

## CURRICULUM VITAE of FABIO ZWIRNER

- Personal data** Born in Padua (Italy) on January 4, 1958
- Present position** Full Professor (*Professore Ordinario*) of Theoretical Physics  
Physics and Astronomy Department 'G. Galilei'  
University of Padua
- Address** Via Marzolo, 8  
I-35131 PADOVA  
phone: +39-049-8277258  
fax: +39-049-8277112  
mobile: +39-347-5323009  
e-mail: fabio.zwirner@pd.infn.it
- Education**
- Ph.D. in Physics (1987), International School for Advanced Studies (SISSA-ISAS), Trieste, Italy
  - Master in Physics (1983), International School for Advanced Studies (SISSA-ISAS), Trieste, Italy
  - Laurea in Fisica (1981), 110/110 summa cum laude, University of Padua, Italy
- Career path**
- Full Professor of Theoretical Physics, University of Padua (11/2005-now)
  - Paid Scientific Associate, CERN, Geneva, Switzerland, (10/2014-9/2015, on leave from the University of Padua)
  - Paid Scientific Associate, CERN, Geneva, Switzerland, (1/2004-12/2004, on leave from the University of Rome La Sapienza)
  - Full Professor of Theoretical Physics, University of Rome La Sapienza (11/2000-10/2005)
  - Researcher (1988-1993), First Researcher (1993-1998), Director of Researches (1998-2000) in INFN, Sezione di Padova
  - Scientific Staff Member, Theory Division, CERN, Geneva, Switzerland (1990-1996, on leave from INFN, Padua)
  - Postdoctoral Fellow, Theory Division, CERN, Geneva, Switzerland (1989-1990, on leave from INFN, Padua)
  - Postdoctoral Fellow, Theory Group of the Lawrence Berkeley Laboratory and Physics Department of the University of California, Berkeley, USA (1986-1989)
- Research** My research has mostly dealt with the theory and the phenomenology of the fundamental interactions, motivated by the desire to understand, within a consistent theoretical framework, the mass generation for the weak gauge bosons, the quarks and the leptons, and the possible unification of gravity with the other forces at the quantum level. I have been focusing on theoretically motivated extensions of the Standard Model, with emphasis on those based on supersymmetry, supergravity and superstrings. On the one hand, I have been pushing further

the confrontation of the existing models with experiment, identifying new features and possible tests at contemporary and future experimental facilities. On the other hand, I have been exploring how some long-standing theoretical problems (the gauge hierarchy problem, the flavour problem, the cosmological constant problem, and others) may be addressed in the framework of superstring theories and their effective supergravity theories in four and higher dimensions.

According to the INSPIRE database, I am author of 86 publications in the theory and phenomenology of the fundamental interactions, with more than 10200 citations, an average of 119 citations per paper and an h-index of 48. According to Google Scholar, I am author of 160 publications with more than 12400 citations and an h-index of 50. For a summary of the main scientific contributions, with some selected publications, see below.

### Other activities

- Representative of the Italian Ministry of Education, University and Research (MIUR) in the Board of Directors and in the Executive Board of the Italian National Institute for Nuclear Physics (INFN) (2015-now).
- Member of the ERC Scientific Council (2015-now).
- Member of The Academy of Europe – Academia Europaea (2015-now).
- Representative of the Italian Ministry of Education, University and Research (MIUR) in the Steering Committee of the International Centre for Theoretical Physics (ICTP) (2014-now).
- Member (2007-13) and Chairman (2011-3) of the CERN Scientific Policy Committee.
- Member of the Editorial Board of Nuclear Physics B Proceeding Supplement (2013-now).
- Member of the Strategy Secretariat of the European Strategy Session of the CERN Council (2011-13), in particular for the Update of the European Strategy in Particle Physics (2012-13).
- Member of the Board of Directors of Scuola Galileiana, the Excellence School of the University of Padua (2013-now)
- Member (2012-3) of the National Physics Panel (GEV-02) for the Italian Evaluation of the Quality of Research (VQR 2004-10)
- Member (2012-now) of the Scientific Council of the LABEX P2IO (Paris-Sud area).
- Corresponding Member of Istituto Veneto di Scienze, Lettere ed Arti (2005-now).
- Scientist in charge of the Padua team of the ERC Advanced Grant *DaMeSyFla* (2011-16).
- Editor (2003-now) of JHEP, The Journal of High Energy Physics.
- Member (2002-11), Secretary (2007-9) and Chair (2009-11) of the High Energy Particle Physics (HEPP) Board of the European Physical Society (EPS). As such, Chairman of the International Organizing Committee of the International Europhysics Conference on High Energy Physics, EPS-HEP 2011.
- Divisional Associate Editor of Physical Review Letters (2002-2008).
- Scientist in charge of the INFN team (Padua, Pisa, Rome) of the European RTN/ITN Networks "Across the Energy Frontier" (10/2000-9/2004), "The Quest for Unification" (10/2004-9/2008), "Unification in the LHC era" (10/2009-9/2013).
- Member of Plenary ECFA (European Committee for Future Accelerators) (1998-2006).
- Coordinator of the Padua INFN Theory Group (about 50 FTE) and referee for the National Grant Committee of the INFN Theory Group (1997-2000).
- Member of the CERN LEP Experiments Committee (1993-1996).

- Expert evaluator for: The European Commission in FP6, FP7, HOR2020 (Member of Individual Fellowships PHY Panels; Remote Referee for PE2 ERC Advanced Grants); MIUR-Italy (Member of the PE Selection Committee for SIR 2014; Remote Referee for FIRB, PRIN, Rita Levi Montalcini); INFN-Italy; ANR-France; DFG-Germany; INTAS; SNF-Switzerland; NORDITA; University of Zurich; University of Helsinki; CERN-PH-TH.

**Scientific results** My main scientific contributions are summarized below, see also the list of publications.

The study of baryon- and lepton-number non-conservation in extensions of the Standard Model. In particular: the identification of new mechanisms for baryon-number violating processes such as neutron-antineutron oscillations, and of a phenomenologically viable supersymmetric extension of the Standard Model with broken R-parity and baryon number.

The quantification of the naturalness concept in supersymmetric extensions of the Standard Model.

Pre-LEP studies of weak neutral currents in the Standard Model, and in its extensions with additional  $U(1)$  factors motivated by  $E_6$  unification. In particular: the identification of new phenomenological consequences of mass and kinetic mixing between massive neutral gauge bosons; the realization that, after the inclusion of radiative corrections, the value of the electroweak mixing angle extracted from neutral current data favoured (minimal) grand unified models with supersymmetry at the weak scale over those without supersymmetry.

The first systematic study of the phenomenology of the non-minimal supersymmetric extension of the Standard Model with a Higgs sector containing a gauge-singlet field.

The formulation of the first consistent heterotic string compactifications with spontaneously broken  $N = 1$  supersymmetry, via the string generalization of the Scherk-Schwarz mechanism, and the identification of their effective supergravity theories.

The identification of the large radiative corrections, mostly due to the top quark and its supersymmetric partners, affecting the Higgs sector of the Minimal Supersymmetric extension of the Standard Model. The detailed study of their phenomenological consequences, in particular for Higgs searches at LEP and the LHC, with the formulation of precise two-loop predictions for the MSSM Higgs boson masses in terms of the model parameters.

The understanding of how string threshold corrections to the gauge coupling constants can be incorporated in the four-dimensional effective theory in a way consistent with local supersymmetry and target-space duality, thanks to four-dimensional versions of the string anomaly-cancellation mechanisms.

The study of the electroweak phase transition in the Minimal Supersymmetric extension of the Standard Model, with the realization that electroweak baryogenesis could take place only for light Higgs and stop masses (subsequently excluded by experimental data).

The exploration of the possibility of dynamically generating some parameters of the Minimal Supersymmetric Standard Model, such as the scale of soft-supersymmetry breaking terms and the largest fermion masses. More recently, a geometrical interpretation of the SM-like nature of the observed Higgs boson in the above context.

The identification of some universal features of  $N = 1$  supergravity models with a very light gravitino: model-independent phenomenological signatures, leading to the present absolute lower bound on the gravitino mass; generalization of the low-energy theorems for supersymmetry in the presence of matter fields.

The study of symmetry-breaking phenomena in field-theoretical orbifold constructions with compactified extra dimensions, with the identification and the interpretation of novel localized symmetry-breaking sources.

The study of supersymmetry breaking and moduli stabilization in  $N \geq 1$  compactifications of higher-dimensional supergravities, associated with the corresponding superstring theories, in the presence of general fluxes and localized sources. In particular: the identification of the effective superpotential for geometric and non-geometric fluxes; the first complete example of full stabilization of the geometrical moduli by fluxes; the clarification of the origin of D terms from the D-brane action, of their role in moduli stabilization and of the limit of validity of the effective two-derivative supergravity; the generalization of the Freed-Witten anomaly-cancellation condition to a full set of localized Bianchi identities, constraining the simultaneous presence of fluxes and localized sources, connected by a web of string dualities and with a common origin in M-theory; the precise correspondence between  $N = 4$  flux compactifications and the gaugings of their effective supergravities.

The study of a class of minimal  $Z'$  models, with universal or non-universal couplings to the Standard Model fermions, and of their phenomenological consequences, in particular for the early phase of the LHC.

The study of the classical vacua of  $N=8$  supergravity with fully broken supersymmetry in flat space: in particular, the proof that the one-loop effective potential is finite and that all the known classical vacua can be connected and have a negative-definite one-loop vacuum energy.

The formulation of supergravity models of large-field inflation in which, at the end of inflation, supersymmetry is spontaneously broken with naturally vanishing classical vacuum energy.

The study of how to consistently use Effective Field Theories to set universal bounds on heavy-mediator Dark Matter at colliders.

### Some talks

- 'Extensions of the Standard Model', invited rapporteur talk at the EPS High Energy Physics Conference, Brussels, Belgium, 1995.
- 'The Higgs Puzzle: Experiment and Theory', invited plenary talk at the 20th International Symposium on Lepton and Photon Interactions at High Energies (Lepton-Photon 01), Rome, Italy, 2001.
- 'Supersymmetry breaking with extra dimensions', invited plenary talk at the 9th International Symposium on Particles, Strings and Cosmology (PASCOS 03), Mumbai, India, 2003.
- 'N=1 effective potentials for superstring compactifications with general fluxes', invited plenary talk, String Phenomenology, LMU, Munich, Germany, 2005.
- 'Landscape vs. swampland: the power of local symmetries', invited plenary talk, String Phenomenology, KITP, Santa Barbara, USA, 2006.
- 'Z' models and the early LHC', Sommerfeld Theory Colloquium, LMU, Munich, Germany, 2010.

- 'LHC results and prospects from a theorist's viewpoint', invited review talk, Strings 2011, Uppsala, Sweden, 2011.
- 'Particle physics on the move', invited talk at the Council of the European Physical Society, CERN, Geneva, Switzerland, 2012
- 'Quantum corrections to broken N=8 supergravity', invited plenary talk, Planck 2012, Warsaw, Poland, 2012.
- 'Theory Summary', invited summary talk, Rencontres de Moriond on Electroweak Interactions and Unified Theories, La Thuile, Italy, 2013.
- 'Symmetry breaking and light scalars in realistic supergravities', invited plenary talk, Planck 2014, Paris, France, 2014.
- 'What next after the Standard Model triumph?', invited plenary talk, 40th anniversary conference of the Laboratoire de Physique Théorique de l'Ecole Normale Supérieure, Paris, 2015.
- 'Sgoldstino-less supergravity models of inflation', invited plenary talk, Planck 2015, Ioannina, Greece, 2015.
- 'Learning from the LHC', invited plenary talk, String Phenomenology 2015, Madrid, Spain, 2015.
- 'Concluding talk', invited summary talk, Higgs Hunting 2015, LAL-Orsay, France, 2015.

### Some lectures

- 'Phenomenological Supersymmetry: the SUSY Higgs sector', invited lectures at the 30th Course of the International School of Subnuclear Physics, Erice, Italy, 1993.
- 'Supersymmetric Models and Supersymmetry Breaking', invited lectures at the 12th Winter School in Theoretical Physics, Jerusalem, Israel, 1994-5.
- 'Beyond the Standard Model', invited lectures at the 1997 European School of High-Energy Physics, Menstrup, Denmark, 1997.
- 'The Hunt for the Higgs particle', invited lectures at the CERN Academic Training, CERN, Geneva, Switzerland, 2007.
- 'Physics expectations at the TeV scale', invited lectures as Cours de la federation LPNHE-LPTENS-LPTHE, Paris, France, 2008.
- 'BSM Physics at the LHC', invited lectures at the Winter School on Strings, Supergravity and Gauge Theories, CERN, 2009.

### Students

Some former Ph.D. students:

- Andrea Brignole (tenured position in INFN, Padua)
- Andrea Donini (tenured position in Autonoma University, Madrid)
- Pietro Slavich (Directeur de Recherche in CNRS, LPTHE-Paris)
- Elena Perazzi (VP, Equity Volatility Strategies Group, Goldman Sachs, New York)
- Giovanni Villadoro (indefinite appointment as Research Scientist at ICTP, Trieste)
- Ennio Salvioni (co-supervised with C. Grojean, postdoctoral fellow at UC-Davis, USA)
- Oleksii Matsedonskyi (co-supervised with A. Wulzer, postdoctoral fellow at Scuola Normale Superiore, Pisa)

## 20 selected publications

(for a complete list, see <http://inspirehep.net/search?p=find+a+zwirner,fabio>)

1. 'Observable  $\Delta B = 2$  Transitions without Nucleon Decay in a Minimal Supersymmetric Extension of the Standard Model', *Physics Letters* 132B (1983) 103.
2. 'Aspects of the Super-Unification of Strong, Electroweak and Gravitational Interactions' (with J. Ellis, K. Enqvist and D.V. Nanopoulos), *Nuclear Physics* B276 (1986) 14.
3. 'Observables in Low-Energy Superstring Models' (with J. Ellis, K. Enqvist and D.V. Nanopoulos), *Modern Physics Letters A*1 (1986) 57.
4. 'Neutral currents within and beyond the Standard Model' (with G. Costa, J. Ellis, G.L. Fogli and D.V. Nanopoulos), *Nuclear Physics* B297 (1988) 244.
5. 'Higgs bosons in a non-minimal supersymmetric model' (with J. Ellis, J.F. Gunion, H.E. Haber and L. Roszkowski), *Physical Review* D39 (1989) 844.
6. 'Superstrings with spontaneously broken supersymmetry and their effective theories' (with S. Ferrara, C. Kounnas and M. Porrati), *Nuclear Physics* B318 (1989) 75.
7. 'On radiative gauge symmetry breaking in the minimal supersymmetric model' (with G. Gamberini and G. Ridolfi), *Nuclear Physics* B331 (1990) 331.
8. 'Radiative corrections to the masses of supersymmetric Higgs bosons' (with J. Ellis and G. Ridolfi), *Physics Letters* B257 (1991) 83.
9. 'On radiative corrections to supersymmetric Higgs boson masses and their implications for LEP searches' (with J. Ellis and G. Ridolfi), *Physics Letters* B262 (1991) 477.
10. 'On loop corrections to string effective field theories: field-dependent gauge couplings and sigma-model anomalies' (with J.-P. Derendinger, S. Ferrara and C. Kounnas), *Nuclear Physics* B372 (1992) 145.
11. 'The supersymmetric charged Higgs boson mass and LEP phenomenology' (with A. Brignole, J. Ellis and G. Ridolfi), *Physics Letters* B271 (1991) 123.
12. 'Testing the Higgs sector of the Minimal Supersymmetric Standard Model at Large Hadron Colliders' (with Z. Kunszt), *Nuclear Physics* B385 (1992) 3.
13. 'Mass formulae and natural hierarchy in string effective supergravities' (with S. Ferrara and C. Kounnas), *Nuclear Physics* B429 (1994) 589.
14. 'On the  $\mathcal{O}(\alpha_t^2)$  two-loop corrections to the neutral Higgs boson masses in the MSSM' (with A. Brignole, G. Degrandi and P. Slavich), *Nuclear Physics* B631 (2002) 195 [hep-ph/0112177].
15. 'On the two-loop sbottom corrections to the neutral Higgs boson masses in the MSSM' (with A. Brignole, G. Degrandi and P. Slavich), *Nuclear Physics* B643 (2002) 79 [hep-ph/0206101].
16. 'Superpotentials in IIA compactifications with general fluxes' (with J.-P. Derendinger, C. Kounnas and P.M. Petropoulos), *Nuclear Physics* B715 (2005) 211 [hep-th/0411276].
17. 'N = 1 effective potential from dual type-IIA D6/O6 orientifolds with general fluxes' (with G. Villadoro), *Journal of High Energy Physics* 0506 (2005) 047 [hep-th/0503169].
18. 'De-Sitter vacua via consistent D-terms' (with G. Villadoro), *Physical Review Letters* 95 (2005) 231602 [hep-th/0508167].
19. 'Minimal Z' models: present bounds and early LHC reach' (with E. Salvioni and G. Villadoro), *JHEP* 0911 (2009) 068 [arXiv:0909.1320 [hep-ph]].
20. 'On sgoldstino-less supergravity models of inflation' (with G. Dall'Agata), *JHEP* 1412 (2014) 172 [arXiv:1411.2605 [hep-th]].