Physics Letters B 799 (2019) 134990

Contents lists available at ScienceDirect

Physics Letters B

www.elsevier.com/locate/physletb

Corrigendum

Erratum to: "Perturbative unitarity bounds for effective composite models" [Phys. Lett. B 795 (2019) 644-649]

S. Biondini [a,*], R. Leonardi [b], O. Panella [b], M. Presilla [c,d]

[a] Van Swinderen Institute, University of Groningen, Nijenborgh 4, NL-9747 AG Groningen, Netherlands
[b] Istituto Nazionale di Fisica Nucleare, Sezione di Perugia, Via A. Pascoli, I-06123 Perugia, Italy
[c] Dipartimento di Fisica e Astronomia "Galileo Galielei", Università degli Studi di Padova, Via Marzolo, I-35131, Padova, Italy
[d] Istituto Nazionale di Fisica Nucleare, Sezione di Padova, Via Marzolo, I-35131, Padova, Italy

ARTICLE INFO

Article history:
Received 25 September 2019
Accepted 27 September 2019
Available online 4 October 2019
Editor: G.F. Giudice

Keywords:
Perturbative unitarity
Composite models
Composite fermions
LHC Run 2
High-Luminosity and High-Energy LHC

ABSTRACT

Numerical results for the partial wave unitarity bounds on the parameter space (Λ, M) of dimension-6 effective operators of a composite scenario presented in Biondini et al. (2019) [1] are revised. Figs. 2-5 and Table 1 are to be replaced by the following corresponding figures and table. We briefly comment on the impact on the conclusions presented in the original article.

We have revised Fig. 2, Fig. 3, Fig. 4, Fig. 5 and Table 1 of the original article [1]. While the theoretical formula of the perturbative unitarity bound given in Eq. (11) of [1] is correct, we have found a bug in the simulation chain of its numerical implementation.

The correct implementation produces the new results depicted in Fig. 2, Fig. 3, Fig. 4, Fig. 5 and Table 1 of this erratum, which we discuss in the following.

We observe that there is a value of the compositeness scale Λ, which depends on the parton collision energy $\sqrt{\hat{s}}$ and the excited fermion mass M, above which the unitarity bound saturates. One can estimate an upper bound for such a value from Eq. (11) by setting the collision energy $\sqrt{\hat{s}} = \sqrt{s}$; it is represented with the dotted (black) line in Figs. 2-5 for the corresponding nominal energies $\sqrt{s} = 13$, 14, 27 TeV. An approximated (maximal) value of $\Lambda \approx \sqrt{s/3}$, which saturates the unitary bound, is obtained when $s \gg M^2$.

At variance with our previous findings in [1], the impact of the unitarity bound is strongly dependent on the fraction of events (f) that satisfy the condition of Eq. (11) in [1]. This conforms with

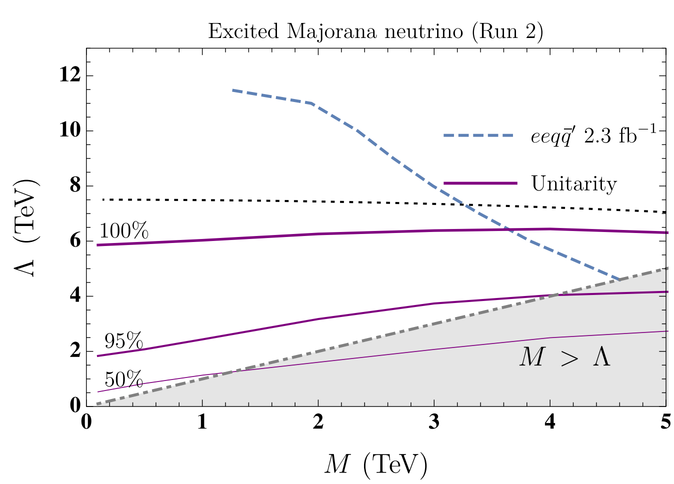

Fig. 2. The unitarity bound in the (M, Λ) plane compared with the Run 2 exclusion at 95% CL from [3], dashed line (blue), for the $eeq\bar{q}'$ final state signature. The solid (violet) lines with decreasing thickness represent the unitarity bound respectively for 100%, 95% and 50% event fraction satisfying Eq. (11) in [1]. The dot-dashed (gray) line stands for the $M = \Lambda$ condition. Here and in the following figures both Λ and M start at 100 GeV, and the dotted (black) curve corresponds to the theoretical unitarity bound (Eq. (11) of [1] with $\hat{s} = s$).

DOI of original article: https://doi.org/10.1016/j.physletb.2019.06.042.
* Corresponding author.
E-mail address: s.biondini@rug.nl (S. Biondini).

https://doi.org/10.1016/j.physletb.2019.134990
0370-2693/

Table 1
In the first line we quote the bounds reported in the CMS analysis of like sign dilpetons and diquark for excited neutrinos [3] and the bounds from CMS for two analyses for excited charged leptons [4,5]. In second (third) line, we quote instead the strongest mass bound obtained from Figs. 2 and 5 when the perturbative unitarity bound with $f = 100\%$ (50%) crosses the 95% C.L. exclusion curve from the experimental studies.

	LHC Run 2 (N^*) 2.3 fb^{-1}, $\sqrt{s} = 13$ TeV	LHC Run 2 (e^*) 35.9 fb^{-1}, $\sqrt{s} = 13$ TeV	LHC Run 2 (e^*) 77.4 fb^{-1}, $\sqrt{s} = 13$ TeV
$M = \Lambda$	$M \le 4.6$ TeV [3]	$M \le 4.0$ TeV [4]	$M \le 5.5$ TeV [5]
Unitarity 100%	$M \le 3.6$ TeV ($\Lambda = 6.4$ TeV)	$M \le 3.3$ TeV ($\Lambda = 6.5$ TeV)	$M \le 4.9$ TeV ($\Lambda = 6.4$ TeV)
Unitarity 50%	–	$M \le 4.9$ TeV ($\Lambda = 2.8$ TeV)	$M \le 7.0$ TeV ($\Lambda = 2.9$ TeV)

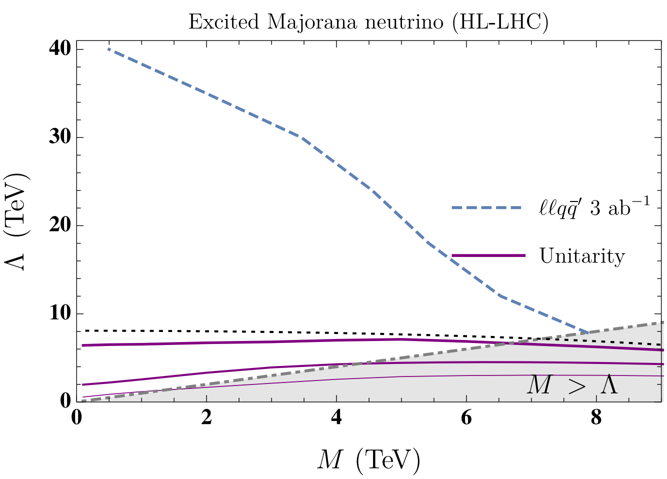

Fig. 3. The unitarity bound in the plane (M, Λ) for the three event fractions as in Fig. 2 compared with the expected exclusion limit from the High Luminosity projections study in [6] for LHC at $\sqrt{s} = 14$ TeV at 3 ab^{-1} of integrated luminosity.

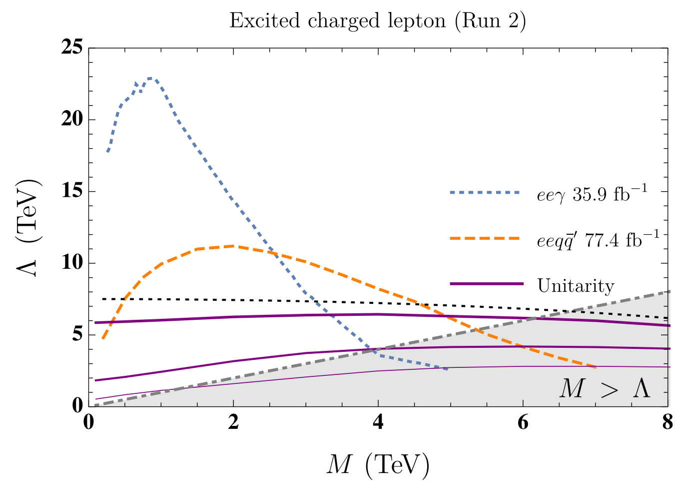

Fig. 5. The unitarity bound in the plane (M, Λ) for the three event fractions as in Fig. 2 compared with the exclusion limits from the Run 2 for charged leptons searches with two different final states [4,5].

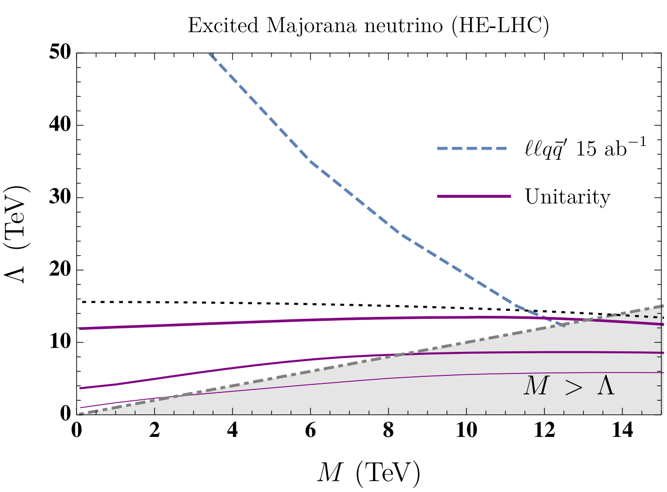

Fig. 4. The unitarity bound in the plane (M, Λ) for the three event fractions as in Fig. 2 compared with the exclusion curve from the HE-LHC projection studies in [6] for $\sqrt{s} = 27$ TeV at 15 ab^{-1} of integrated luminosity.

the results in [2], at least in the $\Lambda - M$ region considered there. We show three solid (violet) curves in each figure that correspond to 100%, 95% and 50% of the events satisfying the condition in Eq. (11) of [1]. The trend of the curves is different from that found in the original article [1].

The comparison with the observed and expected limits produces different mass reaches. As far as the LHC Run 2 is concerned, we quote the corresponding mass values in the new Table 1 for the searches of excited neutrinos and excited charged leptons. As for the CMS analyses on the excited charge leptons, we can exploit the data as provided in the region $M > \Lambda$ and inspect the interplay with the unitarity bound for $f = 100\%, 95\%, 50\%$. On the other hand, we cannot provide as many mass values for the excited neutrino searches [1], due to the lack of experimental data in the same region $M > \Lambda$.

On the basis of the new results, it is the author's opinion that further investigations may be devoted to a better understanding of the theoretical error. Indeed the strong dependence of the unitarity bound on the fraction of events f, especially so in the low-mass region, calls perhaps for an estimate of possible higher order terms in the effective theory expansion (operators of dimension-7 for contact interactions). In doing so, one could pinpoint to a particular choice of f in a more rigorous way.

Acknowledgements

We are especially thankful to Dr. Oleg Zenin and Dr. Andrey Kamenshchikov (ATLAS Collaboration) for pointing out an inconsistency between our previous numerical results and the theoretical formula of the unitarity bound, and for crosschecking some of our revised numerical results.

References

[1] S. Biondini, R. Leonardi, O. Panella, M. Presilla, Perturbative unitarity bounds for effective composite models, Phys. Lett. B 795 (2019) 644–649, https://doi.org/10.1016/j.physletb.2019.06.042.
[2] M. Endo, Y. Yamamoto, Unitarity bounds on dark matter effective interactions at LHC, J. High Energy Phys. 06 (2014) 126, https://doi.org/10.1007/JHEP06(2014)126, arXiv:1403.6610.
[3] A.M. Sirunyan, et al., Search for a heavy composite Majorana neutrino in the final state with two leptons and two quarks at $\sqrt{s} = 13$ TeV, Phys. Lett. B 775 (2017) 315–337, https://doi.org/10.1016/j.physletb.2017.11.001, arXiv:1706.08578.

[4] A.M. Sirunyan, et al., Search for excited leptons in $\ell\ell\gamma$ final states in proton-proton collisions at $\sqrt{s} = 13$ TeV, Submitted to: J. High Energy Phys. (2019), https://doi.org/10.1007/JHEP04(2019)015, arXiv:1811.03052.

[5] Search for Excited Leptons Decaying via Contact Interaction to Two Leptons and Two Jets, Tech. Rep. CMS-PAS-EXO-18-013. CERN, Geneva, 2019, URL http://cds.cern.ch/record/2667479.

[6] X. Cid Vidal, et al., Beyond the standard model physics at the HL-LHC and HE-LHC, arXiv:1812.07831.