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Hard processes in hadron-nucleus and nucleus-nucleus interactions

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**HARD PROCESSES IN
HADRON-NUCLEUS AND
NUCLEUS-NUCLEUS INTERACTIONS**

H. Satz and X.-N. Wang

(Editors)

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HARD PROCESSES IN $p + A$ AND $A + A$ COLLISIONS

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In the search for the quark-gluon plasma, a deconfined system of quarks and gluon, in high energy nucleus-nucleus collisions, hard processes have played an essential role as probes of the properties of dense matter. Because of the hard scales involved, these processes happen early in the collisions and can later on resolve the short distance nature of the medium. In order to use them for this purpose, one should first understand the basic processes in the absence of the deconfined medium, and then study what modifications each basic process experiences in the deconfined quark-gluon plasma. This is the purpose of the *Hard Probe Collaboration*, a group of theorists who are interested in the problem and are willing to dedicate a considerable amount of their time to work on it, with the help of a number of outside experts on hard processes.

The hard processes to be considered are the production of

- prompt photons,
- Drell-Yan dileptons,
- open charm,
- quarkonium states,
- hard jets and high p_T hadrons.

In the first volume of our work which is published in *Int. J. Mod. Phys. A* **10**, 2881-3090, 1995, as a first step we took a survey of the above hard processes in hadronic collisions and provided the up-to-date calculation of the productions rates and their dependence on parton distributions and renormalization scales, with comparison with the existing experimental data.

In this second volume, we will address mainly the normal nuclear modification of the hard processes in hadron-nucleus collisions and similar effects in nucleus-nucleus collisions in the absence of the formation of the quark-gluon plasma. We will have two reviews on the problems of hard processes in hadron-nucleus and nucleus-nucleus

collisions. They will then be followed by a survey of the nuclear modification of the parton distributions, since each hard process will depend on these parton distributions. The remaining discussions of this volume will be dedicated to the consequences of the modified parton distributions and the transverse momentum broadening due to initial multiple parton scattering inside nuclei. However, even within this scope our understanding of the multiple scattering is still limited. Therefore, we have left out discussion of quarkonium production in $p + A$ collisions since we still lack a solid theoretical understanding of the nuclear dissociation of the quarkonium. Even though there have been a lot of theoretical studies of the parton energy loss and modified fragmentation functions, we will leave them to the future volume where we will survey progresses in the study of the modification of hard processes in a dense medium.

Though the work reported in this volume is done mainly by the corresponding authors, they are also the results of the many discussions during and after many workshops and collaboration meetings. The complete list of members of the Hard Probes Collaboration is given below. We express our sincere gratitude to ETC/Trento (May 1995), the Institute of Nuclear Theory (Nov. 1996 and May 1998), Technical University of Lisbon (Oct. 1997) and Physics Department of University of Jyvaskyla (Sept. 1999) for the financial support that made these meetings possible.

Members of The Hard Probe Collaboration

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