

Lorentz workshop
*Tomography of the quark-gluon
plasma with heavy quarks*

Closing remarks

10-14 October 2016 – Lorentz Center@Oort, Leiden (the Netherlands)

Welcome slide from Monday

We look forward
having an exciting,
inspiring and
productive workshop

*Museum Boijmans Van
Beuningen, Rotterdam*

and are grateful
to our sponsors



Lorentz center

Tomography of the Quark-Gluon Plasma with Heavy Quarks

Workshop: 10 – 14 October 2016, Leiden, the Netherlands

Scientific Organizers

- Jörg Aichelin, Subatech Nantes
- Raphael Granier de Cassagnac, LLR Palaiseau
- Maria Paola Lombardo, LNF Frascati
- André Mischke, Utrecht U
- Nu Xu, CCNU/Berkeley Lab

Topics

- Which Heavy-Flavour Observables?
- Charmonia Versus Bottomonia
- Open Charm versus Beauty
- How Do Theoretical Models Differ?
- What Tells the Lattice?
- Current Issues and Limitations

The Lorentz Center is an international center for scientific workshops. Its aim is to organize workshops for researchers in an atmosphere that fosters collaborative work, discussions and interactions. For registration see: www.lorentzcenter.nl

Image: 'The Tower of Babel' (Vienna) by Pieter Bruegel the Elder ca. 1563-1565. Poster design: Stephen Nova Studios, INL

Universiteit Leiden The Netherlands FOM STW NIKHEF NWO Lorentz center

www.lorentzcenter.nl

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Universiteit Leiden **FOM** **STW** **Nikhef** **NWO** **Lorentz center**

www.lorentzcenter.nl

Some statistics

- 50 participants
- Participants origin →
- Gender: 38(m) / 12(f)
- Age: 6 students
- 13.5h plenary talks
- 14.4h discussion session

Country	Participants
France	6
USA	6
Italy	5
Germany	10
Netherlands	9
Brazil	4
China	2
South Africa	1
Serbia	1
UK	2
Spain	2
Switzerland	1

Discussion groups

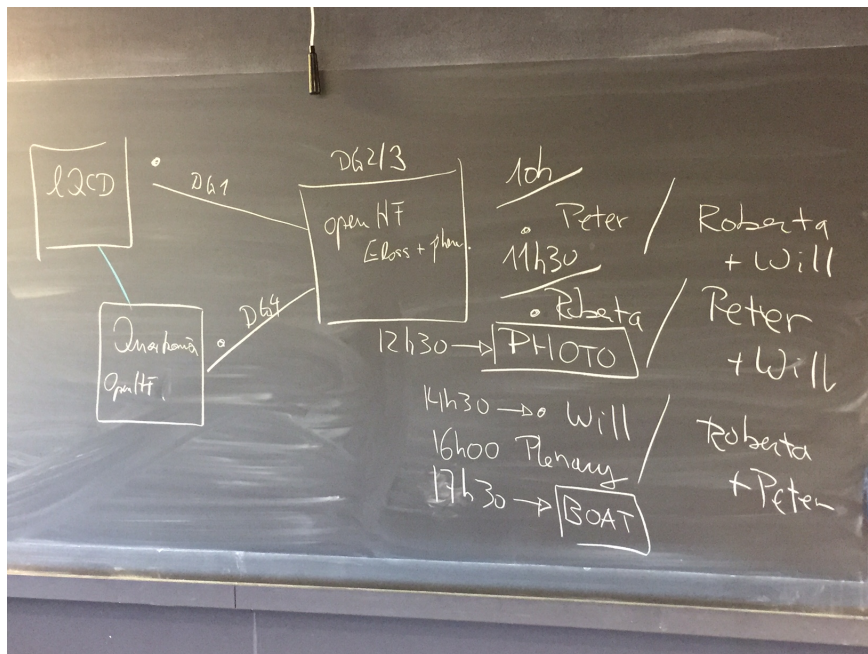
Conveners

Peter Petreczky and Maria Paola Lombardo

Will Horowitz and Matt Nguyen

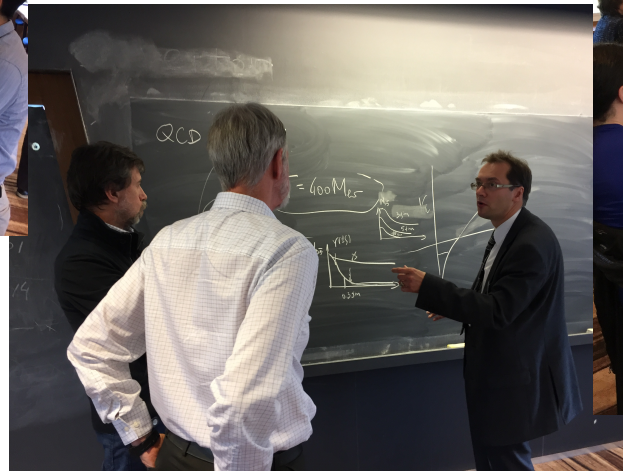
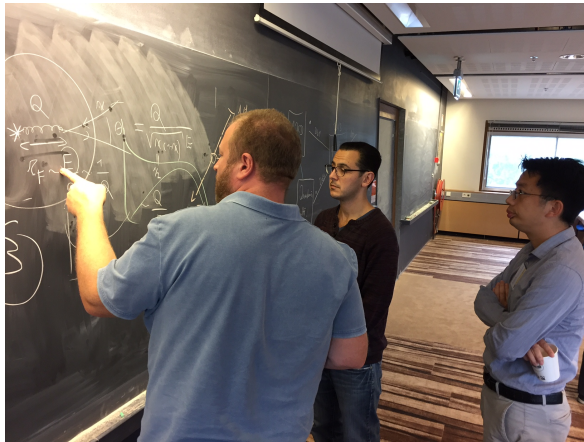
Roberta Arnaldi and Torsten Dahms

Big thanks!



Scientific discussions: impressions

“Classical” blackboards are essential!



Outcome and how to proceed...

- Critical document on where the field is going
 - Content: focus on open issues; converge on questions
 - Setup
 - 1-2 page from each DG
 - ~2 pages on outcome from joint DG meetings
 - Link to EMMI RRTF document
 - Timeline: submit to arXiv in 2-3 weeks
 - Authorship: all participants in alphabetic order
 - Indico website with all talks
- QM'17 contribution
 - Abstract
 - Summary of this and EMMI RRTF (?) meetings
- Next meeting: proposal Brazil in Feb.2018

Heavy-flavour production and medium properties in high-energy nuclear collisions – Quo vadis?

Veni, Vidi,...

G. Aarts,²³ J. Achelin (co-organiser),²⁴ C. Allton,²³ R. Arnaldi (co-convener),⁷ S. Bass,³ C. Bedda,¹⁰ N. Brambilla,⁴ E. Bratkovskaya,²² P. Braun-Munzinger,²² G.E. Bruno,² T. Dahms (co-convener),⁴ S.K. Das,²⁹ H. Dembinski,¹⁷ M. Djordjevic,¹³ E. Ferreira,²⁶ A. Frawley,⁵ P.-B. Gossiaux,²⁴ R. Granier de cassagnac (co-organiser),¹⁴ A. Grelli,¹⁰ M. He,¹⁸ W. Horowitz (co-convener),²⁰ G.M. Innocenti,¹⁶ M. Jo,¹⁴ O. Kaczmarek,²⁸ P. Kuijfer,¹⁹ M. Laine,¹¹ M.P. Lombardo (co-organiser),⁸ A. Mischke (co-organiser),^{10,19} M. Munhoz,²⁷ M. Nahrgang,²⁴ M. Nguyen (co-convener),¹⁴ A.C. Oliveira da Silva,^{27,10} P. Petreczky (co-convener),¹ A. Rothkopf,¹² M. Schmelling,¹⁷ E. Scapparini,⁷ T. Song,⁶ J. Stachel,²¹ A. Suaide,²⁷ L. Tolos,⁹ B. Trzeciak,¹⁰ L. Van Doremalen,¹⁰ L. Vermunt,¹⁰ S. Vigolo,¹⁰ N. Xu (co-organiser),¹⁵ Z. Ye,³⁰ H. Zanolini,^{27,10} and P. Zhuang²⁵

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¹¹Institute for Theoretical Physics, University of Bern, Switzerland.

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³⁰University of Illinois, Chicago, USA.

(Dated: October 13, 2016)

Both open and hidden heavy-flavour physics in high-energy collisions between heavy atomic nuclei is entering a new and exciting stage towards reaching a clearer understanding of the new experimental results with the possibility to link them directly to the advancement in lattice QCD. Recent results from experiments and theoretical developments regarding open and hidden heavy-flavour dynamics have been debated at the Lorentz Workshop Tomography of the quark-gluon plasma with heavy quarks, which was held in October 2016 in Leiden. In this contribution, identified common understandings and developed strategies for the upcoming five years will be discussed to achieve a profound knowledge of the dynamical properties of the quark-gluon plasma (QGP) in high-energy nuclear collisions.

I. INTRODUCTION

Over the last decade, different experimental probes have been used to characterisation the QGP. Heavy quarks play a crucial role as a probe thanks to their large mass with respect to the temperature of the plasma consisting of gluons and light quarks. Therefore, heavy quarks are ideal probes for the study of the QGP properties because they are produced in the very early stage of the collision testifying the entire space-time evolution of the system. Furthermore,

the thermalisation time of heavy quarks is likely to be larger than the lifetime of the plasma, which offers the unique opportunity to have a non-fully thermalised probe that will carry more information on its dynamical interaction with the medium. In addition, from the theoretical point of view, the large mass of heavy quarks makes the evaluation of the so-called Quarkonia correlators and transport coefficients feasible directly from lattice QCD calculations.

Furthermore, the experimental results at both RHIC and LHC collision energies have surprisingly shown a large suppression of the transverse momentum dependent nuclear modification factor (R_{AA}) of heavy-quark particles in heavy-ion collisions and a large elliptic flow v_2 has been observed. This has challenged all theoretical approaches that are not able to describe correctly both observables (R_{AA} and v_2).

While the measurements of the dynamics of heavy quarks in the medium became feasible in the last decade, the physics of Quarkonia production is historically one the main probe of the existence of the QGP and has been studied for nearly thirty years. The new experiments at the LHC and their relation to the results from RHIC allow clarifying the expected Quarkonia melting along with the recombination and regeneration dynamics in the plasma. Moreover, new insights were obtained from the recent developments in lattice QCD from the evaluation of the spectral functions and the possibility at the LHC to reconstruct experimentally the presence of single excited states in the QGP, especially for bottomonia states. This is opening up the possibility to have stringent constraints from both the theoretical and experimental sides for the understanding of the Quarkonia production in the plasma.

The Lorentz workshop Tomography of the quark-gluon plasma with heavy quarks [1], which was held from 10-14 October 2016 in Leiden, the Netherlands, provided the platform for experimentalists and theoreticians to discuss recent results from experiments and theoretical developments regarding open and hidden heavy-flavour dynamics in high-energy nucleus-nucleus collisions.

II. LATTICE QCD

III. HIDDEN HEAVY-FLAVOUR

IV. OPEN HEAVY-FLAVOUR

V. SUMMARY, CONCLUSIONS AND PERSPECTIVES

VI. ACKNOWLEDGMENTS

[1] <http://www.lorentzcenter.nl/lc/web/2016/785/info.php3?wsid=785venue=Oort>.

Good memories



biking



breakfast, hotel



conference dinner

Lorentz Center support



*Thanks a lot
Aimée and Merlijn*



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Thank you!