NOTE ON LIGHT GLUINO

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It is controversial if a light gluino of mass below 5 GeV is phenomenologically allowed. Below we list some of the most important and least controversial constraints which need to be met for a light gluino to be viable. For reviews on the subject, see, *e.g.*, Ref. 1.

1. Either $m_{\tilde{g}} \lesssim 1.5$ GeV or $m_{\tilde{g}} \gtrsim 3.5$ GeV to avoid the CAKIR 94 limit. See also Ref. 2 for similar quarkonium constraints on lighter masses.
2. The lifetime of the gluino or the ground state gluino-containing hadron (typically, $g\tilde{g}$) must be $\gtrsim 10^{-10}$ s in order to evade beam-dump and missing energy limits [1,2].
3. Charged gluino-containing hadrons (*e.g.* $\tilde{g}u\bar{d}$) must decay into neutral ones (*e.g.* $R^0(\tilde{g}g)\pi^+$ or $(\tilde{g}u\bar{u})e^-\bar{\nu}_e$) with a lifetime shorter than about 10^{-7} s to avoid the AKERS 95R limit. Older limits for lower masses and shorter lifetimes are summarized in Ref. 1.
4. The lifetime of $R^0 \to \rho^0\tilde{\gamma}$, if allowed, must be outside the ADAMS 97B range. The $R_p^+(\tilde{g}uud)$ state, which is believed to decay weakly into $S^0(\tilde{g}uds)\pi^\pm$ (FARRAR 96), must be heavier than 2 GeV or have lifetime $\tau_{R_p} \gtrsim 1$ ns or $\tau_{R_p} \lesssim 50$ ps (*e.g.* if the strong decay into $S^0K^\pm$ is allowed), or its production cross sections must be at least a factor of 5 smaller than those of hyperons, to avoid ALBUQUERQUE 97 limit.
5. $m_{\tilde{g}} \geq 6.8$ GeV (95% CL) if the "experimental optimization" method of fixing the renormalization scale is valid and if the hadronization and resummation uncertainties are as estimated in BARATE 97L, from the D_2 event shape observable in Z^0 decay. The 4-jet angular distribution is less sensitive to renormalization scale ambiguities and yields a 90%CL exclusion of a light gluino (DEGOUVEA 97). A combined LEP analysis based on all

the Z^0 data and using the recent NLO calculations [3] is warranted.

6. Constraints from the effect of light gluinos on the running of α_s apply independently of the gluino lifetime and are insensitive to renormalization scale. They disfavor a light gluino at 70% CL (CSIKOR 97), which improves to more than 99% with jet analysis.

References

1. G.R. Farrar, Phys. Rev. **D51**, 3904 (1995);
in SUSY 97, Proceedings of the Fifth International Conference on Supersymmetries in Physics," 27-31 May 1997, Philadelphia, USA, edited by M. Cvetic and P. Langacker (Nuc. Phys. B (Proc. Suppl.) 62 (1998)) p. 485. `hep-ph/9710277`.
2. R.M. Barnett, in SUSY 95, Proceedings of the International Workshop on Supersymmetry and Unification of Fundamental Interactions, Palaiseau, France, 15-19 May 1995, edited by I. Antoniadis and H. Videau (Editions Frontieres, Gif-sur-Yvette, France, 1996) p. 69.
3. L. Dixon and A. Signer, Phys. Rev. **D56**, 4031 (1997);
J.M. Campbell, E.W.N. Glover, and D.J. Miller, Phys. Lett. **B409**, 503 (1997).