenon-lanthanum colliding systems occupy an intermediate position between proton-proton and lead-lead reactions. The new experimental data on these reactions will allow us to clarify whether the rapid increase of the ϕ rapidity distribution is unique to lead-lead collisions, or present also for much smaller colliding nuclei. In this context, the project will provide **unique experimental information,** which will improve our understanding on the system sizes and collision energies needed to create the quark-gluon plasma.

Figures provided by:
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