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The theory group of SUBATECH (Nantes, France) has an opening for a 3 year

PhD position on "improved treatment of quarkonia production in ultrarelativistic heavy ion collisions"

The context: The interpretation of the ultrarelativisitc heavy ion collision (URHIC) data collected at the CERN and RHIC Collider is the center of interest of the high energy theory group at Subatech. We have developed in the recent years the event generator EPOS3 to study the soft physics as well as EPOS-HQ to study heavy quarks which traverse the plasma of quark and gluons, formed in these reactions. The goal of this approached is to develop a program which reproduces simultaneously the heavy as well as the light quark physics to reduce the uncertainties inherent in this approaches because the underlying theory of strong interactions, the Quantum-Chromo-Dynamics (QCD) can only solved in special cases.

Among various "hard probes" of particular interest is the so called "quarkonia suppression" suggested by Matsui and Satz. Quarkonia are bound states of heavy quarks, stable in the vacuum which would be dissolved at finite temperature when immerged in a quark gluon plasma due to the QCD equivalent of the Debye screening mechanisms. Due to such phenomenon, quarkonia are often referred to as "QGP thermometer", as various bound states would dissolve at different temperature above the deconfinement temperature T_c. Although this picture is quite appealing, its concrete implementation in numerical models is often performed with pretty crude approximations and assumptions, for instance neglecting finite dynamical time scales inherent to the ultrarelativistic heavy ion collision. In recent years, one has also realized that some quarkonia could be formed at or prior to the transition towards the confined phase by 2 heavy quarks stemming from disconnected origins. This so called "recombination mechanism" is usually modelled assuming quasi-stationary bound states what also constitutes a questionable approximation.

Recently, we (among some researchers) have started to investigate the feasibility to deal with quarkonia formation in URHIC adopting the viewpoint and concepts of the so-called "open quantum system" (see f.i. ref. [1-3]), which appear to be the correct dynamical framework for such situation. In particular, we were able to treat the somehow simpler case of bottomonia production at the large hadron collider (LHC) where only one beauty-antibeauty pair is considered, with promising perspectives…

The thesis: During the PhD thesis, we plan to pursue the investigation of quarkonia production in URHIC resorting to the concepts and methods of open quantum systems. Although we have previously gained some experience on this topic, several important open questions remain which need to be addressed in the future PhD thesis: role of the color degree of freedom in the time evolution, dealing with several heavy-quarks pairs in the same system and improved treatment of the recombination, better characterization of the initial quantum state,… Apart

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from theoretical developments, some part of the PhD is expected to be devoted to phenomenological studies on the URHIC studied experimentally at RHIC and LHC colliders. This could encompass some extension to the proton-nucleus case as well.

The candidate: We expect from the candidate a solid background in theoretical physics, especially of the different aspects of QCD as well as basic knowledge in numerical physics. Candidates with good knowledge of open quantum systems are encouraged to apply as well, even if they have a less extended background in QCD.

The group: The theory group of SUBATECH is composed of 13 permanent senior researchers (among them 7 oriented towards high energy physics), 1 postdoc and 4 PhD students. Further general information can be found on our website http://www-subatech.in2p3.fr.

The position: 3 year PhD CNRS-fellowship with social and health benefits starting from fall 2018.

The process: Candidates should send a CV, a statement of their research interests and two letters of recommendation to the head of the theory group, Prof. P.B. Gossiaux (gossiaux@subatech.in2p3.fr, tel +33 2 51 85 84 32), to whom further information can be obtained. Application will run until the 30th of April 2018.

References:

1. "The Schrödinger–Langevin equation with and without thermal fluctuations", R. Katz and P.B. Gossiaux; Annals Phys. 368 (2016) 267-295, arXiv:1504.08087
2. "Upsilon suppression in the Schrödinger–Langevin approach", Pol Bernard Gossiaux, Roland Katz; Nucl.Phys. A956 (2016) 737-740
3. "Dynamical bottomonium-suppression in a realistic AA background ", P.B. Gossiaux et R. Katz, Journal of Physics: Conf. Series 779 (2017) 012041