EURIDICE

Precision results for (g-2) for muon and the lightest Higgs boson in 2HDM(II)

hep-ph/0103223v3
hep-ph/0112112 Snowmass proc
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(hep-ph/020807)

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Start-off Collaboration Meeting

INFN–Frascati, 18-20 October 2002

TWO-HIGGS-DOUBLET-MODEL

CP conserv. 2HDM(II) with soft violation of Z_2 symmetry (μ^2 term):
$\Rightarrow$ five Higgs bosons: $h, H, A, H^\pm$
$\Rightarrow$ 7 parameters :$M_h, M_H, M_A, M_{H^\pm}$, α, β, and μ^2

MODEL II (as in MSSM)

Couplings (relative to SM):	h	A
to W/Z:	$\chi_V = \sin(\beta-\alpha)$	0
to down quarks/leptons:	$\chi_d = \chi_V - \sqrt{1-\chi_V^2}\tan\beta$	$-i\gamma_5 \tan\beta$
to up quarks:	$\chi_u = \chi_V + \sqrt{1-\chi_V^2}/\tan\beta$	$-i\gamma_5/\tan\beta$

For H couplings like for h with:
$\sin(\beta-\alpha) \leftrightarrow \cos(\beta-\alpha)$ and $\tan\beta \rightarrow -\tan\beta$.

Pattern relation holds: $\boxed{(\chi_u + \chi_d)\chi_V = 1 + \chi_u\chi_d}$

I. Ginzburg, MK, P. Osland, hep-ph/0101208

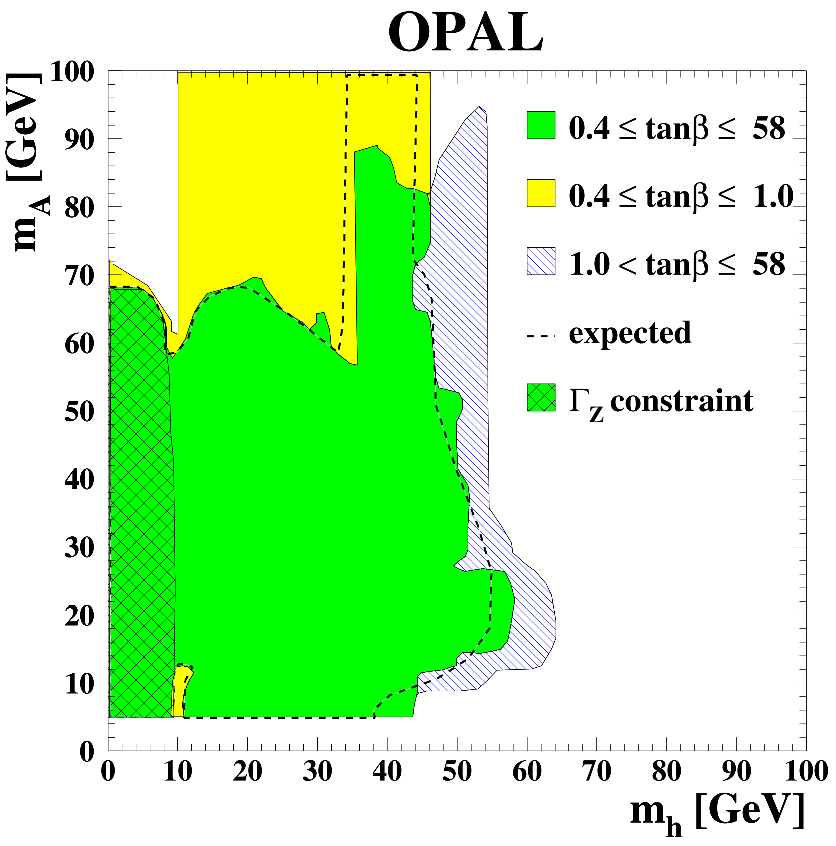
Existing constraints:

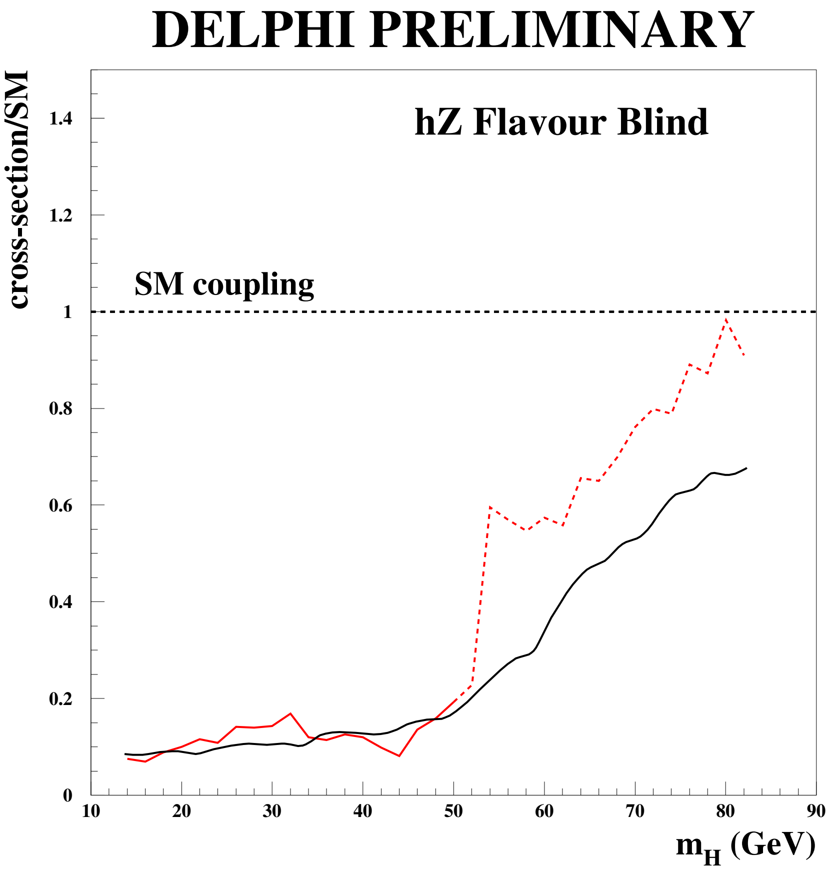
LEP • direct:(h) Bjorken process $Z \to Zh$,
(hA) pair prod. $e^+e^- \to hA$,
(h/A) Yukawa pro. $e^+e^- \to bbh/A$
($H^\pm$) $e^+e^- \to H^+H^-$
via loop:(h/A, and $H^\pm$) $Z \to h/A\gamma$

Others exp.• via loop:(h/A) Wilczek process $\Upsilon \to h/A\gamma$
loop: ($H^\pm$) $b \to s\gamma$ $M_{H^\pm} > 350$GeV

Global fit •(all Higgses)
Chankowski at al., EPJC 11,661,1999, also PL B496,195,2000

Light h OR light A in agreement with current data





Light scalar h $\rightarrow$ small $\beta - \alpha$!

DATA and SM prediction for $g-2$ for muon $a_\mu \equiv \frac{(g-2)_\mu}{2}$

$$a_\mu^{exp} = 11659203(8) \cdot 10^{-10}$$

E821, Phys. Rev. Lett. **89** (2002) 101804 [Erratum-ibid. **89** (2002) 129903] [arXiv:hep-ex/0208001]

$$a_\mu^{SM} = a_{QED} + a_\mu^{EW} + a_\mu^{had}$$

had=vac.pol.1+vac.pol.2+ lbl

$\rightarrow$

A significant revision due to change in sign of the light by light hadronic contribution to a_μ light-by-light (lbl):

previous av: -8.5(2.5)10^{-10}

recent:

Knecht,Nyffeler +8.3(1.2)

Hayakawa,Kinoshita +8.9(1.5)

Bijnens,et al +8.3(3.2)

Blokland,et al. +5.6

$$\Delta a_\mu = a_\mu^{exp} - a_\mu^{SM}$$

Old (2.6σ) New(new lbl, 1.6σ)

Case A (DH'98 vp**)** Δa_μ=**43 (16)** 10^{-10} **25(16)** 10^{-10} $\Rightarrow$

- **64** $< \delta a_\mu^{new} < 564 \cdot 10^{-11}$

Case B (J2000 vp**)** **New B (new lbl+J2002vp)**

Δa_μ=**36 (19)** 10^{-10} **29(17)** 10^{-10}

- **34** $< \delta a_\mu^{new} < 620 \cdot 10^{-11}$

SM contributions

Hadronic contribution	[in 10^{-11}]	
ho (Krause)	– 100	(6)
lbl (Nyffeler)	80	(40)
vp1 (Jeg02)	6889	(58)
had [FJ02]	6869	(71)

SM and data

SM contribution		$[\text{in } 10^{-11}]$
QED	116 584 705.7	(2.9)
had[FJ02]	6 869.0	(70.7)
EW	152.0	(4.0)
tot	116 591 726.7	(70.9)
$\Delta a_\mu(\sigma)$		303.3 (106.9)
lim(95%)		$93.8 \le \delta a_\mu \le 512.8$

[HMNT (ex)]: $\Delta a_\mu(\sigma) = 297.0\,(107.2)$ $87.2 \le \delta a_\mu \le 507.4$,
[HMNT(in)] : $\Delta a_\mu(\sigma) = 357.2\,(106.4)$ $148.7 \le \delta a_\mu \le 565.7$
[DEHZ (e+e-)]: $\Delta a_\mu(\sigma) = 339.0\,(112)$

Jegerlehner, Talk at Marseille, March 2002
Hagiwara et al (hep-ph/0209187v2)
Davier et al (hep-ph/0208177)

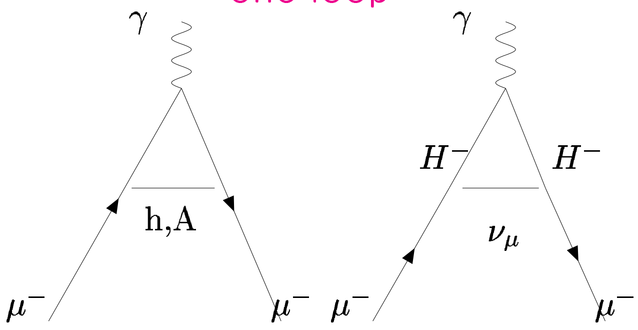
δa_μ region can be used to constrain parameters of new models

2HDM contribution to a_μ: $a_\mu^{\text{2HDM}} = a_\mu^h + a_\mu^A + a_\mu^H + a_\mu^{H^\pm}$

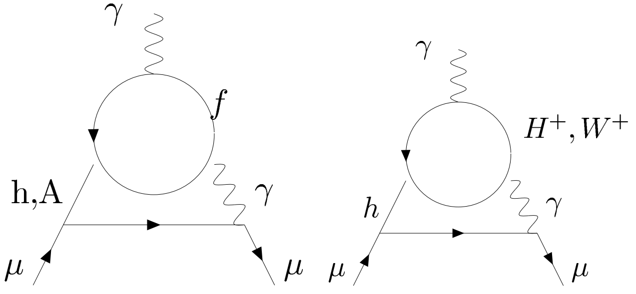
•light h scenario : $a_\mu^{\text{2HDM}} \approx a_\mu^h$

•light A scenario : $a_\mu^{\text{2HDM}} \approx a_\mu^A$

one loop



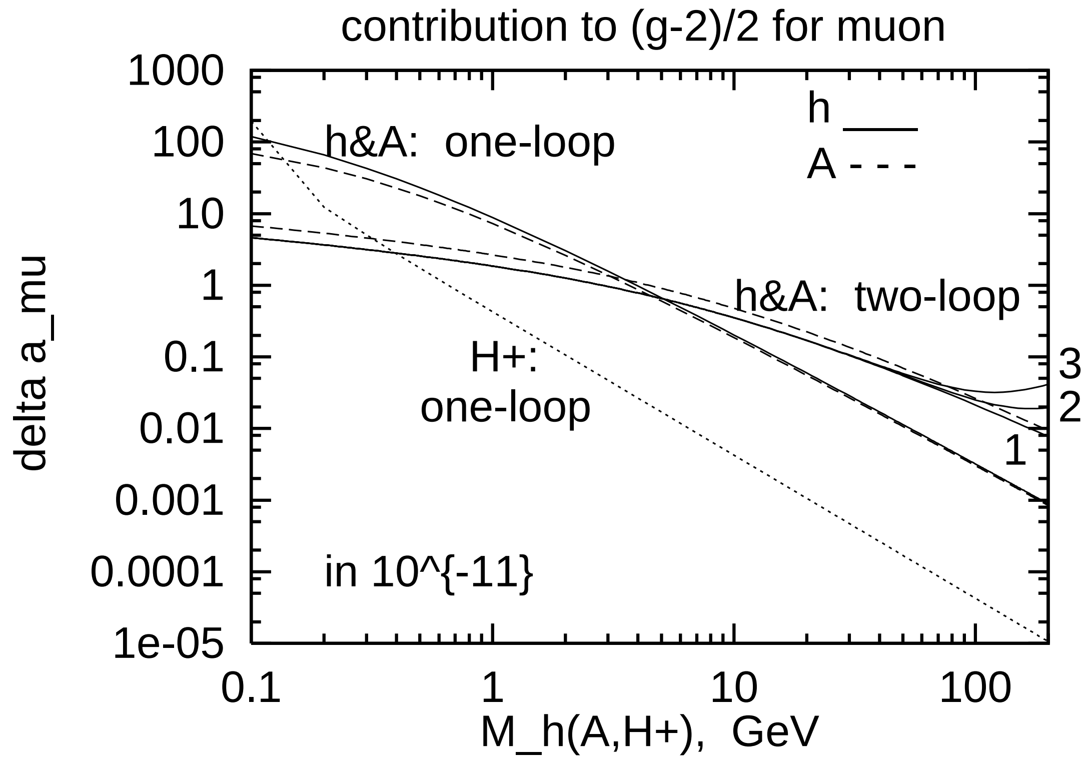
two loop



Zochowski,MK'96,MK'01;Dedes,Haber'01   Chang at al.,Cheung at al, Wu,Zhou, MK'01,'02..

Two loop contributions larger than one-loop for mass $\sim$ few GeV!

Various contributions for couplings = 1



1– no H^+

2– $M_{H^\pm}$=800GeV

3– $M_{H^\pm}$=400GeV

light A

contr. positive

for mass above 5 GeV

light h

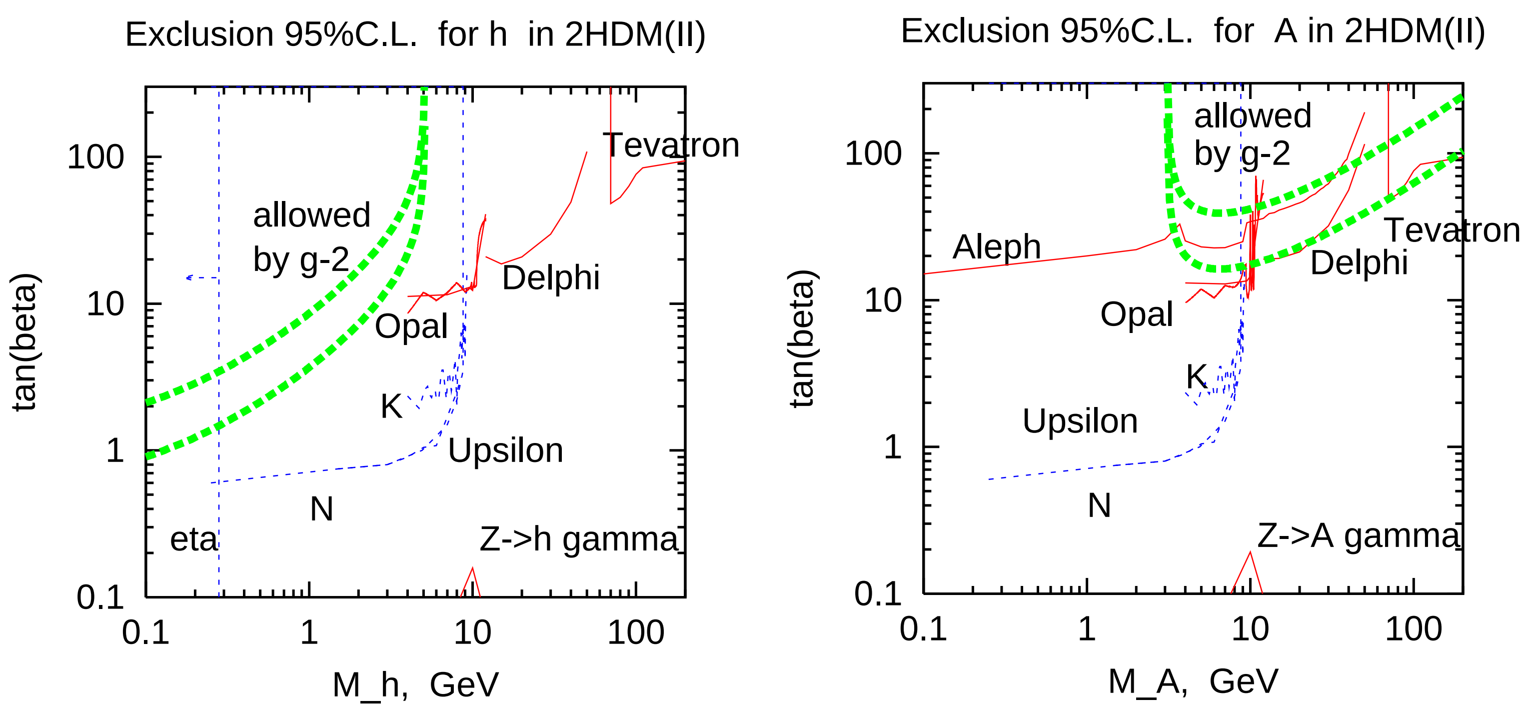
contr. positive

for mass below 3 GeV

$\beta - \alpha = 0,\ \mu^2 = 0$

Combined 95% CL constraints for h and A in 2HDM(II)

scalar h for $\beta-\alpha=0, \mu^2=0$ — pseudoscalar A



thick lines : upper & lower limits from g-2

plus LEP data, etc

New estimations $\Rightarrow$ allowed regions for A only if all existing data are taken into account

A with mass 25-70 GeV and $25 < \tan\beta < 115$ in agreement with all data