CURRICULUM VITAE: **Aleksandr Azatov**

SISSA

Education

2010 PhD in Physics, University of Maryland, College Park
Thesis title :"Flavor physics in the models with warped extra dimension"
[redacted]

2005 MSc Physics, Particle Physics , Tbilisi State University
Thesis title:" The basic processes in non-linear σ-QED".
[redacted]

2003 BSc Physics, Tbilisi State University

Employment

Associate professor (RTDB) SISSA 16/12/2019-present time

Assistant professor (RTDB) SISSA 16/12/2016- 15/12/2019

Senior Post-Doc ICTP 01/10/2015-01/10/2020 (renounced to start the position at SISSA)

Postdoctoral Fellow, CERN Theory Department 2013-2015

Post-Doc Dipartimento di Fisica Università di Roma "La Sapienza" 2010-2013

Teaching Assistant, Department of Physics, University of Maryland, College Park 2005-2010

Research Assistant,Elementary Particle Theory Group, Department of Physics, University of Maryland, College Park 2006-2010

Grants

2019 - "The consequences of flavour: from precision measurements to fundamental physics", PRIN 2017 grant, young researcher line. Coordinator of the SISSA node (funding of the SISSA node 122.365 e).

Abilitazione

Abilitiazione Scientifica nazionale settore 02/A2, FASCIA II
13/07/2018-13/07/2024 `https://asn16.cineca.it/pubblico/miur/esito-abilitato/02%252FA2/2/5`

Permanent positions

2016 - The winner of the INFN competition (7th place) for the permanent researcher

position in theoretical physics (total 15 positions), renounced for the position at SISSA.

Teaching

2016- present time, " Electroweak and Strong Interactions " (part of the course related to the strong interactions and collider physics), taught together with Prof. S. Petcov, SISSA

2016- present time, " Beyond the Standard Model " (part of the course related to the Higgs physics, electroweak precision measurements), taught together with Prof. A. Romanino, SISSA

2016-present time, supervision of three PhD students at SISSA

- [redacted]

2020 "TThe School for Future Electron Positoron Colliders (Feb 24 2020 - Feb 28 2020) " KEK, Japan, lectures on the physics Beyond Standard Model.

2016-2020 member of the SISSA PhD entrance exam committee.

2014 "The Second Asia-Europe-Pacific School of High-Energy Physics" Puri, India, discussion leader

2005-2010 Teaching assistant for the various undergraduate and graduate courses at University of Maryland, College Park.

Refereeing

Journal of High Energy Physics; Physical Review Letter;Physical Review D;Physics Letters B; European Physical Journal C; New Journal of Physics;Journal of Physics G;

- 11/2017 Physics Letters B, - certificate of the Outstanding Contribution in Reviewing

Fellowships

2008-2009 Maryland Center for Fundamental Physics fellowship

Invited Conference talks

2021 "Friction forces on ultra-relativistic bubbles", Computations that matter workshop, Lorentz Center, University of Leiden

2020 "Precision diboson measurements ", New Physics on the Low-Energy Precision Frontier CERN workshop

2019 "Precision diboson production at LHC " , Portoroz 2019 workshop

2018 “Novel measurements of anomalous triple gauge couplings ” 2nd FCC workshop, CERN

2017 “Measurements of anomalous TGC at LHC” , Brda 2017 meeting

2017 “Status of the Composite Higgs”, EPS 2017

2017 “The challenges of EFT at LHC”, Krakow Epiphany Conference

2016 “SM/BSM interference pattern” , “BSM faces LHC run-2 realities” workhsop, DESY, Hamburg

2016 “Higgs Flavour: top Higgs interactions and exclusive measurements” ,Higgs Hunting 2016, Paris

2016 “ Resolving the gluon fusion loop for the Higgs production”, ZPW2016:Higgs physics at the LHC, Zurich

2015 “ Resolving the gluon fusion loop for the Higgs production” , “Gearing up for LHC13” workshop, GGI , Florence

2015 “EFT analysis of the off-shell Higgs production in gluon fusion at FCC” , LFC15, ECT*, Trento

2015 “Review of BSM Higgs physics” SM@LHC , GGI, Florence

2014 “Taming the off-shell Higgs” HEFT2014, IFT, Madrid

2014 “New insights from the Higgs physics”, ICTP-SAIFR , Sao Paulo

2014 “Top-pair as final state and its interplay with the Higgs Physics”, “The flavor of Higgs”, Weizmann Institute, Rehovot

2014 “Probing Higgs couplings with high p_T Higgs production”, Centro de Ciencias de Benasque Pedro Pascual, Benasque

2014 “Composite Higgs flavor violaion”, The top-charm frontier at the LHC, CERN, Geneva

2013 “New Prospects for Higgs Compositeness in h $\rightarrow$ Z gamma”, HEFT2013, CERN, Geneva

2013 “Electroweak Symmetry Breaking and the Scalar Boson: Confronting Theories at Colliders”, EW interactions and Unified Theories, Rencontres de Moriond

2012 “Implications of LHC results for TeV-scale physis”,CERN
“Contextualizing this Higgs at the LHC”

2012 XX International Workshop on Deep-Inelastic Scattering and Related Subjects, “A theoretical review of the BSM Higgs”

2010 DISCRETE, Symposium on Prospects in the Physics of Discrete Symmetries, “Gauged discrete symmetries and proton stability in SUSY GUT ”

2008 Brookhaven Forum "Terra Incognita: From LHC to Cosmology"
" Flavor violation tests of the warped/composite in the Two-Site approach"

Invited seminar talks

May 2020 "Phase transitions in perturbative walking dynamics" On-line Newton 1665 seminars

May 2018 "Measurements of anomalous TGC at LHC" , ETH Zurich

April 2017 Testing BSM Physics with Higgs pT distributions at the LHC &HL-LHC, CERN, ATLAS internal meeting.

March 2016 "Diphotons from Diaxions?", Institut Jozef Stefan

March 2016 "Diphotons from Diaxions?", University of Padua

February 2016 "Diphotons from Diaxions?", Technische Universitat Mnchen (TUM)

February 2015 "EFT analysis of the Higgs physics", SNS Pisa

May 2015 "Warped dipoles completed", University of Mainz

May 2013 "Testing Higgs compositeness at LHC", ICTP

May 2013 "Testing Higgs compositeness at LHC", University Of Maryland

April 2013 "Testing Higgs compositeness at LHC", Harvard University

December 2012 "Higgs couplings after discovery", ETH Zurich

December 2012 "Higgs couplings in the Composite Higgs Models", University of Padua

April 2012 "Light custodians in the Composite Higgs Models", EPFL Lausanne

March 2012 "Bounding Light Higgs", University of Southern Denmark, CP3 Odense

February 2012 "Higgs physics in the Composite Higgs Models", DaMeSyFla project grant meeting, SISSA Trieste

October 2011 "Superconformal Technicolor", University of Southampton

November 2009 "Flavor physics of the scalar sector in RS models", Brookhaven National Laboratory

October 2009 "Flavor physics of the scalar sector in RS models", Department of Physics , University of Delaware.

Workshop organization

2019 "WIN2019. The 27th International Workshop on Weak Interactions and Neutrinos" Bari

2018 "HEFT (Higgs and Effective Field Theories 2018)" workshop, MITP, Mainz

2016 “BSM faces LHC run-2 realities” workshop, DESY, Hamburg

Languages

English, Italian, Russian,Georgian

Research activity

The major part of my research was devoted to the studies of the Higgs boson properties in the various scenarios of Beyond Standard Model (BSM) physics and the new ways to verify them [5,9,12,13,15,16,17,18,20]. The current measurements of the Higgs couplings do not observe any significant deviations from the values predicted by the Standard Model(SM). However the complete analysis of the exclusive measurements is still going on and can become one of the ways to unveil the effects of the new physics (NP). In the case when there is a mass gap between the NP resonances and the SM fields, one can parametrize consistently all their effects in terms of the higher dimensional operators in the framework of the Effective Field Theory (EFT). The contributions of the higher dimensional operators are more important at high energies so that the analysis of the differential distributions becomes a necessary tool in disentangling the NP effects from the SM background.

In the paper [13] we have noticed that the current measurements of the Higgs couplings are not very sensitive to the simultaneous modification of the top Yukawa coupling and an addition of the contact interaction between the Higgs boson and two gluons. In the papers [5,12,13] we have shown that this flat direction can be lifted by the analysis the boosted or off-shell Higgs production. These constraints, although very week for the 8 TeV Large Hadron Collider (LHC) dataset will become very important for the studies of the 14 TeV collisions. The above-mentioned flat direction, although might seem completely artificial arises naturally in the models with the heavy fermionic top partners [21]. In the paper [9] we studied the double Higgs production in the gluon fusion. This process is very important at LHC for the measurement of the triple Higgs coupling, but at the same time it appears to be very useful in disentangling the effects of the different operators contributing to the gluon fusion and one of the most intriguing results of our paper is that double Higgs production can become a competitive measurement of the top Yukawa coupling.

In the papers [18,20] we presented one of the first studies of the constraints on the Higgs couplings from the LHC results. We have shown that the inclusive measurements usually contain non SM-like solution in the Higgs coupling parameter space and that exclusive analysis are essential in differentiating the deviations in the Higgs couplings. In the papers [16,17,20] we studied the implications of the Higgs couplings fits on the most popular BSM scenarios: Composite Higgs models and the Supersymmetry. Using the type II two Higgs doublet model we have analysed the parameter space of the Higgs coupling achievable in the supersymmetric models, and we have presented the current preferences of the Higgs couplings fits. We have also related the modifications of the Higgs potential to the deviations of the Higgs couplings.

The precision program at the LHC does not confine only to the Higgs physics, but includes testing all the interactions between the SM particles. For this purpose the EFT machinery becomes particularly useful since it permits parametrizing the leading deviations from the SM in terms of the limited number of parameters, assuming the truncation at the dimension six level. The question of the validity of such a truncation depends on the UV theory behind the given EFT and on the size of the interference between the SM and EFT contributions. In the paper [6] we have shown that for the

$2 \to 2$ scattering processes the leading terms in energy are always zero if at least one transversely polarized gauge boson is present. This makes the precision measurements particularly challenging, however we have shown [4] that such suppression can be overcome by considering various differential distributions. In the further study [1] we have presented a careful analysis of the LHC and HL-HE(high luminosity and High energy) prospects for these measurements including the realistic treatment of the detector simulation and inclusion of the higher order QCD effects.

One of the biggest drawbacks of the SM is that the Higgs mass is quadratically sensitive to the NP scale, which is often dubbed as a "hierarchy problem". One of the most attractive solutions to this problem can be achieved in the models where the Higgs appears as a bound state of new strong dynamics. The narrow width of the Higgs boson and the absence of the other strongly coupled resonances at the scale of the Higgs mass can be explained within the composite Higgs models where the Higgs appears as a pNGB of the strong dynamics. In the [15]we have shown that the Higgs rare decay $h \to Z\gamma$ can be an interesting signature of the pNGB models since the corrections to this process unlike the others are not suppressed by the Goldstone boson symmetry of the Higgs field. In the paper [21] we have studied the modifications of the gluon fusion production cross section in the composite Higgs scenarios and we have explained why in the most simplistic models the total cross section is reduced and is independent of the mass of light composite fields. We have also identified the conditions the model has to satisfy in order to increase the rate of this process compared to the SM prediction. In the papers [8,14] we have looked at the current collider bounds and the future prospects on the charge 5/3 fermion and composite gluon fields which naturally arise in the composite Higgs models. This composite gluon is generically a very broad resonance which makes it very hard to discover at the LHC, however it still gives a sizeable contribution to the pair production of the fermionic top partners thus leading to the nontrivial constraints on the parameter space of the model.

One of the possible UV completions of the four dimensional composite Higgs models is achieved within the warped extra dimensional Randall-Sundrum models, which present dual five-dimensional description of the strong dynamics. I have worked on the phenomenology of the five dimensional model and one of the interesting features we have noticed in [10,25,27] was that for some observables like the Higgs mediated flavor violation, the Higgs production in gluon fusion and the dipole moments, the effective non-decoupling of the ultra heavy Kaluza-Klein (KK) modes. This effect, overlooked before, leads to the significant increase of the rates for the processes above, making it very important for the phenomenology of the five-dimensional models.

I am also interested in the supersymmetric models. One of the main problems of the supersymetric model building is that it is very hard to generate Higgs mass heavy enough to be 125 GeV with stop masses below TeV scale. In the papers [23,24] we addressed this issue by coupling the MSSM to the new strongly coupled sector, which makes Higgs heavy. The novelty of the model was that by construction the breaking of the supersymmetry triggered the confinement of the strong sector, thus we were able to address the issue of coincidence between the strong and electroweak scales. In the paper [22] we have proposed another way to raise the Higgs mass to the observed value of 125 GeV by adding electroweak triplets and a singlet and then generating the new contribution to the Higgs potential from the F terms.

At last I am very interested in the recently observed flavour anomalies in the lepton universality violating observables. In the reference [2] we have presented a comprehensive analysis of these decays modes both in a model independent way and

subsequently, in the context of composite Higgs models. We have explicitly shown the severe constraints originating from the linearly realized $SU(2) \times U(1)$ symmetry of the SM correlating the various $\Delta F = 1$ and $Z\tau\tau$,$Z\nu\nu$ couplings. In the composite Higgs models we have shown that these anomalies can be accommodated only if the scale of the new strong dynamics is below TeV making new states soon discoverable at LHC. In the reference [3] we have presented a careful analysis of the models where the flavour anomalies appear sue to the final states with right-handed neutrino, including all the bounds coming from the collider searches, flavour physics and cosmological considerations.

Currently I am mainly working on the following three directions of the research:

- Investigation and optimization of the precision measurements at the future colliders along the lines of the references [1,4,5].
- Investigation of the NP models behind the flavour anomalies. In particular we are investigating the supersymmetric models which can provide the desired effect
- The signals in the stochastic gravitation wave(GW background from the first order phase transitions in the early universe. In particular we are interested in analysing the new physics models which can be observed in the future experiments.

Publications

1. A. Azatov, M. Vanvlasselaer and W. Yin, [arXiv:2106.14913 [hep-ph]].
2. A. Azatov, M. Vanvlasselaer and W. Yin, JHEP **03** (2021), 288 doi:10.1007/JHEP03(2021)288 [arXiv:2101.05721 [hep-ph]].
3. A. Azatov and M. Vanvlasselaer, JCAP **01** (2021), 058 doi:10.1088/1475-7516/2021/01/058 [arXiv:2010.02590 [hep-ph]].
4. L. Alasfar, A. Azatov, J. de Blas, A. Paul and M. Valli, JHEP **12** (2020), 016 doi:10.1007/JHEP12(2020)016 [arXiv:2007.04400 [hep-ph]].
5. A. Azatov and M. Vanvlasselaer, JHEP **09** (2020), 085 doi:10.1007/JHEP09(2020)085 [arXiv:2003.10265 [hep-ph]].
6. A. Azatov, D. Barducci and F. Sgarlata, JCAP **07** (2020), 027 doi:10.1088/1475-7516/2020/07/027 [arXiv:1910.01124 [hep-ph]].
7. A. Azatov, D. Barducci and E. Venturini, JHEP **1904** (2019) 075 doi:10.1007/JHEP04(2019)075 [arXiv:1901.04821 [hep-ph]].
8. A. Azatov, D. Barducci, D. Ghosh, D. Marzocca and L. Ubaldi, JHEP **1810** (2018) 092 doi:10.1007/JHEP10(2018)092 [arXiv:1807.10745 [hep-ph]].
9. A. Azatov, D. Bardhan, D. Ghosh, F. Sgarlata and E. Venturini, JHEP **1811** (2018) 187 doi:10.1007/JHEP11(2018)187 [arXiv:1805.03209 [hep-ph]].
10. A. Azatov, J. Elias-Miro, Y. Reyimuaji and E. Venturini, JHEP **1710** (2017) 027 doi:10.1007/JHEP10(2017)027 [arXiv:1707.08060 [hep-ph]].
11. A. Azatov, C. Grojean, A. Paul and E. Salvioni, JHEP **1609** (2016) 123 doi:10.1007/JHEP09(2016)123 [arXiv:1608.00977 [hep-ph]].
12. A. Azatov, R. Contino, C. S. Machado and F. Riva, Phys. Rev. D **95** (2017) no.6, 065014 doi:10.1103/PhysRevD.95.065014 [arXiv:1607.05236 [hep-ph]].
13. L. Aparicio, A. Azatov, E. Hardy and A. Romanino, "Diphotons from Diaxions," JHEP **1605** (2016) 077 doi:10.1007/JHEP05(2016)077 [arXiv:1602.00949 [hep-ph]].

14. A. Azatov, D. Chowdhury, D. Ghosh and T. S. Ray, "Same sign di-lepton candles of the composite gluons," JHEP **1508** (2015) 140 [arXiv:1505.01506 [hep-ph]].

15. A. Azatov, R. Contino, G. Panico and M. Son, "Effective field theory analysis of double Higgs boson production via gluon fusion," Phys. Rev. D **92** (2015) 3, 035001 [arXiv:1502.00539 [hep-ph]].

16. K. Agashe, A. Azatov, Y. Cui, L. Randall and M. Son, "Warped Dipole Completed, with a Tower of Higgs Bosons," JHEP **1506** (2015) 196 [arXiv:1412.6468 [hep-ph]].

17. A. Azatov, G. Panico, G. Perez and Y. Soreq, "On the Flavor Structure of Natural Composite Higgs Models & Top Flavor Violation," JHEP **1412** (2014) 082 [arXiv:1408.4525 [hep-ph]].

18. A. Azatov, C. Grojean, A. Paul and E. Salvioni, "Taming the off-shell Higgs boson," Zh. Eksp. Teor. Fiz. **147** (2015) 410 [J. Exp. Theor. Phys. **120** (2015) 354] [arXiv:1406.6338 [hep-ph]].

19. A. Azatov and A. Paul, "Probing Higgs couplings with high p_T Higgs production," JHEP **1401** (2014) 014 [arXiv:1309.5273 [hep-ph]].

20. A. Azatov, M. Salvarezza, M. Son and M. Spannowsky, "Boosting Top Partner Searches in Composite Higgs Models," Phys. Rev. D **89** (2014) 075001 [arXiv:1308.6601 [hep-ph]].

21. A. Azatov, R. Contino, A. Di Iura and J. Galloway, "New Prospects for Higgs Compositeness in $h \to Z\gamma$," Phys. Rev. D **88** (2013) 7, 075019 [arXiv:1308.2676 [hep-ph]].

22. A. Azatov and J. Galloway, "Electroweak Symmetry Breaking and the Higgs Boson: Confronting Theories at Colliders," Int. J. Mod. Phys. A **28**, 1330004 (2013) [arXiv:1212.1380 [hep-ph]].

23. A. Azatov, S. Chang, N. Craig and J. Galloway, "Higgs fits preference for suppressed down-type couplings: Implications for supersymmetry," Phys. Rev. D **86**, 075033 (2012) [arXiv:1206.1058 [hep-ph]].

24. A. Azatov, R. Contino, D. Del Re, J. Galloway, M. Grassi and S. Rahatlou, "Determining Higgs couplings with a model-independent analysis of h -¿gamma gamma," JHEP **1206**, 134 (2012) [arXiv:1204.4817 [hep-ph]].

25. A. Azatov, O. Bondu, A. Falkowski, M. Felcini, S. Gascon-Shotkin, D. K. Ghosh, G. Moreau and S. Sekmen, "Higgs boson production via vector-like top-partner decays: Diphoton or multilepton plus multijets channels at the LHC," Phys. Rev. D **85**, 115022 (2012) [arXiv:1204.0455 [hep-ph]].

26. A. Azatov, R. Contino and J. Galloway, "Model-Independent Bounds on a Light Higgs," JHEP **1204**, 127 (2012) [arXiv:1202.3415 [hep-ph]].

27. A. Azatov and J. Galloway, "Light Custodians and Higgs Physics in Composite Models," Phys. Rev. D **85**, 055013 (2012) [arXiv:1110.5646 [hep-ph]].

28. K. Agashe, A. Azatov, A. Katz and D. Kim, "Improving the tunings of the MSSM by adding triplets and singlet," Phys. Rev. D **84**, 115024 (2011) [arXiv:1109.2842 [hep-ph]].

29. A. Azatov, J. Galloway and M. A. Luty, "Superconformal Technicolor: Models and Phenomenology," Phys. Rev. D **85**, 015018 (2012) [arXiv:1106.4815 [hep-ph]].

30. A. Azatov, J. Galloway and M. A. Luty, "Superconformal Technicolor," Phys. Rev. Lett. **108**, 041802 (2012) [arXiv:1106.3346 [hep-ph]].

31. A. Azatov, M. Toharia and L. Zhu, "Higgs Production from Gluon Fusion in Warped Extra Dimensions," Phys. Rev. D **82**, 056004 (2010) [arXiv:1006.5939 [hep-ph]].
32. K. Agashe, A. Azatov, T. Han, Y. Li, Z. G. Si and L. Zhu, "LHC Signals for Coset Electroweak Gauge Bosons in Warped/Composite PGB Higgs Models," Phys. Rev. D **81**, 096002 (2010) [arXiv:0911.0059 [hep-ph]].
33. A. Azatov, M. Toharia and L. Zhu, "Higgs Mediated FCNC's in Warped Extra Dimensions," Phys. Rev. D **80**, 035016 (2009) [arXiv:0906.1990 [hep-ph]].
34. A. Azatov, M. Toharia and L. Zhu, "Radion Mediated Flavor Changing Neutral Currents," Phys. Rev. D **80**, 031701 (2009) [arXiv:0812.2489 [hep-ph]].
35. K. Agashe, A. Azatov and L. Zhu, "Flavor Violation Tests of Warped/Composite SM in the Two-Site Approach," Phys. Rev. D **79**, 056006 (2009) [arXiv:0810.1016 [hep-ph]].
36. A. T. Azatov and R. N. Mohapatra, "Flavor Physics in SO(10) GUTs with Suppressed Proton decay Due to Gauged Phys. Rev. D **78**, 015002 (2008) [arXiv:0802.3906 [hep-ph]].
37. A. T. Azatov, "Radiative corrections to the lightest KK states in the $T_2/(Z_2 \times Z_2')$ orbifold," JHEP **0710**, 067 (2007) [arXiv:hep-ph/0703157].
38. A. T. Azatov and J. L. Chkareuli, "Nonlinear QED and physical Lorentz invariance," Phys. Rev. D **73**, 065026 (2006) [arXiv:hep-th/0511178].

Conference proceedings

1. A. Azatov, PoS EPS **-HEP2017** (2017) 255. doi:10.22323/1.314.0255
2. A. Azatov, Acta Phys. Polon. B **48** (2017) 897. doi:10.5506/APhysPolB.48.897
3. A. Azatov, "EFT Analysis of Off-shell Higgs Production in Gluon Fusion at fcc," Frascati Phys. Ser. **61**, 35 (2016).
4. A. Azatov, R. Contino and J. Galloway, "Contextualizing the Higgs at the LHC," arXiv:1206.3171 [hep-ph].
5. A. Azatov, "Flavor physics in SO(10) GUTs with suppressed proton decay due to gauged discrete symmetry," J. Phys. Conf. Ser. **335**, 012024 (2011).
6. G. Brooijmans *et al.*, arXiv:1203.1488 [hep-ph].

Contributions to the working group reports

Particpation in the working group dedicated to the studies of the "HL-HE LHC(High Luminosity , High Emergy LHC) possibilities for the contribution Higgs physics: The BSM reach of WW and/or WZ differential measurements at high energy/luminosity M. Cepeda *et al.* [Physics of the HL-LHC Working Group], arXiv:1902.00134 [hep-ph].

Participation in the serious of the FCC workshops resulting in the contribution to the CERN report on FCC: A. Abada *et al.* [FCC Collaboration], CERN-ACC-2018-0057. A. Abada *et al.* [FCC Collaboration], CERN-ACC-2018-0058. A. Abada *et al.* [FCC Collaboration], CERN-ACC-2018-0059. A. Abada *et al.* [FCC Collaboration], CERN-ACC-2018-0056.

Participation in the working group The CLIC Physics Potential, author of the section "General discussion in NP models for sizes of $t \to hc, c+MET, Zc, \gamma c$" for the CERN Yellow book report J. de Blas *et al.*, CERN Yellow Rep. Monogr. Vol. 3 (2018) doi:10.23731/CYRM-2018-003 [arXiv:1812.02093 [hep-ph]].