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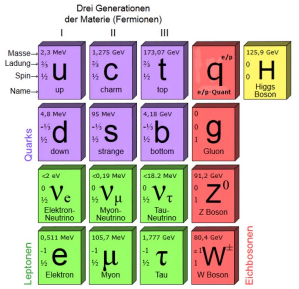
Particle Physics Group

EPPSU Theory Meeting, May 24 2024

Mission: Study phenomenological and quantum field theoretic aspects of the Standard Model of Elementary particle physics and models of New Physics in the context of

- high-energy collider processes (LHC and future colliders)
- high-precision low-energy processes
- dark matter, beyond SM, and astro particle physics
- Effective field theories (SMEFT, SCET, NRQCD, HQET, …)
- Apply rigorous QFT methods in phenomenological analyses
- Support regional, national and international collaborations and networks



Group structure (2024):

- Prof. Dr. André Hoang (Head)
- Prof. Dr. Massimiliano Procura
- Ass. Prof. Dr. Josef Pradler (Fast-TT, ERC, shared position with ÖAW)
- Dr. Alessandro Broggio (Uni.Assistant)
- Dr. Tyler Corbett (Uni. Assistant)
- Dr. Rudi Rahn (MSCA Fellow)

- Prof. Dr. Simon Plätzer (Research Fellow)
- Dr. Dmitri Melikhov (Research Fellow)

- 4 (+1) PhD students
- 4 Master students

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Strategic perspective beyond the specific research directions:

- Austria is a small country with a small particle physics community
- This implies particular local restrictions concerning funding and research possibilities that must be accounted for
- Middle and long term planning (research, personel, funding) must account the possibility of Viennese, regional and national collaborations on common (incl. theory and experiment) projects on the basis of the existing expertises

Ongoing collaborations and internatioinal networking

- Bern, Bonn, CERN, Hamburg, Karlsruhe, Lund, Madrid, Manchester, Salamanca, Valencia, Wuppertal
- MIT, UCSD, Los Alamos, Michigan State, Northwestern, Fermilab
- Bhopal
- Snowmass Initiative 2020-2022
- (g-2) Theory Initiative, Higgs Cross Section Working Group
- High-luminosity Large-Hadron-Collider (→ 2036)
- Future Lepton Collider, LCWS
- LHC top quark Working Group

Teaching

- Bachelor: STEOP2, Quantum mechanics, Particle physics 1
- Master: Adv. particle physics (|PP2), Intro QM, Adv. Quantum mechanics, E-dynamics
- Graduate: Particle Physics III (applications)
- Cooperation with Math. Physics: QFT

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Hoang

Collider physics phenomenology and Effective Field Theories

- Top quark precision physics
- Top quark mass
- Pert. theory at large orders (renormalons, OPE)
- Jet physics and heavy quark physics
- Multi-loop computations
- Theory consultant for CMS top quark group
- Event-shape distribution
- Determination of QCD parameters (m_q, α_S)
- SCET, NRQCD, (b)HQET

Procura

Low-energy precision observables and Effective Field Theories

- Hadronic contributions to $(g\text{-}2)_\mu$
- Light-by-light scattering
- Jet substructure
- Multi-differential cross sections
- Energy correlators
- Fragmentation
- SCET, Chiral perturbation theory, SMEFT

Pradler

Particle nature of dark matter and the early universe

- Dark matter detection
- DM production in the early universe
- Cosmo probes of NP (CMB, 21cm, Neff)
- Astro probes of NP (stellar cooling, indirect detection)
- Pheno of sub-GeV DM (intensity front, direct detect.)
- Self-interacting DM
- Pheno of dark photons, axions
- Primordial nucleothynsesis as probe of NP
- Baryogenesis scenarios connected to DM

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Broggio

Precision calculations and EFT applications to LHC phenomenology

- LHC precision physics
- Resummation in EFT framworks (threshold, N-jettiness, electroweak)
- Subleading power in SCET
- Top quark production processes
- LHC processes using the GENEVA Monte-Carlo
- Electroweak resummation for dark matter annihilation processes

Corbett

Model independent descriptions of physics beyond the SM

- SMEFT phenomenology
- Loop improved SMEFT predictions
- SMEFT at higher orders in $1/\Lambda^2$
- Electroweak and Higgs phenomenology within SMEFT
- SMEFT constraints from phenomenology
- geoSMEFT: summation of the vev expansion

Rahn

Automation in phenomenology and Effective Field Theories

- Automated calculations in SCET
- Non-global logarithms
- Factorization breaking effects
- Resummation of higher order corrections
- Operator bases for BSM EFT's
- Quasi parton distributions