Recommendations from
WG1 and WG2 meeting in Lisbon

The second meeting of the WG2 was held—together with the WG1 and the GDRE " Heavy Quarks"—at the Instituto Superior Técnico, Universidade de Lisboa from Monday, June 11 till Thursday, June 14 2018

This meeting followed the recommendation of the first WG2 meeting to have the next meeting together with the lattice gauge calculation people who are organised in WG1. Because the experimentalists were interested in this discussion which has an immediate influence on the interpretation of their experimental result the GDRE "Heavy Quark" joined this meeting. The second meeting had also a larger scope than the first meeting and covered the whole variety of topics treated by members of this WG. Therefore only a part of the meeting was in common with the Working Group 1.

In this joint meeting of WG1 and WG2 we discussed topics of mutual interest, with input from fundamental (lattice QCD, diagrammatics), effective (effective field theory, transport theory, models) and phenomenological approaches, as well as experimental data. The emphasis for WG1 was on understanding the phase structure of QCD and related theories, especially in non-standard scenarios, such as in the presence of external magnetic fields or at nonzero baryon density, where standard numerical algorithms break down. QCD-like theories are being employed to investigate parts of the phase diagram not accessible in QCD itself and new algorithms, especially for QCD at nonzero baryons, are critically assessed.

The specific recommendations for WG1 that arose out of this meeting is to further develop the study of QCD-like theories. This should be done for a number of reasons, namely to

(a) gain insight into QCD itself

(b) test and verify methods and effective theories as an approximation to QCD

(c) study these theories in their own right, as they are of interest for other phenomena in Nature.

A prime example for the latter is the theory of graphene, which can be investigated using standard lattice QCD methods, but is of course highly relevant in the context of materials.

In the joint session of WG1+WG2, this was supplemented by a review of the theoretical approaches which relate properties of the QGP with experimental observables, also beyond those involving heavy quarks

The questions which we addressed included

(a) thermal crossover at small chemical potential - role of strange hadrons? freeze-out patterns? lattice view? spectral modifications?

(b) transport coefficients - what is known theoretically? from the lattice? experimentally?

(c) heavy quarks - stability of hidden charm and bottom mesons? Evidence for survival of hidden charm mesons in a QGP?

(d) Role of fluctuations: what is relation between fluctuations of conserved quantities (baryon number, strangeness, charge) obtained in lattice calculations and the data observed in experiments

(e) are there other observables (dileptons, polarized Lambdas....) which may carry information on the QGP and how we can interpret the experimental results.

(f) how can the present theoretical models become more realistic by including for example magnetic fields or new approaches to the fragmentation function.

As far as heavy quarks are concerned there was a long discussion about what lattice can provide and what the numerical programs, which simulate heavy ion reactions in order to interpret the experimental results, need to make more realistic predictions. Especially the need of transport coefficients, not only at zero momentum but as function of the particle momentum has been discussed but one has also realised that to obtain these or similar quantities on the lattice a time scale will beyond the present COST action is necessary.

For the physics not related to heavy quarks the meeting was a first exchange of ideas which have been extensively discussed and criticised. There, the recommendations have been made to include the elements of criticism when advanced approaches will be presented at the next WG2 meeting.