distribution function (DF) employed in deriving these regions from the experimental rates. Thus, their location relative to the theoretical scatter plot changes depending on the galactic DM properties [45]. The domains shown in Fig. 5 were obtained by using for the DF the standard isothermal sphere with $\rho_0 = 0.30$ GeV cm^{-3}, $v_0 = 220$ kmsec^{-1}, with $v_{\rm esc} = 650$ kmsec^{-1} for DAMA/LIBRA experiment and $v_{\rm esc} = 544$ kmsec^{-1} for CRESST. The use of a DF with a larger (smaller) value of ρ_0 would move downward (upward) the experimental regions by a factor proportional to ρ_0. Increasing (decreasing) the speeds generically produces a displacement toward lower (higher) masses [45].

In conclusion, by taking into account various sources of uncertainties, mainly the ones mentioned in the two last items, the experimental regions shown in Fig. 5 may change sizably. In the case of the DAMA/LIBRA experiment, the regions which encompass the effects of various uncertainties are plotted in Figs. 1, 2, 3, and 7 of Ref. [10].

Negative results reported by other experiments of DM direct detection [46–48] are in tension with the signals measured by DAMA/LIBRA and CRESST. It should however be noted that a number of questions about various physical and technical features of the specific detectors or of the relevant analyses have been raised [49–51]. One further experiment, CoGeNT [6], reports the measurement of an yearly modulated signal. If interpreted in terms of a coherently interacting dark matter particle, this signal gives a region in the $m_\chi - \xi\sigma^{\rm (nucleon)}_{\rm scalar}$ plane, which is approximately located around $m_\chi \sim 10$ GeV and $\xi\sigma^{\rm (nucleon)}_{\rm scalar} \sim (3 - 10) \times 10^{-41}$ cm^2, thus somewhat displaced from the region singled out by the scatter plot of Fig. 6. However, a redetermination of the region toward smaller $\sigma^{\rm (nucleon)}_{\rm scalar}$ and larger m_χ is being undertaken by the CoGeNT Collaboration [52].

B. The neutralino subpopulation singled out by a Higgs at 126 GeV

We turn now to the analysis of a subset of the neutralino population considered in the previous section which would be selected by an indication of a possible Higgs signal at the LHC. Actually, the ATLAS Collaboration, in a search for a SM Higgs boson, measures an excess of events around a mass of 126 GeV, and restricts the most likely mass region (95% C.L.) to 115.5–131 GeV (global statistical significance about 2.3σ) [11]. Similar results (with a lower statistical significance) are presented by CMS [12]. We address the question of what might be the implications of these measurements (in case the effect is confirmed in future runs at the LHC) under the hypothesis that this possible signal is attributed to the production of the heavier neutral *CP*-even Higgs boson *H* of the MSSM [53].

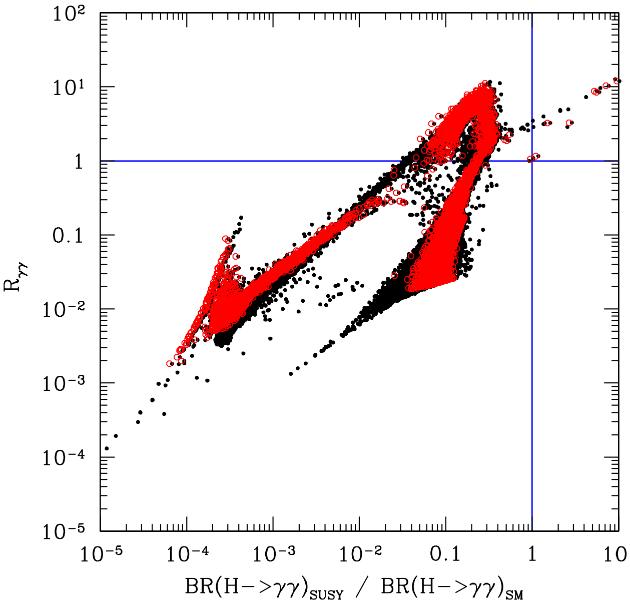

FIG. 6 (color online). Production cross-section ratio $R_{\gamma\gamma} \equiv [\sigma(gg \to H) \times {\rm BR}(H \to \gamma\gamma)]_{\rm MSSM}/[\sigma(gg \to h){\rm BR}(h \to \gamma\gamma)]_{\rm SM}$ as a function of ${\rm BR}(H \to \gamma\gamma)_{\rm MSSM}/{\rm BR}(h \to \gamma\gamma)_{\rm SM}$ for the configurations discussed in Sec. III A. Black points refer to *H* masses in the range 115 GeV $\le m_H \le$ 131 GeV, while (red) circles refer to an *H* mass interval more focused around 126 GeV (specifically: 125 GeV $\le m_H \le$ 127 GeV).

Within our light neutralino population, we select the subset of configurations with 115 GeV $\le M_H \le$ 131 GeV. These are contained in the band shown in the right panel of Fig. 2, with values of the m_A parameter in the range 90 GeV $\le M_A \le$ 129 GeV. This subpopulation of light neutralinos would have a neutralino-nucleon elastic cross section in the domain depicted in Fig. 5 by (red) crosses, and would then be in amazing agreement with the results of DM direct detection.

The identification of a putative Higgs boson with the *H* boson appears to be compatible in terms of production cross section and branching ratios. This is shown in Fig. 6, where the exclusive production cross-section ratio $R_{\gamma\gamma} \equiv [\sigma(gg \to H) \times {\rm BR}(H \to \gamma\gamma)]_{\rm MSSM}/[\sigma(gg \to H)\,{\rm BR}(H \to \gamma\gamma)]_{\rm SM}$ is plotted as a function of ${\rm BR}(H \to \gamma\gamma)_{\rm MSSM}/{\rm BR}(H \to \gamma\gamma)_{\rm SM}$ for our configurations. Here, $\sigma(gg \to H)$ is the Higgs production cross section through the gluon fusion process. We have calculated both quantities using FeynHiggs 2.8.6 [54]. Indeed, our population of light neutralinos contains many configurations which are in agreement with the putative Higgs signal. This is a property arising spontaneously in our scenario. Notice that although the BR of Higgs decay into 2 photons is typically smaller than the corresponding SM branchng ratio, $R_{\gamma\gamma}$ can be SM-like, due to enhanced production cross sections.

Though imposing the above requirement would imply some further selection within the neutralino population previously discussed, we do not find in our scan any significant correlation between $R_{\gamma\gamma}$ and the properties of relic neutralinos, such as the neutralino relic abundance $\Omega_\chi h^2$ or the neutralino-nucleon cross section $\xi\sigma^{(\mathrm{nucleon})}_{\mathrm{scalar}}$. In fact $R_{\gamma\gamma}$ is mainly affected by the production cross section $\sigma(gg \to H)$, which depends on supersymmetric-QCD parameters that do not enter directly into the calculation of relic neutralino observables. Although a thorough analysis of these aspects is beyond the scope of the present paper, the previous considerations are sufficient to conclude that our scenario can be compatible with the possible Higgs signal at the LHC in a natural way.

IV. CONCLUSIONS

We have reviewed the status of the phenomenology of light neutralinos in an effective MSSM at the electroweak scale, in light of new results obtained at the CERN Large Hadron Collider. First, we considered the impact of the new data obtained by the CMS Collaboration on the search for the Higgs-boson decay into a tau pair, and by the CMS and LHCb Collaborations on the branching ratio for the decay $B_s \to \mu^+ + \mu^-$, and we established that, on the basis of these data, the new value for the lower bound of the neutralino mass is $m_\chi \simeq 18$ GeV.

Then, we have examined the possible implications of the excess of events found by the ATLAS and CMS Collaborations in a search for a SM-like Higgs boson around a mass of 126 GeV, with a most likely mass region (95% C.L.) restricted to 115.5–131 GeV (global statistical significance about 2.3σ). We have derived that the excess around $m_H^{\mathrm{SM}} = 126$ GeV, which nevertheless needs a confirmation by further runs at the LHC, would imply a neutralino in the mass range 18 GeV $\lesssim m_\chi \lesssim$ 38 GeV, with neutralino-nucleon elastic cross sections fitting well the results of the dark matter direct search experiments DAMA/LIBRA and CRESST.

It is worth stressing that light neutralinos in the mass range considered here do not appear to be constrained by DM indirect searches (such as astrophysical gamma fluxes of diffuse extragalactic origin or from dwarf galaxies, and the low-energy cosmic antiproton flux). A detailed investigation of these aspects would however deserve a dedicated analysis.

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Note Added.—After the submission of the present paper, a new upper bound (at 95% C.L.) on the branching ratio for the decay $B_s \to \mu^+ + \mu^-$ has been presented by the LHCb Collaboration: $\mathrm{BR}(B_s \to \mu^+\mu^-) < 4.5 \times 10^{-9}$ [56]. If the previous upper bound $\mathrm{BR}(B_s \to \mu^+\mu^-) < 1.08 \times 10^{-8}$, employed in our analysis, is replaced by the new LHCb upper limit, the lower bound on the neutralino mass rises from the value of about 18 GeV, presented above, to about 20 GeV.

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