Searching for New Subatomic Particles and Forces at Proton Colliders

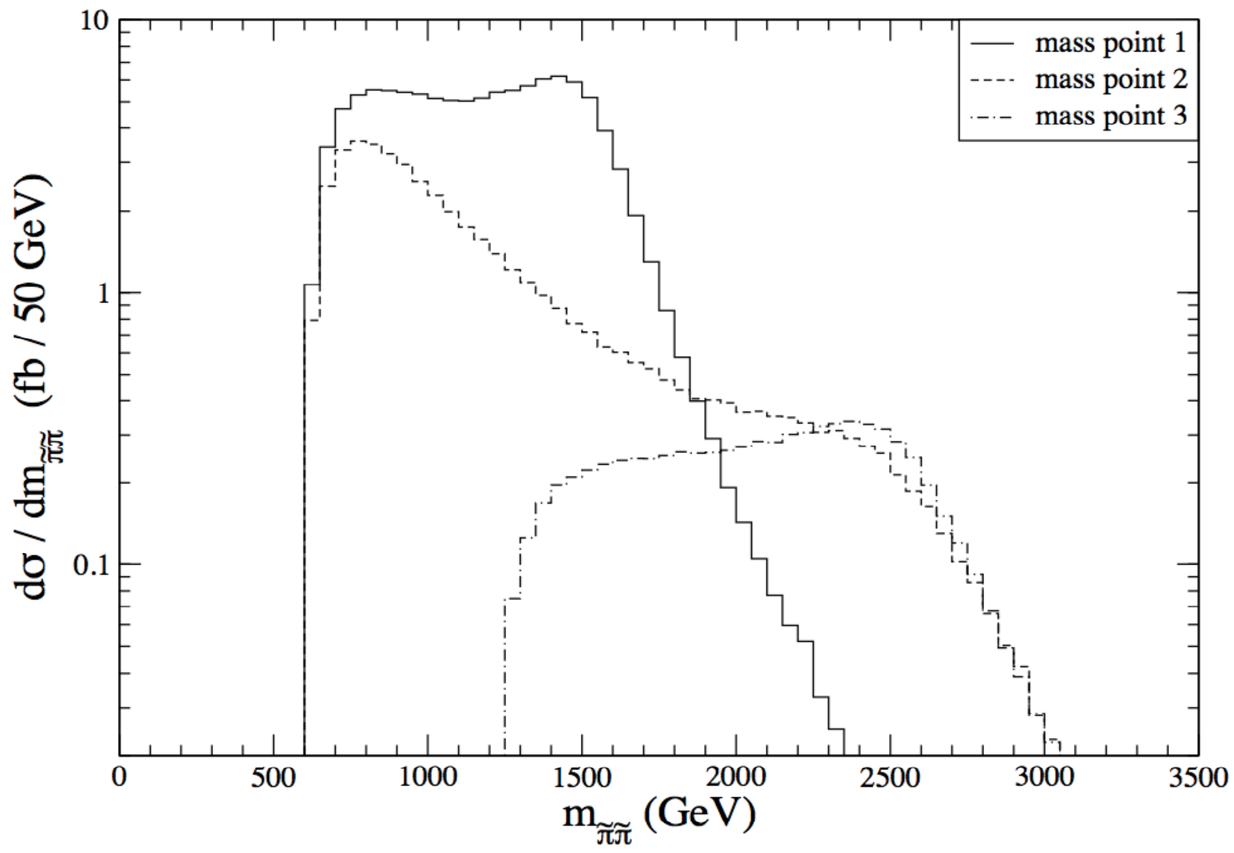
(Hypothesis)

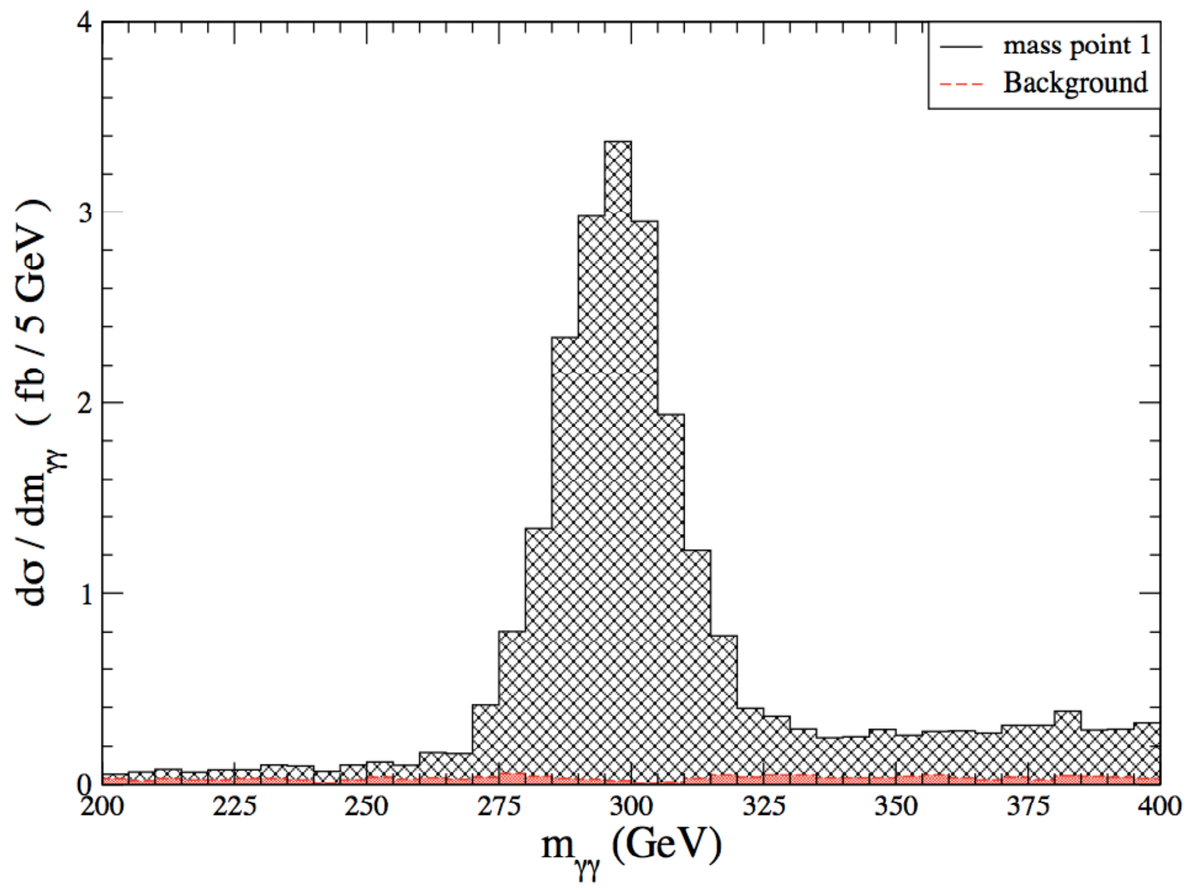
There exist a new “nuclear force” and new “quarks” at a very short distance, about a trillionth of the atomic scale.

(Results)

Very striking, novel Experimental signatures should be observable at the Large Hadron Collider, located near Geneva, Switzerland.

- (Upper figure) Signatures of a resonance decaying to massive charged particles.
- (Lower figure) Signatures of multi-photon resonances.





(For experts) Abstract from C. Kilic, and T. Okui, JHEP 1004 (2010) 128

We investigate in detail the LHC phenomenology of "vectorlike confinement", where the Standard Model is augmented by a new confining gauge interaction and new light fermions that carry vectorlike charges under both the Standard Model and the new gauge group. If the new interaction confines at the TeV scale, this framework gives rise to a wide range of exotic collider signatures such as the production of a vector resonance that decays to a pair of collider-stable charged massive particles (a "di-CHAMP" resonance), to a pair of collider-stable massive colored particles (a "di-R-hadron resonance), to multiple photons, Ws and Zs via two intermediate scalars, and/or to multi jet final states. To study these signals at the LHC, we set up two benchmark models: one for the di-CHAMP and multi-photon signals, and the other for the di-R-hadron and multijet signals. For the di-CHAMP/multi-photon model, Standard Model backgrounds are negligible, and we show that a full reconstruction of the spectrum is possible, providing powerful evidence for vectorlike confinement. For the di-R-hadron/multijet model, we point out that in addition to the di-R-hadron signal, the rate of the production of four R-hadrons can also be sizable at the LHC. This, together with the multi-jet signals studied in earlier work, makes it possible to single out vectorlike confinement as the underlying dynamics.

Takemichi Okui, Department of Physics, okui@hep.fsu.edu