

BSM @ IPPP

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Who are we?



+28 PG students

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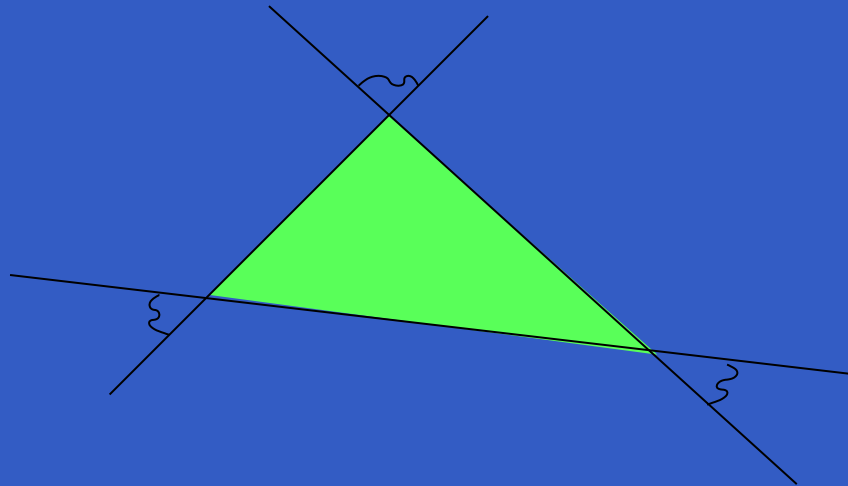


String phenomenology + “Other”

- String model building: investigated constructions of D6-branes on type IIA orientifolds on $T^6 / (Z_2 \times Z_2)$ which admit *non-factorisable* lattices (Forste, Zavala + Timirgizui).
- Investigates a new corner in the landscape of intersecting D-brane model constructions

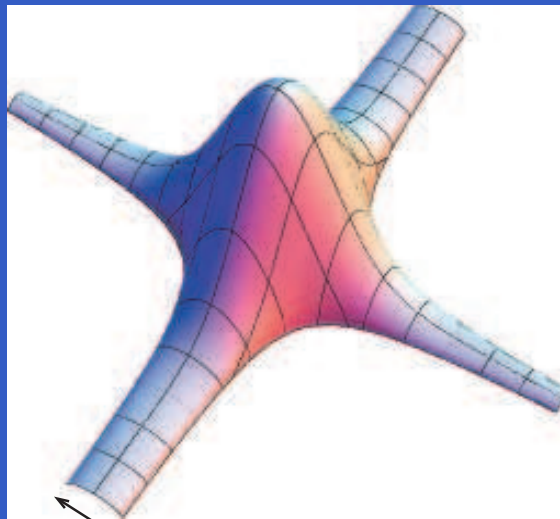
String phenomenology + “Other”

- Perturbation theory on intersecting D-branes (Abel, Goodsell): Yukawas. FCNC's ($M_{str} > 10^2 TeV$)
- Showed how space-time instantons (“E2-branes”) contribute to effective Yukawa couplings - geometrical explanation of hierarchies



String phenomenology + “Other”

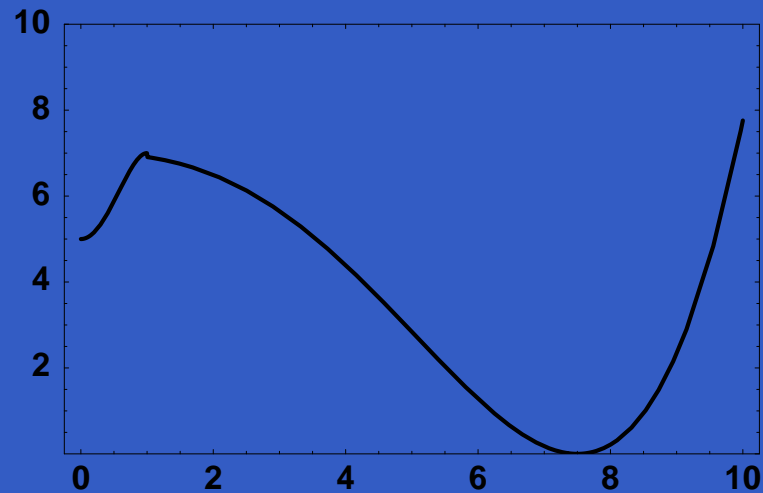
- Gluon amplitudes at strong coupling using AdS/CFT (Abel, Forste, Khoze following Alday, Maldacena) to test conjecture of Bern-Dixon-Smirnov;



Asymptotic
“winding”

String phenomenology + “Other”

- Metastable SUSY breaking - new models for hidden sector based on $N = 1$ QCD (Abel, Durnford, Jaeckel, V.V.Khoze)



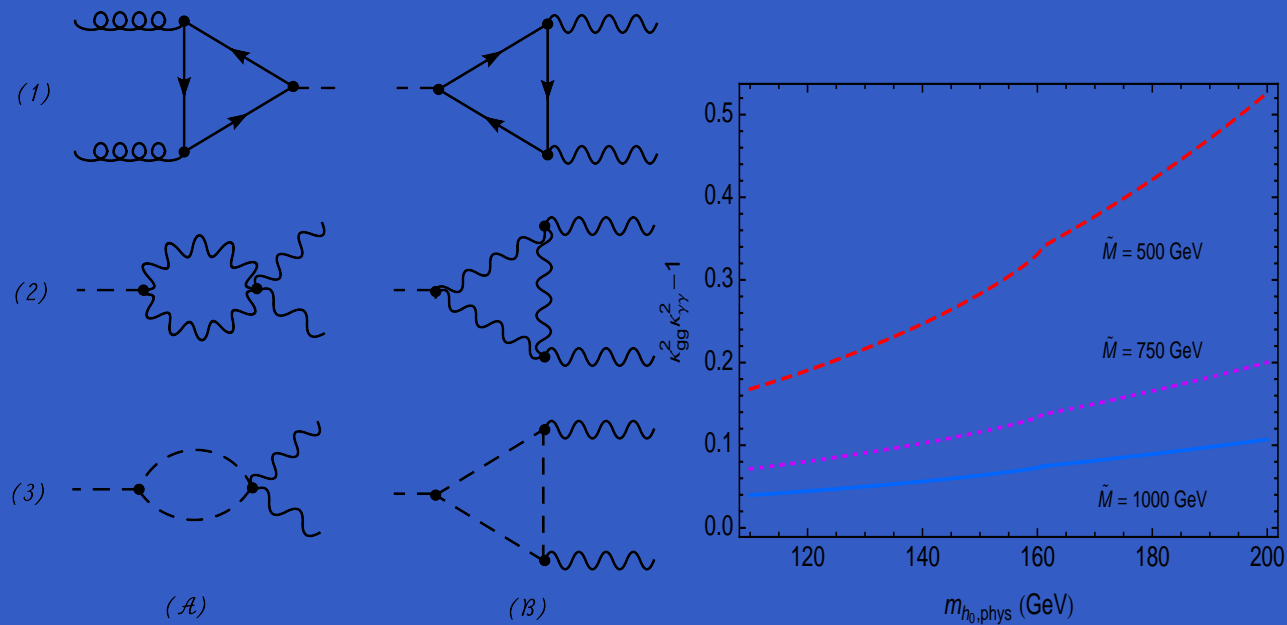
String phenomenology + “Other”

- “baryon-deformed” QCD: spontaneous R -symmetry breaking \rightarrow heavy scalars

| | Model A | Model B |
|--------------------------------------|--------------------|-----------------|
| Q_{Minn} | 8.32×10^5 | 1×10^7 |
| $\tan \beta$ | 58.7 | 38.9 |
| $\text{sgn} \mu_{\text{MSSM}}$ | + | + |
| $\mu_{\text{MSSM}}(Q_{\text{SUSY}})$ | 2891 | 939 |
| $\tilde{e}_L, \tilde{\mu}_L$ | 4165 | 747.9 |
| $\tilde{e}_R, \tilde{\mu}_R$ | 2133 | 399.8 |
| $\tilde{\tau}_L$ | 1818 | 319.4 |
| $\tilde{\tau}_R$ | 4093 | 737.5 |
| \tilde{u}_1, \tilde{c}_1 | 11757 | 1963 |
| \tilde{u}_2, \tilde{c}_2 | 11205 | 1867 |
| \tilde{t}_1 | 10345 | 1593 |
| \tilde{t}_2 | 11061 | 1825 |
| \tilde{d}_1, \tilde{s}_1 | 11784 | 1973 |
| \tilde{d}_2, \tilde{s}_2 | 11144 | 1851 |
| \tilde{b}_1 | 10298 | 1754 |
| \tilde{b}_2 | 11060 | 1822 |
| χ_1^0 | 60.8 | 270.3 |
| χ_2^0 | 125.0 | 524.8 |
| χ_3^0 | 2906 | 949.0 |
| χ_4^0 | 2929 | 950.3 |
| χ_1^\pm | 100.7 | 526.5 |
| χ_2^\pm | 2894 | 945.6 |
| h_0 | 124.8 | 137.6 |
| A_0, H_0 | 184.5 | 975.1 |
| H^\pm | 207.4 | 978.6 |
| \tilde{g} | 414.2 | 1500 |
| $\tilde{\nu}_{1,2}$ | 4175 | 740.2 |
| $\tilde{\nu}_3$ | 4095 | 724.4 |

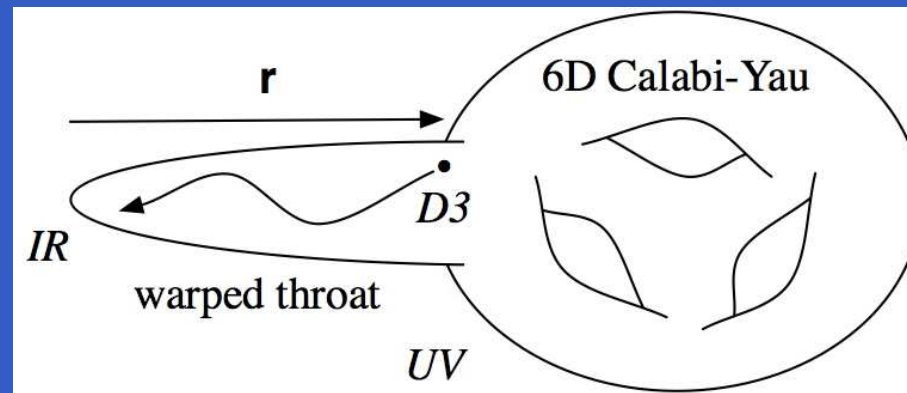
String phenomenology + “Other”

- Lee-Wick SM (Krauss, Zwicky + Underwood): from finite QED by Lee & Wick "declare" Pauli-Villars field as physical. The quadratic divergences go away!
- golden channel $gg \rightarrow h^0 \rightarrow \gamma\gamma$ for Lee-Wick masses 500-1000GeV



Cosmology, ν 's, DM

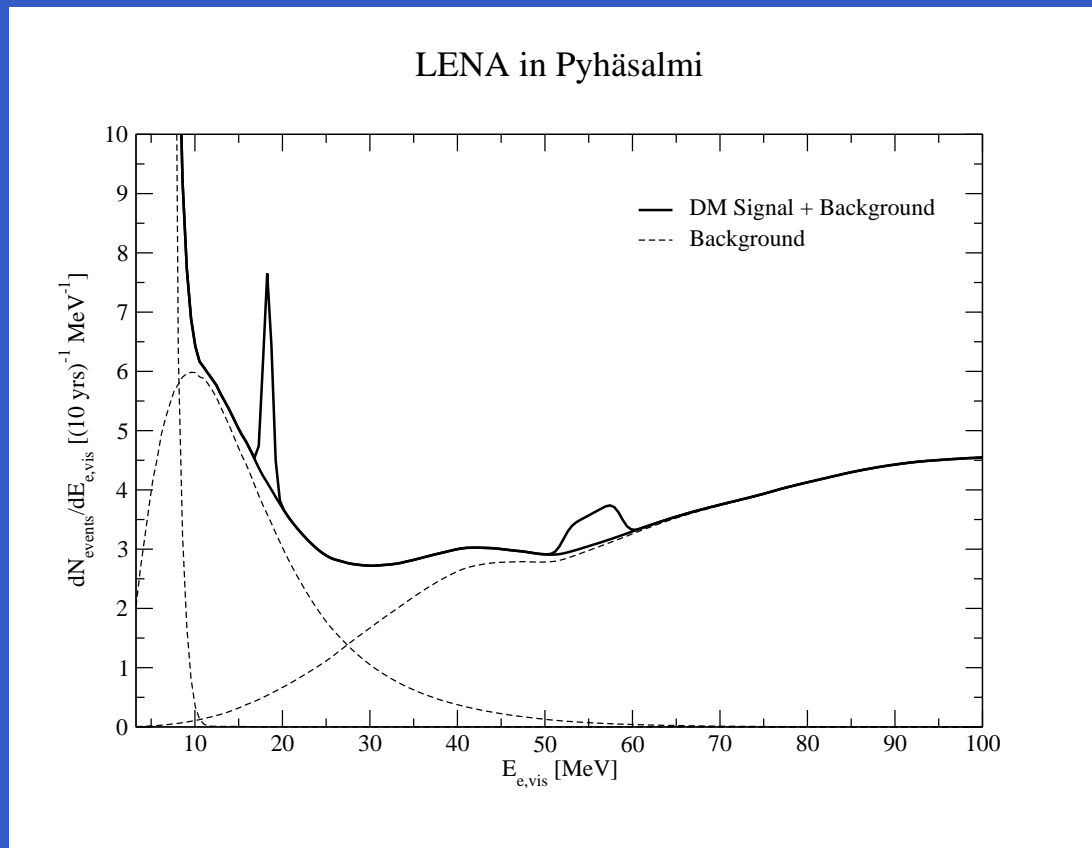
- Consequences of D3-brane angular (as well as radial) motion in a warped compactification with fluxes - “Spinflation” (Gregory, Zavala+Easson)
- Extra degrees of freedom of angular motion corresponds to having a multifield inflationary scenario with non-standard kinetic terms



Cosmology, ν 's, DM

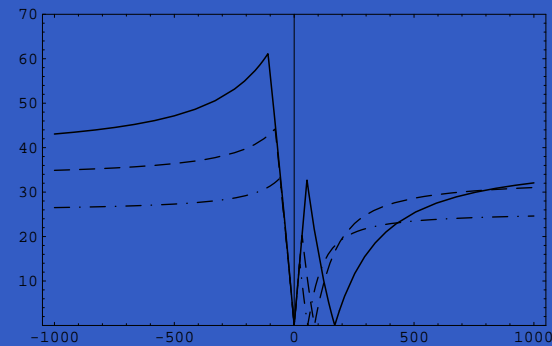
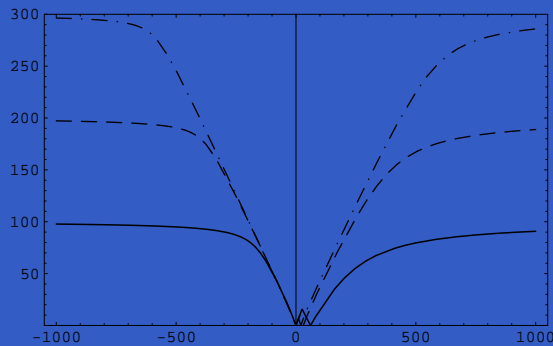
- MeV Dark Matter and neutrinos: extend SM by adding interaction between ν 's and MeV scalars (Pascoli, Palomares-Ruiz + Boehm, Farzan, Hambye, Mena).
- Cross-section required to explain DM induces neutrino masses.
- Testing in present and future neutrino detectors (LENA)

Cosmology, ν 's, DM



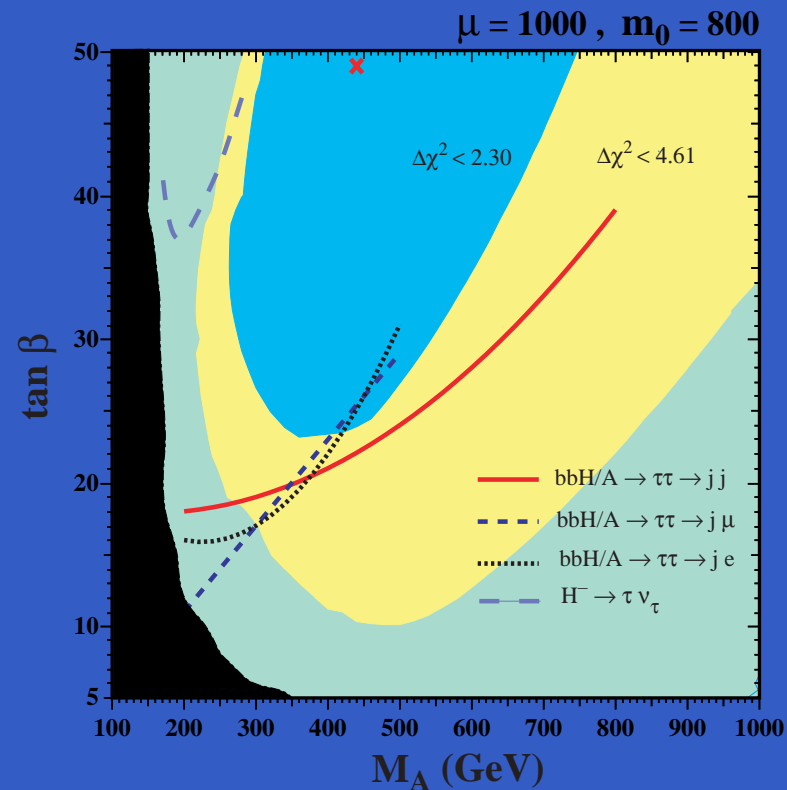
Cosmology, ν 's, DM

- LSP in MNSSM: a kind of "simplest" singlet extension of the MSSM without the domain wall problem of the NMSSM
- Theoretical upper bound on LSP mass in MNSSM (Hasselbach, Moortgat-Pick + Miller, Nevzorov, Trusov)



Cosmology, ν 's, DM

- CDM-compatible $M_A - \tan \beta$ planes (Weiglein + Ellis, Heinemeyer, Olive): Large parts of plane preferred by EWPO and BPO



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Cosmology, ν 's, DM

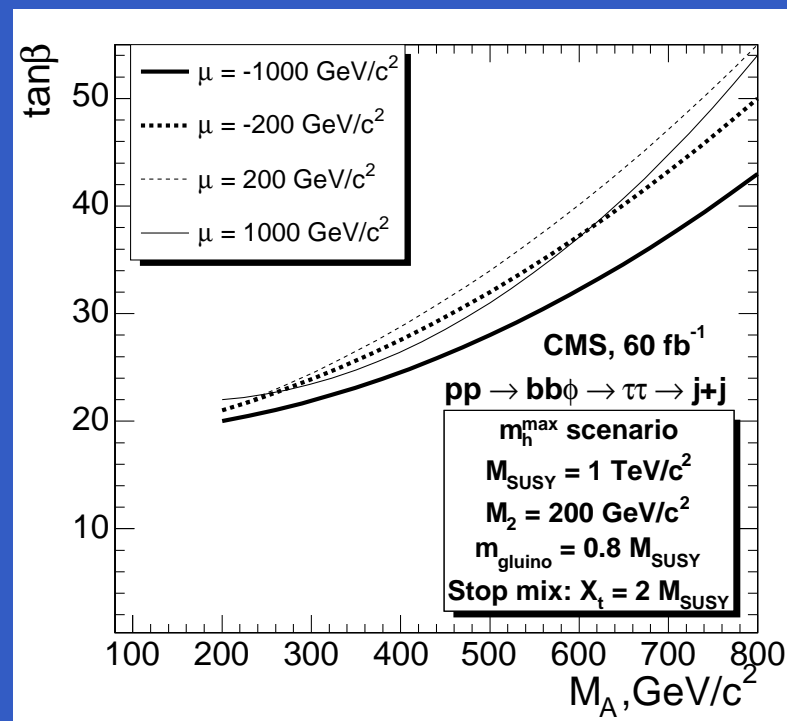
Additional SUSY DM interests covered in Santoso's talk

SUSY phenomenology

- Monte-Carlo event generators (Gigg, Grellscheid, Richardson): new release of HERWIG++ (20/11/2007)
- Included a new method of adding BSM physics.
- CP-conserving MSSM, Minimal UED model and Randall-Sundrum Model were included
- New structure makes adding new models easier
- Work ongoing on NMSSM and other extended SUSY models

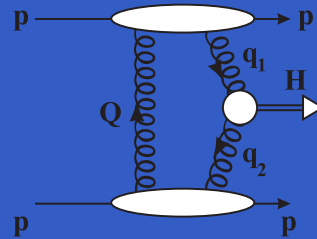
SUSY phenomenology

- Study of variation of 5σ higgs discovery contours with μ (m_h^{max} scenario) (Weiglein+Nikitenko *et al* (CMS-UK))
- Shift of discovery contour by upto $\Delta \tan\beta=12$



SUSY phenomenology

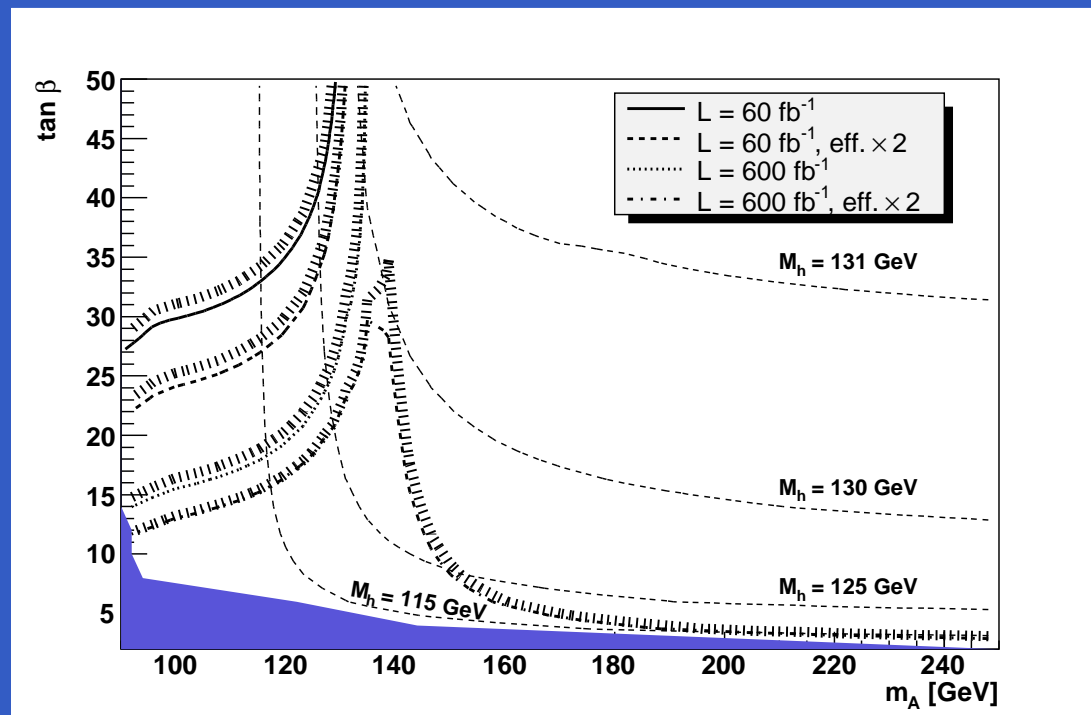
- Central Exclusive Diffractive higgs production (V.A.Khoze, Martin, Stirling, Weiglein +Heinemeyer, Ryskin, Tasevsky)



- Protons remain undestroyed, forward proton tagging in roman pot detectors.
- No hadronic activity between outgoing protons and Higgs decay products
- Good mass resolution, access to $H \rightarrow b\bar{b}$ decay mode
- Experimentally challenging

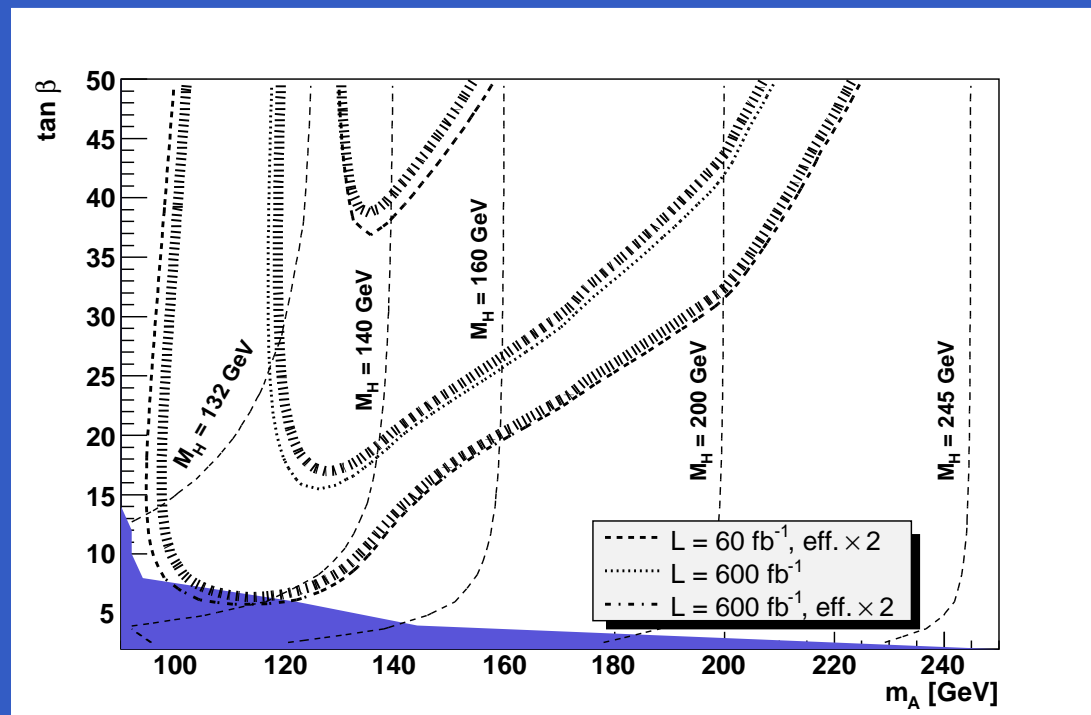
SUSY phenomenology

- 3σ contours for CED production of light MSSM higgs
- Good coverage with high integrated luminosity



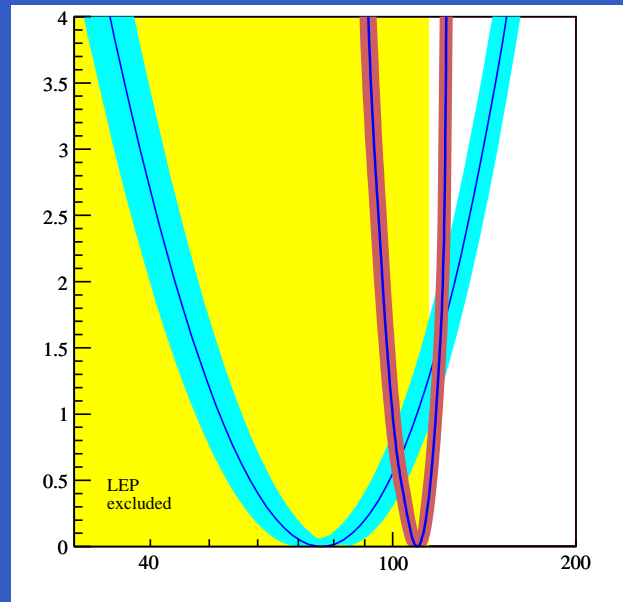
SUSY phenomenology

- Significant discovery reach for CED production of heavy CP even MSSM higgs
- e.g. 5σ contours: discovery of 140GeV Higgs for all values of $\tan\beta$



SUSY phenomenology

- Improved global χ^2 fit in Constrained MSSM (Weiglein + Buchmuller, Cavanaugh, de Roek, Heinemeyer, Isidori, Paradisi, Ronga, Weber)
- Includes all observables of the LEP-EW-WG + CDM density (WMAP) , $(g - 2)_\mu$, $BR(b \rightarrow s\gamma)$, $BR(B_s \rightarrow \mu^+ \mu^-)$.



SUSY phenomenology

- Spin and polarization effects at the ILC (Moortgat-Pick)
- CP-violation at the LHC and ILC, (Moortgat-Pick, Smillie, Tattersall)

Not only but also ...

- CP phase dependence of two loop QCD corrections to Higgs mass in MSSM (Weiglein + Heinemeyer, Hollik, Rzehak)
- Unparticles (Zwicky)
- Dirac neutrinos, and leptogenesis (Abel, Dedes, Page + Tamvakis)
- EDMS's (Abel + Lebedev)
- $(g - 2)_\mu$ is 3.4σ away from SM value (Martin + Hagiwara, Nomura, Teubner)
- “Light-through-a-wall” experiments, and axion physics (Jaeckel+Ringwald)
- PVLAS and millicharged particles (Abel, Jaeckel, Khoze + Ringwald)

Summary ...

Many new interesting developments!

LHC is coming!

What will be BSM?