Discovering New Physics at LHC

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CERN TH

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Outline

What new physics can we expect to see?

What new physics can we hope to see?

How will we see it?

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Nuffin*

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What new physics can we expect to see?

Nuffin*

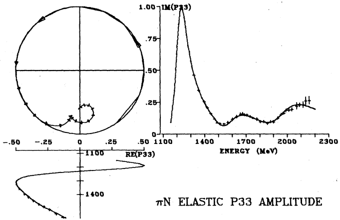
What new physics can we hope to see?

Dunno*

How will we see it?

What can we expect to see?

Unitarity in *WW* scattering



Cutkosky et al, 1979

- $a_0 \sim \frac{1}{32\pi}\frac{2s}{v^2} < \frac{1}{2} \implies \sqrt{s} < \sqrt{8\pi}v \sim 1.2\,TeV$

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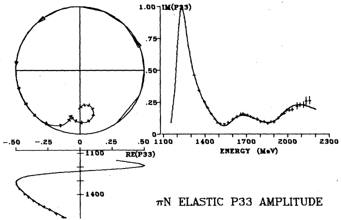

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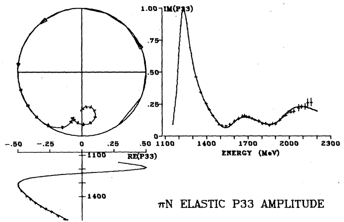

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- $a_1 \sim \frac{1}{32\pi}\frac{s^2}{v^4}\frac{1}{16\pi^2}\log\frac{\mu^2}{s} \implies \sqrt{s} < 4\pi v \sim 3.0\, TeV$

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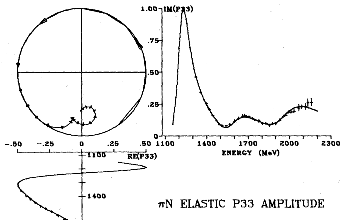

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- cf. QCD: $\sqrt{8\pi}f_\pi < m_\rho < 4\pi f_\pi$

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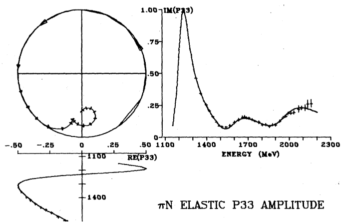

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- cf. QCD: 470 MeV $<$ 770 MeV $<$ 1170 MeV

What can we hope to see?

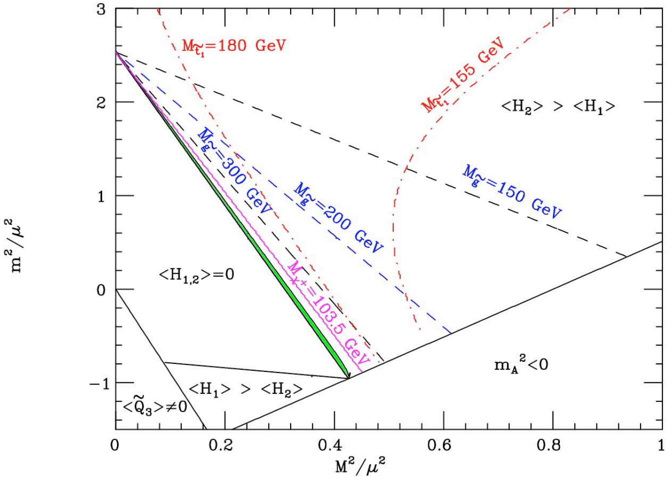
Is the Planck/weak hierarchy a red herring?

If it isn't, why haven't we seen anything, yet?

If it isn't, why haven't we seen anything yet?

- direct searches, $\gtrsim 100$ GeV
- nucleon decay, $\gtrsim 10^{16}$ GeV
- flavour physics, $\gtrsim 10^{6}$ GeV
- electroweak precision tests, $\gtrsim 10^{3}$ GeV

If SUSY, why haven't we seen any superpartners?



Giudice and Rattazzi, 0606105

If strong coupling, what about flavour and EWPT?

- Symmetry for $\frac{m_W}{m_Z}$: $SO(4)/SO(3)$

  Sikivie et al., 1980

- Symmetry for $Z \to bb$: $O(4)/O(3)$

  Agashe et al., 0605341

- ‘Symmetry’ for S: $SO(5)/SO(4)$

  Georgi and Kaplan, 1984

- Symmetry to hide the Higgs at LEP: $SO(6)/SO(5)$

  BMG et al., 0902.1483

Something else?

- We only need one light d. o. f. to cancel the top divergence
- One d. o. f. is not so hard to hide ...

How will we see it?

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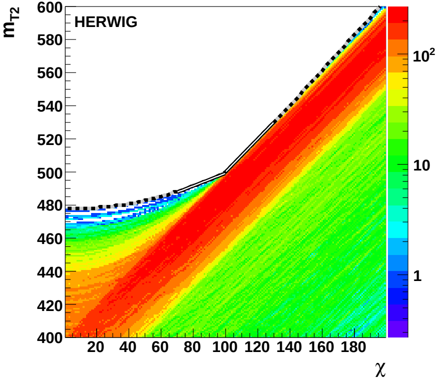
(Given that we don't know what we're looking for.)

Devise methods that are as model-independent as possible ...

The LHC-Dark Matter connection

DM pair-produced, invisible
Can we measure its mass?



Barr, BMG and Lester, 0711.4008

Algebraic varieties

Kim, 0910.1149

Strongly-coupled models

Worked hard to make them like SM . . .

Strongly-coupled models

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... so how do we distinguish them?!

- Flavour suggests fermion masses arise differently from SM
- Bi-linear *vs.* linear — Kaplan, 1991
- Lightest fermions are least mixed with strong sector
- Coloured, electroweak fermions $\implies$ coloured, electroweak scalars ?
- Composite leptoquarks: $2\chi \to 2(t,b) + 2(\tau,\nu)$

BMG, 0910.1789

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Summary

- What can we expect to see?
- What can we hope to see?
- How will we see it?