Higgs, New Bosons, WIMPs, Other Searches

Ken-ichi Hikasa (Tohoku U.)

HIGGS BOSONS

Higgs Bosons

- Review by M. Carena, C. Grojean, M. Kado, V. Sharma (53 pages, written Nov 2013) → Following talk
- Data Listings (Overseer: G. Weiglein; Encoder: K. Hikasa; Consulted by H. Haber for 2014 update)
  - H^0 promoted to real particle, finally after >30 yrs in RPP
  - 138 new papers in 2014 edition (50 in 2012)
  - Split into 3 sections → Reflected to summary table
    - The H^0 at 125 GeV
    - Neutral H^0 searches (incl. MSSM H_1^0, A^0)
    - Charged $H^\pm$ (doublet) and $H^{\pm\pm}$ (triplet/singlet)

Summary Table

- H^0
  - mass, spin, σB
- H^0 searches
  - SM, MSSM mass limits
- $H^{\pm}$, $H^{\pm\pm}$ searches
  - $H^{\pm}$ mass limit

H^0 $J = 0$

Mass $m = 125.7 \pm 0.4$ GeV

H^0 Signal Strengths in Different Channels

Combined Final States = 1.17 ± 0.17 (S = 1.2)

$WW^* = 0.87^{+0.24}_{-0.22}$

$ZZ^* = 1.11^{+0.34}_{-0.28}$ (S = 1.3)

$\gamma\gamma = 1.58^{+0.27}_{-0.23}$

$b\bar{b} = 1.1 \pm 0.5$

$\tau^+\tau^- = 0.4 \pm 0.6$

$Z\gamma < 9.5$, CL = 95%

Neutral Higgs Bosons, Searches for

Searches for a Higgs Boson with Standard Model Couplings

Mass $m > 122$ and none 128–710 GeV, CL = 95%

The limits for H_1^0 and A^0 in supersymmetric models refer to the m_h^{max} benchmark scenario for the supersymmetric parameters.

H_1^0 in Supersymmetric Models ($m_{H_1^0} < m_{H_2^0}$)

Mass $m > 92.8$ GeV, CL = 95%

A^0 Pseudoscalar Higgs Boson in Supersymmetric Models [n]

Mass $m > 93.4$ GeV, CL = 95% $\tan\beta > 0.4$

Charged Higgs Bosons ($H^{\pm}$ and $H^{\pm\pm}$), Searches for

$H^{\pm}$ Mass $m > 80$ GeV, CL = 95%

Listings: H^0 Section

- Mass (4 new papers)
- Spin, CP (notes only)
- Width (notes only)
- Signal strengths in different channels (12 new papers)
  - Combined
  - WW, ZZ, $\gamma\gamma$
  - bb, $\tau\tau$
  - $Z\gamma$ (limit)

Neutral H^0 Searches

- MSSM H^0, A^0 (7 new papers)
- Others (newly split into 5 subsections)
  - General two-doublet models
  - Fermiophobic (13 new papers)
  - Invisible (6 new papers)
  - Light A^0 (4 new papers)
  - Others (2 new papers)
- SM Higgs limits (49 + 2 new papers)

Neutral H^0 Searches

- Problem: Most limits use pre-H^0 (125 GeV) assumptions (especially in production cross section), will be only of historical interest
  - SM H^0 limits can be hidden very soon
  - What to do with the other subsections?
  - Need updated framework and experimental analyses

Charged H Searches

- $H^{\pm}$ mass limits (6 new papers)
  - Final results from LEP (2013!)
  - Limits from top decay (LHC)
  - Indirect limits from flavor physics
- $H^{\pm\pm}$ mass limits (4 new papers)
  - SU(2) triplet
  - SU(2) singlet

Higgs bosons summary

- Up to 2012

ALL SEARCH LIMITS

- Current

H^0 DATA

H^0 LIMITS
SM & non-SM

$H^{\pm}$ LIMITS

- Future

MORE
H^0 DATA

2^{nd} H^0
LIMITS?

MORE
$H^{\pm}$ LIMITS?

Slides prepared by M. Tanabashi

HEAVY BOSONS, TECHNICOLOR, COMPOSITENESS

Heavy bosons other than Higgs

- Encoder : M. Tanabashi (Nagoya)
- Overseer: K. Copic left LBNL Jan. 2014
  H. Haber (tentative)
- Number of reviewed papers:
  19 papers (10 for W'/Z', 1 for LQ)
- Highlights
  W'/Z' mini-reviews (new numbers from LHC)
  Brooijmans, Chen, Dobrescu
  LQ mini-review (new numbers from LHC)
  Rolli and M.T.

Dynamical EW Symmetry Breaking

- Encoder : M. Tanabashi (Nagoya)
- Overseer: J. Terning (-2013);
  K. Agashe (2014-)
- Number of reviewed papers:
  6 papers (techni-rho and top-color Z')
- Highlight

Technicolor mini-review [Chivukula, Narain, Womersley] has been revised. It now contains new theoretical paragraphs explaining various possibilities for the 125GeV composite Higgs boson.

Quark/Lepton Compositeness

- Encoder : M. Tanabashi (Nagoya)
- Overseer: J. Terning (UC Davis)
- Number of reviewed papers:

  8 papers (contact int. & excited quark)
- Plan

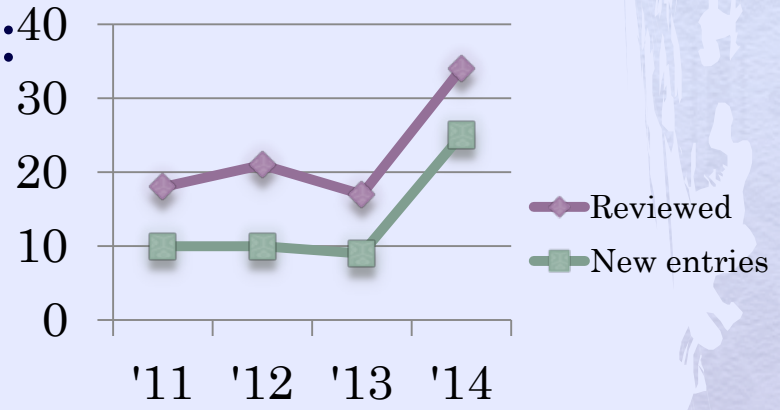
We plan to update the mini-review to include experimental constraints from LHC (2015 Summer). Experimental physicists (ATLAS and CMS) will join the authors of the mini-review.

Slides prepared by F. Takahashi

AXIONS AND OTHER VERY LIGHT BOSONS

Axions and Other Very Light Bosons

- Encoder: F. Takahashi (Tohoku U)
- Overseer: G. Raffelt (MPI)
- Number of reviewed papers:
  - 17 papers in 2012/3
    - New entries: 9 papers
    - 1 for light boson, 8 for axions
  - 32 papers in 2013/4
    - New entries: 25 papers
    - 2 for light boson, 15 for axions, 1 for majorons, 6 for hidden photons



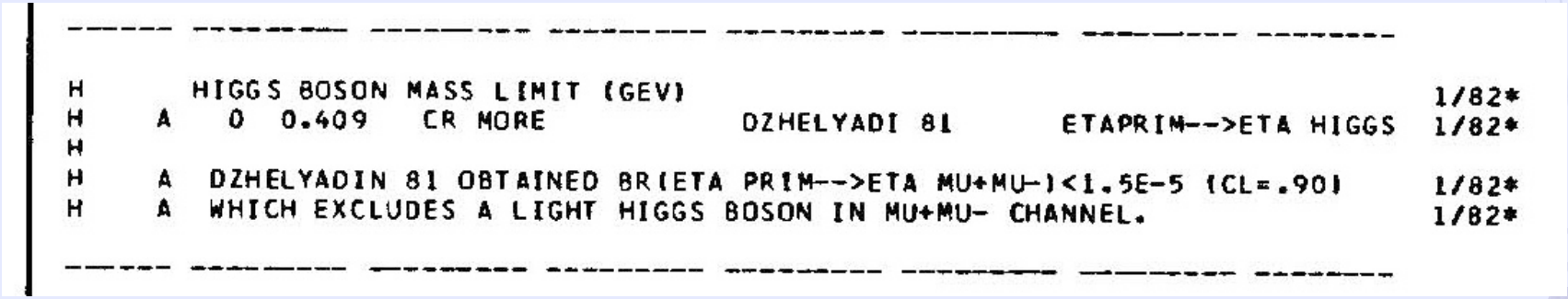
- Reorganization continued (slow and steady)
- Limits on hidden photons included from 2014.

In early times, Higgs searches, …, extra dimension limits were all in this section.

WIMPS AND OTHER PARTICLE SEARCHES

“Other” depends on time

- 1982: First Higgs entry in RPP, located in ‘Other stable particle searches’ section



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H       HIGGS BOSON MASS LIMIT (GEV)                                          1/82*
H     A   0  0.409   CR MORE              DZHELYADI 81      ETAPRIM-->ETA HIGGS  1/82*
H
H     A  DZHELYADIN 81 OBTAINED BR(ETA PRIM-->ETA MU+MU-)<1.5E-5 (CL=.90)     1/82*
H     A  WHICH EXCLUDES A LIGHT HIGGS BOSON IN MU+MU- CHANNEL.                1/82*
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WIMPs and Other Particle Searches

- Located at the end of the book
- Contains everything which cannot be assigned to other sections
  - Extra Dim limits *used to* be here (2000)
  - WIMPs are still here, but neutralino-specific limits moved to SUSY section (2004)
- 'Minireview'
  - Just explains the structure of the section

WIMPs and Other Particle Searches

- Data Listings (Overseer-Encoder: K. Hikasa)
- Subcategories: WIMPs, stable particles in matter, neutral particle production, jet-jet resonances, charged particle production…
- New subsection
  - WIMPs: reorganized (see below)
  - Charged particle mass limits (LHC)
  - Quantum black hole production (LHC)

WIMP subsections

- WIMP scattering cross section limits subsection reorganized (in 2013 update)
  - Spin-independent σ on nucleon (from 2008 on)
  - Spin-dependent σ on proton (from 2003 on)
  - Spin-dependent σ on neutron
- New subsection on collider production limits
  - may or may not be related to scattering

WIMPs and Other Particle Searches

- New 2014 entries
  - WIMPs: 32 papers (20 scattering, 6 annihilation, 6 collider), 94 measurements
  - General new physics searches: 9 papers (LHC, Tevatron)
  - Jet-jet resonance: 5 papers (LHC, Tevatron)
  - Stable charged particle: 3 papers (LHC)
  - Quantum black hole: 6 papers (LHC)