

Production and decays in the MSSM

Sparticle production

1. List all possible pair-production processes of sparticles in the MSSM (assuming R -parity) at hadron colliders, i.e. with initial (anti-)quarks, q_i, \bar{q}_i and gluons g . Distinguish the partonic $2 \rightarrow 2$ scattering processes according to electroweak and strong interactions.
2. Give examples of the observed final states for the SPS1a particle spectrum shown in Fig. 1.

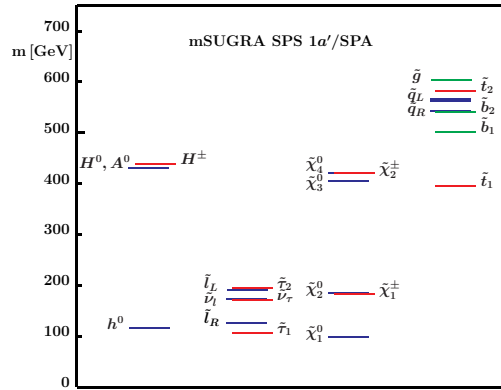


Figure 1: SPS1a: “Typical” mSUGRA point with intermediate value of $\tan\beta$.

Decay kinematics

1. Show that for the 3-body neutralino decay $\chi_2^0 \rightarrow \ell\ell\chi_1^0$ the following relation for the masses holds:

$$m(\ell\ell) < m(\chi_2^0) - m(\chi_1^0). \quad (1)$$

2. Why is it important that the intermediate state is $Z^*\chi_1^0$ with a virtual Z^* -boson rather than an on-shell Z -boson ?
3. In most of the parameter space the neutralino decay chain proceeds as $\chi_2^0 \rightarrow \tilde{\ell}\ell \rightarrow \ell\ell\chi_1^0$. Show that in this case the upper mass limit is given by

$$m(\ell\ell) < m(\chi_2^0) \sqrt{1 - \left(\frac{m(\tilde{\ell})}{m(\chi_2^0)}\right)^2} \sqrt{1 - \left(\frac{m(\chi_1^0)}{m(\tilde{\ell})}\right)^2}. \quad (2)$$

Hint:

Assume R -parity. In all cases the mass of the final state leptons can be neglected.