PHYSICS AT LC – II

TOP & COLLIDER OPTIONS

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INTERACTION MEETING ON LINEAR COLLIDER,
NEW DELHI

OUTLINE

I. TOP PHYSICS

- MEASUREMENTS AT LC
- ISSUES ON TOP POLARIZATION
- ISSUES ON BEAM POLARIZATION
- SOME RECENT THEORETICAL WORK

II. $\gamma\gamma$ OPTION

- HIGGS PHYSICS
- OTHER ELECTRO-WEAK PROPERTIES
- EXTRA DIMENSIONS

III. $e\gamma$, e^-e^- OPTIONS

- ANOMALOUS COUPLINGS
- EXTRA DIMENSIONS.

I. TOP PHYSICS

INTEREST IN TOP QUARKS:

- HEAVIEST QUARK ($m_t \sim 175$ GeV)
- MASS CLOSE TO EWSB SCALE
- LARGE YUKAWA COUPLING IN SM ($Y_t \sim 1$)
- DECAYS FASTER THAN HADRONIZATION TIME SCALE

$\Gamma_t \sim$ GeV

$\tau \sim 3.6 \times 10^{-24}$ s. $< \tau_H \sim 10^{-23}$ s.

TOP QUARK AT e^+e^- COLLIDER:

($\sqrt{s} \gtrsim 350$ GeV)

- PRODUCTION THROUGH $e^+e^- \to t\bar{t}$
- CROSS SECTION ~ 500 fb ($\sqrt{s} = 500$ GeV)
- ABOUT 10^5 $t\bar{t}$ / YEAR

($\int L\,dt \sim 200\,fb^{-1}$)

- MEASUREMENTS THROUGH

SEMILEPTONIC CHANNELS (B.R. $2 \times 4/27$)

$$e^+e^- \longrightarrow t\bar{t} \to (b\ell^+\bar{\nu}_\ell)(\bar{b}q\bar{q}')$$
$$\to (b\bar{q}q')(\bar{b}\ell^-\nu_\ell)$$

PURELY LEPTONIC CHANNELS (B.R. 4/81)

$$e^+e^- \longrightarrow t\bar{t} \to (b\ell^+\bar{\nu}_\ell)(\bar{b}\ell^-\nu_\ell)$$

MEASUREMENTS NEAR THRESHOLD :

- TOP MASS DETERMINATION :

  SHAPE OF TOTAL PRODUCTION C.S.
  IN THE THRESHOLD REGION

- MORE DETAILED FIT TO

  $\sigma_{t\bar{t}}$, p_t DISTRIBUTION , F-B ASYM

  GIVES $m_t(1S)$, $\alpha_s(M_Z)$, Γ_t , $g_{t\bar{t}H}$

- F-B ASYMM. MEASURES INTERFERENCE
  BETWEEN V & A CONTRIBUTIONS :
  S-WAVE & P-WAVE RESONANCE CONTRIBUTIONS

- POLARIZATION OF TOP QUARK CAN BE
  MEASURED TO STUDY ITS PROPERTIES

MEASUREMENTS IN THE CONTINUUM

PRECISION MEASUREMENTS OF THE PROPERTIES OF TOP (MASS, WIDTH, DECAY BRANCHING RATIOS, ...) AND ITS COUPLINGS CAN BE MADE.

→ TEST OF STANDARD MODEL.

ELECTROWEAK COUPLINGS

COUPLINGS OF THE TOP QUARK TO E.W. GAUGE BOSONS (γ, Z, W) MAY BE WRITTEN AS:

$$\mathcal{L}^{\text{eff.}}_{\gamma,Z} = \sum_{i=\gamma,Z} e\left[\bar{t}\gamma_\mu\left(F_V^i + F_A^i\gamma_5\right)t\, G^{i\mu} + \frac{i}{2m_t}\bar{t}\sigma_{\mu\nu}\left(c_M^i + \gamma_5 c_d^i\right)t\, F_i^{\mu\nu}\right]$$

$F^i_{V,A}$: FORM FACTORS (V, A)

c_M^i : MAGNETIC DIPOLE COUPLING

c_d^i : ELECTRIC DIPOLE COUPLING (P, T VIOLATING)

$$\mathcal{L}^{\text{eff}}_{tbW} = -\frac{g}{\sqrt{2}} V_{tb}\,\bar{t}\left[\gamma^\mu\left(f_{1L}P_L + f_{1R}P_R\right)W^i_\mu - \frac{i}{m_W}\sigma^{\mu\nu}\left(f_{2L}P_L + f_{2R}P_R\right)W_{\mu\nu}\right]b$$

SIMILARLY FOR $\bar{t}\bar{b}\bar{W}$

SM: $f_{1L}=1$, $\bar{f}_{1L}=1$, REST ZERO.

FORWARD-BACKWARD ASYMMETRY CAN BE USED TO DETERMINE/CONSTRAIN $F_{V,A}^{\gamma,Z}$

FOR OTHER FORM FACTORS, MORE DETAILED INFORMATION IS NEEDED: TOP POLARIZATION AND/OR DECAY DISTRIBUTIONS (ENERGY, ANGULAR) (PARTICULARLY FOR STUDYING CP VIOLATION)

FULL SPIN DENSITY MATRIX INFORMATION

$\equiv$ DECAY DISTRIBUTION INFORMATION

(IFF DECAY IS GOVERNED BY SM).

SOME ISSUES RELATED TO TOP POLARIZATION

1. TOP POLARIZATION CAN BE MEASURED ONLY THROUGH DECAY DISTRIBUTIONS

   (J. KÜHN 1984; CZARNECKI, JEZABEK & KÜHN 1994)

   (NEEDS ACCURATE KNOWLEDGE OF DECAY)

2. PREDICTIONS FOR POLARIZATION DEPEND ON CHOICE OF SPIN BASIS

   (S. PARKE & Y. SHADMI 1996; G. MAHLON & PARKE 1997

ALTERNATIVE APPROACH:

MAKE PREDICTIONS FOR DECAY LEPTON ANGULAR DISTRIBUTIONS

ADVANTAGE

- INDEPENDENT OF ANOMALOUS tbW COUPLINGS IN THE LINEAR APPROX. OF ANOMALOUS COUPLINGS.

(GRZADKOWSKI & HIOKI, SDR)

(FIRST SHOWN TO HOLD FOR $m_b \to 0$. THEN FOUND TO BE TRUE FOR $m_b \neq 0$.)

- THIS PROPERTY DOES NOT DEPEND ON PRODUCTION PROCESS FOR $t\bar{t}$

(FOR $\gamma\gamma \to t\bar{t}$: OHKUMA 2002; GODBOLE, SDR, SINGH 2003.
FOR ANY PROCESS: GRZADKOWSKI & HIOKI)

- DOES NOT NEED PRECISE RECONSTRUCTION OF TOP ENERGY-MOMENTUM.

- TOP SPIN BASIS NOT RELEVANT

- INCIDENTALLY, ALSO INDEPENDENT OF QCD CORRECTIONS TO tbW VERTEX

HOW CAN ONE STUDY DECAY PROPERTIES/ ANOMALOUS tbW COUPLINGS?

ANSWER: USE b QUARK DISTRIBUTION

(DIFFICULT IN PRACTICE)

OR

USE $\ell^{\pm}$ ENERGY DISTRIBUTION

(WITH/WITHOUT ANGULAR DIST.)

(GRZADKOWSKI & HIOKI, SDR)

e^-/e^+ BEAM POLARIZATION

e^- LONGITUDINAL POLARIZATION OF 80% EXPECTED TO BE AVAILABLE

e^+ LONG. POL. MAY BE LIMITED TO 60%

IN PRINCIPLE, LONG. POLARIZATION CAN BE CONVERTED TO TRANSVERSE.

- LONGITUDINAL POLARIZATION CAN HELP BY EITHER SUPPRESSING COUPLINGS OR ENHANCING COUPLINGS

  → HELPS TO SUPPRESS BACKGROUND

  → CAN HELP TO ENHANCE SENSITIVITY

- FLIPPING OF SIGN OF POLARIZATION CAN GIVE ADDITIONAL INDEPENDENT DATA.

SOME ISSUES RELATED TO TRANSVERSE POLARIZATION

TRANSVERSE e^- AND/OR e^+ POL. CAN HELP TO ENHANCE SENSITIVITY TO CERTAIN COUPLINGS

RECENT EXAMPLES:

T. RIZZO (2002) : IN THE CONTEXT OF TEV-SCALE GRAVITY & EXCHANGE OF MASSIVE SPIN-2 GRAVITONS

J. FLEISCHER, K. KOLODZIEJ, F. JEGERLEHNER (1994) : ANOMALOUS COUPLINGS IN $e^+e^- \to W^+W^-$

2 DIFFERENT ROLES PLAYED BY TRANSVERSE POL.

1. IN $e^+e^- \to t\bar{t}$ CP VIOLATION (OR T VIOLATION) NEEDS EITHER POLARIZED BEAMS OR MEASUREMENT OF TOP POLARIZATION.

   IF TRANSVERSE POLARIZATION IS PRESENT TRIPLE PRODUCTS (CP & T-ODD) CAN BE SEARCHED FOR (WITHOUT t DECAY DISTRIBUTIONS)

   e.g., $\vec{p}_{e^-} \times (\vec{s}_{e^-} - \vec{s}_{e^+}) \cdot \vec{p}_t$

   (B. ANANTHANARAYAN & SDR, 2003)

2. ONE CAN USE AZIMUTHAL DISTRIBUTIONS TO LOOK FOR VIOLATION OF CHIRAL INVARIANCE.

FOR $e^+e^- \to f\bar{f}$:

$$\frac{d\sigma}{d\Omega} \propto \frac{1}{4}\Big(|T_{+-}|^2 + |T_{++}|^2 + |T_{--}|^2 + |T_{-+}|^2 \Big)$$

$$+ 2 P \bar{P}\, \mathrm{Re}\Big(e^{-2i\phi}\, [T_{+-}^* T_{-+}] + [T_{++}^* T_{--}] \Big)$$

$$+ 2 P\, \mathrm{Re}\Big(e^{-i\phi}\, [T_{+-}^* T_{--} + T_{++}^* T_{-+}] \Big)$$

$$+ 2 \bar{P}\, \mathrm{Re}\Big(e^{-i\phi}\, [T_{+-}^* T_{++} + T_{--}^* T_{-+}] \Big)$$

CHIKASA 1986)

CHIRAL INVARIANCE $\Rightarrow$ $T_{++} = 0$ (EQUAL
($m_e = 0$) $T_{--} = 0$ e^- & e^+ HELICITIES)

$\to$ NO $\cos\phi$, $\sin\phi$ TERMS

ASYMMETRY LIKE $\phi \to -\phi + \pi$ ($\cos\phi \to -\cos\phi$)

OR $\phi \to 2\pi - \phi$ ($\sin\phi \to -\sin\phi$)

CAN SEARCH/MEASURE T_{++} OR T_{--} AMPLITUDES

THESE DO NOT INTERFERE WITH ONLY LONGITUDINAL POLARIZATION

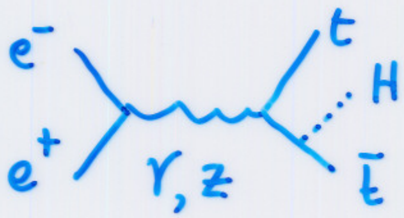
THIS IS WHERE TRANSVERSE POL. CAN HELP

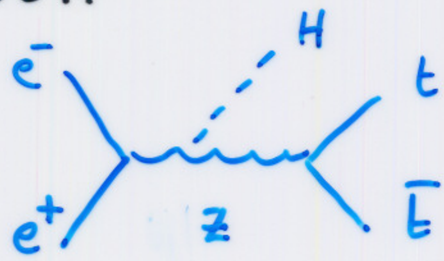
OTHER TOP COUPLINGS

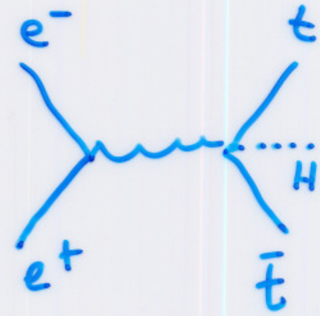
- ## $\bar{t}tH$ Yukawa coupling.

CAN BE MEASURED IN THE PROCESS

$$e^+e^- \rightarrow t\bar{t}H$$





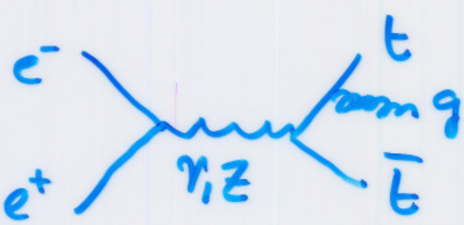


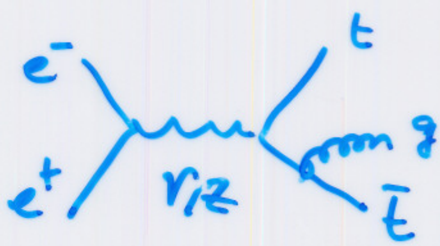
DEPENDING ON THE MASS OF THE HIGGS THIS PROCESS WOULD HAVE VARYING SENSITIVITY

DETAILED STUDY OF BACKGROUND & LOOP CORRECTIONS NEEDED

- ## GLUONIC COUPLINGS OF TOP

AN e^+e^- COLLIDER IS A GOOD PLACE TO MEASURE THE $t\bar{t}g$ COUPLING THROUGH $e^+e^- \rightarrow t\bar{t}g$ SINCE ONLY t & $\bar{t}$ CAN EMIT A GLUON (NOT e^+e^- OR γ, Z)





BEYOND SM : SOME RECENT WORK

CP VIOLATION IN TOP PRODUCTION & DECAY :

- SEVERAL PROPOSALS HAVE EXISTED
- INVOLVE MEASUREMENT OF TOP POLARIZATION OR DECAY PRODUCT CORRELATIONS/DISTRIBUTIONS

(KANE, LADINSKY & YUAN; SCHMIDT & PESKIN; ... BERNREUTHER ET AL. ; ....)

- RECENT WORK INVOLVING DECAY DISTRIBUTIONS :

- CHARGED LEPTON ANGULAR DISTRIBUTION : (P. POULOSE & SDR / B. GRZADKOWSKI & Z. HIOKI SDR)
  - → MEASURE OF ELECTRIC & WEAK DIPOLE COUPLINGS
  - → INDEPENDENT OF CP VIOLATION IN DECAY
  - → INCLUDING EFFECT OF LONGITUDINAL POL.
  - → INCLUDING $O(\alpha_s)$ QCD CORRECTIONS

  CP-VIOLATING ANGULAR ASYMMETRY LEADS TO BEST LIMITS OF $(1-2)\times 10^{-18}$ e cm

  (90% CL, $\sqrt{s} = 500$ GeV, $\int L\,dt = 500\, fb^{-1}$)

  - → CLOSE TO OPTIMISTIC VALUES FROM POPULAR EXTENSIONS OF SM

- CHARGED LEPTON ENERGY DISTRIBUTIONS & b-QUARK ENERGY & ANGULAR DISTRIBUTIONS : (B. GRZADKOWSKI & Z. HIOKI, SDR)
  - → CONTRIBUTIONS FROM BOTH DIPOLE COUPLINGS & CP-VIOLATION IN DECAY.

SINGLE TOP PRODUCTION

→ SINGLE TOP PRODUCTION IS POSSIBLE THROUGH

$e^+e^- \to e^-\bar{\nu}_e t\bar{b}$

(S. AMBROSANIO & B. MELE 1994;
N. DOKHOLIAN, G.V. JIKIA 1994)

A LARGE NUMBER OF DIAGRAMS CONTRIBUTE

SOME CORRESPOND TO $e^+e^- \to t\bar{t}$ FOLLOWED BY DECAY, AND THESE HAVE TO BE SUBTRCTED

RIGHT-HANDED POLARIZATION $(e_R^- e_R^+)$ ~~bkk~~ HELPS TO REMOVE THE $t\bar{t}$ BACKGROUND

$\sigma(e_R^- e_R^+) \sim$ FEW fb AT $\sqrt{s} > 500$ GeV

AND CAN BE MEASURED

(E. BOOS ET AL. 2001)

→ ANOMALOUS tbW COUPLINGS CAN BE CONCTRAINED

$-0.05 \leq f_{2R} \leq 0.05$

FOR $\sqrt{s} = 500$ GeV, $L = 500\,fb^{-1}$

→ FLAVOUR-CHANGING COUPLINGS TO Z & γ CAN PRODUCE SINGLE TOP:

$e^+e^- \to t\bar{q}$

(V. OBRAZTSOV ET AL. 1998
T. HAN & J. HEWETT, 1999
S. BAR-SHALOM & J. WUDKA, 1999)

CAN BE USED TO BOUND $Zt\bar{q}$, $\gamma t\bar{q}$ COUPLINGS

BEAM POLARIZATION CAN HELP REDUCE BACKGROUND.

J. AGUILAR-SAAVEDRA, 2001.

II. PHOTON COLLIDER : $\gamma\gamma$ OPTION

HIGH-ENERGY PHOTONS PRODUCED BY COMPTON BACKSCATTERING OF INTENSE LASER BEAMS OFF HIGH-ENERGY ELECTRONS

ENERGY SPECTRUM OF PHOTONS DETERMINED BY

$$x = \frac{4 E_b \omega_0}{m_e^2} = 15.3 \left(\frac{E_b}{TeV}\right)\left(\frac{\omega_0}{eV}\right)$$

E_b : ELECTRON ENERGY

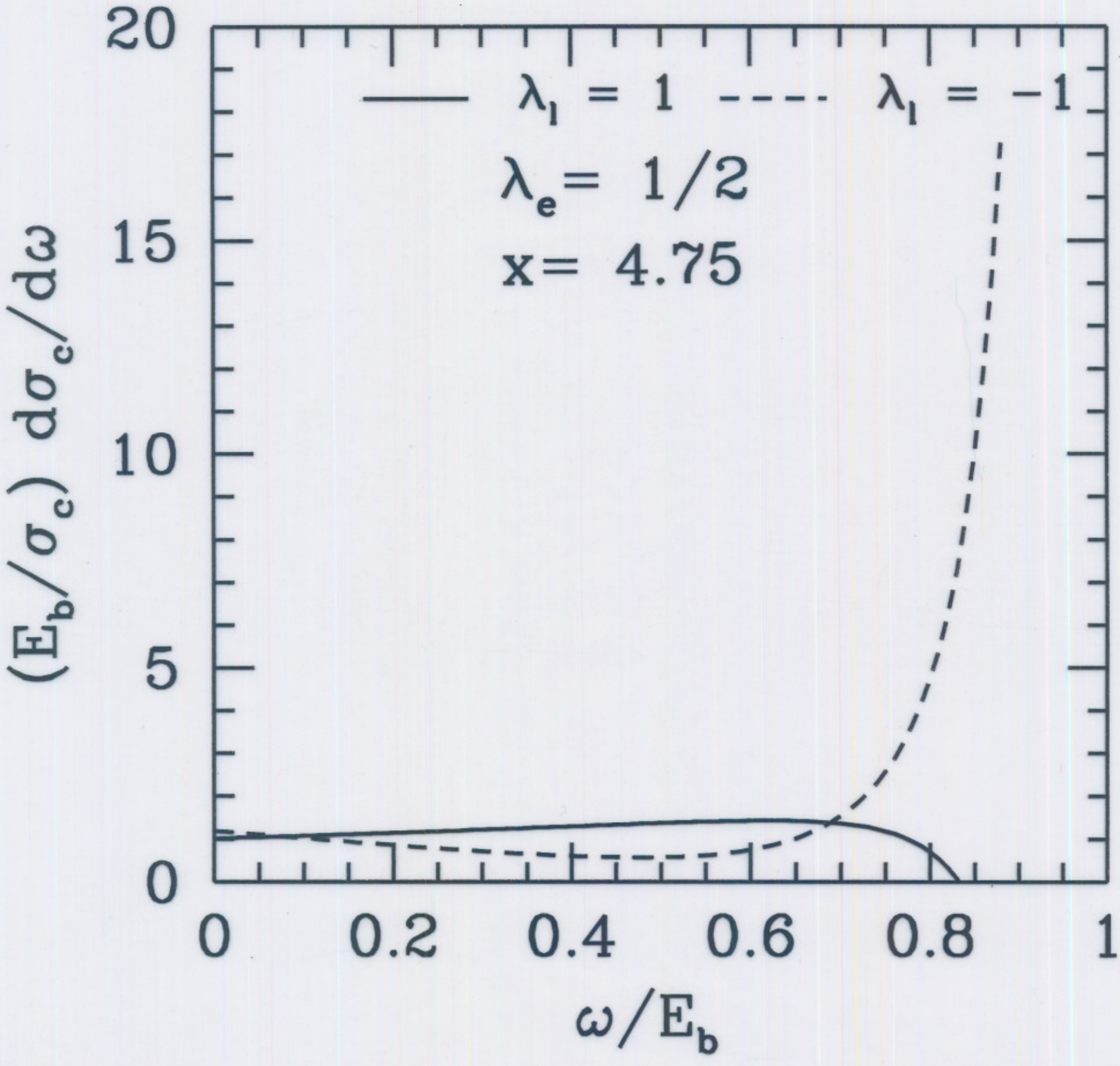
ω_0 : LASER ENERGY

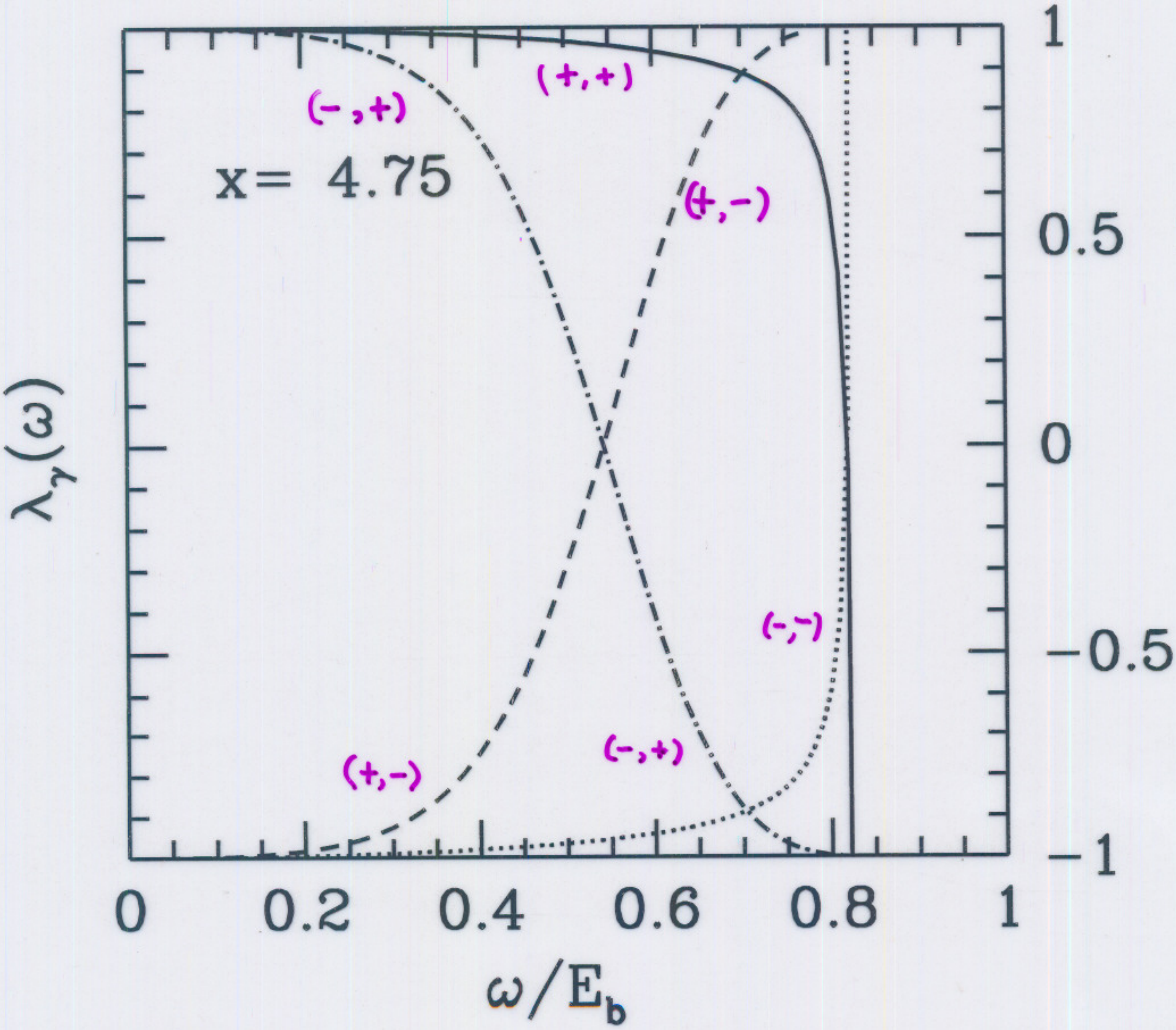
AND POLARIZATION OF ELECTRONS & LASER γ's

LARGE FRACTION OF THE ELECTRON ENERGY & POLARIZATION TRANSFERRED TO THE HIGH-ENERGY PHOTON. $\left(\frac{\omega_{max}}{E_b} = \frac{x}{x+1}\right)$

(FOR OPPOSITE HELICITIES)

FOR $\lambda_e \lambda_\gamma = -1/2$, BOTH INTENSITY AND POLARIZATION PEAK AT LARGE ENERGY


λ_l = 1
λ_l = −1
λ_e= 1/2
x= 4.75
(E_b/σ_c) dσ_c/dω
ω/E_b
0
5
10
15
20
0.2
0.4
0.6
0.8
1



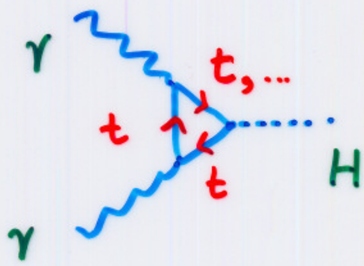
(+,+)
(−,+)
x= 4.75
(+,−)
(−,−)
(−,+)
(+,−)
$\lambda_\gamma(\omega)$
ω/E_b
0
0.2
0.4
0.6
0.8
1
−1
−0.5
0
0.5
1

APPLICATIONS : TWO-PHOTON ACCESSIBLE MORE DIRECTLY

HIGGS PHYSICS

e^+e^-H COUPLING SUPPRESSED BY m_e/E

$\gamma\gamma H$ COUPLING POSSIBLE AT ONE LOOP



- HIGGS CAN BE PRODUCED AS RESONANCE.
- ACCURATE DETERMINATION OF $H\gamma\gamma$ COUPLING (AND HENCE $\Gamma(H\to\gamma\gamma)$ POSSIBLE)

  (IMPORTANT FOR DETERMINATION OF PARAMETERS

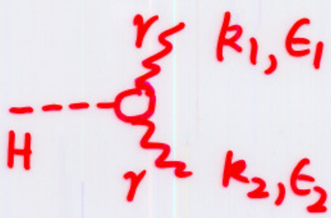
- CP PROPERTIES OF HIGGS CAN BE DETERMINED USING POLARIZED PHOTONS

  (GRZADKOWSKI & GUNION, 1992)

EFFECTIVE COUPLINGS :

SCALAR : $(k_1\cdot k_2\,\epsilon_1\cdot\epsilon_2 - \epsilon_1\cdot k\,\epsilon_2\cdot k_1)$

PSEUDOSCALAR : $\epsilon_{\mu\nu\alpha\beta}\,\epsilon_1^{\mu}\epsilon_2^{\nu}k_1^{\alpha}k_2^{\beta}$



BEYOND SM : (MULTI-HIGGS, MSSM)

- MORE THAN ONE HIGGS
- CP VIOLATION

CP PROPERTIES OF HIGGS CAN BE DETERMINED ALSO FROM FINAL STATE POLARIZATION IN

$$\gamma\gamma \to t\bar{t}$$

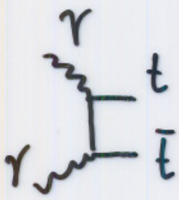
(E. ASAKAWA ET AL., 2000, 2003)

~~S. CHOI & K. HAGIWARA, 1995; M.S. BAEK ET AL. 1997)~~

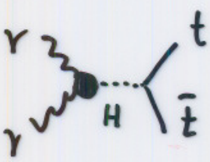
$t, \bar{t}$ POLARIZATION INFORMATION CAN BE BYPASSED USING CHARGED LEPTON ANGULAR ASYMMETRIES

(R. GODBOLE, SDR, R.K. SINGH, 2003)

MODEL INDEPENDENT ANALYSIS :



$$V_{t\bar{t}H} = -ie\frac{m_t}{m_W}\left(S_t + i\gamma^5 P_t\right)$$



$$V_{\gamma\gamma H} = -\frac{i\alpha}{4\pi}\sqrt{s}\left[S_\gamma\left(\epsilon_1\cdot\epsilon_2 - \frac{1}{k_1\cdot k_2}\epsilon_1\cdot k_2\,\epsilon_2\cdot k_1\right)\right.$$
$$\left. - P_\gamma\frac{1}{k_1\cdot k_2}\epsilon_{\mu\nu\alpha\beta}\,\epsilon_1^\mu\epsilon_2^\nu k_1^\alpha k_2^\beta\right]$$

S_γ, P_γ : COMPLEX FORM FACTORS

ANOMALOUS tbW INTERACTIONS DONT CONTRIBUTE

6 PARAMETERS : $\begin{cases} S_t, P_t \\ \mathrm{Re}\,S_\gamma \quad \mathrm{Im}\,S_\gamma \\ \mathrm{Re}\,P_\gamma \quad \mathrm{Im}\,P_\gamma \end{cases}$

CHOOSE $2\lambda_e \lambda_\ell = -1$ (HARD PHOTON SPECTRU[M])

& $\lambda_{e^-} = \lambda_{e^+}$ (HIGGS COUPLE TO PHOTONS OF EQUAL HELICITY ; SM : OPPOSIT[E])

NOW $\lambda_{e^-} = +\frac{1}{2}$ OR $-\frac{1}{2}$

CORRESPONDING TO ℓ^+ OR ℓ^- IN FINAL STATE, WE HAVE 4 COMBINATIONS

$\sigma(+,+)$ $\sigma(+,-)$ $\sigma(-,+)$ $\sigma(--)$

CAN CONSTRUCT 6 ASYMMETRIES:

2 CP-VIOLATING

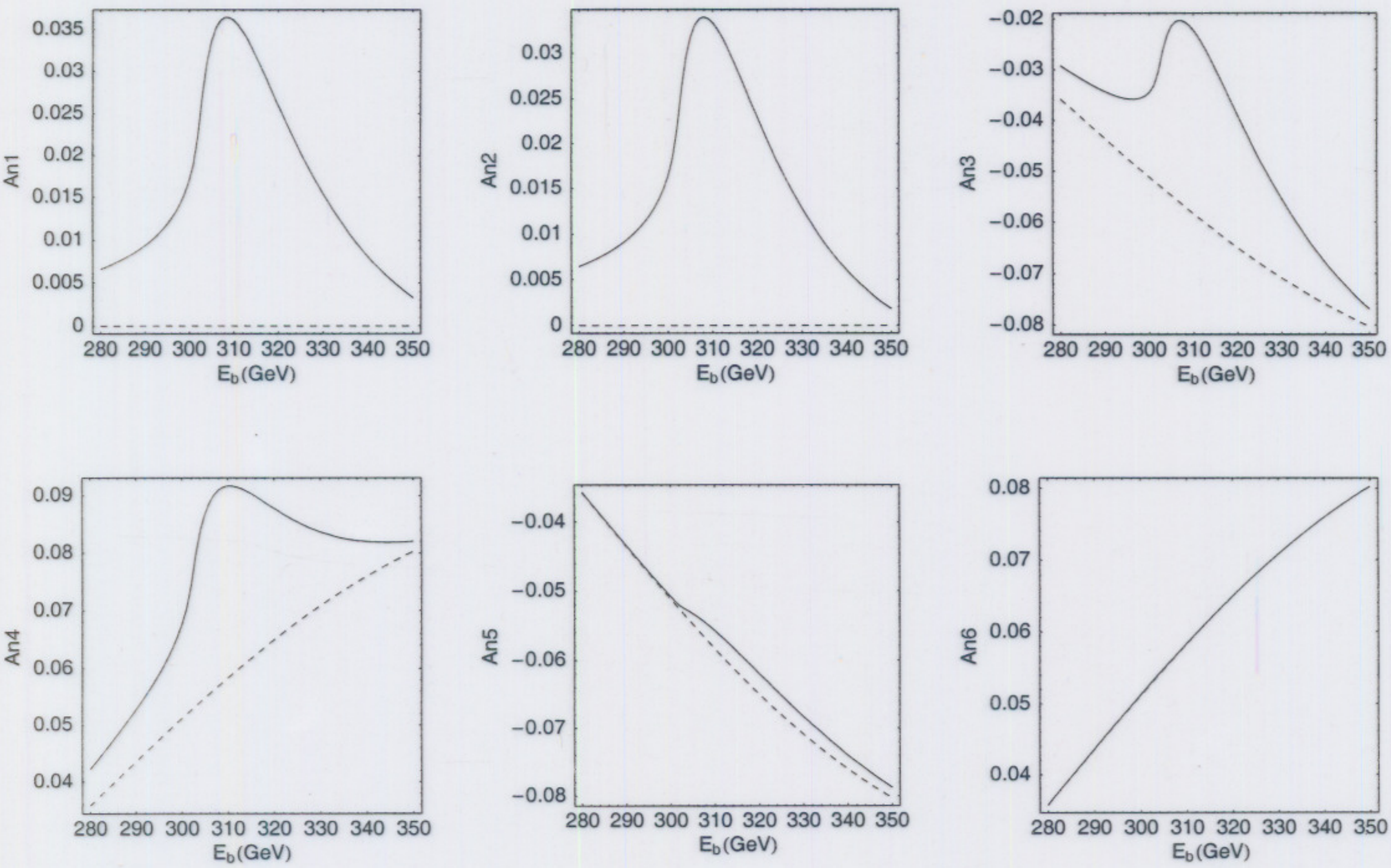
2 CHARGE ASYMMETRIES

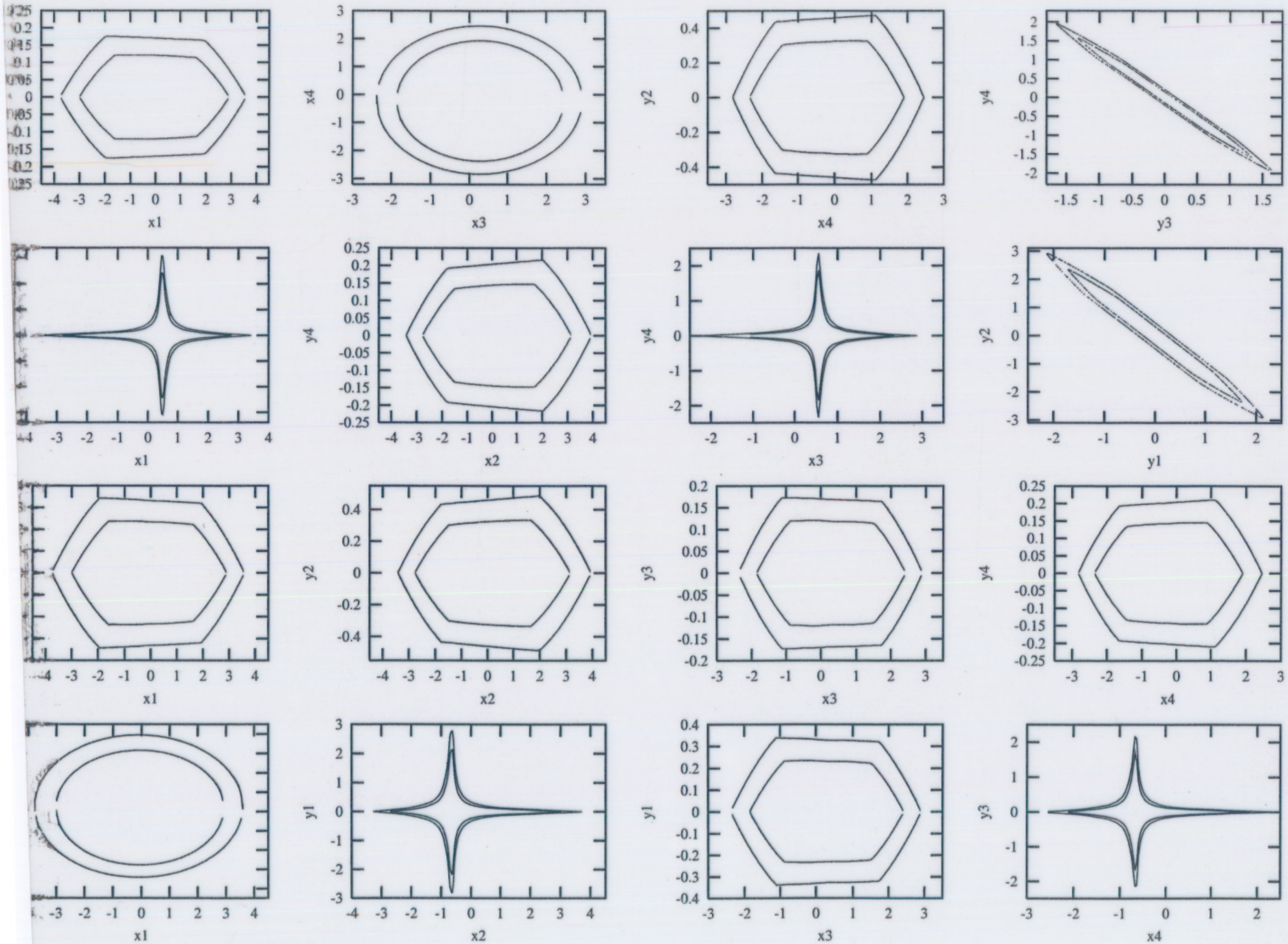
2 POLARIZATION ASYMMETRIES

CAN FIND REGIONS IN PARAMETER SPACE WHERE THE THEORY CAN BE DISTINGUISHED FROM S.M. AT 95% C.L.

- STRONG LIMITS ON CP-VIOLATING COMBINATIONS OF PARAMETERS (VARIED 2 AT A TIME)
- DETERMINATION OF ALL PARAMETERS NEEDS LINEAR POLARIZATION

ASYMMETRIES IN MSSM FOR A CHOICE OF PARAMETRS.




x1
x4
x3
y2
x4
y4
y3
x1
y4
x2
y4
x3
y2
y1
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x2
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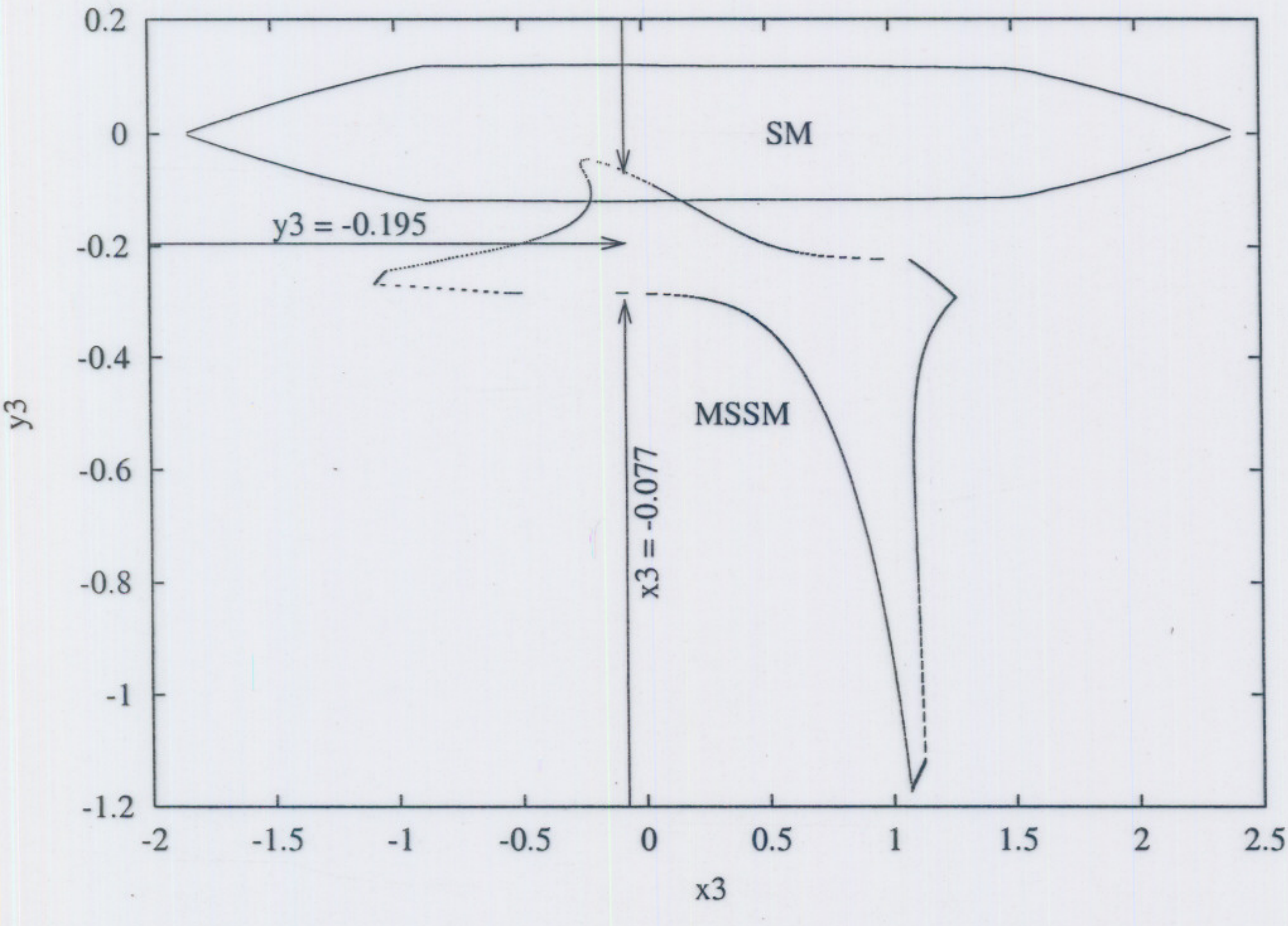
y1
x3
y3
x4


0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
2.5
x3
y3
SM
MSSM
y3 = -0.195
x3 = -0.077

OTHER ELECTROWEAK PROPERTIES :

$\gamma\gamma$ CAN HELP MEASURE SEPARATELY ELECTRIC DIPOLE MOMENTS d^γ (INDEPENDENT OF d^Z)

USE OF TOP POLARIZATION TO STUDY CP-VIOLATIN[G]

DIPOLE COUPLINGS OF TOP :

S.Y. CHOI & K. HAGIWARA (1995)

M.S. BAEK , S.Y. CHOI & C.S. KIM (1997)

USE OF DECAY-LEPTON ASYMMETRIES TO MEASURE TOP DIPOLE COUPLING :

P. POULOSE & SDR (1998)

INCLUDING ANOMALOUS $\gamma\gamma Z$ COUPLING WITH d

P. POULOSE & SDR (1999)

INCLUDING $\gamma\gamma H$ COUPLING AS WELL AS d_t^γ :

B. GRZADKOWSKI, Z. HIOKI, K. OHKUMA, J. WUDKA (2003)

OTHER THAN TOP : CHOI, HAGIWARA & BAEK (1996) ($\gamma\gamma \to W^+W^-$)

J.L. HEWETT & F.J. PETRIELLO (2001) ($\gamma\gamma \to \gamma\gamma, \gamma Z, ZZ$)

G. GOUNARIS & F.M. RENARD (1996) ....

EXTRA DIMENSIONS :

- GRAVITONS HAVE TREE-LEVEL COUPLING TO TWO PHOTONS

- CAN CONTRIBUTE TO REAL GRAVITON EMISSION AS WELL AS VIRTUAL GRAVITON EXCHANGE.

A NUMBER OF CALCULATIONS HAVE BEEN CARRIED OUT FOR VARIOUS FINAL STATES WITH GRAVITON EXCHANGE :

T. RIZZO (1999) (GAUGE BOSONS)

K. AGASHE & N.G. DESHPANDE (1999)

D. ATWOOD ET AL. (2000) (REAL GRAVITONS)

H. DAVOUDIASL (1999)

K.Y. LEE ET AL. (1999) (W^+W^-) $(t\bar{t})$

* P. MATHEWS, P. POULOSE, K. SRIDHAR (1999) $(t\bar{t})$

D. K. GHOSH, P. MATHEWS, P. POULOSE, K. SRIDHAR (1999)

M. DONCHESKI & R.W. ROBINETT (2000) → (2 JETS)

S. R. CHOUDHURY, A.S. CORNELL, G.C. JOSHI (2002) $(\gamma\gamma \to ZZ)$

* FOR EXAMPLE, FROM TOTAL CROSS SECTIONS & RAPIDITY DISTRIBUTIONS, LIMIT ON M_S OF 1.6 TeV $(\sqrt{s} = 500$ GeV$)$ $(\int L dt = 10$ fb$^{-1})$ IS POSSIBLE.

→ IMPROVES TO 1.95 TeV OR 2.5 TeV WITH POLARIZATION.

CALCULATIONS WITH REALISTIC SPECTRUM

IDEAL COMPTON SCATTERED SPECTRUM IS VALID IF

1) LASER POWER IS SMALL
2) PRIMARY ELECTRON BEAMS SUFFICIENTLY WIDE

1) ⇒ NON-LINEAR EFFECTS SMALL

2) ⇒ EFFECTS RELATED TO PHOTON SCATTERING ANGLE CAN BE NEGLECTED.

SIMULATION IN A REALISTIC CASE DONE BY V. TELNOV, AND ALSO BY P. CHEN ET AL. ("CAIN")

A. ZARNECKI HAS PROVIDED A PARAMETRIZATION WHICH AGREES WITH TELNOV SIMULATION AT THE HIGH ENERGY END.

ZARNECKI'S PARAMETRIZATION "COMPAZ" HELPS TO INTERPOLATE FOR VARIOUS BEAM ENERGIES

WORK IS IN PROGRESS TO REVISE LIMITS ON VARIOUS NEW PHYSICS IN $\gamma\gamma \to t\bar{t}$ USING CompAZ. (R. M. GODBOLE, P. MATHEWS, P. POULOSE, SDR, R. K. SINGH)

→ INTERESTING EFFECTS GET DILUTED

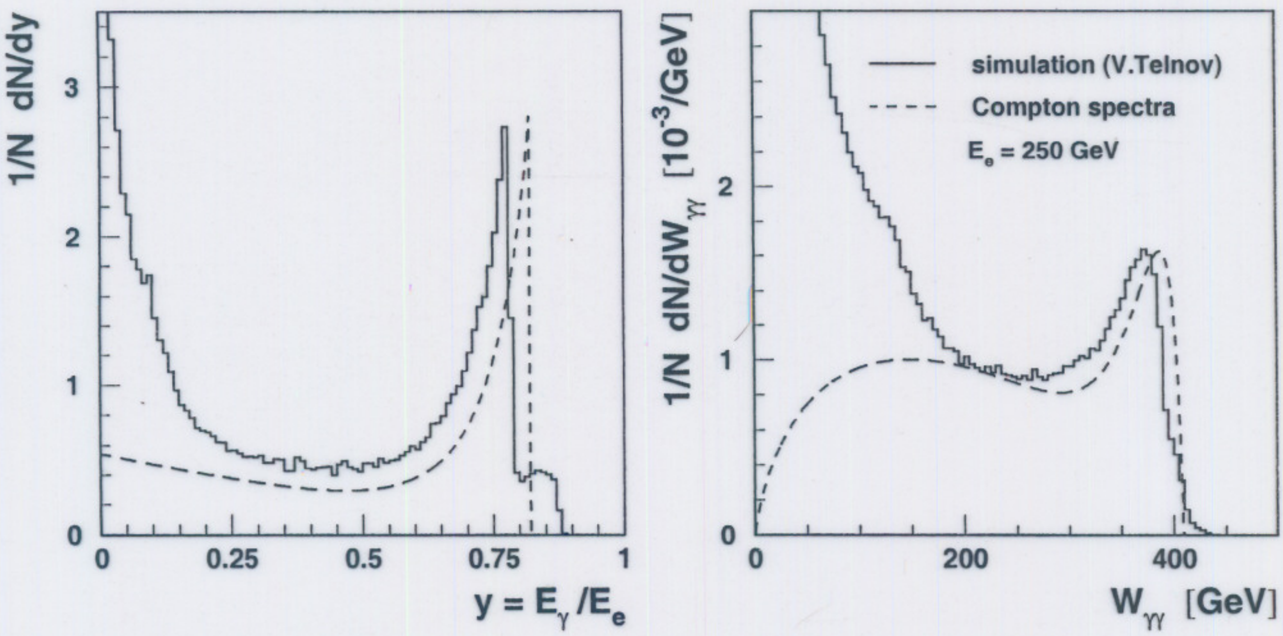


Fig. 1. Energy distribution for photons (left plot) and the $\gamma\gamma$ center-of-mass energy distribution (right plot) from full simulation of luminosity spectrum by V.Telnov [7] (solid line), compared to expectations for the simple Compton scattering (dashed line). For better comparison of shape, Compton spectra is scaled to the same height of the high energy peak.

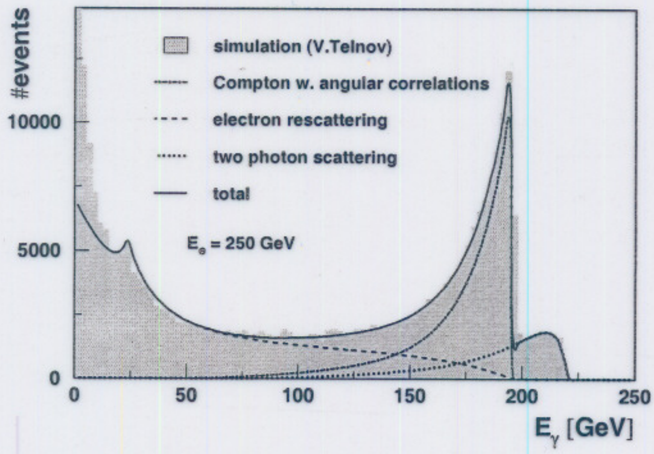


Fig. 3. Comparison of the photon energy distribution obtained from full simulation of luminosity spectrum by Telnov [7], with the fitted contributions of different processes considered in the described model, as indicated in the plot.

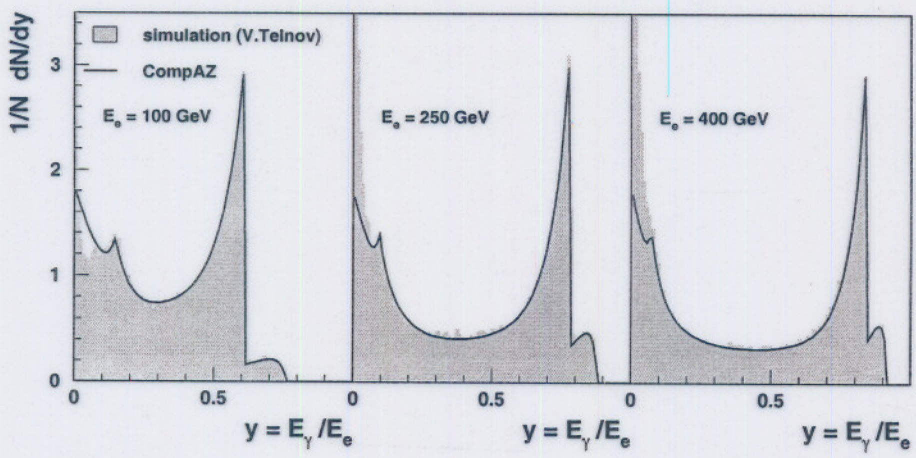


Fig. 4. Comparison of the photon energy distribution from the fitted parametrization with the distribution obtained from full simulation of luminosity spectra [7], for three electron beam energies, as indicated in the plot. Imposed cut on the energy of the second photon is 40, 150 and 260 GeV respectively.

$e\gamma$ & e^-e^- OPTIONS

$e\gamma$ OPTION MAY BE REALIZED BY USING COMPTON BACKSCATTERING FOR ONE OF THE BEAMS.

- SOMEWHAT BETTER CONTROL ON POLARIZATION
- A DIFFERENT RANGE OF PROCESSES ACCESSIBLE (SUSY : PREVIOUS TALK)

- AN OBVIOUS PROCESS WITH $e\gamma$ OPTION IS

$$e\gamma \to e\gamma \quad \text{(COMPTON SCATTERING)}$$

WHICH CAN BE USED TO CONSTRAIN NEW PHYSICS.

(H. DAVOUDIASL, 1999 ; EXTRA DIMENSIONS)

(P. MATHEWS, 2001 : NON-COMMUTATIVE SPACE-TIME)

- $e\gamma \to eG$ (G : GRAVITON) HAS BEEN PROPOSED FOR TEST OF WEAK SCALE GRAVITY

(D.K. GHOSH, P. POULOSE, K. SRIDHAR, 2000
D. ATWOOD, S. BAR-SHALOM, A. SONI, 2000)

STRINGENT BOUNDS MAY BE OBTAINED USING e & γ POLARIZATION

- VARIOUS ELECTROWEAK PROCESSES ARE POSSIBLE

e.g. $e^-\gamma \to \nu W$, $e^-\gamma \to e^- Z$, $e^-\gamma \to \bar{t} b \nu$ *

* G. JIKIA, 1992; E. BOOS ET AL., 1996, 1997, 2001; J.J. CAO ET AL., 1998

ANALYSIS QUITE COMPLICATED.

AGAIN, OBVIOUS PROCESS THAT CAN BE STUDIED WITH e^-e^- OPTION IS

$$e^-e^- \to e^-e^- \quad \text{(MØLLER SCATT.)}$$

- HERE NEUTRAL PARTICLES (γ, Z, Z', Graviton) CAN CONTRIBUTE ONLY THROUGH t, u CHANNEL EXCHANGE.

- s CHANNEL CAN BE USEFUL FOR DOUBLY-CHARGED PARTICLES — ~~GAUGE~~ HIGGS BOSONS, "DILEPTONS", ETC.

  (C.A. HEUSCH, 1995; F. CUYPERS, 1995
  M. RAIDAL, 1996 ...)

- t, u CHANNEL GRAVITON EXCHANGE IS STUDIED BY

  T. RIZZO 1999; D.K. GHOSH & S. RAYCHAUDHURI 2000.
  (ADD MODEL) (R-S MODEL)