

Andreas Nyffeler

Research Summary:

My field of research is phenomenological particle physics. I work on precision tests of the Standard Model and on new physics models in the TeV region. I am particularly interested in the analysis of the electroweak symmetry breaking sector in the Standard Model and its extensions and in the low-energy structure of the strong interactions.

I. Little Higgs models with T-parity at future colliders

A few years ago, new physics models called Little Higgs, have been proposed as another solution to the hierarchy problem of the Standard Model. They are situated somehow in between weakly interacting supersymmetric and strongly interacting Technicolor models. In addition to a light Higgs boson, many new particles are predicted in the TeV region, which will be explored by the upcoming LHC collider and, later on, at an International Linear Collider (ILC). If some additional discrete symmetry is invoked, called T-parity, there exists a lightest stable particle, usually the heavy neutral partner of the photon, which leads to events with missing transverse energy and which can serve as a viable dark matter candidate. A thorough understanding of the phenomenology of such Little Higgs models with T-parity is necessary in order to distinguish them from the MSSM with R-parity or Universal Extra Dimensions (UED) with KK-parity. With my colleagues at HRI, I have started to work out some consequences for searches for these new particles in the Littlest Higgs model with T-parity (LHT) at the LHC and how to distinguish the signals from the MSSM and UED.

a) Invisible Higgs boson decay in the Littlest Higgs model with T-parity
(with Raghavendra Srikanth Hundi and Biswarup Mukhopadhyaya)

We have shown that there are regions in the parameter space of the LHT, allowed by electroweak precision data, where the Higgs boson can decay invisibly into a pair of heavy photons A_H with a substantial branching ratio. The $BR(H \rightarrow A_H A_H)$ varies between 93% and 5% for Higgs masses between 115 and 600 GeV and for a symmetry breaking scale f in the LHT in the range 450 - 550 GeV. The total decay width of the Higgs boson in the LHT can thereby be enhanced by an order of magnitude compared to the SM for Higgs masses around 130 GeV. It is very likely that a Higgs boson with such a substantial invisible branching ratio can be detected at the LHC and the ILC.

b) Leptonic signals from the Littlest Higgs model with T-parity at the LHC
(with Asesh Krishna Datta, Paramita Dey, Sudhir Kumar Gupta and Biswarup Mukhopadhyaya)

Very recently, we started some detailed simulations on specific signals in the LHT and the MSSM at the LHC (di- and trileptons, with or without hard jets and missing energy) to explore regions in the parameter space, where these models differ or where they might lead to similar event characteristics.

II. Anomalous magnetic moment of the muon

This is some ongoing long-term project with Marc Knecht and Michel Perrottet (CPT-CNRS, Marseille, France) on higher order hadronic corrections to the muon $g-2$. Based on methods developed earlier for the evaluation of the pion-pole contribution to hadronic light-by-light scattering, we currently study the contributions from scalar intermediate states. Using QCD short-distance constraints from the operator product expansion on the relevant form factors in large- N_C QCD, in addition to experimental data on the form factors, and with a semi-analytical approach to the resulting two-loop integrals, we try to better assess the model dependence of earlier estimates in the literature. In this way we hope to get a better control of some of the hadronic uncertainties in the Standard Model prediction for the muon $g-2$ which presently make it difficult to interpret the deviation from the experimentally measured value.

Publications:

1. R.S. Hundi, B. Mukhopadhyaya and A. Nyffeler, *Invisible Higgs boson decay in the littlest Higgs model with T-parity*, Phys. Lett. B **649**, 280, (2007)

Conference/Workshops Attended:

1. *Workshop on LHC Physics 2006*, TIFR Mumbai, September 2006.
Talk: Little Higgs at the LHC
2. *Topical Meeting on Physics at the LHC*, HRI, December 2006.
Talk: Effective Field Theories and the LHC
3. *21st International Workshop on Weak Interactions and Neutrinos (WIN07)*, Saha Institute, Kolkata, January 2007.
Talks: 1. Little Higgs models
2. Invisibly decaying Higgs boson in the littlest Higgs model with T-parity
4. *International Workshop on Theoretical High Energy Physics (IWTHEP07)*, IIT Roorkee, March 2007.
Talk: Invisibly decaying Higgs boson in the littlest Higgs model with T-parity

Other Activities:

1. I was involved in the organization of a Topical Meeting on Physics at the LHC at HRI, December 2006.
2. I have organized at HRI, together with V. Ravindran, a discussion and reading group on Effective Field Theory and the Renormalization Group. I have also given several lectures on effective field theories in this framework. February - May 2007.
3. Pheno lunch talk: Narrow width approximation limitations and Breakdown of the Narrow Width Approximation for New Physics (based on hep-ph/0703077 and hep-ph/0703058), April 10, 2007.