Higgs production in peripheral electromagnetic AA and pp interactions at the LHC

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1. Peripheral electromagnetic collisions
   - Equivalent photon approximation
   - Hevy ion cross section and luminosities
2. Higgs decay $H \to \gamma\gamma$. Effective $H\gamma\gamma$ vertex.
3. Higgs production in peripheral electromagnetic collisions.
   - $M_H = 120$ GeV, $\gamma\gamma \to H \to b\bar{b}$
   - $M_H = 185$ GeV, $\gamma\gamma \to H \to ZZ$
4. Conclusions and problems.

1. Peripheral electromagnetic collisions

- **Equivalent photon approximation**

The spectrum of equivalnet photons for nuclei is given by

$$N(\omega, b) = \frac{Z^2\alpha}{\pi^2 b^2 \beta^2} x^2 (K_1^2(x) + \frac{1}{\gamma^2} K_0^2(x)), \quad (1)$$

where $x = \omega b/\gamma v$, $\omega = E_\gamma$, b — impact parameter, $\beta = v/c$ and $\gamma = \sqrt{1-\beta^2}$ is the Lorentz factor of moving charge.

- **HI cross section**

$$\sigma_{AA\to AAX} = \int d\omega_1 d\omega_2 N(\omega_1) N(\omega_2) \sigma_{\gamma\gamma\to X}(\omega_1\omega_2), \quad (2)$$

K.A.Chikin, V.L.Korotkikh, A.P.Kryukov, L.I.Sarycheva, I.A.Pshenichnov, J.P.Bondorf and I.N.Mishustin, Inclusive meson production in peripheral collisions of ultrarelativistic heavy ions, Eur. Phys. J. A **8**, 537 (2000)

G.Baur, Ultraperipheral Collisions at RHIC and LHC, arXiv:0711.2882 [hep-ph]

- **Luminosity for different nucleai**

A	$\sqrt{s}$, TeV	$L, \mathrm{cm}^{-2} s^{-1}$	L, pb^{-1}	$(\frac{Z}{82})^4 L, \mathrm{pb}^{-1}$
Pb^{82}_{208}	574	$4.2 \cdot 10^{26}$	0.013	0.013
Sn^{50}_{120}	350	$7.6 \cdot 10^{27}$	0.24	0.033
Kr^{36}_{84}	252	$3.2 \cdot 10^{28}$	1.01	0.037
Ar^{18}_{40}	126	$4.2 \cdot 10^{29}$	16.4	0.038
O^{8}_{16}	56	$1.4 \cdot 10^{31}$	441.5	0.039
p	7	$1.0 \cdot 10^{34}$	$3.15 \cdot 10^{5}$	n/a

2. Higgs decay $H \to \gamma\gamma$. Effective $H\gamma\gamma$ vertex.

- **Higgs decay $H \to \gamma\gamma$**

In SM there is no $H_{\gamma\gamma}$ vertex.
However, there is available interaction via loops:

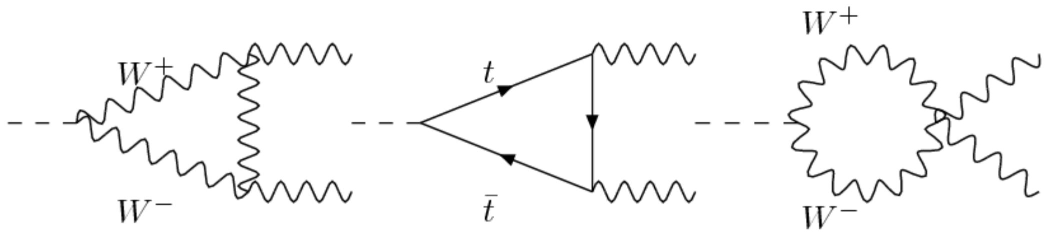


Fig. 1: Effective $H\gamma\gamma$ vertex.

$$\Gamma(H \to \gamma\gamma) = \frac{G_F \alpha^2 M_H^3}{128\sqrt{2}\pi^3} \| \sum_f N_{cf} e_f^2 A_f^H(\tau_f) + A_W^H(\tau_W) \|^2 \tag{3}$$

- **Effective $H\gamma\gamma$ vertex**

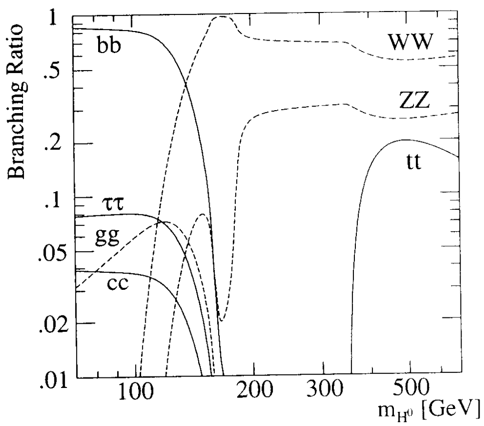


Fig. 2: Branching ratios for the main decays of the SM Higgs boson (from Journal of Physics G, Particle Data Group, 2006).

Γ, GeV	$M_H = 120$ GeV	$M_H = 185$ GeV
$\Gamma(H \to \gamma\gamma)$	$9.00 \cdot 10^{-6}$	$7.60 \cdot 10^{-5}$
$\Gamma(H \to gg)$	$1.71 \cdot 10^{-4}$	$1.71 \cdot 10^{-4}$
$\Gamma(H \to all)$	$4.5 \cdot 10^{-3}$	$8.5 \cdot 10^{-2}$

3. Higgs production in peripheral electromagnetic collisions.

- **Higgs production cross section**

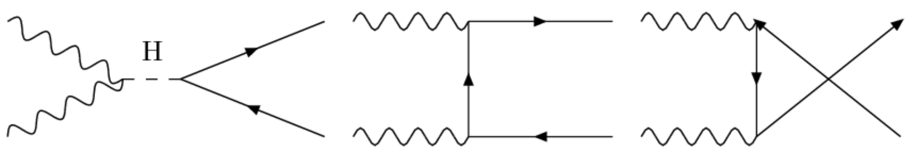


Fig. 3: b-jets production in $\gamma\gamma \to b\bar{b}$ fusion in EM collisions at LHC.

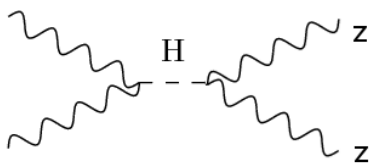
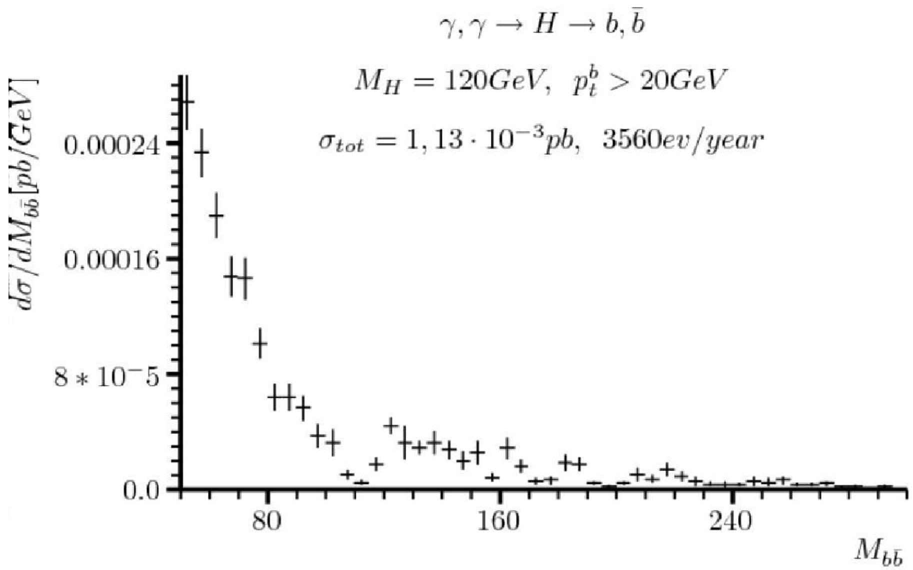


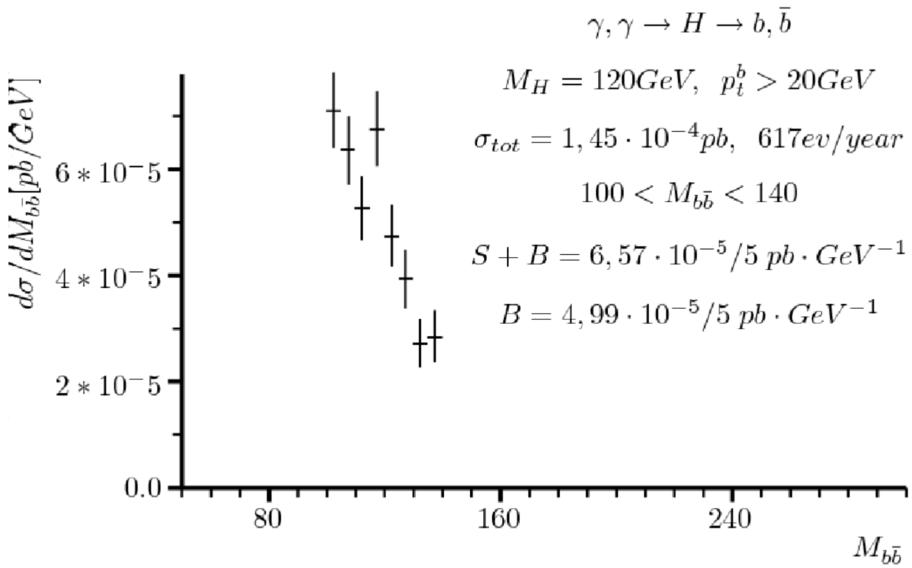
Fig. 4: b-jets production in $\gamma\gamma \to Z^0 Z^0$ fusion in EM collisions at LHC.

	$M_H = 120$ GeV $\gamma\gamma \to H \to b\bar{b}$		$M_H = 185$ GeV $\gamma\gamma \to H \to e^+e^-e^+e^-$	
A	σ, pb	ev/year	σ, pb	ev/year
Pb^{82}_{208}	7.17	0.09	$1.1 \cdot 10^{-2}$	$\ll 1$
Sn^{50}_{120}	2.98	0.72	$6.7 \cdot 10^{-3}$	$\ll 1$
Kr^{36}_{84}	1.40	1.41	$4.4 \cdot 10^{-3}$	$\ll 1$
Ar^{18}_{40}	0.221	3.62	$1.0 \cdot 10^{-3}$	$\ll 1$
O^{8}_{16}	0.026	11.48	$1.4 \cdot 10^{-4}$	$\ll 1$
p	$1.1 \cdot 10^{-4}$	31.5	$8.7 \cdot 10^{7}$	0.2

Cross section



Cross section-2



4. Conclusions and problems

- **Conclusions**

1. For light Higgs ($M_H = 120$ GeV) in EM interactions in pp collisions can be observed Higgs peak with signal/background ration $S/B = 30\%$ in 2 b-jets channel.
2. Its very difficult to discover rather heavy Higgs ($M_H \geq 185$ GeV) in EM interaction in HI and pp collisions.
3. All calculation was made by CompHEP program with some nonstandard extensions for EPA spectrum.

- **Problem**

How to select EM interaction among all pp interactions? TOTEM?