Curriculum vitae

Name: Hubert SIMMA

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Nationality: German

Education:

Universität Konstanz, Germany, 10/1982 – 9/1984

Universität Zürich, 10/1984 – 8/1988

Diploma in physics, 1988

ETH Zürich, 9/1988 – 6/1992

Ph.D. in physics, 1992, thesis title:
"Aspects of B-Mesons: Rare Decays and CP Violation"

Positions held:

Teaching assistant, ETH Zürich, 10/1988 – 6/1992

Postdoctoral fellow, DESY (Hamburg site), 10/1992 – 9/1995

Postdoctoral fellow, University of Edinburgh, 10/1995 – 9/1996

Postdoctoral fellow, DESY (Zeuthen site), 10/1996 – 3/2000
(scientific association to INFN, APE-group, 10/1996 – 11/1999)

Staff researcher, DESY (Zeuthen site), since 4/2000
(guest lecturer, Univ. Milano Bicocca, 8/2006 – 7/2009)

Languages: German, English, Italian

Research Activities

My physics research has mainly been focused on theoretical and computational high-energy physics, in particular on the phenomenology of electroweak processes within the Standard Model, and on methodic and algorithmic problems in lattice gauge theory. I have also committed major research effort to the design, development and implementation of massively parallel computers for lattice QCD (LQCD) applications. After the successful completion of these development projects my research interests returned to physics problems in LQCD and to interdisciplinary studies in the context of scientific computing.

Elementary particle phenomenology

At the beginning of my research activity I have worked on the problem of how to identify the important effects of CP violation and new physics in experimental data from rare decays of B-mesons. In this context I have developed a strong interest in effective low-energy theories and in the different theoretical methods to compute the required hadronic matrix elements.

During my PhD thesis I performed a first complete one-loop calculation of various "penguin" decays into two gluons or photons ($b \to sgg$, $sg\gamma$, $s\gamma\gamma$) [1]. I systematically investigated CP-violating rate asymmetries in inclusive and exclusive decays of charged B mesons and estimated the strong phases from the absorptive part of the decay amplitudes at the quark level [2,3,4]. I also investigated the potential of detecting new physics with D mesons [5].

As a post-doc at DESY I investigated the systematic application of the equations of motion and the rôle of ghost contributions in renormalisation-group improved computations of short-distance QCD corrections [6], and I worked with different approaches to evaluate hadronic matrix elements for B decays.

For exclusive radiative B-decays, like $B \to K^*\gamma$ or $\rho\gamma$, I calculated the decay matrix elements within the framework of QCD sum-rules on the light cone [7], and estimated CP-violating rate asymmetries from two-loop diagrams with additional gluon exchange in relativistic quark models [9].

For a various hadronic two-body decays of the type $B^\pm \to VV$, PV and PP, I computed estimates of CP-violating rate asymmetries and angular correlations [8,10]. I also investigated the baryonic decay $\Lambda_b \to \Lambda + J/\Psi$ which has a particular rich structure of angular correlations [14]. Some of these observables were also estimated by including predictions from heavy quark effective theory (HQET).

Lattice QCD

Within the framework of numerical simulations of QCD on the lattice my interest derives from phenomenologically relevant problems, like the computation of hadronic matrix elements of quark operators and the mechanism of chiral symmetry breaking, but I also became strongly interested in methodological questions, like non-perturbative renormalisation, and in numerical simulation algorithms.

My research activity in LQCD started within the ALPHA project, which aims at the precise determination of fundamental parameters of QCD, like the running coupling α_s and quark masses. In order to monitor the low-lying eigenvalues of the Dirac operator during simulations, I developed a substantially accelerated iterative method (modified conjugate gradient) to compute the low-lying eigenvalues of sparse hermitian matrices [13,16]. This algorithm became an important tool in various contexts, e.g. in investigations of a multi-boson algorithm for dynamical fermions [11] and in non-perturbative determinations of improvement coefficients and renormalisation factors [15].

Within the UKQCD collaboration I took part in first simulations with the non-perturbatively improved Wilson quarks and I analysed “exceptional” configurations which have almost vanishing eigenvalues of the Wilson-Dirac operator [24]. Since these eigenvalues are not only relevant for numerical simulations, but can be related to the breaking of chiral symmetry, I investigated the space-time localisation and chiral properties of the eigenmodes and measured their correlation with topological effects [17,18,19].

With the availability of first APEmille systems at DESY, I continued to work on LQCD within the ALPHA project and started early physics production runs on the new machine. These simulations extended the non-perturbative determination of the running coupling in quenched QCD to much lower energy scales [31], and we started simulations to measure the step scaling function of the running coupling with two massless flavours [28].

Within the ALPHA project I carried out extensive production runs on the apeNEXT machines with the $O(a)$ improved Schrödinger functional for $N_f = 2$ light quarks in large volumes. These simulations provided interesting insights into algorithm behaviour [38] and effects of dynamical fermions [41].

During the last years I carried out large-scale simulations with $N_f = 2 + 1$ dynamical flavours and open boundary conditions within the Coordinated Lattice Simulation (CLS) to generate high-quality gauge ensembles [66] that provide the basis for a wide physics programme ranging from the determination of fundamental parameters of QCD to phenomenological applications.

Apart from my interest in the determination of fundamental parameters of QCD for $N_f > 2$ flavours, my research activities during the last years were focused on HQET on the lattice. This framework provides a solid method for the non-perturbative renormalisation and matching to full QCD [40,56,63], and eventually can provide precise lattice results in heavy-flavour phenomenology [47,49–51,55,57–65,67], in particular for hadronic matrix elements, like decay constants and form factors that are needed for the determination of the CKM matrix of the Standard Model.

Computer development

In 1996 I started to intensively work on behalf of DESY within the APEmille development project at INFN [20,21,22,25,29]. I participated in the final definition of various software components, and then developed and organised large parts of the system tests during the development and prototype phase. During my extensive verification tests of the control and floating-point processors I came into close contact with processor design. Based on application-driven analyses and simulations I was able to identify architectural bottlenecks and to propose minor improvements which were included in the final chip design.

The experience and knowledge which I have gained during the development of APEmille was essential for the subsequent testing and successful integration of the first prototype machines at DESY-Zeuthen, and then for building up the very stable production system with more than 1000 processors. Moreover, I re-designed main parts of the compilation chain which were essential for the quick start-up of physics production on APEmille.

During the installation phase of APEmille starting in 2000, I built up a small group of physicists and computer scientists at DESY in Zeuthen to work on the next generation of APE machines [23] within the apeNEXT-collaboration (INFN, DESY, University of Paris Sud).

Apart from the development of major software components for apeNEXT, the group at Zeuthen has played a crucial rôle in the definition, verification, debugging and benchmarking of the processor design. In this context I gained experience in VLSI technology and improved or implemented parts of the VHDL design, e.g. for the memory controller, the communication interface and the global interrupt logic.

Within the software development, I have carried out the entire design, implementation and maintenance of a TAO compiler for both architectures, APEmille and apeNEXT. Within the team at Zeuthen we also developed the prototype for a C compiler, including suitable language extensions to handle the parallelism of the architecture, and we provided relevant contributions to other main software components, like the assembly-level optimiser and operating system.

After the completion of the development and commissioning of apeNEXT, I joined the Collaborative Research Centre (SFB) in Germany to build in collaboration with IBM the QPACE computer [43,45,48,53], a massively parallel machine based on the Cell processor. Together with scientists at INFN in Ferrara, I designed, implemented and tested the custom torus network for QPACE [52,54].

In the context of machine development I also became interested in the theoretical analysis of the complex interrelation between the computational tasks of scientific computing applications (application signatures) and the hardware characteristics of the computer system. Therefore, I studied methods for theoretical performance-modelling and -analysis [39], and extended them to a systematic framework for guiding the development of improved algorithms or hardware architectures (or to identify relevant optimisation strategies for the code implementation). With this method I have also investigated algorithms and implementations of general-interest scientific computing problems beyond LQCD, like FFT on a d-dimensional torus networks.

Teaching Activities

Since the time of my university studies, I have gained experience in the supervision and scientific training of students, for instance,

- as teaching assistant during my university and PhD studies at University and ETH Zürich (1985–1992)
- at the University of Edinburgh (co-supervision of a PhD thesis, 1996–1997)
- within the APE-Group at the University of Rome (supervision of several laboratory theses, 1998–2000)
- at the Humboldt University of Berlin (co-supervision of a diploma thesis, 2006)
- as "professore a contratto" at the University Milano Bicocca (course on "Scientific High-Performance Computing", co-supervision of a PhD thesis and semester theses, 2006-2009)

Also within my activity for the APE project at DESY, the interdisciplinary transfer of technical and theoretical knowledge has become an integral and important aspect of my daily work. The continuous training of new group members, guest visitors, and summer students from many coutries was a prerequisite for building up an active and productive development group.

My experience in lecturing has grown from numerous presentations at workshops, user-oriented tutorials and conferences, where I had opportunities to explain the methods of lattice QCD simulations or the relevant technical aspects of dedicated QCD machines to audiences with very different backgrounds, e.g.

- Plenary talk at "International Computational Accelerator Physics Conference", Darmstadt, 2000 [26]
- Lectures at the Joint Training Course on "Algorithms and Computers" of the EU IHP network "Hadron Phenomenology from the Lattice", Wuppertal, Mar 2001
- Invited talks at the "International Conference on Statistical Mechanics and Field Theory", Bari, 2000, 2002, and 2004

- Lectures and program organisation for the "APE Tutorial", Zeuthen, Feb 19–21, 2002
- Lecture at the training workshop "Lattice Practitices", Zeuthen, Nov 2006
- Lectures on "Theoretical Physics on Supercomputers" at the International School of Theoretical Physics, Parma, Sept 8–13, 2008
- Organization of the training workshops "Lattice Practices", Zeuthen, 2011, 2012, and 2014

With the course "Scientific High-Performance Computing" for PhD students at the University of Milano Bicocca in 2007 I gained teaching experience within the stimulating framework of a university course.

Other Activities

- Member of the computer-time allocation commitee for the APE systems at DESY, 1994-1995
- Organisation of the "Meeting on Massively Parallel Computing using Quadrics Systems" (together with W. Friebel), Zeuthen, 5.-6.10.1995
- Member of the procurement commitees for APEmille and apeNEXT systems, 1999 and 2004
- Member of the local organising committee of the "XIX International Symposium on Lattice Field Theory (Lattice 2001)", Berlin, 19.-24.8.2001
- Member of the apeNEXT Collaboration Board, 2001–2005
- Member of the International Lattice Data Grid (ILDG) working groups for middleware and metadata since 2010
- Member of the scientific council of the John von Neumann Institute for Computing (NIC) since 2011

Publications

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[16] T. Kalkreuter and H. Simma, "An Accelerated Conjugate Gradient Algorithm to Compute Low-Lying Eigenvalues of Sparse Hermitian Matrices", Proceedings of *International Conference on High-Performance Computing and Networking*, Brussels, Belgium, April 15-19, 1996, p. 980

[17] K. Jansen, C. Liu, H. Simma and D. Smith, "Low-lying eigenvalues of the Wilson-Dirac operator", Nucl. Phys. B (Proc. Suppl.) 53 (1997) 262

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[42] M. Della Morte, *et al.* (ALPHA Collaboration), "Scaling test of two-flavor $O(a)$-improved lattice QCD", JHEP 0807 (2008) 037

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Dichiarazione

Il sottoscritto acconsente, ai sensi del D. Lgs. 30/06/2003 n. 196, al trattamento dei propri dati personali e alla pubblicazione del presente curriculum vitae sul sito dell' Universit di Ferrara.

Hubert Simma

(Hubert Simma)