HIGGS-MASS PREDICTIONS

Thomas Schücker

Centre de Phisique Théorique, Unité Mixte de Recherche (UMR 6207)
du CNRS et des universités d'Aix–Marseille et de Sud Toulon–Var
Laboratoire affilié à la FRUMAM (FR 2291)
CNRS-Luminy, Case 907, 13288 Marseille Cedex 9, France
and
Université d'Aix–Marseille
Jardin du Pharo, 58 bd Charles Livon, 13284 Marseille Cedex 07, France
thomas.schucker@gmail.com

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A compilation of Higgs-mass predictions is proposed.

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1. Introduction

Many physicists hope that the electroweak Higgs scalar will be observed soon at the LHC. The literature contains a plethora of predictions or upper limits of the Higgs mass based on many different ideas, models and calculational techniques. Privileged among them is the value $m_H = 150 \pm 36$ GeV currently given by the LEP Electroweak Working Group, because it only relies on precision electroweak data, non-observation of the Higgs today and the minimal hypothesis that the standard model is correct as it stands.

A compilation of all other predictions is attempted here. Some models make additional predictions or postdictions, that are indicated. The point in time separating pre- and postdiction is taken as the time of publication of the model.

The predictions are organised in increasing order of the central value of the predicted mass interval. In the second section, the upper limits are presented in increasing order as well. The third section contains two lower limits. Older predictions and limits incompatible with today's experimental lower limit of 114 GeV are not recorded here. As another example not covered, I should mention the supersymmetric model by Dermíšek and Gunion (2005) with a Higgs mass of 100 GeV. Because of exotic decay channels this model is still compatible with LEP data. Also not recorded are predictions that come with postdictions contradicting present experimental numbers.

The references are in alphabetical order of the first author's last name with first name and date as secondary criteria.

2. Predictions

• $m_H = 109 \pm 12$ GeV
Authors: Buchmüller *et al.* (2007)
Idea: constrained minimal supersymmetric standard model combined with electroweak precision data, flavor physics and abundance of cold dark matter
Techniques: multi-parameter fit, renormalisation group equation. The top mass is taken to be $m_t = 170.9 \pm 1.8$ GeV.
Other predictions: many supersymmetric particles

• $m_H = 115.3 \pm 0.1$ GeV
Author: Schücking (2007)
Idea: interpretation of the SU(2) × U(1) group of the electroweak forces as symmetry group of the Eguchi–Hanson metric
Techniques: differential geometry and quaternions

• $m_H = 115.4 \pm 0.9$ GeV
Author: Popovic (2010)
Idea: top quark as bound state of 3 prequarks, Higgs of 2 prequarks
Techniques: arithmetic

• $m_H = 115.9 \pm 2$ GeV
Authors: Cassel and Ghilencea (2011)
Idea: supersymmetry
Techniques: constrained minimal supersymmetric extension of the standard model plus consistency of the lightest supersymmetric particle as dark matter with the WMAP data
Other predictions: many supersymmetric particles

• $m_H = 117 \pm 4$ GeV
Authors: Gogoladze, Okada and Shafi (2007)
Idea: Higgs boson as zero mode of gauge boson along a fifth compactified dimension
Techniques: a boundary condition on the Higgs self-coupling at compactification scale Λ and renormalisation group flow up to energies of $\Lambda \sim 10^8$ GeV

- $m_H = 117 \pm 12$ GeV

Authors: Kane, Kumar, Lu and Zheng (2011)
Idea: compactified string/M theories
Techniques: minimal supersymmetric extension of the standard model
Other predictions: many supersymmetric particles

- $m_H = 118$

Authors: Arbuzov, Barbashov, Pervushin, Shuvalov and Zakharov (2008)
Idea: three peaks of the cosmic microwave background are explained by the decay of primordial Higgs, W and Z bosons into photons.
Techniques: conformal cosmology
Other prediction: $m_H = 216$

- $m_H = 120 \pm 6$ GeV

Authors: Ellis, Nanopoulos, Olive and Santoso (2005)
Idea: supersymmetry
Techniques: minimal supersymmetric extension of the standard model with universal soft supersymmetry-breaking masses
Other predictions: many supersymmetric particles

- $m_H = 121 \pm 6$ GeV

Authors: Feldstein, Hall and Watari (2006)
Idea: superstring inspired landscape of vacua and some probability density for the parameters of the Higgs potential
Techniques: renormalisation group flow up to energies of $\Lambda \sim 10^{19}$ GeV
Postdiction: $m_t = 176 \ \pm 2$ GeV

- $m_H = 121.25 \pm 2.25$ GeV

Authors: Li, Maxin, Nanopoulos and Walker (2011)
Idea: supersymmetry
Techniques: F-theory no scale supergravity and SU(5)
Other predictions: many supersymmetric particles

- $m_H = 121.8 \pm 11$ GeV

Authors: Froggatt and Nielsen (1995)
Idea: two approximately degenerate vacua, one in which we live, the other of Planck energy
Techniques: renormalisation group equations
Postdiction: $m_t = 173 \ \pm 4$ GeV

- $m_H = 122 \pm 10$ GeV

Authors: Djouadi, Heinemeyer, Mondragon and Zoupanos (2004)
Idea: a supersymmetric version of SU(5)
Techniques: renormalisation group flow up to energies of $\Lambda \sim 10^{16}$ GeV
Other predictions: many supersymmetric particles
Postdictions: $m_t = 174$–183 GeV

• $m_H = 122.8$ GeV
Author: Bogan (2009)
Idea: simple relations between cosmological constant, GUT scale and masses of the electron, inflaton, and Higgs
Techniques: geometric mean

• $m_H = 123$ GeV
Author: Stech (2010)
Idea: SO(10) or E_6 grand unification plus a SO(3) flavour symmetry
Techniques: group representations

• $m_H = 123.5 \pm 5.5$ GeV
Authors: Heinemeyer, Mondragon and Zoupanos (2007)
Idea: a supersymmetric Grand Unified Theory that can be made all-loop finite
Techniques: renormalisation group flow with $m_t = 170.9$ GeV
Other predictions: supersymmetric particles

• $m_H = 124 \pm 21$ GeV
Authors: Barger, Deshpande, Jiang, Langacker and Li (2007)
Idea: supersymmetry broken at 10^5–10^{16} GeV and gauge coupling unification at $\Lambda \sim 10^{16}$–10^{17} GeV
Techniques: renormalisation group flow up to energies of Λ
Other predictions: new vectorlike fermions with masses in the 200–1000 GeV range

• $m_H = 124 \pm 10$ GeV
Authors: Arbuzov, Glinka, Lednicky and Pervushin (2007), version 6
Idea: condensates, conformal cosmology
Techniques: Coleman–Weinberg potential
Other predictions: $m_H = 275 \pm 25$ GeV, version 1

• $m_H = 124.2 \pm 13.2$ GeV
Authors: Codoban, Jurcisin and Kazakov (1999)
Idea: supersymmetry
Techniques: minimal supersymmetric extension of the standard model with non-universal soft supersymmetry-breaking masses
Other predictions: many supersymmetric particles

• $m_H = 125 \pm 5$ GeV
Authors: Kahana and Kahana (1993)
Idea: dynamical symmetry breaking and the Higgs as a deeply bound state of two top quarks
Techniques: Nambu–Jona-Lasinio theory
Other predictions: $m_t = 175 \pm 5$ GeV. Note that the top was discovered in 1995.

- $m_H = 125 \pm 4$ GeV

Authors: Gogoladze, Okada and Shafi (2007)
Idea: Higgs boson as zero mode of gauge boson along a fifth compactified dimension
Techniques: a boundary condition on the Higgs self-coupling at compactification scale Λ and renormalisation group flow up to energies of $\Lambda \sim 10^{13}$–10^{14} GeV

- $m_H = 126.3 \pm 2.2$ GeV

Authors: Shaposhnikov and Wetterich (2009)
Idea: assume that gravity is asymptotically safe, that there are no intermediate energy scales between the Fermi and Planck scales, that the gravity induced anomalous dimension of the Higgs selfcoupling is positive.
Techniques: renormalisation group flow with $m_t = 171.2$ GeV

- $m_H = 127.5 \pm 7.5$ GeV

Authors: Chankowski, Falkowski, Pokorski and Wagner (2004)
Idea: supersymmetry and the Higgs as a pseudo-Goldstone boson of some extra global symmetry
Techniques: smaller fine-tuning than in the minimal supersymmetric extension of the standard model. The computation of the Higgs mass depends on the top mass taken to be $m_t = 178 \pm 4.3$ GeV.
Other predictions: many supersymmetric particles and an additional Z-boson with a mass of 3 TeV

- $m_H = 129.6$ GeV

Authors: Calmet and Fritzsch (2001)
Idea: confining SU(2) and a 'complementarity principle'
Techniques: 1-loop corrections

- $m_H = 130 \pm 6$ GeV

Authors: Dae Sung Hwang, Chang-Yeong Lee and Ne'eman (1996)
Idea: embedding of the electroweak Lie algebra $su(2) \oplus u(1)$ in the superalgebra $su(2|1)$
Techniques: renormalisation group flow
Postdictions: $\sin^2 \theta_w = 0.229 \pm 0.005$

- $m_H = 130 \pm 10$ GeV

Authors: Nakayama and Takahashi (2011)
Idea: identify the Higgs with the inflaton and use correlation between Higgs mass and a spectral index of density perturbations of 0.95–0.96
Techniques: PeV scale supersymmetry breaking
Other predictions: many supersymmetric particles

- $m_H = 131 \pm 10$ GeV

Authors: Gogoladze, Li, Senoguz and Shafi (2006)
Idea: 7 dimensional orbifold with SU(7) grand unification and split supersymmetry
Techniques: a boundary condition on the Higgs self-coupling at unification scale Λ and renormalisation group flow up to energies of $\Lambda \sim 10^{16}$ GeV
Other predictions: $m_H = 146 \pm 8$ GeV

- $m_H = 134 \pm 9$ GeV

Authors: Ni, Lou, Lu and Yang (1998)
Idea: a Gaussian effective potential
Techniques: renormalisation group flow up to energies of $\Lambda \sim 10^{15}$ GeV

- $m_H = 135 \pm 6$ GeV

Authors: Gogoladze, Li and Shafi (2006)
Idea: 7 dimensional $N = 1$ supersymmetric orbifold with SU(7) grand unification
Techniques: a boundary condition on the Higgs self-coupling at unification scale Λ and renormalisation group flow up to energies of $\Lambda \sim 10^{16}$ GeV
Other predictions: $m_H = 144 \pm 4$ GeV

- $m_H = 135 \pm 15$ GeV

Authors: Arkani-Hamed and Dimopoulos (2004)
Idea: split supersymmetry
Techniques: fine tuning and renormalisation group flow up to energies of 10^{16} GeV

- $m_H = 137 \pm 23$ GeV

Authors: Medina, Shah and Wagner (2007)
Idea: a warped fifth dimension and an extension of the electroweak gauge symmetry to SO(5) $\times$ U(1) in the bulk, broken at the boundaries
Techniques: Coleman–Weinberg potential

- $m_H = 140 \pm 10$ GeV

Authors: Babu, Gogoladze, Rehman and Shafi (2008)
Idea: minimal supersymmetric extension of the standard model plus complete vectorlike multiplets of grand unified groups
Techniques: some fine tuning and renormalisation group flow up to energies of 10^{16} GeV. The top mass is taken to be $m_t = 172.6 \pm 1.4$ GeV.
Other predictions: many supersymmetric particles

- $m_H = 141 \pm 2$ GeV

Authors: Hall and Nomura (2009)
Idea: minimal supersymmetric extension of the standard model plus supersymmetry breaking at very high scale, motivated from a multiverse
Techniques: huge fine tuning and 2-loop corrections with a top mass of 173.1 GeV
Other predictions: no supersymmetric particles

- $m_H = 143 \pm 37$ GeV

Authors: Cabibbo, Maiani, Parisi and Petronzio (1979)
Idea: the big desert: no new particles besides the Higgs and validity of perturbative quantum field theory up to the Planck scale
Techniques: renormalisation group flow up to energies of 10^{19} GeV. The computation of the Higgs mass depends on the top mass taken here to be $m_t = 171.5 \pm 2$ GeV.

- $m_H = 143.2 \pm 28.8$ GeV

Authors: Gogoladze, Okada and Shafi (2007b)
Idea: 2 extra dimensions compactified on an orbifold
Techniques: a boundary condition on the Higgs self-coupling at compactification scale Λ and renormalisation group flow up to energies of $\Lambda \sim 10^{19}$ GeV

- $m_H = 143.4 \pm 1.3$ GeV

Author: Popovic (2010)
Idea: radiatively generated Higgs mass
Techniques: cancellation of certain leading divergences

- $m_H = 144 \pm 4$ GeV

Authors: Gogoladze, Li and Shafi (2006)
Idea: 7 dimensional $N = 1$ supersymmetric orbifold with SU(7) grand unification
Techniques: a boundary condition on the Higgs self-coupling at unification scale Λ and renormalisation group flow up to energies of $\Lambda \sim 10^{16}$ GeV
Other predictions: $m_H = 135 \pm 6$ GeV

- $m_H = 145 \pm 7$ GeV

Author: Liu (2005)
Idea: supersymmetry broken at 10^{11} GeV and a $\mathbb{Z}_3$ symmetry among generations
Techniques: radiative corrections

- $m_H = 146 \pm 8$ GeV

Authors: Gogoladze, Li, Senoguz and Shafi (2006)
Idea: 7 dimensional orbifold with SU(7) grand unification and split supersymmetry
Techniques: a boundary condition on the Higgs self-coupling at unification scale Λ and renormalisation group flow up to energies of $\Lambda \sim 10^{16}$ GeV
Other predictions: $m_H = 131 \pm 10$ GeV

- $m_H = 146 \pm 19$ GeV

Authors: Barger, Jiang, Langacker and Li (2005)
Idea: supersymmetry broken at high scale and gauge coupling unification at $\Lambda \sim 10^{16}$–10^{17} GeV
Techniques: renormalisation group flow up to energies of Λ

• $m_H = 148.1 \pm 10.7$ GeV
Author: Popa (2009)
Idea: let the Higgs be the inflaton by adding a strong, non-minimal coupling $\varphi^2 R$ of the scalar to gravity.
Techniques: effective action with $m_t = 171.3$ GeV and its confrontation with the observed spectral index and tensor-to-scalar ratio of the Cosmic Microwave Background

• $m_H = 150 \ \pm \ 36$ GeV
Authors: The LEP Electroweak Working Group
Idea: non-observation of the Higgs and quantum corrections by Higgs loops to precision electroweak data
Techniques: experiment and quantum field theory

• $m_H = 150 \pm 10$ GeV
Authors: Barger, Chiang, Jiang and Li (2004)
Idea: supersymmetry broken at 10^{11} GeV and Peccei–Quinn symmetry
Techniques: radiative corrections

• $m_H = 150 \pm 20$ GeV
Authors: Arvanitaki, Davis, Graham and Wacker (2004)
Idea: split supersymmetry
Techniques: fine tuning and renormalisation group flow up to energies of 10^{16}GeV

• $m_H = 150 \pm 50$ GeV
Authors: Bai, Fan and Han (2007)
Idea: supersymmetry and a long-lived metastable supersymmetry breaking vacuum
Techniques: little Higgs mechanism, 1-loop corrections
Other predictions: many supersymmetric particles plus new gauge bosons and electroweak triplets at 1 TeV

• $m_H = 150 \pm 24$ GeV
Authors: Shaposhnikov and Wetterich (2009)
Idea: assume that gravity is asymptotically safe, that there are no intermediate energy scales between the Fermi and Planck scales
Techniques: renormalisation group flow with $m_t = 171.2$ GeV

• $m_H = 150$ GeV
Authors: Chiang and Nomura (2010)
Idea: E_6 unification in six dimensions and $S^2/\mathbb{Z}_2$ orbifold compactification
Techniques: tree level masses from Kaluza–Klein model

• $m_H = 153 \pm 3$ GeV
Author: Okumura (1997)
Idea: a vague variant of the Connes–Lott model
Techniques: 2-loop renormalisation group flow up to energies of 10^{13} GeV. The computation of the Higgs mass depends on the top mass taken here to be $m_t = 171.5 \pm 2$ GeV.

- $m_H = 154 \pm 6$ GeV

Authors: Ananthanarayan and Pasupathy (2001)
Idea: weak dependence of the ratio between Higgs self-coupling and top Yukawa coupling squared on renormalisation scale
Techniques: 1- and 2-loop corrections

- $m_H = 154 \pm 37$ GeV

Authors: Gogoladze, He and Shafi (2010)
Idea: vectorlike isospin doublets of quarks with masses of several 100 GeV are added to the standard model to achieve gauge unification at 3×10^{16} GeV. Assuming the validity of perturbative quantum field theory up to this energy constrains the Higgs-mass as in Cabibbo, Maiani, Parisi and Petronzio (1979).
Techniques: renormalisation group flow
Other predictions: these new vectorlike quarks

- $m_H = 154.4 \pm 0.5$ GeV

Author: Beck (2001)
Idea: 'chaotic strings' describing the dynamics of vacuum fluctuations underlying dark energy
Techniques: stochastic quantization
Postdictions: all fermion and gauge bosons masses, all gauge couplings

- $m_H = 155 \pm 8$ GeV

Authors: Schrempp and Schrempp (1993)
Idea: a strongly infrared attractive line in the m_t–m_H plane is found
Techniques: 1-loop renormalization group equations

- $m_H = 160 \pm 8$ GeV

Authors: Roepstorff and Vehns (2000)
Idea: combining gauge and Yukawa interactions in one generalised Dirac operator
Techniques: superconnections
Postdictions: $m_t = 160 \pm 8$ GeV

- $m_H = 160 \pm 20$ GeV

Authors: Langacker, Paz, Wang and Yavin (2007)
Idea: an extension of the minimal supersymmetric extension of the standard model plus a hidden sector plus a Z' mediating supersymmetry breaking by couplings to the hidden sector
Techniques: 2-loop corrections up to energies of 10^7–10^{11} GeV
Other predictions: many supersymmetric particles

- $m_H = 160 \pm 24.5$ GeV

Authors: Barvinsky, Kamenshchik, Kiefer, Starobinsky and Steinwachs (2009)
Idea: let the Higgs be the inflaton by adding a strong, non-minimal coupling $\varphi^2 R$ of the scalar to gravity
Techniques: effective action to 1-loop with $m_t = 171$ GeV and its confrontation with the observed spectral index and tensor-to-scalar ratio of the Cosmic Microwave Background

• $m_H = 160 \pm 30$ GeV
Author: Bezrukov (2008)
Idea: let the Higgs be the inflaton by adding a strong, non-minimal coupling $\varphi^2 R$ of the scalar to gravity
Techniques: effective action and its confrontation with the observed spectral index and tensor-to-scalar ratio of the Cosmic Microwave Background

• $m_H = 160 \pm 34$ GeV
Authors: Bezrukov and Shaposhnikov (2009)
Idea: let the Higgs be the inflaton by adding a strong, non-minimal coupling $\varphi^2 R$ of the scalar to gravity
Techniques: effective action to 2-loop with $m_t = 171.2$ GeV and its confrontation with the observed spectral index and tensor-to-scalar ratio of the Cosmic Microwave Background

• $m_H = 160.7 \pm 24$ GeV
Authors: Bezrukov, Magnin and Shaposhnikov (2008)
Idea: let the Higgs be the inflaton by adding a strong, non-minimal coupling $\varphi^2 R$ of the scalar to gravity
Techniques: effective action to 1-loop with $m_t = 171$ GeV and its confrontation with the observed spectral index and tensor-to-scalar ratio of the Cosmic Microwave Background

• $m_H = 160.9 \pm 0.1$ GeV
Author: Ne'eman (1986)
Idea: embedding of the electroweak Lie algebra $su(2) \oplus u(1)$ in the superalgebra $su(2|1)$
Techniques: classical field theory
Postdictions: $\sin^2 \theta_w = 1/4$

• $m_H = 161.8033989$ GeV
Author: El Naschie (2005)
Idea: E-infinity theory
Techniques: ?

• $m_H = 165 \pm 5$ GeV
Authors El Naschie (2005b)
Idea: minimal supersymmetric extension of the standard model plus 'Pauli's principle of bidivision and symmetry reduction'
Techniques: no quantum corrections

• $m_H = 170 \pm 10$ GeV
Authors: Chamseddine and Connes (1996)
Idea: derivation of the standard model from gravity by generalising Riemannian to noncommutative geometry
Techniques: operator algebras, heat-kernel expansion and renormalisation group flow up to energies of $\Lambda \sim 10^{13}$–10^{17} GeV. The computation of the Higgs mass depends on the top mass taken to be $m_t = 170.9 \pm 2.5$ GeV.

Other predictions: conceptual uncertainty in proper time measurements of $\Delta\tau \sim \hbar/\Lambda = 10^{-41}$–$10^{-37}$ s
Postdictions: $m_W^2/(\cos^2\theta_w\, m_z^2) = 1$, gluons must be massless and must have pure vector-couplings, $m_t < 186.3$ GeV

- $m_H = 177.5 \pm 7.5$ GeV

Authors: Antusch, Kersten, Lindner and Ratz (2002)
Idea: the Higgs as a composite particle from neutrino condensation
Techniques: seesaw mechanism, gap equation, renormalisation group flow up to the condensation scale $\Lambda = 10^{16}$ GeV

- $m_H = 182 \pm 4$ GeV

Author: Namsrai (1996)
Idea: Higgs mass from space-time curvature
Techniques: general relativity and solitons

- $m_H = 185 \pm 5$ GeV

Author: Schrempp and Schrempp (1986)
Idea: a largely unspecified strong interaction is assumed to soften the elastic scattering of longitudinally polarised W bosons.
Techniques: a superconvergence sum rule

- $m_H = 185.7 \pm 0.1$ GeV

Author: Trostel (1987)
Idea: a geometrisation of the Yukawa couplings
Techniques: spinor connections

- $m_H = 186 \pm 8$ GeV

Authors: Tolksdorf and Thumstädter (2006)
Idea: differential geometric unification of general relativity and the standard model
Techniques: generalised Dirac operators, heat kernel expansion and renormalisation group flow up to energies of $\Lambda \sim 10^{10}$ GeV. The computation of the Higgs mass depends on the top mass taken to be $m_t = 174 \pm 3$ GeV.

- $m_H = 194 \pm 80$ GeV

Authors: García-Bellido, Figueroa and Rubio (2008)
Idea: let the Higgs be the inflaton by adding a strong, non-minimal coupling $\varphi^2 R$ of the scalar to gravity
Techniques: effective action and its confrontation with the observed spectral index and tensor-to-scalar ratio of the Cosmic Microwave Background, lower limit from non-observation of the Higgs at LEP

- $m_H = 196$ GeV

Authors: Chiang, Nomura and Sato (2011)
Idea: SO(12) unification in six dimensions and $S^2/\mathbb{Z}_2$ orbifold compactification
Techniques: tree level masses from Kaluza–Klein model

• $m_H = 197.2 \pm 124.8$ GeV
Authors: Froggatt, Laperashvili, Nevzorov, Nielsen and Sher (2006)
Idea: non-supersymmetric extension of the standard model with two Higgs doublets and the multiple point principle
Techniques: renormalisation group flow up to energies of $\Lambda \sim 10^4$–10^{19} GeV
Other predictions: additional neutral and charged scalars with masses larger than 202.4 GeV

• $m_H = 200 \pm 20$ GeV
Authors: Froggatt, Nevzorov, Nielsen and Thompson (2008)
Idea: non-supersymmetric extension of the standard model with two Higgs doublets and the multiple point principle
Techniques: renormalisation group flow up to energies of $\Lambda \sim 10^5$ GeV. The computation of the Higgs mass depends on the top mass taken to be $m_t = 171.4 \pm 2.1$ GeV.
Other predictions: enhanced top-Higgs coupling

• $m_H = 200 \pm 50$ GeV
Author: Cvetič (1995)
Idea: it is supposed that the 1-loop contributions of the scalar self-interactions to the effective potential are distinctly less than those of the Yukawa couplings of the top
Techniques: 1-loop corrections with cut-off at 10^3 GeV. The computation of the Higgs mass depends on the top mass taken to be $m_t = 180$ GeV.

• $m_H = 203 \pm 2.2$ GeV
Author: Squellari and Stephan (2007)
Idea: extension of Chamseddine and Connes' spectral action to include three vectorlike isospin doublets
Techniques: operator algebras, heat-kernel expansion and renormalisation group flow up to $\Lambda = 3$–5×10^7 GeV. The computation of the Higgs mass depends on the top mass taken to be $m_t = 170.9 \pm 2.6$ GeV.
Other predictions: six new leptons with masses of $10 - 550$ TeV, conceptual uncertainty in proper time measurements of $\Delta\tau \sim \hbar/\Lambda \sim 10^{-32}$ s
Postdictions: $m_W^2/(\cos^2\theta_w\, m_z^2) = 1$, gluons must be massless and must have pure vector-couplings

• $m_H = 210 \pm 10$ GeV
Authors: Andrianov and Romanenko (1995)
Idea: modified Veltman condition and fixed point in running of Yukawa coupling
Techniques: renormalisation group flow up to energies of 10^{16} GeV
Postdictions: $m_t = 175 \pm 5$ GeV

• $m_H = 216$
Authors: Arbuzov, Barbashov, Pervushin, Shuvalov and Zakharov (2008)
Idea: three peaks of the cosmic microwave background are explained by the decay of primordial Higgs, W and Z bosons into photons
Techniques: conformal cosmology
Other prediction: $m_H = 118$

• $m_H = 218$ GeV
Authors: Elias, Mann, McKeon and Steele (2003)
Idea: absence of tree-level scalar-field masses
Techniques: Coleman–Weinberg potential and summation of leading logarithms

• $m_H = 226 \pm 50$ GeV
Authors: Aranda, Díaz-Cruz and Rosado (2005)
Idea: unification of the weak gauge couplings at intermediate energy Λ and linear or quadratic relation of these to the Higgs self-coupling
Techniques: renormalisation group flow up to energies of $\Lambda \sim 10^{13}$ GeV

• $m_H = 241.2 \pm 1.6$ GeV
Author: Stephan (2007)
Idea: extension of Chamseddine and Connes' spectral action to SU(4) × SU(3) × SU(2) × U(1)
Techniques: operator algebras, heat-kernel expansion and renormalisation group flow up to $\Lambda = 2 \times 10^4$ GeV. The computation of the Higgs mass depends on the top mass taken to be $m_t = 170.9 \pm 2.6$ GeV.
Other predictions: confined SU(4) singlets in the TeV range, conceptual uncertainty in proper time measurements of $\Delta\tau \sim \hbar/\Lambda = 3.3 \times 10^{-29}$ s
Postdictions: $m_W^2/(\cos^2\theta_w\, m_z^2) = 1$, gluons must be massless and must have pure vector-couplings

• $m_H = 250 \pm 50$ GeV
Authors: Barbieri, Hall, Nomura and Rychkov (2006)
Idea: extending the minimal supersymmetric extension of the standard model by adding a chiral singlet with a superpotential interaction with the Higgs doublets
Techniques: renormalisation group flow up to energies of $\Lambda \sim 10$ TeV

• $m_H \approx 250$ GeV
Authors: Ne'eman and Thierry Mieg (1982)
Idea: embedding of the electroweak Lie algebra $su(2) \oplus u(1)$ in the superalgebra $su(2|1)$
Techniques: classical field theory
Postdictions: $\sin^2\theta_w = 1/4$

• $m_H = 253 \pm 10$ GeV
Authors: Arbuzov and Zaitsev (2011)
Idea: Higgs as bound state of heavy quarks
Techniques: Bogoliubov compensation principle
Other predictions: $m_H = 306 \pm 16$ GeV

• $m_H = 255 \pm 145$ GeV
Author: Mahbubani (2004)
Idea: split supersymmetry
Techniques: fine tuning and renormalisation group flow up to energies of 10^{16} GeV

• $m_H = 271 \pm 5$ GeV
Authors: Connes and Lott (1991)
Idea: derivation of the Higgs sector of the standard model from the Yang–Mills sector by generalising Euclidean to noncommutative geometry
Techniques: operator algebras. The computation of the Higgs mass depends on the top mass taken here to be $m_t = 170.9 \pm 2.5$ GeV.
Postdictions: $m_W^2/(\cos^2\theta_w\, m_z^2) = 1$, gluons must be massless and must have pure vector-couplings, $m_t > 139.3$ GeV, $\sin^2\theta_w < 0.543$

• $m_H = 275 \pm 25$ GeV
Authors: Arbuzov, Glinka, Lednicky and Pervushin (2007), version 1
Idea: condensates, conformal cosmology
Techniques: Coleman–Weinberg potential
Other predictions: $m_H = 124 \pm 10$ GeV, version 6

• $m_H = 306 \pm 16$ GeV
Authors: Arbuzov and Zaitsev (2011)
Idea: Higgs as bound state of heavy quarks
Techniques: Bogoliubov compensation principle
Other predictions: $m_H = 253 \pm 10$ GeV

• $m_H = 308.6 \pm 0.3$ GeV
Authors: López Castro and Pestieau (1995)
Idea: absence of quadratic and logarithmic divergences in the top mass
Techniques: 1-loop quantum corrections
Other predictions: $m_t = 170.5 \pm 0.3$ GeV

• $m_H = 309 \pm 6$ GeV
Authors: Decker and Pestieau (1979), also Veltman (1981)
Idea: absence of quadratic 1-loop divergences
Techniques: dimensional reduction. The computation of the Higgs mass depends on the top mass taken here to be $m_t = 170.9 \pm 2.5$ GeV

• $m_H = 317 \pm 80$ GeV
Authors: Bazzocchi and Fabbrichesi (2004)
Idea: flavour symmetry broken together with electroweak symmetry, little Higgs
Techniques: Coleman–Weinberg effective potential
Other predictions: many new particles including a charged scalar with mass 560 ± 192 GeV

• $m_H = 348.2$ GeV
Authors: Bednyakov, Giokaris and Bednyakov (2007)
Idea: $m_H = 2m_t$
Techniques: arithmetic

• $m_H = 374 \pm 6$ GeV
Author: Xiao-Gang He (2002)
Idea: no dependence of total vacuum energy (Casimir plus minimum of Higgs potential) on renormalisation scale

Techniques: Casimir effect and quantum corrections. The computation of the Higgs mass depends on the top mass taken here to be $m_t = 170.9 \pm 2.5$ GeV.

• $m_H = 426$ GeV
Author: Fairlie (1979)
Idea: embedding of the electroweak Lie algebra $su(2) \oplus u(1)$ in the superalgebra $su(2|1)$
Techniques: classical field theory
Postdictions: $\sin^2 \theta_w = 1/4$

• $m_H = 500 \pm 100$ GeV
Authors: Barbieri, Hall and Rychkov (2006)
Idea: adding an inert isospin doublet of pseudo-scalars
Techniques: renormalisation group flow up to energies of $\Lambda \sim 1.5$ TeV
Other predictions: pseudo-scalars with masses between 60 GeV and 1 TeV leading, in particular, to an increased width of the ordinary Higgs scalar

• $m_H = 515 \pm 64$ GeV
Authors: Langguth, Montvay and Weisz (1986)
Idea: lattice gauge theory and triviality of the continuum limit
Techniques: Monte Carlo simulations on 12^4 lattices

• $m_H = 536 \pm 10$ GeV
Authors: Babic, Guberina, Horvat and Stefancic (2001)
Idea: no dependence of cosmological constant on renormalisation scale
Techniques: quantum corrections. The computation of the Higgs mass depends on the top mass taken here to be $m_t = 170.9 \pm 2.5$ GeV.

• $m_H = 760 \pm 21$ GeV
Authors: Cea, Consoli and Cosmai (2003)
Idea: lattice gauge theory and triviality of the continuum limit
Techniques: extrapolation from Ising limit

• $m_H = 1900 \pm 100$ GeV
Authors: Ibañez-Meier and Stevenson (1992)
Idea: vanishing bare Higgs mass and 1-loop effective potential
Techniques: autonomous renormalisation

• $m_H = 10^{18}$ GeV
Authors: Batakis and Kehagias (1991)
Idea: Higgs field as massive excitation of the vacuum configuration of a sigma field coupled to gravity
Techniques: non-linear sigma models

3. Upper bounds

- $m_H < 123$ GeV

Authors: Belyaev, Dar, Gogoladze, Mustafayev and Shafi (2007)
Idea: constrained minimal supersymmetric standard model combined with supersymmetry constraints from colliders and low energy physics and constraints on dark matter
Techniques: renormalisation group equation. The top mass is taken to be $m_t = 171.4$ GeV
Other predictions: many supersymmetric particles

- $m_H < 125$ GeV

Authors: Froggatt, Nevzorov, Nielsen and Thompson (2008)
Idea: non-supersymmetric extension of the standard model with two Higgs doublets and the multiple point principle
Techniques: renormalisation group flow up to energies of $\Lambda \sim 10^{10}$ GeV. The computation of the Higgs mass depends on the top mass taken to be $m_t = 171.4 \pm 2.1$ GeV.

- $m_H < 125$ GeV

Authors: Babu, Gogoladze, Rehman and Shafi (2008)
Idea: minimal supersymmetric extension of the standard model plus complete vectorlike multiplets of grand unified groups
Techniques: some fine tuning and renormalisation group flow up to energies of 10^{16} GeV. The top mass is taken to be $m_t = 172.6 \pm 1.4$ GeV.
Other predictions: many supersymmetric particles

- $m_H < 126$ GeV

Authors: De Simone, Hertzberg and Wilczek (2008)
Idea: let the Higgs be the inflaton by adding a strong, non-minimal coupling $\varphi^2 R$ of the scalar to gravity
Techniques: effective action to 2-loop with $m_t = 171.2$ GeV and its confrontation with the observed spectral index and tensor-to-scalar ratio of the Cosmic Microwave Background

- $m_H < 127$ GeV

Authors: Carena, Nardini, Quiros and Wagner (2008)
Idea: minimal supersymmetric extension of the standard model with a light stop and electroweak baryo-genesis
Techniques: renormalisation group flow up to energies of $\Lambda \sim 10^{16}$ GeV
Other predictions: the light stop with mass < 120 GeV

- $m_H < 130$ GeV

Authors: Okada, Yamaguchi and Yanagida (1991)
Idea: minimal supersymmetric extension of the standard model
Techniques: soft supersymmetry breaking at 1 TeV and quantum corrections
Other predictions: many supersymmetric particles

• $m_H < 130$ GeV
Authors: Bento, Bertolami and Rosenfeld (2001)
Idea: introduction of a stable gauge singlet scalar of mass around 1 GeV coupled to the Higgs, playing the role of cold dark matter and solving problems with small scale structure formation
Techniques: phenomenological constraints from cosmology and particle physics
Other predictions: Higgs decay into a pair of these stable light scalars

• $m_H < 130$ GeV
Authors: Birkedal, Chacko and Gaillard (2004)
Idea: supersymmetry and the Higgs as a pseudo-Goldstone boson of some extra global symmetry
Techniques: SU(6) grand unification
Other predictions: many supersymmetric particles

• $m_H < 130$ GeV
Authors: Passera, Marciano and Sirlin (2008)
Idea: hypothetical errors in the determination of the hadronic leading-order contribution to cure the present discrepancy between experiment and prediction of the muon $g - 2$
Techniques: quantum corrections by Higgs loops to precision electroweak data with $m_t = 172.6 \pm 1.4$ GeV

• $m_H < 130$ GeV
Authors: Nakayama, Yokozaki and Yonekura (2011)
Idea: minimal supersymmetric extension of the standard model plus a scalar singlet
Techniques: quantum corrections
Other predictions: many supersymmetric particles

• $m_H < 139$ GeV
Authors: Kaeding and Nandi (1999)
Idea: a non-minimal supersymmetric extension of the standard model
Techniques: gauge mediated supersymmetry breaking and quantum corrections
Other predictions: many supersymmetric particles

• $m_H < 144$ GeV
Authors: Suematsu and Zoupanos (2001)
Idea: a non-minimal supersymmetric extension of the standard model
Techniques: non-universal soft supersymmetry breaking and quantum corrections
Other predictions: many supersymmetric particles

• $m_H < 144$ GeV
Author: Ma (2011)
Idea: minimal supersymmetric extension of the standard model plus another U(1) gauge boson
Techniques: supersymmetry breaking and quantum corrections
Other predictions: many supersymmetric particles

- $m_H < 146$ GeV
Authors: Huo, Li, Nanopoulos and Tong (2011)
Idea: supersymmetry
Techniques: F-theory and flipped SU(5) × U(1)
Other predictions: many supersymmetric particles

- $m_H < 150$ GeV
Authors: Maloney, Pierce and Wacker (2004)
Idea: supersymmetric extension of the standard model with non-decoupling D-terms
Techniques: soft supersymmetry breaking and renormalisation group flow up to energies of $\Lambda \sim 10^{16}$ GeV
Other predictions: many supersymmetric particles and new gauge bosons with masses in the TeV range

- $m_H < 150$ GeV
Authors: Moroi and Okada (1992)
Idea: supersymmetric extension of the standard model plus a gauge singlet
Techniques: soft supersymmetry breaking and renormalisation group flow up to energies of $\Lambda \sim 10^{16}$ GeV
Other predictions: many supersymmetric particles

- $m_H < 150$ GeV
Authors: Carena, Nardini, Quiros and Wagner (2008)
Idea: minimal supersymmetric extension of the standard model with a light stop
Techniques: renormalisation group flow up to energies of $\Lambda \sim 10^{16}$ GeV
Other predictions: the light stop

- $m_H < 163$ GeV
Authors: Chishtie, Hanif, Jia, Mann, McKeon, Sherry and Steele (2006)
Idea: absence of tree-level scalar-field masses
Techniques: Coleman–Weinberg potential and summation of (next to)^4 leading logarithms

- $m_H < 165$ GeV
Authors: Delgado and Quiros (2000)
Idea: supersymmetric extension of the standard model plus one extra dimension compactified on an orbifold
Techniques: renormalisation group flow with all Higgses in the bulk
Other predictions: many supersymmetric particles

- $m_H < 180$ GeV
Authors: Moroi and Okada (1992)
Idea: supersymmetric extension of the standard model plus extra matter multiplets
Techniques: soft supersymmetry breaking and renormalisation group flow up to energies of $\Lambda \sim 10^{16}$ GeV
Other predictions: many supersymmetric particles

- $m_H < 200$ GeV

Authors: Espinosa and Quiros (1998)
Idea: supersymmetric extension of the standard model plus extra matter multiplets
Techniques: soft supersymmetry breaking and renormalisation group flow up to energies of $\Lambda \sim 10^{16}$ GeV
Other predictions: many supersymmetric particles

- $m_H < 200$ GeV

Authors: Elsayed, Khalil and Morettis (2011)
Idea: supersymmetric extension of the standard model plus an extra U(1) gauge boson with $B - L$ couplings and inverse seesaw
Techniques: radiative corrections
Other predictions: many supersymmetric particles

- $m_H < 230$ GeV

Authors: Bhattacharyya, Majee and Raychaudhuri (2007)
Idea: supersymmetric extension of the standard model plus one extra dimension
Techniques: Kaluza–Klein and radiative corrections

- $m_H < 235$ GeV

Authors: Bhattacharyya, Majee and Ray (2008)
Idea: supersymmetric extension of the standard model plus one extra dimension, Higgs confined to the TeV brane
Techniques: Kaluza–Klein and radiative corrections

- $m_H < 260$ GeV

Authors: Batra, Delgado, Kaplan and Tait (2004)
Idea: supersymmetric extension of the standard model plus a gauge singlet
Techniques: soft supersymmetry breaking and renormalisation group flow up to energies of $\Lambda \sim 10^{16}$ GeV
Other predictions: many supersymmetric particles and a charged Higgs boson lighter than the neutral one

- $m_H < 280$ GeV

Authors: Ham, Shim, Kim and Oh (2010)
Idea: minimal supersymmetric extension of the standard model plus a few vectorlike quarks of masses in the 300–550 GeV range
Techniques: renormalisation group flow to one-loop
Other predictions: many supersymmetric particles

- $m_H < 300$ GeV

Authors: Babu, Gogoladze and Kolda (2004)
Idea: minimal supersymmetric extension of the standard model plus complete vectorlike multiplets of grand unified groups
Techniques: renormalisation group flow up to energies of 10^{16} GeV
Other predictions: many supersymmetric particles

• $m_H < 350$ GeV
Authors: Batra, Delgado, Kaplan and Tait (2003)
Idea: supersymmetric extension of the standard model plus some new gauge bosons
Techniques: soft supersymmetry breaking, some fine tuning
Other predictions: many supersymmetric particles and new gauge bosons with masses in the TeV range

• $m_H < 400$ GeV
Authors: Litsey and M. Sher (2009)
Idea: minimal supersymmetric extension of the standard model with a fourth generation
Techniques: radiative corrections
Other predictions: the fourth generation at LHC energies and many supersymmetric particles

• $m_H < 446$ GeV
Authors: Huitu, Pandita and Puolamaki (1997)
Idea: supersymmetric extension of the left–right symmetric extension of the standard model
Techniques: soft supersymmetry breaking, 1-loop corrections

• $m_H < 450$ GeV
Authors: Bhattacharyya, Majee and Raychaudhuri (2007)
Idea: supersymmetric extension of the standard model plus two extra dimensions
Techniques: Kaluza–Klein and radiative corrections

• $m_H < 724$ GeV
Authors: Langguth and Montvay (1987)
Idea: lattice gauge theory and triviality of the continuum limit
Techniques: Monte Carlo simulations on 16^4 lattices

• $m_H < 800$ GeV
Authors: Appelquist and Yee (2002)
Idea: Kaluza–Klein with one or two extra comactified dimensions
Techniques: computation of quantum corrections induced by Kaluza–Klein particles on precision electroweak measurements of the flavour changing process $b \to s + \gamma$ and on the anomalous magnetic moment of the muon
Other predictions: new dimensions with inverse compactification radius as low as 250 GeV

• $m_H < 880$ GeV
Authors: Jegerlehner, Kalmykov and Veretin (2001)
Idea: quantum corrections in the relation between $\overline{\mathrm{MS}}$- and pole-masses of the W and Z bosons should remain perturbative.
Techniques: 2-loop corrections, asymptotic expansions

• $m_H < 1008$ GeV
Authors: Lee, Quigg and Thacker (1977)
Idea: unitarity requirement

Techniques: partial-wave amplitude of elastic boson scattering in lowest order of perturbation to be bounded by unity

- $m_H < 1020$ GeV

Authors: Dicus and Mathur (1973)
Idea: unitarity requirement
Techniques: partial-wave amplitude of $Z_L Z_L \to Z_L Z_L$ in lowest order of perturbation to be bounded by unity

- $m_H < 1400$ GeV

Authors: Grzadkowski and Gunion (2007)
Idea: W^+W^- scattering in the Randall–Sundrum model with one extra dimension and two 3-branes should remain perturbatively unitary after inclusion of string/M-theoretic excitations.
Techniques: summation of Kaluza–Klein gravitons

4. Lower bounds

- $m_H > 120$ GeV

Authors: Bin He, Okada and Shafi (2009)
Idea: let the Higgs be the inflaton by adding a strong, non-minimal coupling $\varphi^2 R$ of the scalar to gravity, add type III seesaw mechanism and demand vacuum stability and perturbativity
Techniques: renormalisation group flow

- $m_H > 230$ GeV

Authors: Barvinsky, Kamenshchik and Starobinsky (2008)
Idea: let the Higgs be the inflaton by adding a strong, non-minimal coupling $\varphi^2 R$ of the scalar to gravity
Techniques: effective action and its confrontation with the observed spectral index and tensor-to-scalar ratio of the Cosmic Microwave Background

5. Final remarks

Our list contains 96 Higgs-mass predictions. Supersymmetry is behind 26 of them with central values between 120 and 255 GeV. Compactified additional dimensions motivate ten predictions ranging from 117 to 450 GeV. There are three superstring inspired predictions: 117, 121 and 154.4 GeV. The embedding of the electroweak Lie algebra $su(2) \oplus u(1)$ in the superalgebra $su(2|1)$ produces four predictions: 130, 161, 250 and 426 GeV. Five predictions, between 124 and 317 GeV use the Coleman–Weinberg potential. One prediction, $m_H = 125$ GeV uses dynamical symmetry breaking with the Higgs being a deeply bound state of two top quarks. At the same time this model predicted two years prior to the discovery of the top its mass to be $m_t = 175$ GeV. Another prediction for the Higgs mass motivated by dynamical symmetry breaking via a neutrino condensate is at 178 GeV. We have listed four predictions from Connes's noncommutative geometry: 170, 203, 241 and 271 GeV. Lattice gauge theories lead to two predictions: 515 and 760 GeV. Eight predictions are based on the (approximate) vanishing of particular terms related to quantum corrections: 154, 155, 200, 210, 309, 374 and 536 GeV.

We have two lower bounds for the Higgs mass and 37 upper bounds, 26 of which come from supersymmetry.

Six predictions, one upper and one lower bound come from the recent idea that inflation is driven by the Higgs scalar together with a strong non-minimal coupling to gravity. The Higgs mass is obtained from fitting the observed spectral index and tensor-to-scalar ratio of the Cosmic Microwave Background.

The oldest entry is: $m_H < 1020$ GeV by Dicus and Mathur (1973).

The most precise prediction is: $m_H = 161.8033989$ GeV by El Naschie (2005).

The highest prediction is: $m_H = 10^{18}$ GeV by Batakis and Kehagias (1991).

The highest number of predictions by a single co-author, Gogoladze, is 12.

Three intervals are still free of Higgs-mass predictions: 600–739 GeV, 781–1800 GeV and 2000–10^{18} GeV.

In this compilation, we have only considered numerical post- and predictions. Today particle physicists are used to interpret experimental numbers not only in terms of numbers like coupling constants, but also in terms of groups and representations and even in terms of Lagrangians. Only few of the listed models come with constraints on groups, representations and Lagrangians. Supersymmetric models for instance need representations for supersymmetric particles and thereby may be falsified by the LHC. However supersymmetry does not constrain the gauge group nor the Lagrangian. This is different for Connes' noncommutative geometry, which — just as Riemannian geometry — puts severe constraints on the admissible Lagrangians, puts constraints on gauge groups and severe constraints on representations. In particular, the Higgs representation of the noncommutative standard model is not chosen but computed to be one colourless isospin doublet. This is certainly its most startling and robust prediction and may lead to its falsification if more than one physical Higgs is found as predicted by any supersymmetric standard model.

When listing predictions, it is unavoidable to miss references. The first version of this compilation `arXiv:0708.3344 [hep-ph]` posted in 2007 contained 60 references. This final version has 125 references. I would like to acknowledge the feed back of many colleagues who made me aware of ref-

erences, not necessarily theirs, and who contributed to the seven successive versions on the arXiv. Making no claim towards completeness, I do think that, in view of the experimental situation, time is ripe for this final version.

Note added in proof: In early July 2012 a Higgs with mass of 125.5 ± 1.5 GeV was announced in Geneva. Out of the 96 listed predictions, 28 are still compatible with this experimental value.

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