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METing SUSY on the Z peak

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Recently the ATLAS experiment announced a 3 σ excess at the Z-peak consisting of 29 pairs of leptons together with two or more jets, $E_{\mathrm{T}}^{\mathrm{miss}} > 225$ GeV and $H_{\mathrm{T}} > 600$ GeV, to be compared with 10.6 ± 3.2 expected lepton pairs in the Standard Model. No excess outside the Z-peak was observed. By trying to explain this signal with SUSY we find that only relatively light gluinos, $m_{\tilde{g}} \lesssim 1.2$ TeV, together with a heavy neutralino NLSP of $m_{\tilde{\chi}} \gtrsim 400$ GeV decaying predominantly to Z-boson plus a light gravitino, such that nearly every gluino produces at least one Z-boson in its decay chain, could reproduce the excess. We construct an explicit general gauge mediation model able to reproduce the observed signal overcoming all the experimental cuts. Needless to say, more sophisticated models could also reproduce the signal, however, any model would have to exhibit the following features, light gluinos, or heavy particles with a strong production cross-section, producing at least one Z-boson in its decay chain. The implications of our findings for the Run II at LHC with the scaling on the Z peak, as well as for the direct search of gluinos and other SUSY particles, are pointed out.

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1. Introduction

The ATLAS Collaboration has recently presented an intriguing excess at the 3 sigma level of e^+e^- and $\mu^+\mu^-$ pairs just at the Z peak [1], accompanied by hadronic activity and missing transverse energy (MET). More exacly, the main requirements applied in order to discriminate the signal from SM background events are: i) At least two same-flavoured leptons with opposite electric charge with the leading lepton $p_T > 25$ GeV, whereas the subleading lepton p_T can be as low as 10 GeV. Their invariant mass must fall within the Z boson mass window, $81 < m_{ll} < 101$ GeV. ii) All events contain at least two jets with $p_T > 35$ GeV and $|\eta| < 2.5$, and have $E_T^{miss} > 225$ GeV and $H_T = \sum_i p_T^{jet,i} + p_T^{lepton,1} + p_T^{lepton,2} > 600$ GeV. iii) Furthermore, the azimuthal angle between each of the two leading jets and E_T^{miss} is required to be higher than 0.4.

With an integrated luminosity of 20.3 fb^{-1} at a $p-p$ CM energy of 8 TeV, the experiment observes a total of 29 pairs of electrons and muons with an invariant mass compatible with the Z boson mass, with an expected background of 10.6 ± 3.2 pairs. This corresponds to a 3.0 σ significance. No excess over the expected background is observed outside the Z peak [1]. The question that immediately arises is whether SUSY, or some other extension of the Standard Model (SM), is able to explain that excess of Z + MET events taking into account the current limits on beyond the SM physics. A study in those terms within a SUSY framework is presented here.

As we will show (see a more complete analysis in Ref. [2]), the observed signal can only be explained if one has a large production cross-section of heavy SUSY particles (gluinos or squarks) whose decay chain contains about one Z-boson per parent particle. If such an explanation is indeed the answer to the observed excess, our study points out the way to confirm it in the Run II of LHC, as well as cosmological implications, in particular the particle content of dark matter in the Universe. The resulting scheme of SUSY particle mass hierarchy, including charginos and neutralinos, will be apparent.

2. Z-boson production in the MSSM

If the observed excess is confirmed, it would clearly point to a new non-standard process producing additional Z-bosons at LHC energies. This signal would require a significant production of Z-bosons without conflicting with all other experimental searches of beyond the SM particles. In fact, using the central value for the expected background and taking into account the Z-branching ratio to muon and electron, this would imply that we have produced 273 ± 48 additional Z-bosons (with 20.3 fb^{-1}). Assuming the Z-bosons are produced in the decay-chains of beyond the SM particles, Y, produced in the collision, we need to produce at least $273/\mathcal{N}(Y \to Z)$ Y particles, with $\mathcal{N}(Y \to Z)$ the average number of Z-bosons produced in the decay of a Y particle. On the other hand, as we will see next, the experimental cuts used in the experiment, namely $n_{jets} \geq 2$, $E_T^{miss} > 225$ GeV and $H_T > 600$ GeV, define further the characteristics of the Y particle and its decays.

Now, the following question is whether it is possible to produce these extra Z-bosons with the associated event-attributes in some SUSY extension of the SM, while at the same time all the

[1] A similar analysis on Z plus E_T^{miss} has been performed by CMS [3]. However, among other differences, no cut on H_T has been applied. No deviation from SM expectations has been observed here.

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constraints imposed by present new-physics searches at LHC and other experiments are satisfied. In this section, we will assume that the acceptance of the applied selection, also taking into account the reconstruction efficiencies is ideally equal to unity. In Section 3, we will perform a "realistic" simulation in a SUSY model using Delphes [4] to take into account the signal acceptance and detector efficiencies.

We need to produce 273 (225 at one-σ) Z-bosons if we want to accommodate the observed excess in lepton-pairs. Assuming that R-parity is conserved, supersymmetric particles are produced in pairs in processes of the type $pp \to Y\bar{Y}$. Thus, the required cross-section for this process would be,

$$\sigma(pp \to Y\bar{Y}) = \frac{N_{\rm ev}/\mathcal{N}(Y \to Z)}{\mathcal{L}} = \frac{137(113)/\mathcal{N}(Y \to Z)}{20.3\ \text{fb}^{-1}} = \frac{6.7(5.6)\ \text{fb}}{\mathcal{N}(Y \to Z)}, \tag{2.1}$$

where we take into account that two Y particles are produced in each event. So, if we obtained one Z-boson for each Y-particle produced, we would need a production cross-section of (6.7 ± 1.1) fb at the LHC with a CM energy of 8 TeV. Then, the first thing we must do is to determine whether it is still possible to have these production cross-sections for some supersymmetric particle taking into account the constraints from direct searches at LHC. Here, we consider the production cross sections of different supersymmetric particles separately to identify the relevant processes. However, in a full simulation, as done in Section 3, different sparticles contribute to the final Z plus jets plus MET signal and the different contributions must be added.

Naively, the first option to consider in a hadron collider would be strong production of squarks or gluinos (assuming they produce Z bosons in their decays). However, current experimental searches of jets plus missing energy at LHC force the masses of these coloured particles to be high [5, 6, 7]. Nevertheless, as we will see below, in some cases we can still find cross-sections of the required size.

Production cross-sections of gluinos and squarks depend only on their masses and are basically independent of other MSSM parameters. In the case of gluino and squarks of the first generation, the cross-section depends both on the squark and gluino masses due to t-channel contributions, but in the case of stops or sbottoms it depends only on the stop or sbottom mass. In Fig. 1 we present the production cross-section of gluino pairs and light-flavour squark pairs calculated at NLL+NLO with NLL-fast [8, 9] as a function of the gluino or squark mass. The different bands in these figures correspond to the cross-section at one-σ with fixed squark or gluino masses: the blue (dashed) band corresponds to $m_{\tilde{q},\tilde{g}} = 1000$ GeV, the brown (dash-dotted) band to $m_{\tilde{q},\tilde{g}} = 1500$ GeV, the orange (dotted) band has $m_{\tilde{q},\tilde{g}} = 2500$ GeV and the red (solid) band corresponds to decoupled squarks or gluinos. In all these plots, the horizontal grey lines represent the required cross-section at one-σ needed to reproduce the referred ATLAS excess.

As we can see in these figures, the required cross-section is reached only for light gluino and squark masses. In the case of gluino production, the needed cross-section is obtained only for $m_{\tilde{g}} \lesssim 1200$ GeV and favours heavy squark masses. In fact, these gluino masses are in the boundary of the allowed region obtained from jets plus missing E_T searches at LHC [5, 6, 7] and would contribute significantly only if every $\tilde{g}$ produces at least a Z-boson in its decay. For the production of squark pairs, present limits are $m_{\tilde{q}} \gtrsim 1400$ GeV for heavy gluinos and $m_{\tilde{q}} \gtrsim 1650$ GeV for degenerate

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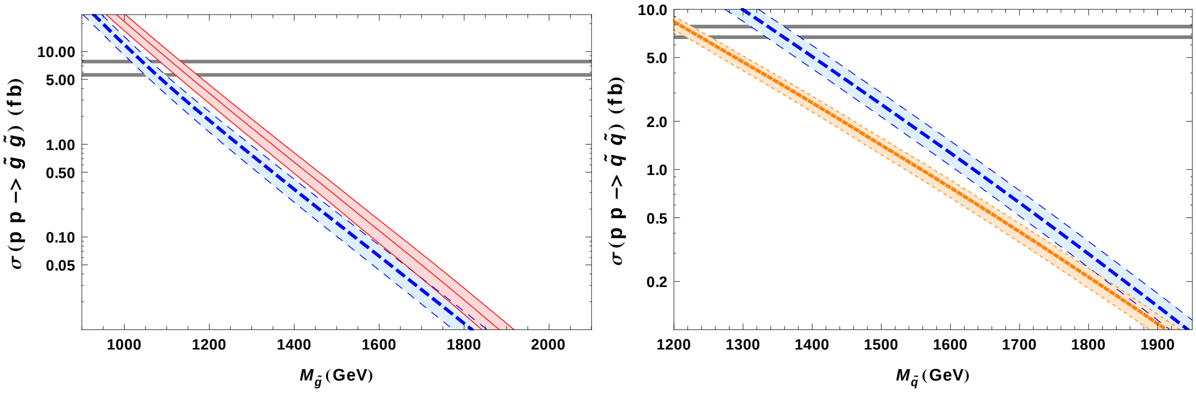

Figure 1: On the left, we show the production cross-section of gluino pairs as a function of the gluino mass for two fixed values of the first generation squark masses: 1000 GeV (blue/dashed) and decoupled squarks (red/solid). On the right, we have the production cross-section of squarks pairs as a function of their mass with gluino masses of 1000 GeV (blue/dashed) and 2500 GeV (orange/dotted).

squarks and gluinos [5, 6, 7]. Under these conditions, $\sigma(pp \to \tilde{q}\tilde{q})$ is always well-below the required cross-section, even for $m_{\tilde{q}} \gtrsim 1400$ GeV.

Another important process is the simultaneous production of squark and gluino. However, we would need both squark and gluino to be light, which is not possible if we take into account the bounds from LHC searches [5, 6, 7]. Other options like strong production of stop pairs or weak production of charginos/neutralinos have smaller production cross sections and thus require much lighter particles. In these conditions, the cuts $H_T > 600$ GeV and $E_T^{\rm miss} > 225$ are very restrictive and most of the events do not survive the cuts Therefore, we must conclude that it is not possible to generate the required cross-section and fulfil the requirements of the observed excess through stop or neutralino/chargino production. In summary, the best option seems to be gluino pair production with $m_{\tilde{g}} \lesssim 1200$ GeV with relatively heavy squarks $m_{\tilde{q}} \gtrsim 3000$ GeV, if we can get at least one Z boson in every gluino decay.

The Next step is to calculate the average number of Z-bosons per parent particle Y, that we use in Eq. (2.1). Z bosons are produced through the decay chains of most MSSM particles, although the number of Z-bosons obtained per each supersymmetric particle produced depends on the identity of the supersymmetric particle initially produced and on the supersymmetric spectrum below its mass. The main sources of Z-bosons are the decays of neutralinos and charginos and also in some squark decays. The couplings of charginos/neutralinos to Z are given by,

$$\mathscr{L}_{Z\chi\chi} = \frac{g_2}{\cos\theta_W} Z_\mu \left[\chi_i^+ \gamma^\mu \left(O'^L_{ij} P_L + O'^R_{ij} P_R\right) \chi_j^- + \bar{\chi}_i^0 \gamma^\mu \left(O''^L_{ij} P_L + O''^R_{ij} P_R\right) \chi_j^0\right] \tag{2.2}$$

$$\text{with} \quad O'^L_{ij} = -V_{i1}V^*_{j1} - \frac{1}{2}V_{i2}V^*_{j2} + \delta_{ij}\sin^2\theta_W \qquad O'^R_{ij} = -U^*_{i1}U_{j1} - \frac{1}{2}U^*_{i2}U_{j2} + \delta_{ij}\sin^2\theta_W$$

$$O''^L_{ij} = -\frac{1}{2}N_{i3}N^*_{j3} + \frac{1}{2}N_{i4}N^*_{j4} \qquad O''^R_{ij} = -O''^L_{ij}\,.$$

Therefore, we can obtain Z bosons in the decays of higgsino-like neutralinos and charginos. For instance in a usual mSugra spectrum, the second neutralino will only produce Z-bosons through its (relatively small) higgsino component while the two heavier neutralinos can be expected to produce a sizeable number of Z-bosons. On the other hand, charginos can produce Z-bosons both

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through the wino and from the higgsino component but only in decays of the heavier charginos, as the lightest one will only decay to a W-boson and a neutralino (or lepton-slepton if $m_{\tilde{l}} \leq m_{\chi^+}$).

In Fig. 2 we can see the values of $\mathcal{N}(\chi_2^0 \to Z)$ as a function of $m_{\chi_2^0}$ in an mSugra model. Here, we obtain $\mathcal{N}(\chi_2 \to Z)$ around 0.1, as expected if the higgsino content is relatively small. Heavier neutralinos can reach $\mathcal{N}(\chi_3 \to Z)$ of at most 0.45 while heavy charginos can produce at most 0.3 Z-bosons per decay.

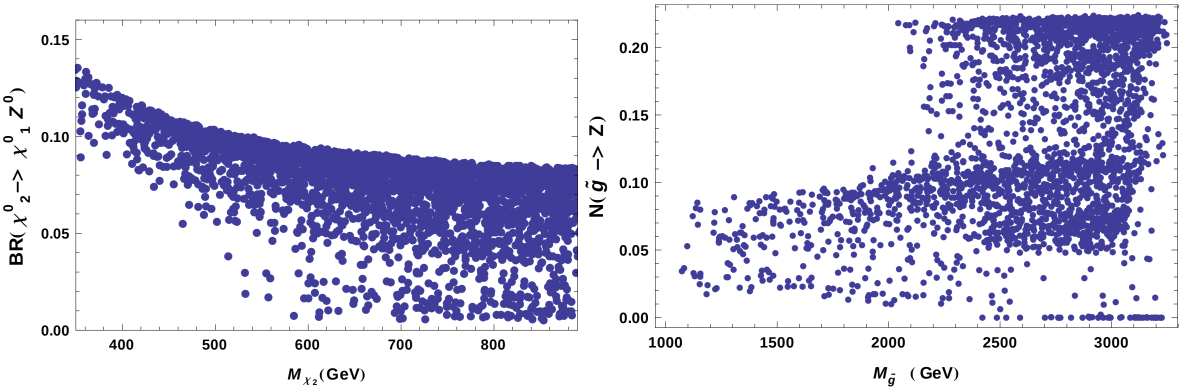

Figure 2: Average number of Z bosons, $\mathcal{N}(Y \to Z)$, in the decays of χ_2^0 (left) and gluino (right) for a typical mSugra spectrum.

Besides chargino and neutralino decays, Z-bosons couple also to sfermions through,

$$\mathcal{L}_{Z\tilde{q}} = \frac{-ig_2}{\cos\theta_W}(T_{3I} - e_I \sin^2\theta_W)\, Z_\mu\, \tilde{q}_\alpha^* \partial^\mu \tilde{q}_\beta \, \left((\Gamma_{qL}^{\rm SCKM})^*_{I\alpha}(\Gamma_{qL}^{\rm SCKM})_{I\beta} + (\Gamma_{qR}^{\rm SCKM})^*_{I\alpha}(\Gamma_{qR}^{\rm SCKM})_{I\beta}\right) . \tag{2.3}$$

As we can see, the Z couplings are chirality diagonal and therefore, in decays, they can only enter through chirality mixing. Therefore we can expect a sizeable amount of Z-bosons produced only through chirality mixing in third generation sfermions in decays like $\tilde{t}_2 \to \tilde{t}_1 + Z$, or $\tilde{b}_2 \to \tilde{b}_1 + Z$ in the large $\tan\beta$ regime. In addition, we obtain Z-bosons in the decay chains of strongly produced sparticles. We can obtain Z-bosons at different steps of the decay chain, either through the couplings of Z to sfermions or to charginos/neutralinos that we saw above. For instance, if we produce a pair of gluinos a possible decay chain would be $\tilde{g} \to \tilde{t}_2 t \to \tilde{t}_1 Z\, t \to \chi_2^+ b\; Z\; t \to \chi_1^+ Z\; b\; Z\; t \to \chi_1^0 W^+\; Z\; b\; Z\; t$. Therefore taking into account the corresponding branching ratios, this decay chain would contribute with $2 \times {\rm BR}(\tilde{g} \to \chi_1^0 W^+\; Z\; b\; Z\; t)$ to $\mathcal{N}(\tilde{g} \to Z)$, the number of Z-bosons produced per $\tilde{g}$ produced. This can be seen in the right-handed plot of Fig. 2. In a typical MSSM spectrum we obtain at most 0.2 Z-bosons per gluino (and similarly for stop) while other squarks produce far fewer Z-bosons per squark. Although Figs. 2 have been obtained from a mSugra spectrum, the expected number of Z bosons would be very similar in other MSSM versions, as it depends only on the spectrum below the mass of the originally produced Y particle and the content of charginos-neutralinos.

As seen above, the only possibility to explain the signal is to produce a stop or a gluino-pair as the lightest coloured sparticle, being all other squarks much heavier and only neutralinos,

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charginos and possibly some sleptons can be below the gluino or stop mass. Moreover, given the size of production cross-sections consistent with the present searches, we need to obtain nearly one Z-boson per Y particle produced. Therefore, from the expected numbers of Z-bosons that we have seen in this section, we have to conclude that it is not possible to reproduce the observed signal in a MSSM with a stable (and light) neutralino.

Nevertheless, we can still consider different variations of the MSSM:

- A light gluino well-below 1 TeV in a sort of compressed spectrum. In these conditions the gluino would be abundantly produced at LHC and even a small number of Z-bosons per gluino could fulfil the requirements.

- A second option is to consider an MSSM where the lightest neutralino decays to a lighter gravitino plus some Z-boson, as can be the case in gauge mediated MSSM. In this case, the neutralino decays to Z-boson and gravitino if it is allowed by phase-space and the branching ratio will depend on the lightest neutralino composition. This is the possibility we will explore in the following.

Thus, we will analyze a situation where the neutralino is the next to lightest supersymmetric particle and the LSP is the gravitino. All supersymmetric particles will decay to the lightest neutralino which then decays to gravitino plus a photon, a Z-boson or a Higgs. The decay width of the lightest neutralino to photon, h or Z plus gravitino [10, 11, 12] is given by,

$$\begin{aligned}\Gamma(\chi_1^0 \to \gamma\tilde{G}) &= \frac{|N_{11}\cos\theta_W + N_{12}\sin\theta_W|^2}{48\pi M_{Pl}^2}\frac{m_\chi^5}{m_{\tilde{G}}^2}\left[1-\frac{m_{\tilde{G}}^2}{m_\chi^2}\right]\left[1+3\frac{m_{\tilde{G}}^2}{m_\chi^2}\right],\\ \Gamma(\chi_1^0 \to Z\tilde{G}) &= \frac{|-N_{11}\sin\theta_W + N_{12}\cos\theta_W|^2}{48\pi M_{Pl}^2}\frac{m_\chi^5}{m_{\tilde{G}}^2}F(m_\chi, m_{\tilde{G}}, m_Z),\end{aligned} \tag{2.4}$$

with $F(x,y,z)$ a function of the particle masses non relevant for our discussion that can be obtained from [12]. As we can see, if the lightest neutralino is bino-like, $N_{11} \simeq 1$, and the mass difference between neutralino and gravitino is larger that the Z-mass, the branching ratios are $\mathrm{BR}(\chi_1 \to \tilde{G}\gamma) \simeq \cos^2\theta_W \simeq 0.8$ and $\mathrm{BR}(\chi_1 \to \tilde{G}Z) \simeq \sin^2\theta_W \simeq 0.2$. Similarly if the lightest neutralino is wino-like, the branching ratios get exchanged. From this equation we can also see that it is possible to get a very large BR to Z bosons as needed to reproduce the observed signal if $(-N_{11}\sin\theta_W + N_{12}\cos\theta_W) \simeq 1$, but this is only possible if the lightest neutralino has a very large wino component. This gaugino composition is possible in the so-called General Gauge Mediation (GGM) scenario, where the gaugino and sfermion masses depend on hidden sector current correlators which can be different for different gauge groups or particle representations.

3. A possible explanation in General Gauge Mediation

Minimal gauge mediation predicts that all scalar and gaugino masses originate from a single scale and powers of the gauge couplings [13]. Recently a model-independent generalization of gauge mediation was proposed under the name of General Gauge Mediation [14, 15], where all the dependence of soft masses on the hidden sector is encoded in three real and three complex

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Particle	$\tilde{g}$	χ_1^0	χ_2^0	χ_3^0	χ_4^0	$\chi_1^\pm$	$\chi_2^\pm$	$\tilde{G}$
Mass (GeV)	911.4	424.9	432.7	1111.8	1117.1	425.8	1117.2	4.8×10^{-9}
Particle	$\tilde{q}_L$	$\tilde{q}_R$	$\tilde{b}_1$	$\tilde{b}_2$	$\tilde{t}_1$	$\tilde{t}_2$	$\tilde{l}_L$	$\tilde{l}_R$
Mass (GeV)	2510	2470	2400	2450	2250	2400	5890	5360
Particle	h	H	A	H^+				
Mass (GeV)	118.1	1250	1250	1253				

Table 1: SUSY spectrum for the point GGM2.

parameters obtained from a small set of current-current correlators. In these models the gaugino and sfermion masses are given by,

$$M_r = g_r^2 M_s \tilde{B}_r^{1/2}(0) \tag{3.1}$$
$$m_{\tilde{f}}^2 = g_1^2 Y_f \zeta + \sum_{r=1}^{3} g_r^2 \mathscr{C}_2(f|r) M_s^2 \tilde{A}_r\,,$$

with

$$\tilde{A}_r = -\frac{1}{16\pi^2}\int dy \left(3\tilde{C}_1^{(r)}(y) - 4\tilde{C}_{1/2}^{(r)}(y) + \tilde{C}_0^{(r)}(y)\right)\,, \tag{3.2}$$

$\tilde{B}_r^{1/2}(0)$, $C_\rho^{(r)}(y)$ (with $\rho = 0, 1/2, 1$, corresponding to scalar, fermion and vector) are associated with the current-current correlators in the hidden sector, ζ is a possible Fayet-Illiopoulos term ($\zeta = 0$ in the following), $\mathscr{C}_2(f|r)$ the quadratic Casimirs and M_s a characteristic SUSY-breaking scale in the hidden sector.

Having six parameters, $\tilde{B}_r^{1/2}(0)$ and $\tilde{A}_r$, to fix the soft masses in the observable sector, it is clear now that we have much more freedom in GGM [16, 17, 18, 19] and, in particular, we have $M_1/g_1^2 \neq M_2/g_2^2 \neq M_3/g_3^2$, as required to have NLSP decay to gravitino and a Z-boson with a branching ratio close to one to reproduce the observed signal at ATLAS. Fortunately, this is possible in GGM as shown in Ref. [20, 19].

In this GGM scenario, we have used SPheno-3.3.3 [21, 22] to obtain the full supersymmetric spectrum at LHC energies. We define the GGM2 point with $M_s = 400$ TeV, $\tilde{B}_1^{1/2} = \tilde{A}_1 = 309$ TeV, $\tilde{B}_2^{1/2} = \tilde{A}_2 = 150$ TeV, $\tilde{B}_3^{1/2} = 110$ TeV, $\tilde{A}_3 = 270$ TeV and $\tan\beta = 9.8$. With these parameters we obtain the spectrum shown in Table 1. With respect to this spectrum, some comments are in order:

1. The two lightest neutralinos and the lightest chargino are very similar in mass, ~ 430 GeV and this allows a large neutrino mixing as required.

2. The gluino is relatively light $m_{\tilde{g}} = 911.4$ GeV which allows for a sizeable production cross-section although taking into account the squark masses of order ~ 3 TeV, this mass is on the verge of exclusion by the latest LHC bounds.

3. The lightest Higgs mass must reproduce the observed value at LHC of $m_h \simeq 125$ GeV and in this spectrum it reaches only 119.4 GeV, but this problem can be solved either by increasing the stop masses taking a larger $\tilde{A}_3$ or assuming extra operators in the Higgs sector [23].

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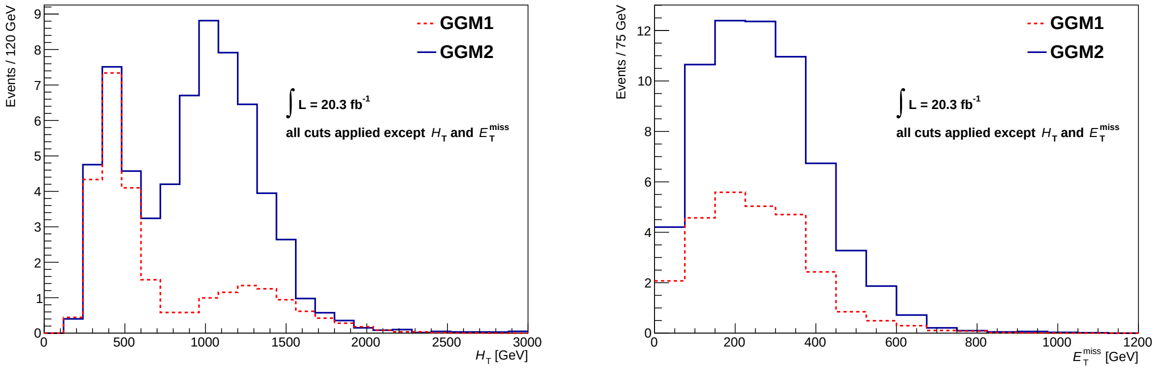

Figure 3: $H_{\rm T}$ (left) and $E_{\rm T}^{\rm miss}$ (right) distributions after applying the selection, except for the cuts on $H_{\rm T}$ and $E_{\rm T}^{\rm miss}$. The GGM1 point is represented by the dashed red line and the GGM2 point, by the solid blue line.

Under these conditions, the lightest neutralino width is $\Gamma_{\chi_1} = 4.097 \times 10^{-10}$ GeV and the BR$(\chi_1^0 \to \tilde{G}Z) = 0.94$. Therefore, gluinos are produced at LHC with a cross-section of 41.6 ± 7.5 fb at NLL+NLO and after going through different decay chains all of them produce a Z-boson plus a gravitino.

We simulate the production of supersymmetric particles at LHC at 8 TeV (LHC8) with this spectrum using Pythia 8.1 [24] with Prospino2 [8, 9, 25] K-factors and the response of the ATLAS detector using Delphes [4]. The selection of events for this study is done as close as possible to that performed in ATLAS [1]. The dashed red line in Fig. 3 and Fig. 4 shows the $H_{\rm T}$ and $E_{\rm T}^{\rm miss}$ distributions respectively for the GGM2 point after applying all the selection except for the $H_{\rm T}$ and $E_{\rm T}^{\rm miss}$ cuts. In Fig. 4, the $E_{\rm T}^{\rm miss}$ distribution is presented separately for strongly produced events (solid blue line) and for the electroweak component of the production (dashed red line) for the same selection as in Fig. 3 but after applying the $H_{\rm T}$ cut, i.e. the final selection except for the cut on $E_{\rm T}^{\rm miss}$. The electroweak component is significantly reduced by the $H_{\rm T}$ cut while mainly only events coming from strong production survive the cut, as expected. We see that the peak in the $E_{\rm T}^{\rm miss}$ distribution is approximately at $m_{\chi_1^0}/2$, and, for $m_{\chi_1^0} = 425$ GeV, a reasonable fraction of the events will survive the $E_{\rm T}^{\rm miss}$ cut at 225 GeV. In the simulation, the strong production represents $\sim 70\%$ of the total cross-section. As seen in Fig. 4, after applying the selection we obtain an expected signal of 28.0 ± 4.7 events, slightly over the excess reported by ATLAS, showing that a signal point defined along these characteristics can be able to reproduce the excess.

4. Prospects and Conclusions

As we have shown, the excess observed in ATLAS, if due to SUSY, requires a gluino of a mass ~ 1 TeV producing nearly one Z-boson per gluino in its decay. This scenario would also require relatively heavy squarks of the first generation with $m_{\tilde{q}} \gtrsim 2.5$ TeV. If this is indeed the correct

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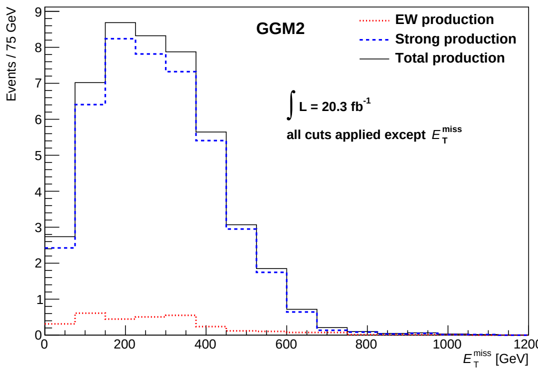

Figure 4: $E_{\mathrm{T}}^{\mathrm{miss}}$ distribution corresponding to the GGM2 point from strong (solid blue line) and electroweak production (dashed red line) with the same selection as in the previous figure and H_{rmT}>600 GeV.

explanation to the observed excess, such light gluinos would be abundantly produced at Run II in LHC together with other SUSY particles. Therefore, the results obtained at pp collisions at 13 TeV will immediately confirm or reject this supersymmetric explanation of the ATLAS excess.

For the point GGM2, the gluino production cross section increases by a factor ~ 15 in going from 8 to 13 TeV centre of mass energy. This would have unambiguous signatures, both on the Z-peak with a scaling of the signal found at LHC8 and in direct searches for gluinos using jets plus missing E_T in the extension of the analysis in [5, 6, 7]. However, to confirm that it is indeed SUSY behind the excess found at the Z-peak, we should search for other sparticles at LHC13. Charginos and neutralinos are expected to be well-bellow the gluino mass in general and could be abundantly produced at LHC. Although our analysis does not fix the masses of $\chi_1^{\pm}$ and $\chi_{1,2}^0$, they are expected to be rather heavy $m_{\chi_1^0} \gtrsim 300$ GeV and degenerate. In some cases, the production cross-section could be large. Notice that, as explained above, electroweak production is also large for these points at 8 TeV, but is eliminated by the cuts on H_{T} and number of jets. Thus, a large electroweak production could be expected at LHC13 and dedicated searches should be encouraged, specially taking into account the requirement of a large production of Z-bosons in chargino and neutralino decays.

We have to emphasize here that it is not difficult to obtain the observed excess for light gluino masses, and a gluino mass in between the two presented examples, $m_{\tilde{g}} \in [900, 1100]$ GeV, could reproduce the observed signal. However, these points may be in conflict with direct searches of jets plus $E_{\mathrm{T}}^{\mathrm{miss}}$ [5, 6, 7]. There is a tension between this excess and the bounds from gluino searches in jets plus $E_{\mathrm{T}}^{\mathrm{miss}}$. This tension will only be solved by the new data at LHC13. Therefore, we have proved that it is indeed possible to construct a Supersymmetric model that accommodates the observed excess of lepton pairs on the Z-peak. The simulations presented here are only a proof of existence and the final model may be very different. Nevertheless, this model will have to share the main features of the examples that we presented here.

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