A SNEAK PREVIEW OF
"THE ILC/CLIC STRING HUNTER'S COMPANION"

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Based on work in progress with
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In string theory, elementary particles are quantized vibrations of fundamental strings. The zero modes are massless, the first harmonic have masses equal to the fundamental mass M, the second $\sqrt{2}\,M$, and in general:

$$M_N = \sqrt{N}M$$

These massive *REGGE* particles have higher spins, ranging from 0 to $N+1$ and come in $SU(3)\times SU(2)\times U(1)$ representations copied from gauge bosons, quarks and leptons. For example, gluon's first Regge excitations are massive spin 0, 1 and 2 color octets. It is very unusual to have the standard model spectrum replicated, at approximately (up to loop corrections) the same mass level M, with higher spins, and then at each $\sqrt{N}M$.

If, as commonly believed, M is in the Planckian regime, we have nothing to say and this text is completely irrelevant.

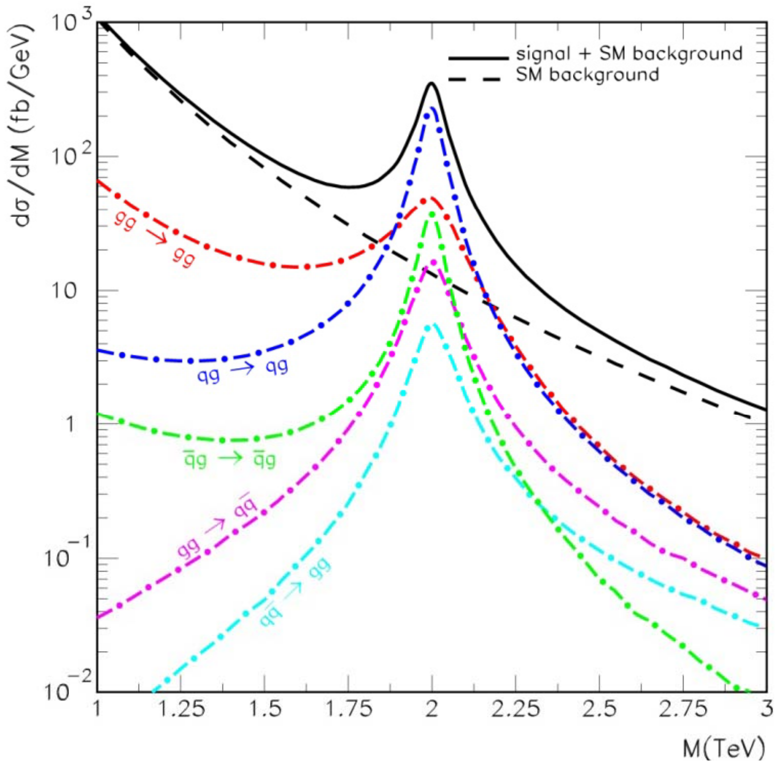
However theoretically, M can be as low as we wish, of order of few TeVs, provided that Nature endowed us with large extra dimensions (say 1 mm). I wish that M were even lower, but Tevatron has already ruled out (not surprisingly) $M < 1\ TeV$.

Such "low string mass" scenario seems far-fetched but it leads to some spectacular experimental consequences.

At this point, it is as plausible as supersymmetry, technicolor or your favorite beyond the standard model scenario.

LHC has the capacity of discovering strongly-interacting resonances with masses in practically all range up to $\left(\frac{\sqrt{s}}{2}\right)_{LHC}$, in most obvious channels like

gluon+gluon → Regge resonance → 2 (or more) jets



The predicted widths $\Gamma \approx \alpha_s M$ are typical for "heavy gluons", even with higher spin.

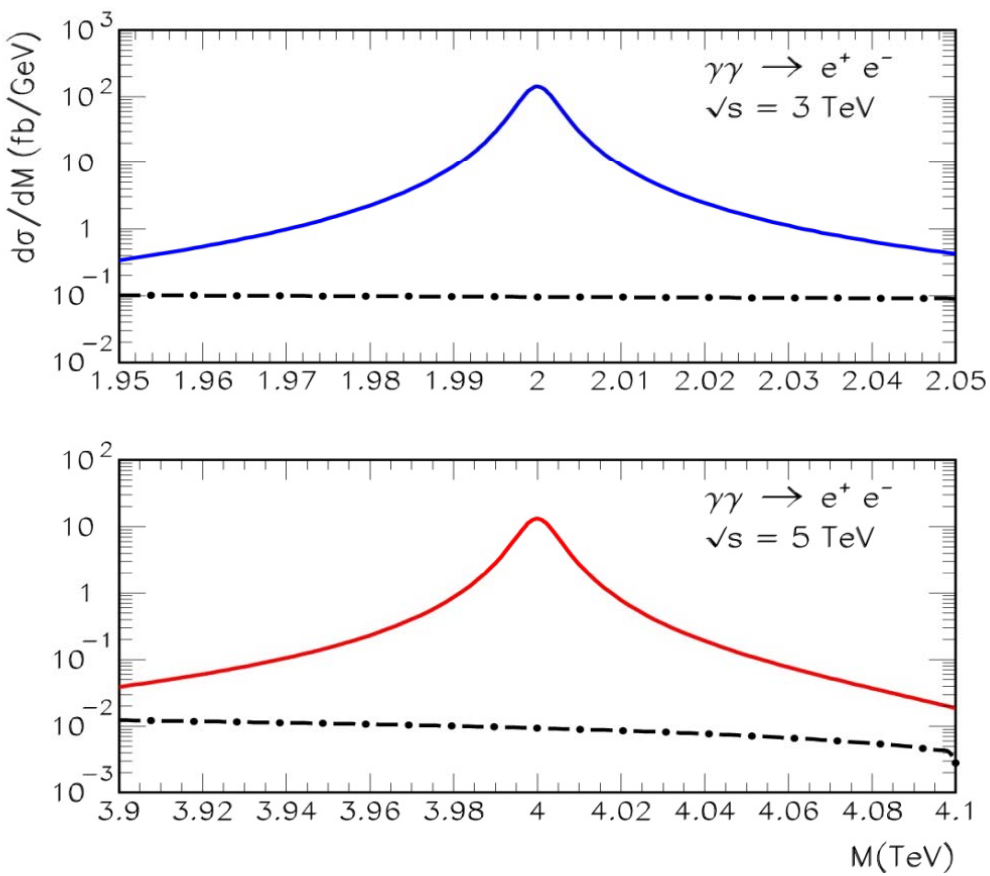
Nevertheless, since it is unlikely the LHC will reach beyond the first string harmonics, people will ask us: "how do you prove that it is a string Regge resonance and not the gluebot (??) predicted by Dr. X thirty years ago?"

We will say:
"Wait till ILC/CLIC…"

Dijet mass distribution (assumed *M=2 TeV*) from L. Anchordoqui, H. Goldberg, D. Lust, S. Nawata, St. Stieberger, T.T., arXiv:0808.0497; The effects of $\sqrt{2}M$ resonances are not shown.

e^+e^- collider sitting on a resonance would allow precise determination of the spin content of the first excited photon and Z (spin 0,1 and 2 with weights predicted by theory).

Photon-photon collider may be even more useful. For example:



$\frac{d\sigma}{dM}$ (units of fb/GeV) vs. M (TeV)

plotted for the case of SM background (dashed line) and the (first resonance) string signal + background for $\sqrt{s}$ = 3 TeV (assume $M=2$ TeV) and $\sqrt{s}$ = 5 TeV (assume $M=4$ TeV).

The next resonance would appear at $\sqrt{3}M$ because photons do not couple to $\sqrt{2}M$ resonances

(γ DFs from Jikia, Eboli et al [arXiv:hep-ph/9210277], Cheung [arXiv:hep-ph/9211262])

In addition, massive photons and Zs will be visible in $\gamma\gamma \rightarrow$ dijets and three jets.

Conclusion: Photons are excellent string probes.

Details to appear in “The ILC/CLIC String Hunter’s Companion”

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