Annihilation of NMSSM neutralinos and Branching Ratios, Particle Decay Channel of lightest CP odd, even Higgs in NMSSM.

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We examine neutralino dark matter within the NMSSM framework by conducting a comprehensive analysis of its parameter space. This involves evaluating neutralino capture and annihilation rates within the Sun. The exploration of potential detection strategies for neutralino dark matter in neutrino experiments hinges on the composition of neutralinos and their primary annihilation pathways. Our study also involves reassessing the maximum thresholds for branching ratios of lepton flavour violation decays by directly referencing the constrained limits on Δa_μ from $g_\mu - 2$ experiment. This work also presents constraints of muon flux, photon, positron and antiproton flux, specifically its independence from experimental intricacies and the universal applicability of recalculation coefficients across NMSSM model. We also calculate the Branching Ratios, Particle Decay Channel of lightest CP odd, even Higgs in NMSSM.

I. INTRODUCTION

The discovery of the 125 GeV Higgs boson at the Large Hadron Collider (LHC) in 2012, while validating the Standard Model (SM) at TeV energy scales, has also underscored the necessity for physics models beyond the SM to account for phenomena such as dark matter (DM). In this pursuit, various supersymmetric (SUSY) models offer the Lightest Supersymmetric Particle (LSP) and Next Lightest Supersymmetric Particle (NLSP) as a compelling candidate for the weakly interacting massive particle (WIMP), aligning with the natural predictions for dark matter, thus driving the exploration into new physics realms. Recent advancements in particle physics experiments have provided a wealth of information on SUSY models. With the data from Run-II Large Hadron Collider (LHC), scientists have been able to probe the characteristics of winos and higgsinos, reaching masses of approximately 1060 GeV for $m_{\tilde{\chi}_1^0} \lesssim 400GeV$ and 900 GeV for $m_{\tilde{\chi}_1^0} \lesssim 400$GeV, respectively. Here, χ_1^0 represents the lightest neutralino, serving as the lightest supersymmetric particle (LSP) and a potential candidate for dark matter (DM) under R-parity

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conservation assumptions. Additionally, the LHC data have placed constraints on squarks with masses lighter than approximately 1850 GeV when the LSP is massless. Furthermore, the combined measurements of the muon anomalous magnetic moment by experiments at Fermilab and Brookhaven National Laboratory indicate a significant deviation from the Standard Model's prediction, hinting at potential new physics beyond the SM. While this deviation may be attributed to uncertainties in hadronic contributions, the possibility of SUSY effects has been widely discussed, promising insights into the mass spectra of electroweakinos and sleptons once confirmed. Moreover, the recent results from the LUX-ZEPLIN (LZ) experiment on direct DM search have set unprecedented limits on DM couplings to SM particles, further highlighting the relevance of SUSY in addressing fundamental questions in particle physics. These remarkable achievements motivate a comprehensive examination of their collective implications for SUSY theory. The minimal supersymmetric standard model (MSSM) stands out as one of the foremost contenders among new physics models, offering an elegant resolution to the hierarchy problem while designating the lightest neutralino as a viable candidate for dark matter (DM). However, challenges such as the µ-problem and the little hierarchy problem have surfaced, particularly under the scrutiny of recent LHC experiments. These issues find resolution in the next-to-minimal supersymmetric standard model (NMSSM), which expands upon the Higgs sector of the MSSM by incorporating a gauge singlet field, denoted as $\hat{S}$. The development of a vacuum expectation value (VEV) for $\hat{S}$, represented by υs, dynamically generates an effective $\mu-$term, naturally aligning its magnitude with the electroweak scale. Furthermore, interactions among Higgs fields $\lambda \hat{S}\hat{H}_u\hat{H}_d$ in the NMSSM [1–3] contribute positively to the squared mass of the SM-like Higgs boson at the tree level. Additionally, the mass can undergo enhancement through singlet-doublet Higgs mixing, particularly if the Higgs boson represents the next to lightest CP even Higgs state. Consequently, the need for significant radiative corrections to the Higgs boson mass is mitigated, offering a solution to the little hierarchy problem within the framework of the NMSSM. Following this introduction, the subsequent section provides a summary of the pertinent characteristics of the NMSSM, along with an outline of the constraints utilized in our exploration of Chargino and Neutralino two body decays in our model. Moving forward to Section 3, we will present the calculated Higgs like Branching ratio decays within the NMSSM. Finally, our findings and implications will be consolidated in Section 4, drawing conclusions based on the analyses conducted.

II. THEORETICAL FOUNDATIONS OF THE NEXT–TO–MINIMAL SUPERSYMMETRIC STANDARD MODEL (NMSSM), ELUCIDATING ITS KEY PRINCIPLES AND FUNDAMENTAL CONCEPTS.

$$W_{NMSSM} = W_{YUKAWA} + \lambda\hat{S}\hat{H}_d\hat{H}_d + \frac{\kappa}{3}\hat{s} + \mu\hat{H}_u.\hat{H}_d + \xi\hat{S} + \frac{1}{2}\mu^{'}\hat{S}^2 \tag{1}$$

where the Yukawa terms contained in W_{Yukawa} resembles as those of the MSSM. $\hat{H}_u = (\hat{H}_u+, \hat{H_u}0)^T$ and $\hat{H}_d = (\hat{H}_d0, \hat{H_d}-)^T$ represents $SU(2)_L$ Higgs doublet. λ, κ are dimensionless coupling parameters signifying invariant trilinear terms under Z_3 symmetry. μ and $\mu^{'}$ are bilinear mass parameters and ξ is the singlet tadpole parameter which are written here explicitly to solve the cosmological domain wall problem. The ξ term may be erased by redefining μ parameter. In this work the ξ term is set to zero.

III. THE NEUTRALINO SECTOR

This mass matrix formulation matrix Neutralino provides a comprehensive understanding of the neutralino sector within NMSSM, encompassing the bino field $\hat{B}$, the Wino field $\hat{W}$, Higgsino fields $\hat{H}_u^0$, $\hat{H}_d^0$, the singlino field $\hat{S}$. Its structure, as delineated in Eq. (2) , elucidates the intricate interplay between these particles, shedding light on their masses and interactions crucial for the model's phenomenological implications.

$$M_{\tilde{\chi^0}} = \begin{bmatrix} M_1 & 0 & -m_Z sin\theta_W cos\beta & m_z sin\theta_W & 0 \\ & M_2 & m_Z cos\theta_W cos\beta & -m_Z cos\theta_W sin\beta & 0 \\ & & 0 & -\mu_{total} & -\frac{1}{2}\lambda_v sin\beta \\ & & & 0 & -\frac{1}{2}\lambda_v cos\beta \\ & & & & 2\frac{\kappa}{\lambda}\mu_{eff} + \mu^{'} \end{bmatrix} \tag{2}$$

M_1, M_2 are the gaugino masses. $\mu_{total} = \mu_{eff} + \mu$ represents the Higssino masses. The neutralino mass eigen states are expressed by

$$\chi_i^0 = N_{i1}\psi_1^0 + N_{i2}\psi_2^0 + N_{i3}\psi_3^0 + N_{i4}\psi_4^0 + N_{i5}\psi_5^0 \tag{3}$$

N_{i3}, N_{i4} are the $\hat{H}_d^0$ and $\hat{H}_u^0$ components in χ_i^0 respectively. N_{i5} represents the singlino components. Given the condition $|m^2_{\tilde{\chi_1^0}} - \mu^2_{total}| > \lambda^2 \upsilon^2$ and the presence of very highly massive gauginos, the singlino dominated mass $\tilde{\chi_1^0}$ and its field composition are roughly estimated as

$$m_{\tilde{\chi_1^0}} = \frac{2\kappa}{\lambda}\mu_{eff} + \mu^{'} + \frac{1}{2}\frac{\lambda^2\upsilon^2}{m^2_{\tilde{\chi_1^0}} - \mu^2_{total}}(m_{\tilde{\chi_1^0}} - \mu_{total} sin2\beta), \quad N_{11} = 0, \quad N_{12} = 0 \tag{4}$$

$$\frac{N_{13}}{N_{15}} = \frac{\lambda\upsilon}{\sqrt{2}\mu_{tot}} \frac{(m_{\tilde{\chi_1^0}}/\mu_{total})sin\beta - cos\beta}{1 - (\frac{m_{\tilde{\chi_1^0}}}{\mu_{tot}})^2}, \quad \frac{N_{14}}{N_{15}} = \frac{\lambda\upsilon}{\sqrt{2}\mu_{tot}} \frac{(m_{\tilde{\chi_1^0}}/\mu_{total})cos\beta - sin\beta}{1 - (\frac{m_{\tilde{\chi_1^0}}}{\mu_{tot}})^2} \tag{5}$$

$$N^2_{15} = \frac{[1 - (\frac{m_{\tilde{\chi_1^0}}}{\mu_{total}})^2]^2}{[(\frac{m_{\tilde{\chi_1^0}}}{\mu_{total}})^2 - 2(\frac{m_{\tilde{\chi_1^0}}}{\mu_{total}})sin2\beta + 1](\frac{\lambda\upsilon}{\sqrt{2}\mu_{tot}})^2 + [1 - \frac{\lambda\upsilon}{\sqrt{2}\mu_{tot}}^2]^2} \tag{6}$$

The above expressions predicts many important characteristics of neutralino. Mass of neutralino depends upon the parameters $\lambda.\kappa, tan\beta, \mu_{eff}, \mu_{total}$. λ, κ are independent parameters in predicting neutralino mass. The field compositions in χ_1^0 are determined by $tan\beta, \mu_{eff}, \lambda, m_{\chi_1^0}, \kappa$ in probing neutralino's properties.

IV. THE HIGGS SECTOR

The Lagrangian of the soft breaking term of the Higgs field takes the following form:

$$-L_{soft} = \lambda A_\lambda S H_u.H_d + \frac{1}{3}A_\kappa \kappa S^3 + m_3^2 H_u.H_d + \frac{1}{2}m_s^{'2} S^2 + h.c + m^2_{H_u}|H_u|^2 + m^2_{H_d}|H_d|^2 + m^2_S|S|^2 \tag{7}$$

H_u, H_d and S are the scalar components of multiplets of Higgs Superfields. Masses of $m^2_{H_u}$, $m^2_{H_d}$ and m^2_S can be expressed in terms of Higgs vevs $< H_u >^0 = \frac{\upsilon_u}{\sqrt{2}}$, $< H_d^0 > = \frac{\upsilon_d}{\sqrt{2}}$ and $< S > = \frac{\upsilon_s}{\sqrt{2}}$ by minimising the scalar potential. As one sees from the soft breaking Lagrangian the Higgs sector in NMSSM model is defined by the yukawa couplings, $\lambda, \kappa, \mu_{eff}$ and the trilinear couplings A_λ, A_κ, the bilinear soft mass parameters, $\mu, \mu^{'}$. related to soft breaking parameters m_3^2, m_S^2. The elements of CP$-$ even Higgs boson mass matrix M_S^2 are as follows:

$$M^2_{S,11} = \frac{2[\mu_{eff}(\lambda A_{\lambda + \kappa\mu_{eff}} + \lambda\mu^{'})] + \lambda m_3^2}{\lambda sin2\beta} + \frac{1}{2}(2m_Z^2 - \lambda^2\upsilon^2)sin^2 2\beta, \tag{8}$$

$$M^2_{S,12} = -\frac{1}{4}(2m_Z^2 - \lambda^2\upsilon^2)sin4\beta, \tag{9}$$

$$M^2_{S,13} = -\frac{1}{\sqrt{2}}(\lambda A_{\lambda + 2\kappa\mu_{eff}} + \lambda\mu^{'})\upsilon cos2\beta, \tag{10}$$

$$M^2_{S,22} = m_Z^2 cos^2 2\beta + \frac{1}{2}\lambda^2\upsilon^2 sin^2 2\beta \tag{11}$$

$$M^2_{S,23} = \frac{\upsilon}{\sqrt{2}}[2\lambda(\mu_{eff+\mu}) - (\lambda A_{\lambda+2\kappa\mu_{eff}} + \lambda\mu^{'})Sin2\beta] \tag{12}$$

$$M^2_{S,33} = \frac{\lambda(A_{\lambda+\mu'})sin2\beta}{4\mu_{eff}}\lambda\upsilon^2 + \frac{\mu_{eff}}{\lambda}(\kappa A_\kappa + \frac{4\kappa^2\mu_{eff}}{\lambda} + 3\kappa\mu^{'}) - \frac{\mu}{2\mu_{eff}\lambda^2\upsilon^2}. \tag{13}$$

And the CP odd Higgs fields are

$$M^2_{P,11} = \frac{2[\mu_{eff}(\lambda A_\lambda + \kappa\mu_{eff} + \lambda\mu^{'}) + \lambda m_3^2]}{\lambda Sin2\beta}, \tag{14}$$

$$M^2_{P,22} = \frac{(\lambda A_\lambda + \kappa\mu_{eff} + \lambda\mu^{'})sin2\beta}{4\mu_{eff}}\lambda\upsilon^2 - \frac{\kappa\mu_{eff}(3A_\kappa + \mu^{'})}{\lambda} - \frac{\mu}{2\mu_{eff}}\lambda^2\upsilon^2 - 2m_S^{'2}, \tag{15}$$

$$M^2_{P,12} = \frac{\upsilon}{\sqrt{2}}(\lambda A_\lambda - 2\kappa\mu_{eff} - \lambda\mu^{'}) \tag{16}$$

$h_i = \{h, H, h_s\}$ and $a_i = \{A_H, A_S\}$ the mass eigen states leads to the following:

$$h_i = V^{NSM}_{h_i}H_{NSM} + V^{SM}_{h_i}H_{SM} + V^S_{h_i}Re[S], \tag{17}$$

$$a_i = V^{NSM}_{P,a_i}A_{NSM} + V^S_{P,a_i}Im[S] \tag{18}$$

These mass eigen states are obtained by unitary rotation matrices V and V_P to diagonalise M_S^2 and M_P^2 respectively. h scalar is the SM like Higgs boson discovered at LHC. H, A_H represents the heavy doublet$-$ dominated states. h_s, A_S are the singlet dominated states. The charged Higgs states $H^\pm$ takes the form:

$$m^2_{H^\pm} = m_A^2 + m_W^2 - \lambda^2\upsilon^2, \tag{19}$$

$$H^\pm = m_A^2 + m_W^2 - \lambda^2\upsilon^2 \tag{20}$$

where $H^\pm = cos\beta H_u^\pm + sin\beta H_d^\pm$. Here $H^\pm = cos\beta H_u^\pm + sin\beta H_d^\pm$ and, $m_A^2 = 2\frac{[\mu_{eff}(\lambda A_\lambda + \kappa\mu_{eff}) + \lambda\mu^{'}) + \lambda m_3^2]}{\lambda sin2\beta}$. Furthermore, extensive searches for additional Higgs bosons, including $H, A_H, h_s, A_s, andH^\pm$, have been conducted at the LHC with considerable intensity, as documented in references. Asymptotically for $\lambda \longrightarrow 0$, the mass matrix elements becomes,

$$M^2_{S,11} = m_A^2 + m_Z^2 sin^2 2\beta, \quad M^2_{S,12} = \frac{-1}{2}m_Z^2 sin4\beta \quad M^2 S_{1,3} = 0 \tag{21}$$

$$M^2_{S,22} = m_Z^2 cos^2 2\beta, \; M^2_{S,23} = 0, \; M^2_{S,33} = \frac{\mu_{eff}}{\lambda}(\kappa A_\kappa + \frac{4\kappa^2\mu_{eff}}{\lambda} + 3\kappa\mu^{'}), \tag{22}$$

$$M^2_{P,11} = m^2_A \; M^2_{P,22} = -\frac{\kappa\mu_{eff}}{\lambda}(3A_\kappa + \mu^{'}) - 2m^{'2}_S \; M^2_{P,12} = 0 \tag{23}$$

Thus it is found that the masses of the heavy doublet−dominated scalars are primarily dictated by the parameters A_λ and m_3. Parameters A_κ and $m^{'}_s$ exists in $M^2_{S,33}$ and $M^2_{P,22}$. Thus m_{h_s}, m_{A_s} varies with A_κ and $m_{s'}$.m.,l Here, The mass range of $m_{H^\pm}$ spans from approximately 1050 GeV to 5000 GeV, aligning well with the constraints observed in the LHC's search for $H^\pm$ particles.

V. MUON G-2

Another aspect of the SUSY source of the muon $g-2$, denoted as a^{SUSY}_μ, involves loops mediated by a smuon coupled with a neutralino, as well as those featuring a muon−type sneutrino interacting with a chargino. The expression of a^{SUSY}_μ in the mass insertion approximation [32], aiming to elucidate its fundamental characteristics are presented here. In this approximation's lowest order, the contributions to a^{SUSY}_μ can be classified into four categories: WHL, BHL, BHR, and BLR, where $W, B, H, L,$ and$R$ denote the wino, bino, higgsino, and left−handed and right−handed smuon fields, respectively. These contributions stem from Feynman diagrams involving transitions such as $\tilde{W} - \tilde{H}_d$, $\mu_L - \mu_R$, and they exhibit the following mathematical forms:

VI. CALCULATION

Neutrino detectors, such as IceCube/DeepCore, are designed with the objective of identifying the capture of Lightest Supersymmetric Particles (LSPs) within the Sun through the detection of neutrinos generated during the LSP annihilation process. The primary observational signal is characterized by the detection of neutrino-induced muons traversing the detector. In this analysis, we investigate the flux of neutrinos and neutrino-induced muons within the $tan\beta = 10$ and 55 planes, as well as across the WMAP-preferred focus-point, coannihilation, and funnel-region strips (the latter applicable to $tan\beta = 55$ only). Additionally, we explore the neutrino flux spectra. The determination of the neutrino spectrum within a detector entails two main stages: (1) the generation of neutrinos from LSP annihilations, and (2) the transmission of these neutrinos from the Sun's core to the detector. Generally, low-energy neutralinos do not directly undergo annihilation into neutrinos; instead, neutrinos are produced during decays or showers of the primary annihilation particles like W bosons, top quarks, or tau leptons (e.g., $\chi\chi \to \tau\bar{\tau}$, with $\tau \to \mu\bar{\nu_\mu}\nu_\tau$). The assessment of neutrino spectra within such showers is intricate due to their occurrence in the dense solar core, leading to potential energy loss by the primary particles before decay. Following neutrino production, they traverse through the Sun where they can experience charged-current or neutral-current interactions that either absorb the neutrinos or diminish their energies, respectively. While the Sun is generally permeable to neutrinos below 100 GeV, it becomes opaque as energies reach 200−300 GeV, resulting in significant suppression of high-energy neutrinos. The consideration of neutrino oscillations between different species during their passage from the Sun to Earth is imperative. Our analysis relies on the neutrino and neutrino-induced muon spectra derived from WimpSim (utilized within DarkSUSY), which simulate both production and propagation processes to generate spectra for various LSP annihilation channels. Furthermore, neutrino production and propagation have been simulated in a prior study. For our current neutrino spectrum analysis, we exclude Higgs annihilation channels and solely include annihilations into quarks, leptons, W and Z bosons.

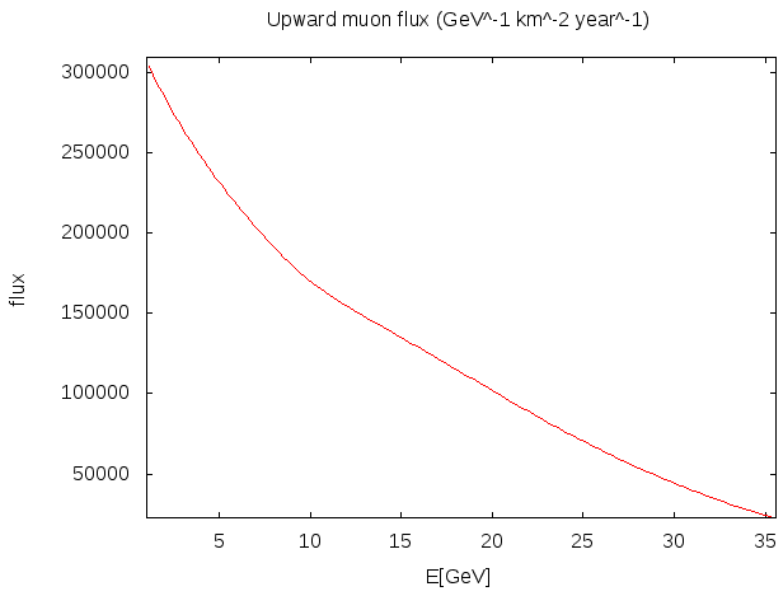

Figure 1: Value of upward muon flux as a function of Energy for calculated values of relic density in this work.

Higgs	Higgs Masses	Widths
h_1	18.05 GeV	$2.80E-04$
h_2	122.64 GeV	$1.91E-02$
h_3	505.06 GeV	$4.94E+00$
h_a	248.54 GeV	$7.97E-01$
h_b	499.53 GeV	$5.97E+00$
H_+	492.81 GeV	$5.24E+00$

Table I: Masses of Higgs and Decay Width.

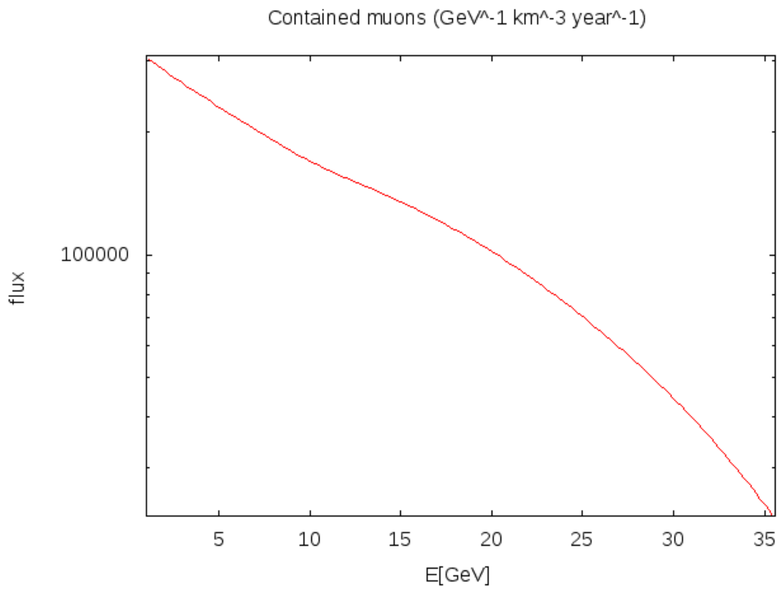

Figure 2: Value of contained muon flux as a function of Energy for calculated values of relic density in this work.

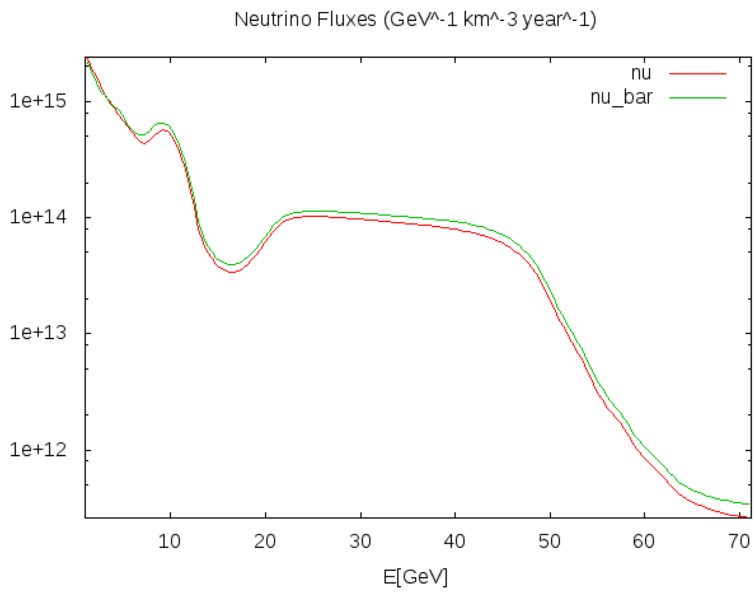

Figure 3: Value of Neutrino flux as a function of Energy for calculated values of relic density in this work as detected by Neutrino Telescope.

VII. CONCLUSION

The discussion pertains to the potential of neutrino, muon and photon, positron flux detection within the NMSSM framework. Our analysis focuses on two categories of NMSSM scenarios: mSUGRA-like models and general NMSSM models without the unification of soft terms. A comprehensive scan across the NMSSM parameter space was conducted utilizing the NMSSMTools package. It was observed that the primary annihilation pathways differ significantly

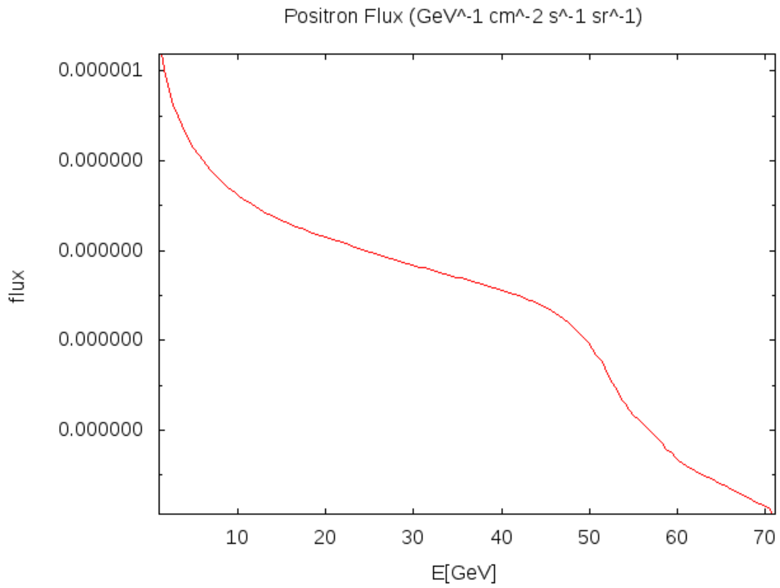

Figure 4: Value of Positron flux as a function of Energy for calculated values of relic density in this work.

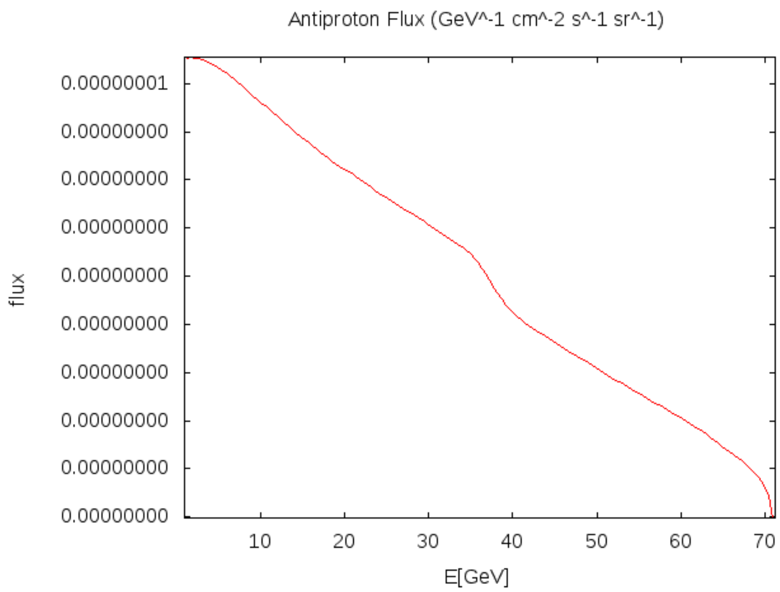

Figure 5: Value of AntiProton flux as a function of Energy for calculated values of relic density in this work.

between mSUGRA-like models and general NMSSM models. In mSUGRA models, the lightest neutralino, predominantly bino, primarily annihilates into bb^- pairs. Nonetheless, annihilation into W^+W^- and tt^- pairs also holds promise for detection at neutrino telescopes. For the general NMSSM model, a notable competition was found between $b\bar{b}$ and $\tau^+\tau^-$ annihilation channels for neutralino masses below the$W-boson$ mass. Conversely, W^+W^- and $t\bar{t}$ channels become comparable to annihilation into scalar pairs for heavier neutralinos. Examination revealed that NMSSM neutralinos with masses around $200GeV$ interact with nucleons in the Sun mainly through axial interactions. As the

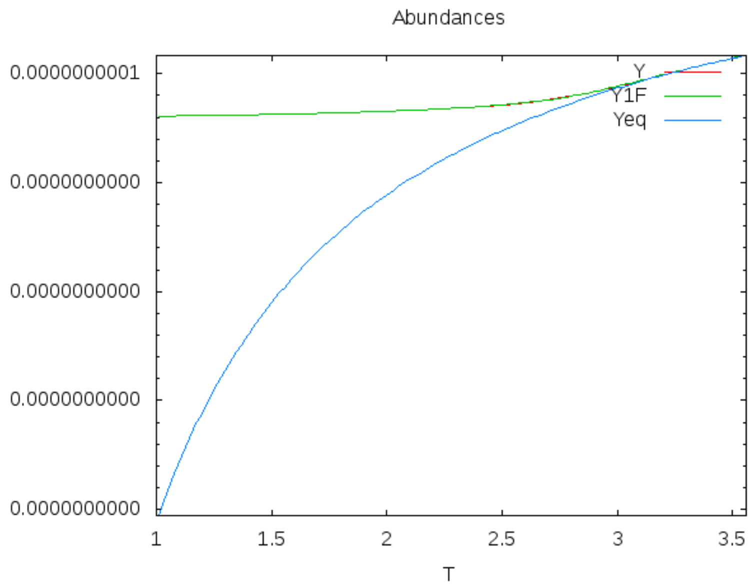

Figure 6: Value of Y as a function of Temperature for calculated values of relic density in this work.

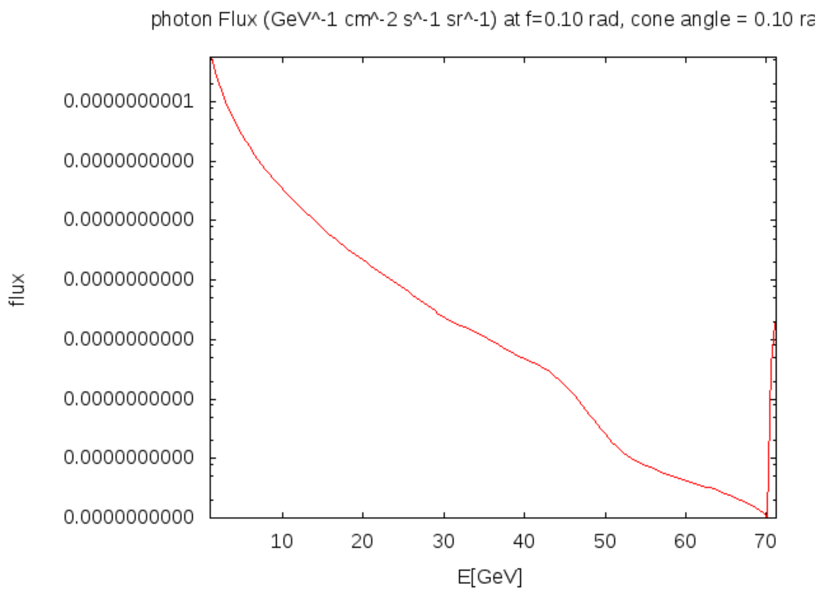

Figure 7: Value of Photon flux as a function of Energy for calculated values of relic density in this work for 124.54 SM like Higgs boson.

mass increases, scalar interactions play a more significant role, leading to predominantly spin-independent scattering for masses exceeding $500GeV$. The composition of annihilation products influences the fractions of low (soft) and high (hard) energy spectra of emitted particles, including neutrinos. The likelihood of a neutrino telescope detecting neutrinos from projected neutralino models is influenced by the energy threshold of the detector for neutrino-induced upward-going muons.

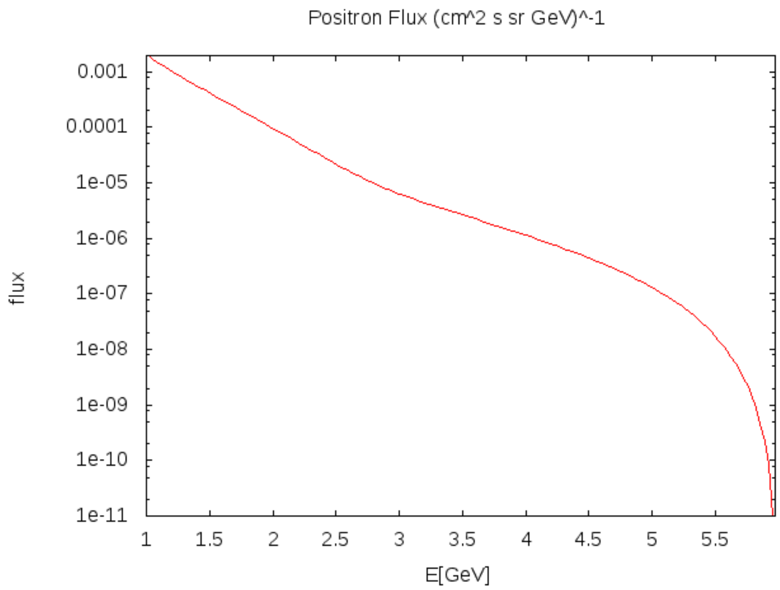

Figure 8: Value of Positron flux as a function of Energy for calculated values of relic density in this work for 124.54 SM like Higgs boson.

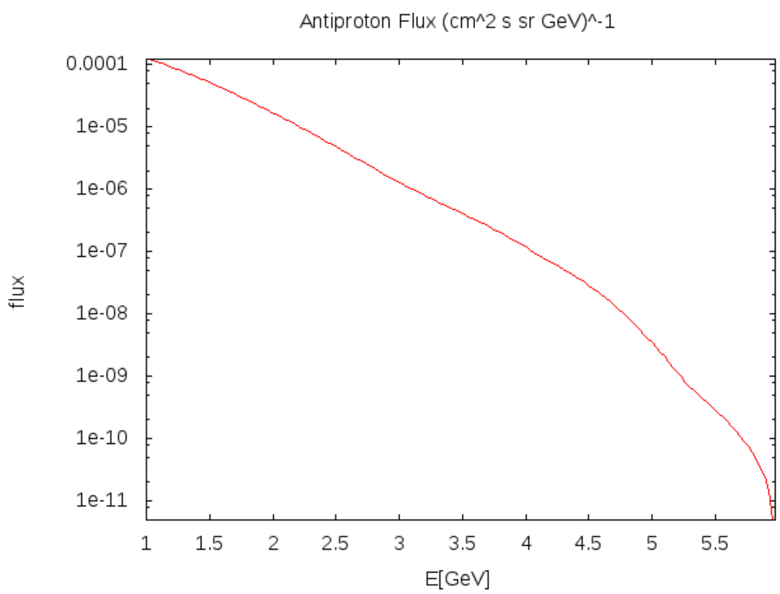

Figure 9: Value of Amtiproton flux as a function of Energy for calculated values of relic density in this work for 124.54 SM like Higgs boson..

VIII. ACKNOWLEDGEMENT

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Branching Ratio	Particle Decay Channel
$9.101241E-01$	$h_1 \to b, B$
$7.971977E-02$	$h_1 \to l, L$
$9.693996E-03$	$h_1 \to G, G$
$1.990615E-04$	$h_1 \to d, D$
$1.990615E-04$	$h_1 \to s, S$
$6.042197E-05$	$h_1 \to c, C$
$3.513639E-06$	$h_1 \to a, A$
$2.225840E-07$	$h_1 \to u, U$

Table II: Branching Ratio, Particle Decay channel of lightest CP odd Higgs h_1 of total width $2.801915E-04$.

Branching Ratio	Particle Decay Channel
$8.046774E-01$	$h_2 \to h_1, h_1$
$1.236143E-01$	$h_2 \to b, B$
$3.292189E-02$	$h_2 \to W^+, W^-$
$1.539206E-02$	$h_2 \to G, G$
$1.356124E-02$	$h_2 \to l, L$
$5.3561257E-03$	$h_2 \to c, C$
$3.912415E-03$	$h_2 \to Z, Z$
$4.688780E-04$	$h_2 \to A, A$
$3.224592E-05$	$h_2 \to d, D$
$3.224592E-05$	$h_2 \to s, S$
$3.129216E-05$	$h_2 \to u, U$

Table III: Branching Ratio, Particle Decay channel of lightest CP even Higgs h_2 of total width $1.919972E-02$.

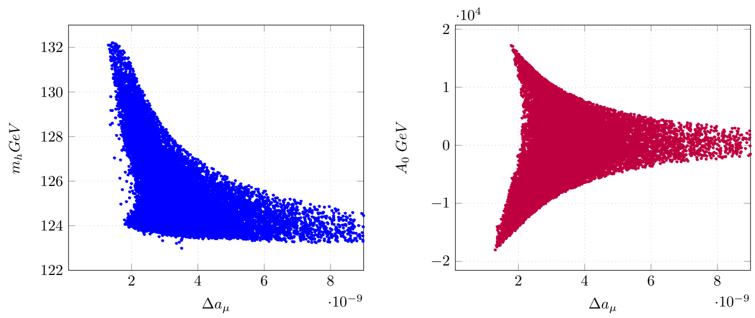

Figure 10: Mass of Lightest CP odd Higgs m_{h_2} and trilinear coupling A_0 as a function of Δa_μ in our constrained mSUGRA model satisfying the current constraint on LFV decays BR($\mu \to e + \gamma$) in the left and right panel respectively.

Annihilation Cross Section	Annihilation Decay Channel of Neutralinos
$9.03E-01$	$o1 \rightarrow b, B$
$7.55E-02$	$o1 \rightarrow l, L$
$2.08E-02$	$o1 \rightarrow G, G$
$1.75E-04$	$o1 \rightarrow d, D$
$1.75E-04$	$o1 \rightarrow s, S$
$6.042197E-05$	$h_1 \rightarrow c, C$
$3.513639E-06$	$h_1 \rightarrow a, A$
$2.225840E-07$	$h_1 \rightarrow u, U$

Table IV: Indirect detection of neutralino of total annihilation cross section $3.96E-25$ cm^3/sec of 124.54 GeV SM like Higgs Boson.

Annihilation Cross Section	Annihilation Decay Channel of Neutralinos
$9.81E-01$	$o1 \rightarrow Z, h_1$
$1.04E-02$	$o1 \rightarrow W^+, W^-$
$6.32E-03$	$o1 \rightarrow b, B$
$7.81E-04$	$o1 \rightarrow c, C$
$7.12E-04$	$o1 \rightarrow l, L$
$6.24E-04$	$o1 \rightarrow Z, Z$
$1.12E-04$	$h_1 \rightarrow h_1, h_2$
$1.02E-04$	$h_1 \rightarrow G, G$

Table V: Indirect detection of neutralino of total annihilation cross section $3.96E-25$ cm^3/sec of 122 GeV SM like Higgs Boson.

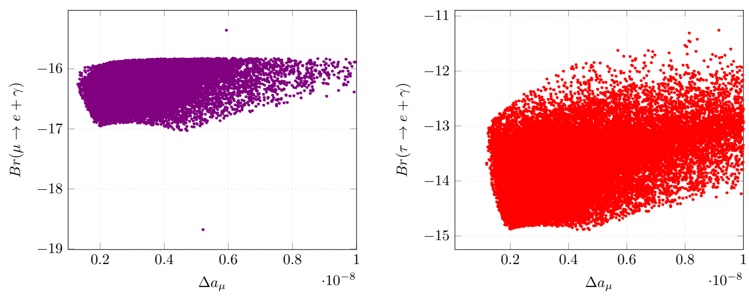

Figure 11: Log 10 (BR($\mu \rightarrow e+\gamma$)), Log 10 (BR($\tau \rightarrow e+\gamma$) as a function of Δa_μ in our constrained mSUGRA model in the left and right panel respectively.

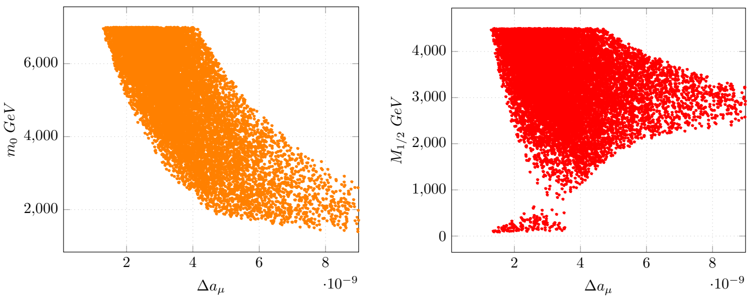

Figure 12: Mass of soft scalar masses m_0 and soft gaugino masses $M_{1/2}$ as a function of Δa_μ in our constrained mSUGRA model satisfying the current constraint on LFV decays BR($\mu \to e + \gamma$), BR($\tau \to e + \gamma$) and BR($\tau \to \mu + \gamma$) in the left and right panel respectively.

Silchar, Assam, India in this regard.

[1] "Neutralino annihilation in the NMSSM with light singlet-like Higgs bosons, Belanger, G., et al.

[2] Branching ratios for Higgs boson decays into neutralinos and charginos in the NMSSM , Li, T., et al.

[3] NMSSM Higgs Boson Decay to Neutralino Pairs at the LHC , Han, C., et al.