



Πανεπιστήμιο  
Κύπρου

ΤΜΗΜΑ ΦΥΣΙΚΗΣ

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σας προσκαλεί την

**Πέμπτη, 14 Ιουλίου 2022, ώρα 17:00**

*στην παρουσίαση της Διδακτορικής Διατριβής του Gustavo Alonso Ramirez Hidalgo*

***“Multilevel Algorithms in Lattice QCD for Exascale Machines”***

This thesis deals with the implementation and development of multilevel methods, for solving linear systems of equations and computing traces of functions of matrices, in the lattice Quantum Chromodynamics (QCD) setting.

When extremely large and ill-conditioned linear systems are being solved via multigrid methods, the scalability of the implementation is typically compromised as we move to a large number of compute nodes. The first contribution of this thesis is on diminishing these scalability issues in DD- $\alpha$ AMG (a library for solving linear systems in lattice QCD). We do this by integrating four methods into the coarsest level: recycling, polynomial preconditioning, block-diagonal preconditioning and pipelining. In doing so, we get remarkable algorithmic and computational gains in the Wilson case, and we are also able to get rid of a somewhat artificial parameter at the coarsest level in the twisted mass case.

We then turn to more computational aspects and, as a second contribution from our work, we extend the DD- $\alpha$ AMG library to become a hybrid GPU+CPU solver by porting some parts of the code via CUDA C. In doing so, we realize the importance of having a smoother based on DD when running on GPUs, as well as of using an (more) aggressive coarsening in the multigrid hierarchy, when running with our hybrid solver.

Finally, we discuss the development and testing of a new method for the computation of traces of functions of matrices,  $\text{tr}(f(A))$ . This new method is based on multilevel Monte Carlo, in combination with a multigrid hierarchy. We have tested the method on the inverse (i.e.  $f(A)=A^{-1}$ ), for three matrices: Schwinger, Wilson and twisted mass. We see remarkable results in Schwinger, and very good and promising results for Wilson and twisted mass. These results open new paths of research, where the multigrid multilevel Monte Carlo method can be used in combination with other methods such as deflation and hierarchical probing.

Η παρουσίαση θα είναι ανοικτή στο κοινό μέσω τηλεδιάσκεψης:

<https://uni-wuppertal.zoom.us/j/95859779148?pwd=OFIKS3B4REND50YxbHUweU9SQ2k1QT09>

Για περισσότερες πληροφορίες παρακαλώ επικοινωνείτε: Τμήμα Φυσικής, τηλέφωνο: 22892820