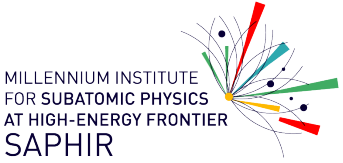
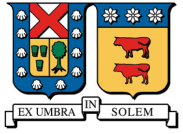
A Dark Vector Resonance at CLiC

Constanza Calender and Alfonso R. Zerwekh
UTFSM, Chile





UNIVERSIDAD TECNICA
FEDERICO SANTA MARIA

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Outline

- Motivation
- The Model
- Methodology
- Results
- Conclusions

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- Why a Dark Vector Resonance ?
  - We want to study dark sectors with their own set of non-Abelian interactions
- Why CLiC ?
  - Clean environment
  - Large c.m. energy ($\sqrt{s} = 3$ TeV)
  - Huge luminosity ($\mathcal{L} = 2000$ fb^{-1})
  - It allows exploration through radiative return to resonance

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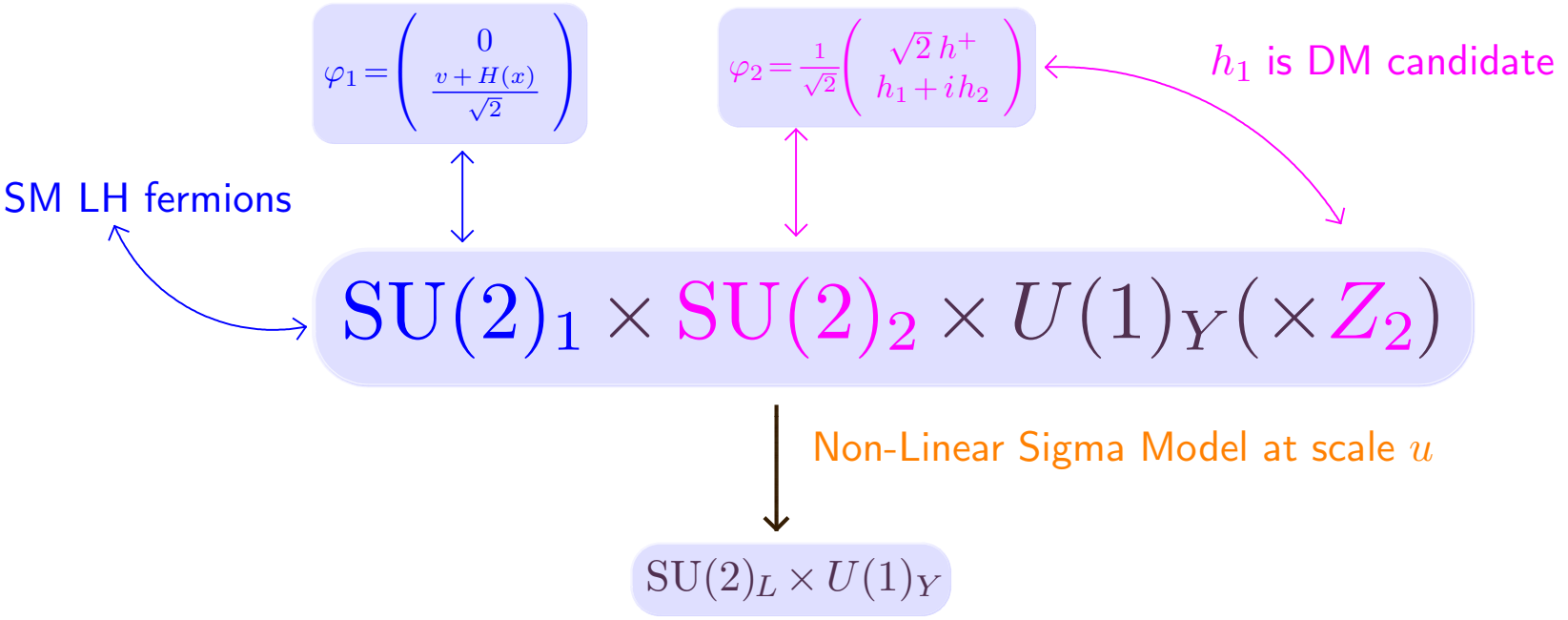
The Model

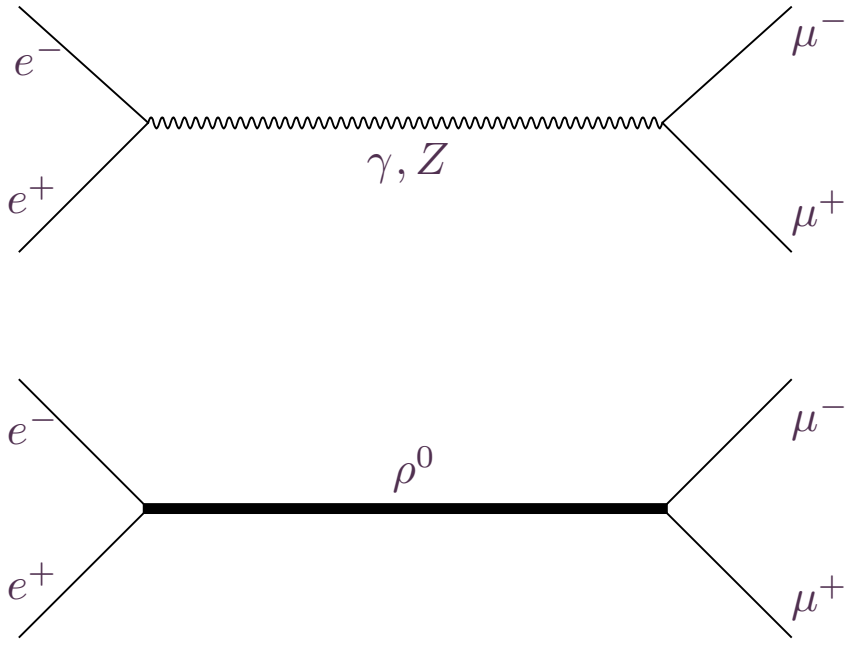

$\varphi_1 = \begin{pmatrix} 0 \\ \frac{v+H(x)}{\sqrt{2}} \end{pmatrix}$
$\varphi_2 = \frac{1}{\sqrt{2}} \begin{pmatrix} \sqrt{2}\,h^+ \\ h_1 + i h_2 \end{pmatrix}$
h_1 is DM candidate
SM LH fermions
$\mathrm{SU}(2)_1 \times \mathrm{SU}(2)_2 \times U(1)_Y (\times Z_2)$
Non-Linear Sigma Model at scale u
$\mathrm{SU}(2)_L \times U(1)_Y$

Spectrum

Particle	Symbol
Higgs	H
Vector Resonances	$\rho_\mu^{0,\pm}$
Dark Matter	h_1
Neutral Pseudo-Scalar	h_2
Charged Scalars	$h^\pm$

We will assume $m_{h_1} \approx m_{h_2} \approx m_{h^\pm}$

$e^+ e^- \longrightarrow \mu^+ \mu^-$

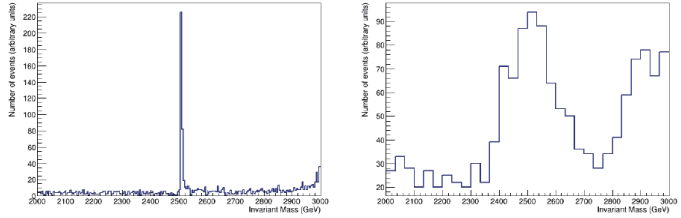


Accelerator and Detector Effects

Initial State Radation + Bremsstrahlung

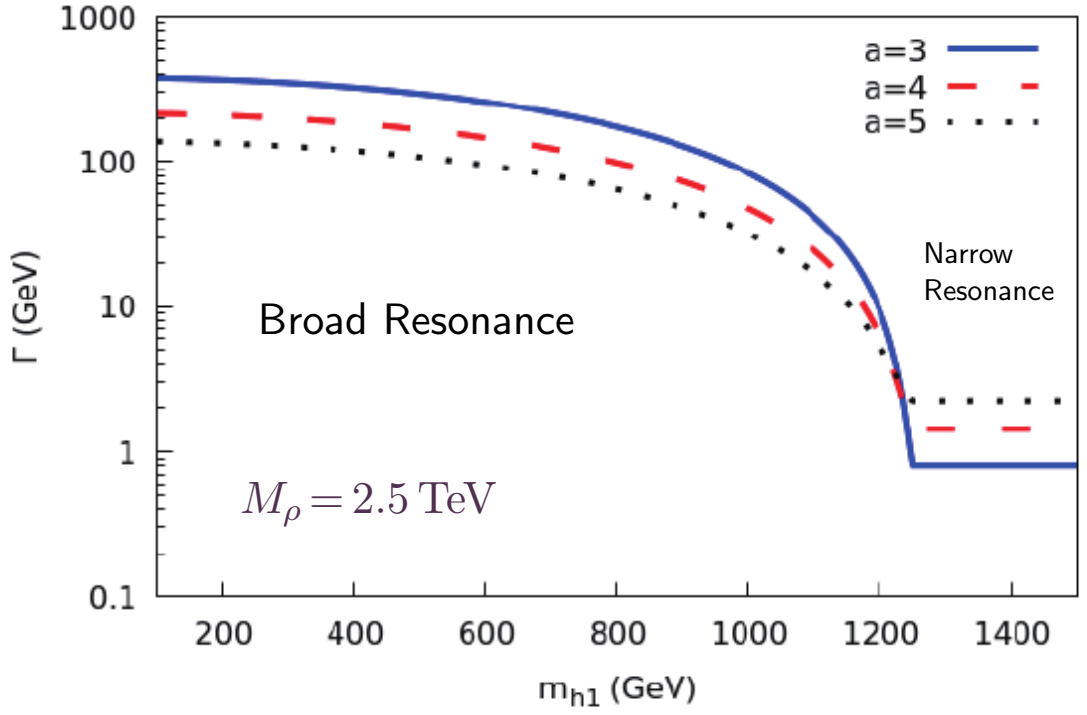
Smearing of momenta (5%)

CLiC Parameters	
max. beam energy	1.5 TeV
bunch length	4.4×10^{-3} cm
beam radius	H: $4.5 \times 10^{-2}\,\mu m$ V: $9 \times 10^{-4}\,\mu m$
particles per bunch	0.37×10^{10}
luminosty	$6 \times 10^{34}\,\mathrm{cm}^{-2}\,s^{-1}$



(a) (b)

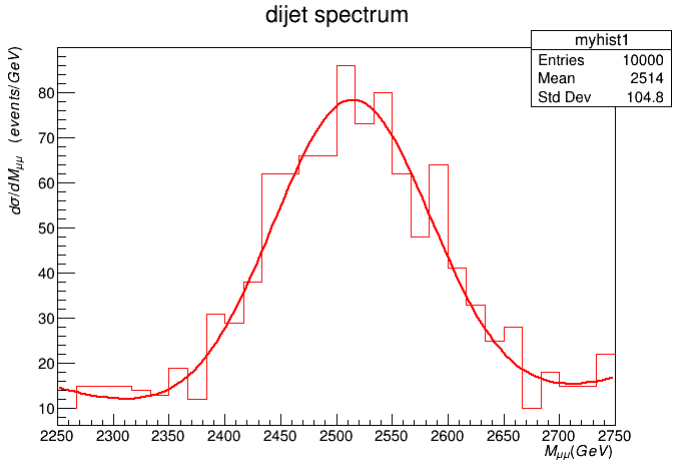
Two Regimes



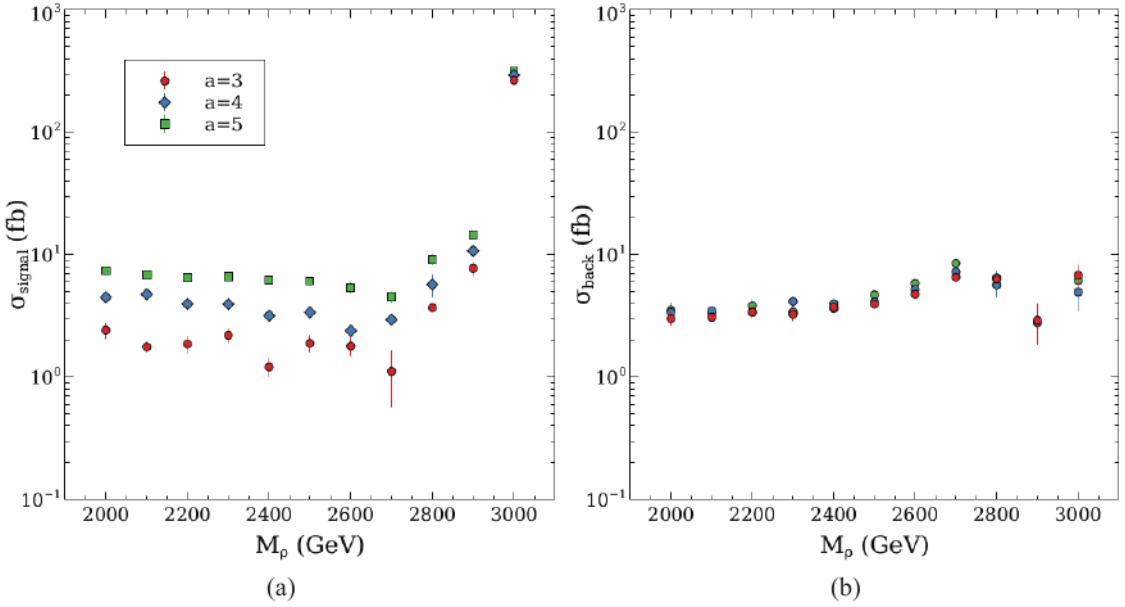
$$a = \frac{u}{v}$$

Procedure

- Generate events (CalcHEP)
- fit gaussian + quadratic background
- Extract resonant part



Results (heavy scalars)



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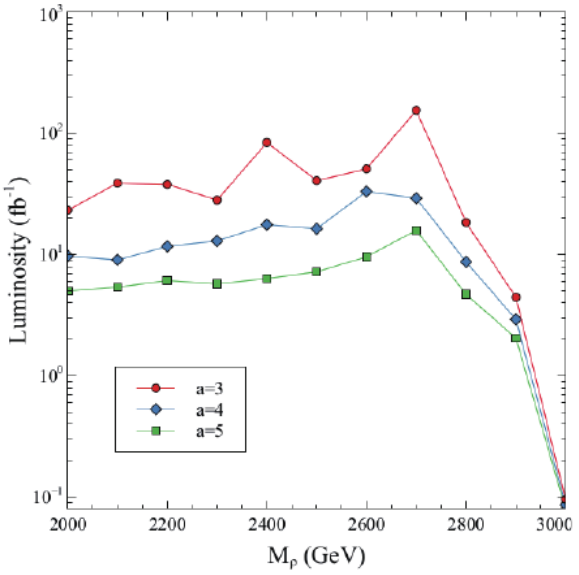
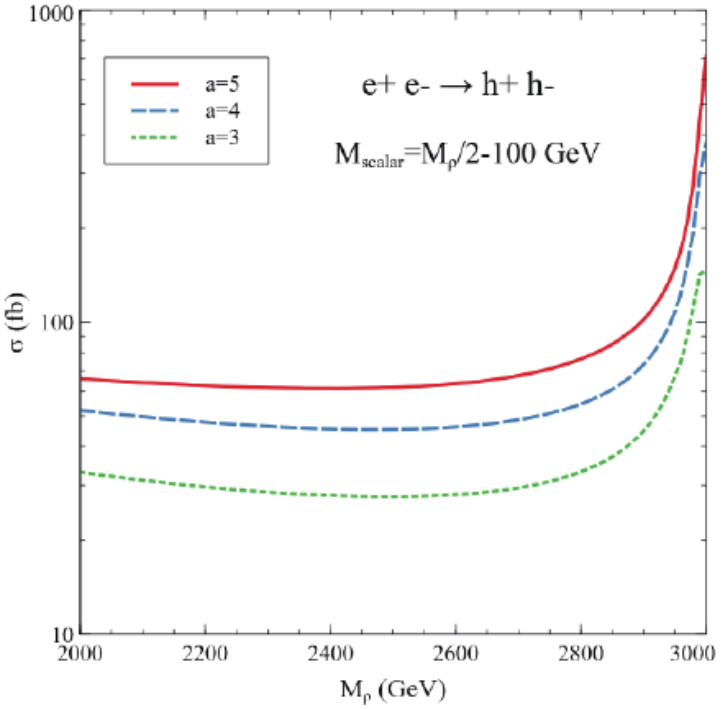
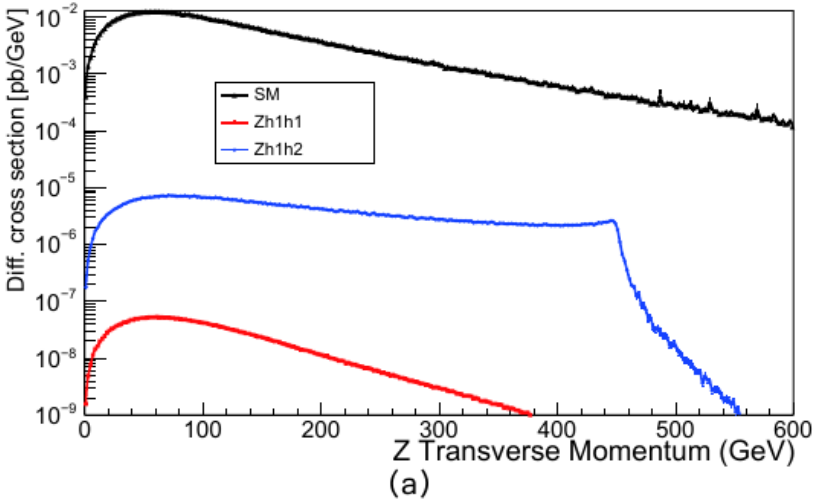


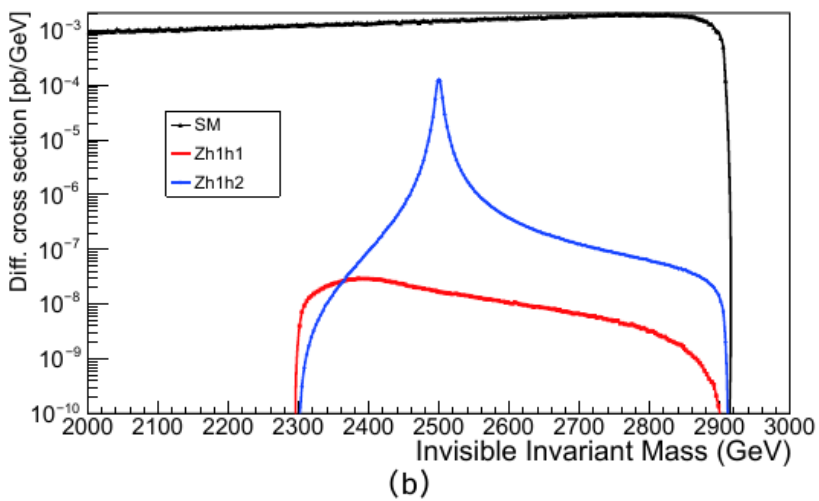
Luminosty need for 5σ excess

Other Results



$e^+ e^- \to Z h_1 h_i \; i = 1, 2$





$M_\rho = 2.5\,\text{TeV}$

Final Thoughts

- CLiC is a good tool for exploring New Physics thanks to
  - High c.m. energy
  - High luminosty
  - Radatiave return to resonances
- It is possible to explore a complex dark sector (at least in some regimes)
- In our example, two promising processes are:
  - Production of a dark vector resonance in the heavy scalar regime
  - Direct production of DM companions

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