MODEL INDEPENDENT BOUNDS ON KINETIC MIXING

By: Anson Hook
SLAC/Stanford

Work in Progress with Eder Izaguirre and Jay G. Wacker
arxiv:1005:xxxx

Why Kinetic Mixing?

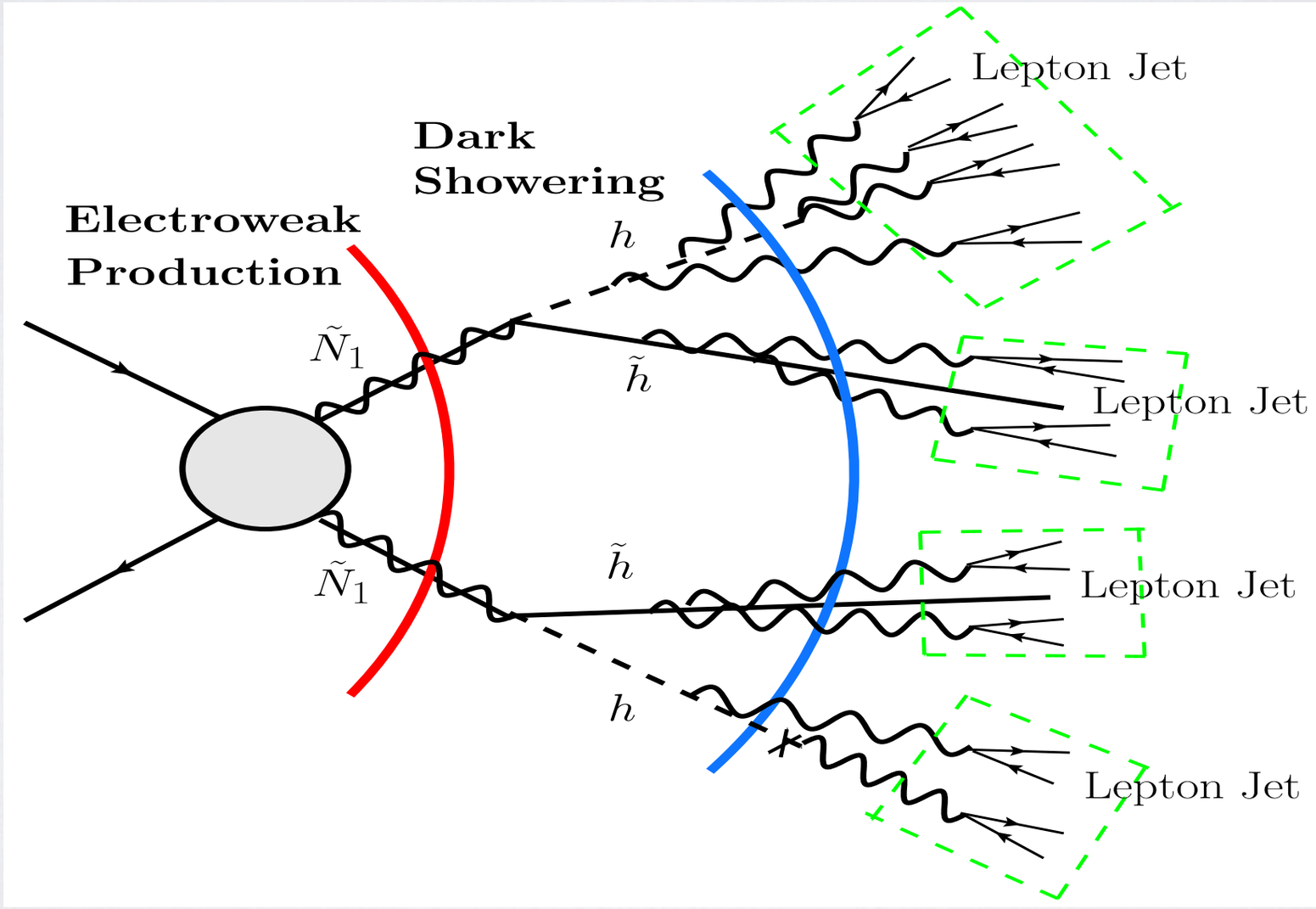
$$\mathcal{L} \supset \frac{1}{2}\epsilon F'_{\mu\nu} F_Y^{\mu\nu}$$

- Renormalizable interaction
  - does not decouple
  - allowable by symmetries

- Numerous astrophysical and direct detection anomalies - Dark Matter?
  - PAMELA/DAMA
  - MeV ~ GeV scale dark sector

Why Kinetic Mixing?

- Gateway to SM
  - Pamela - Leptons

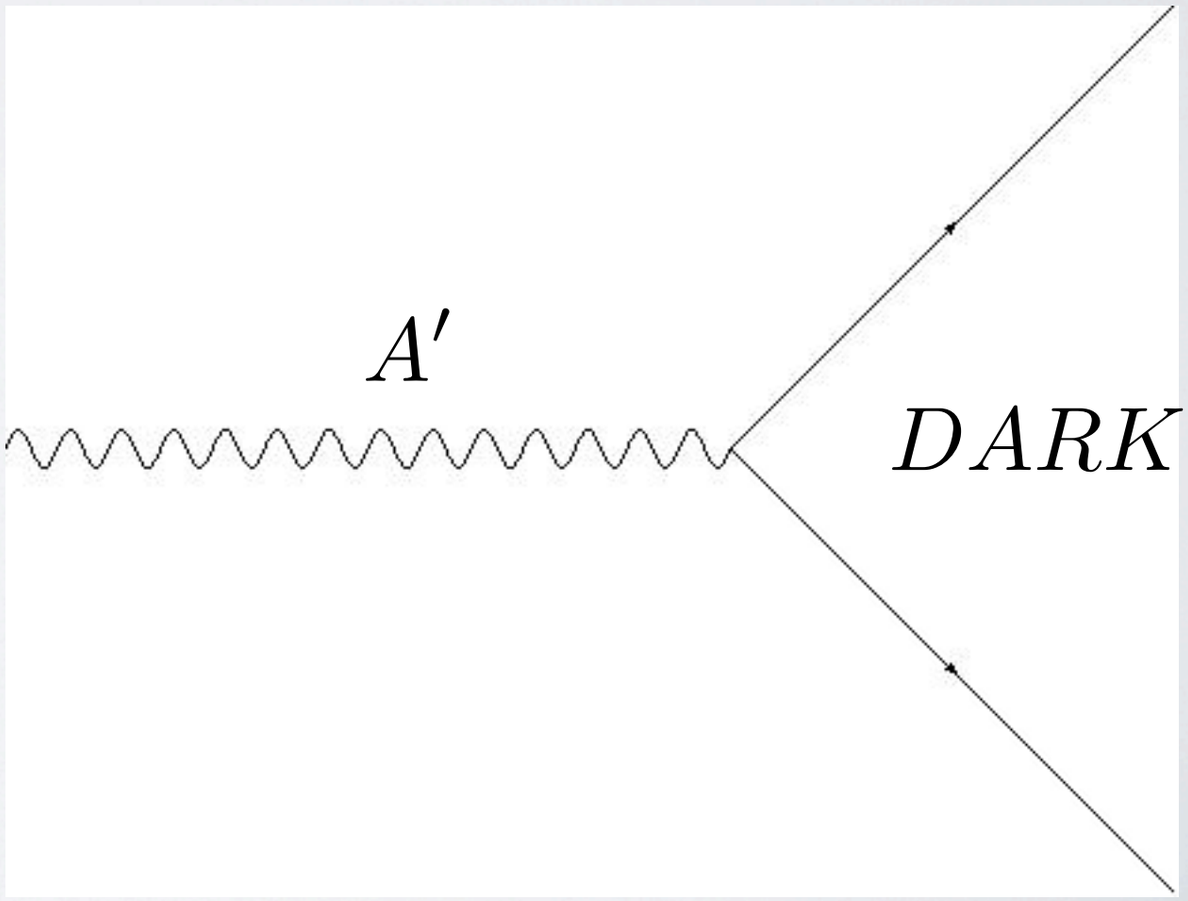


Taken from arxiv:0909.0290

Model Independent Kinetic Mixing

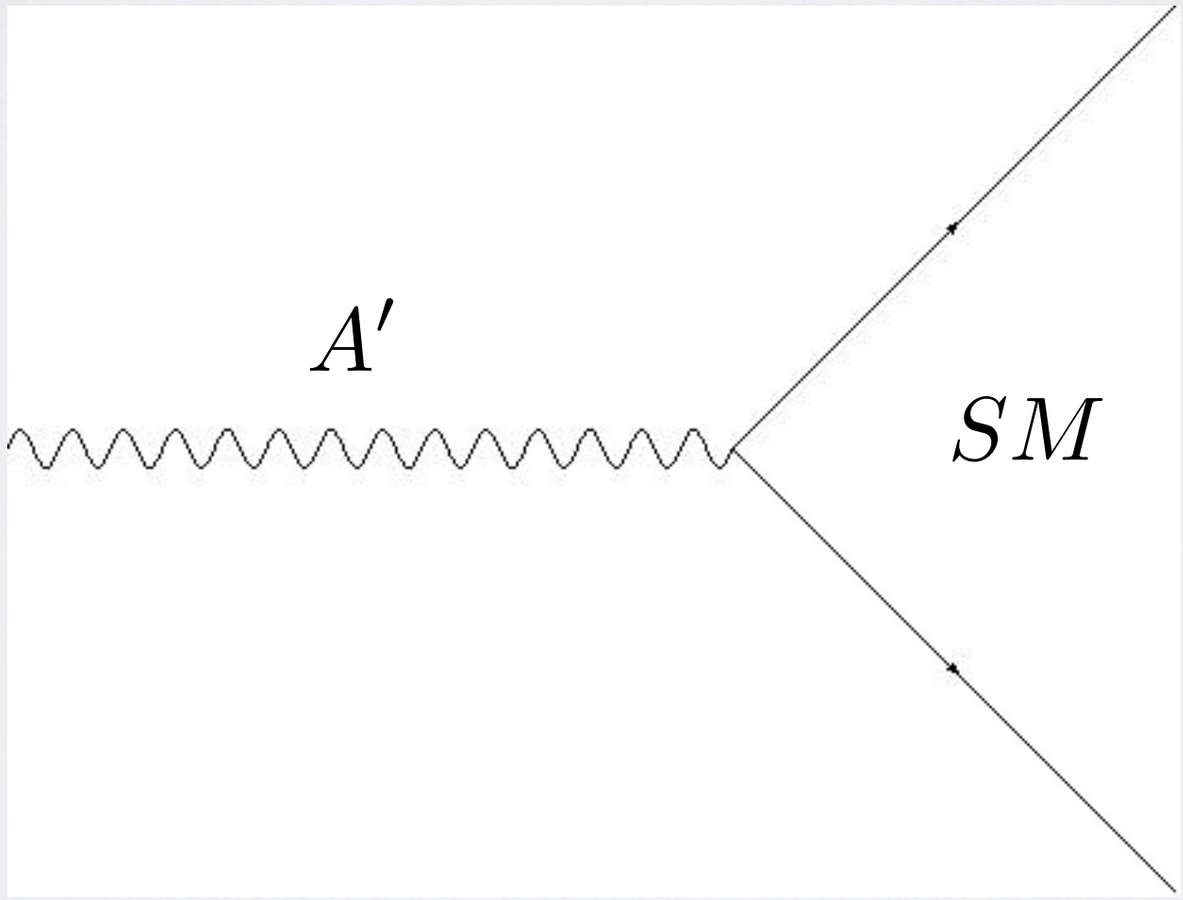
$$\mathcal{L} = \mathcal{L}_{\rm SM} - \frac{1}{2}\epsilon F'_{\mu\nu} F_Y^{\mu\nu} + \frac{1}{2} m^2_{A'} {A'_\mu}^2$$

- No assumptions about decays
- Γ_{DARK} completely unknown
- Any couplings allowed with dark sector

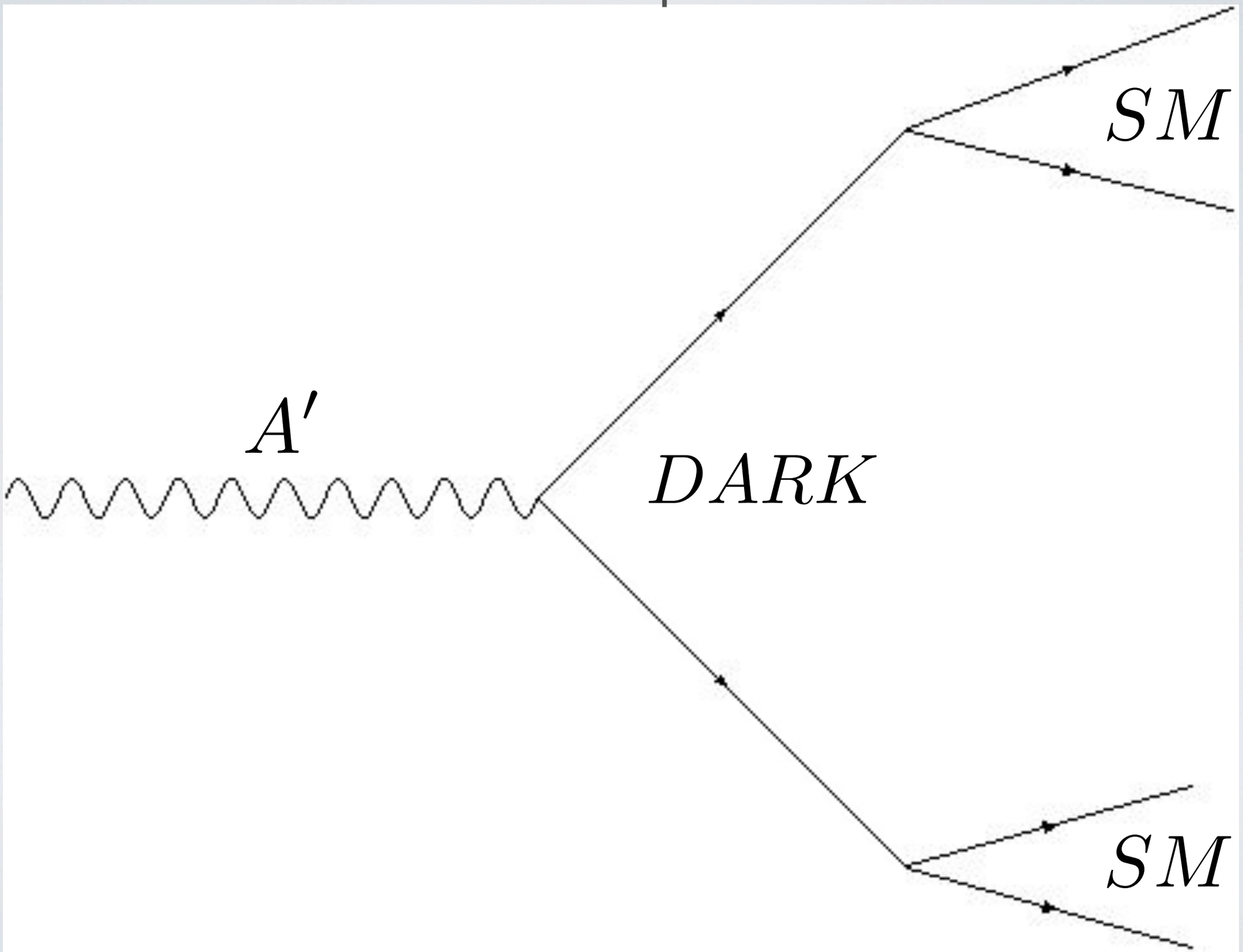


Couplings to the Standard Model

- Determined by diagonalization
  - SM epsilon charged $\Gamma_{SM} = \mathcal{O}(\epsilon^2)$

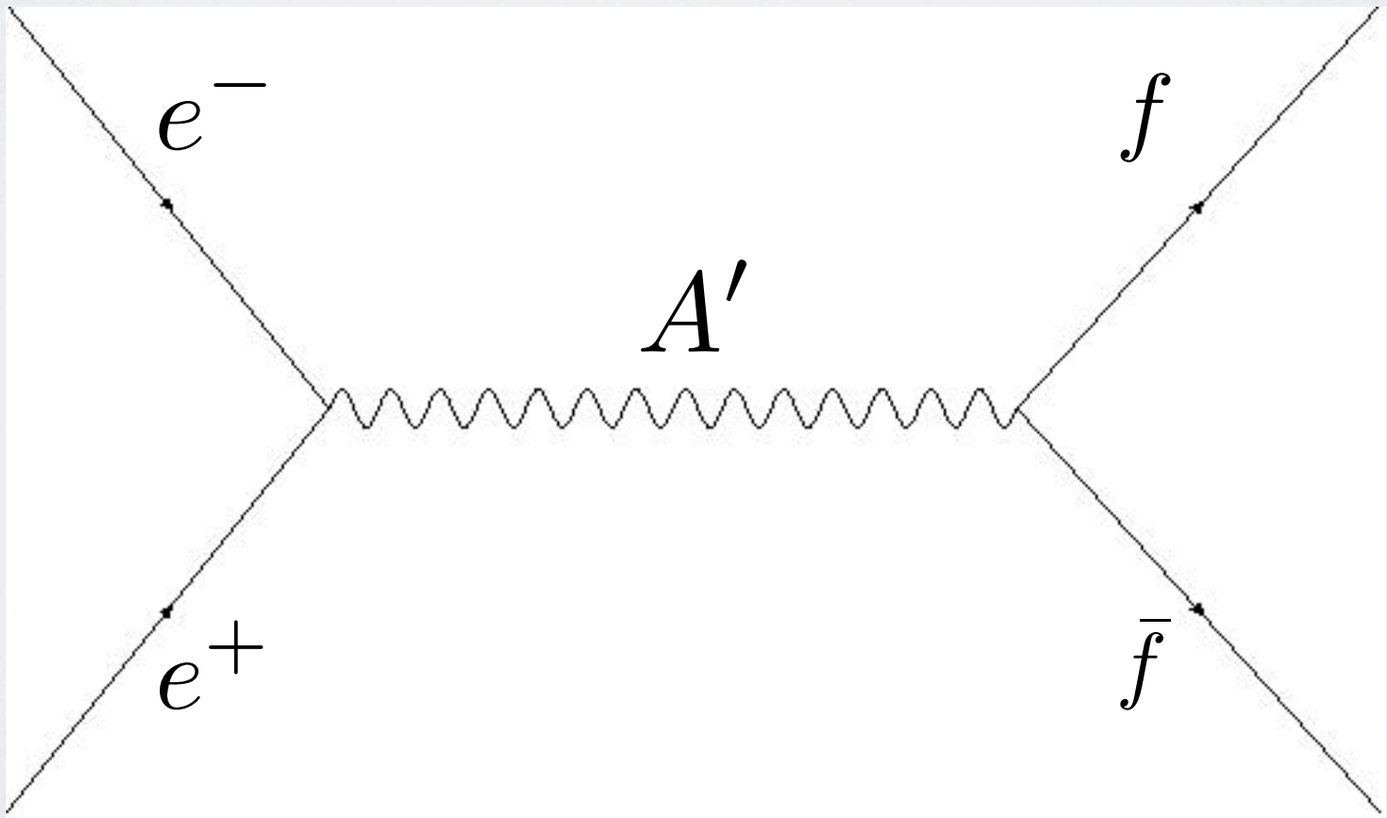


Model Dependent



On Shell Production

- At experimental energies: resonant s channel
- Necessary model dependence
  - Γ_{SM} small
  - $\Gamma_{DARK} = 0$ or $\Gamma_{DARK} = 1\% M_{A'}$ as reference



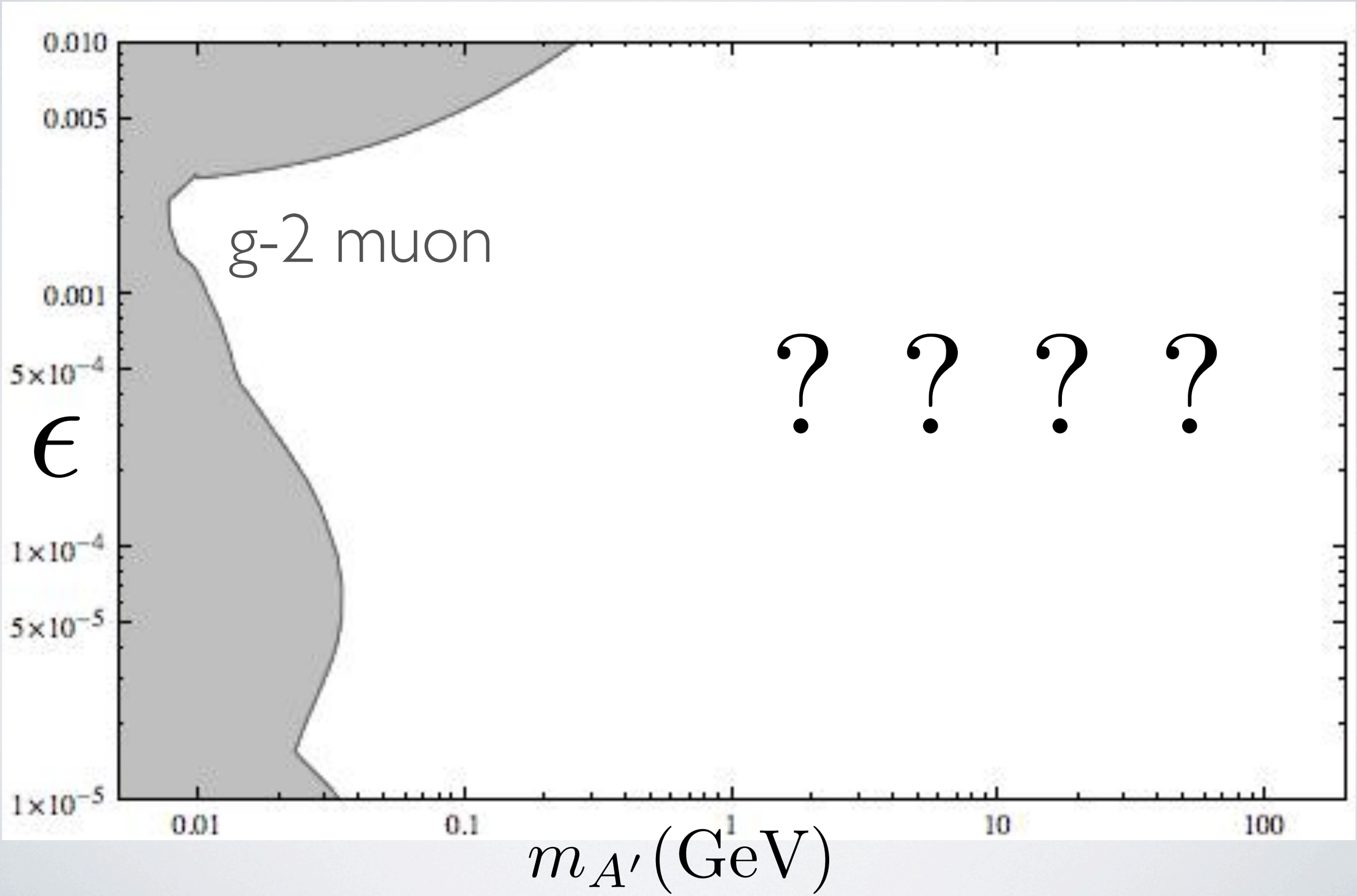
Current Bounds

- Low Mass: g-2 of muon
  - good until ~200 MeV

- High Mass: S & T parameters

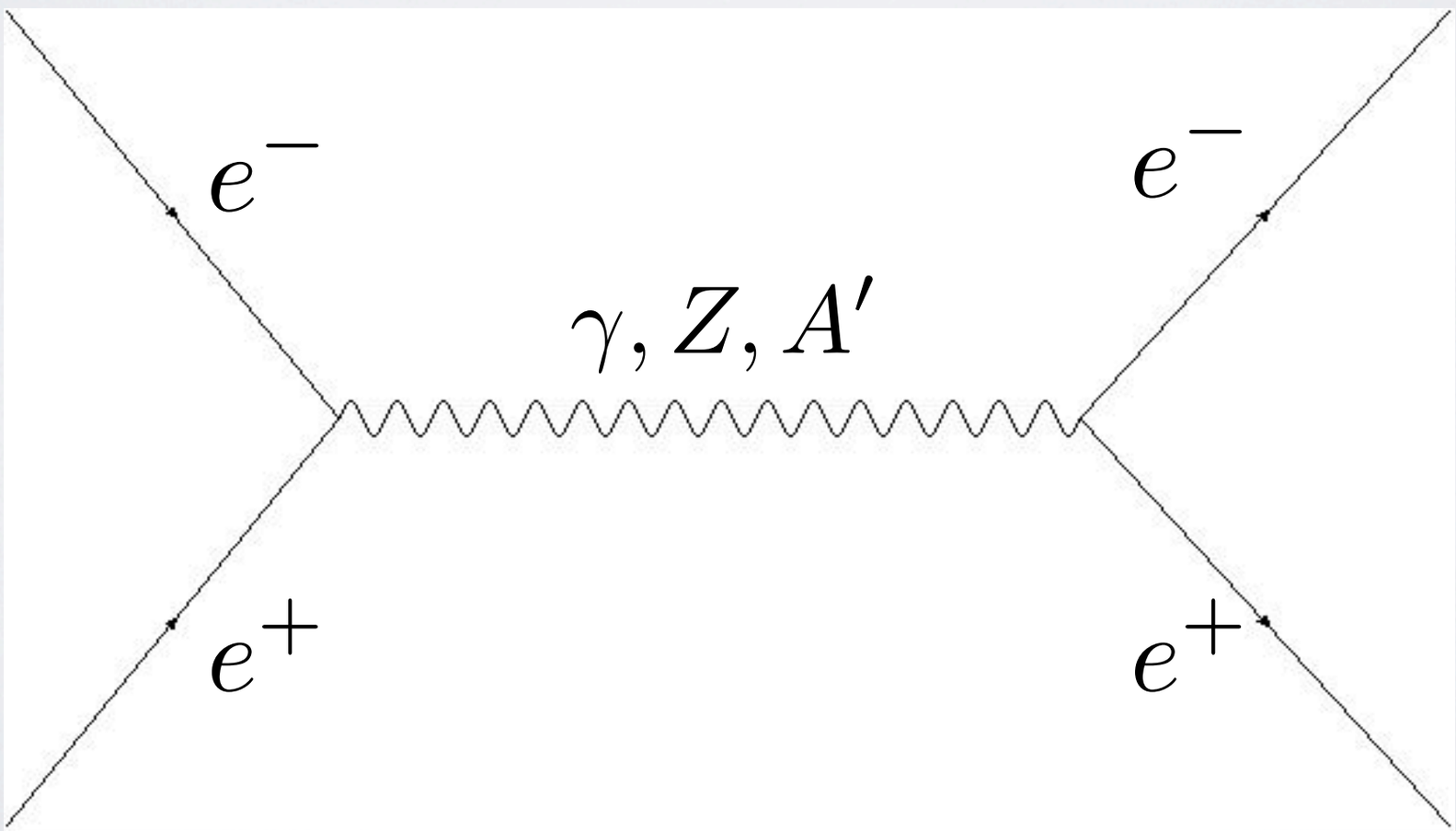
- In between: experiments determine SM parameters

Current Bounds



Model Independent Kinetic Mixing

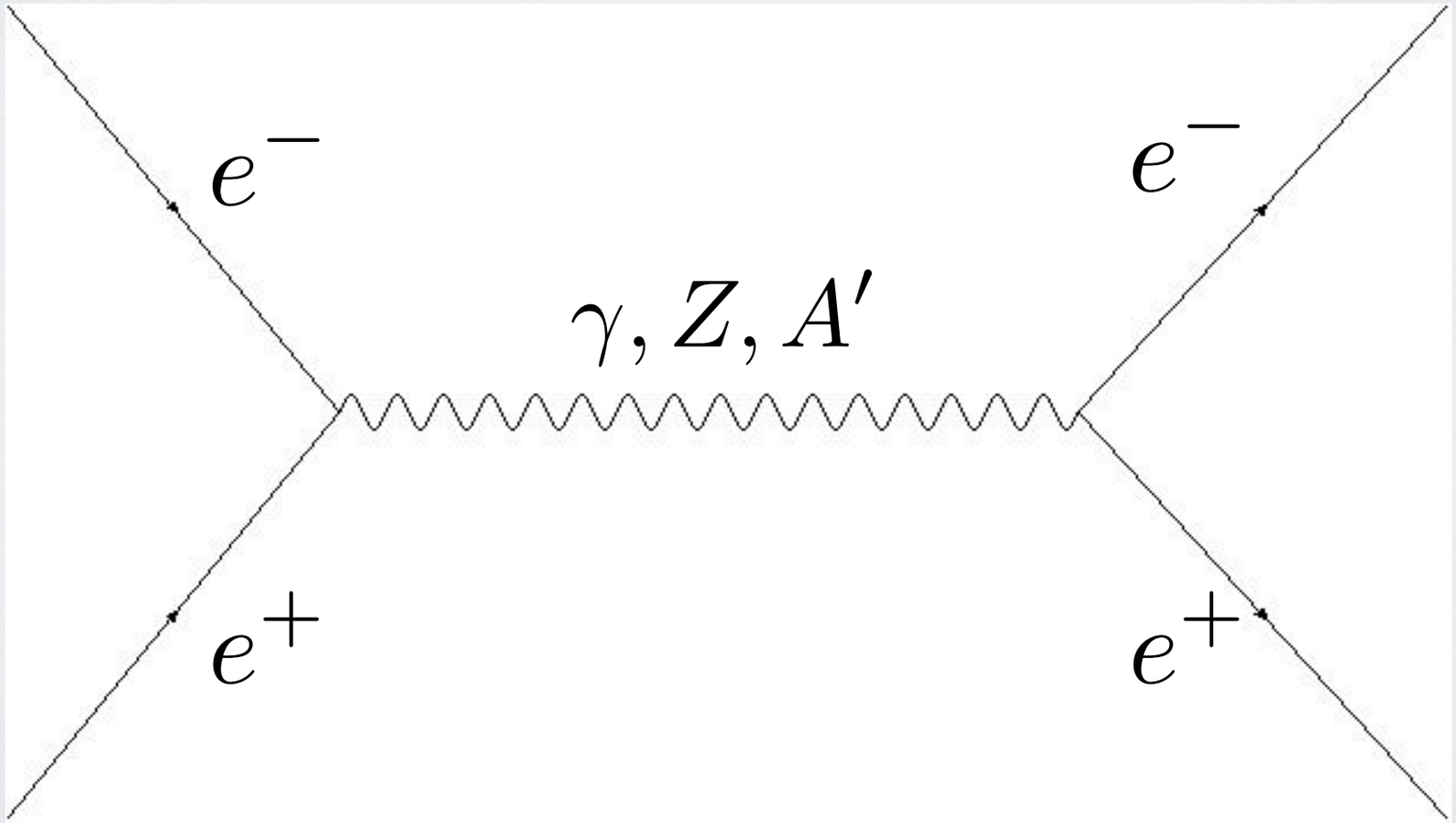
- Electroweak constraints
  - Bhabha scattering



Model Independent Kinetic Mixing

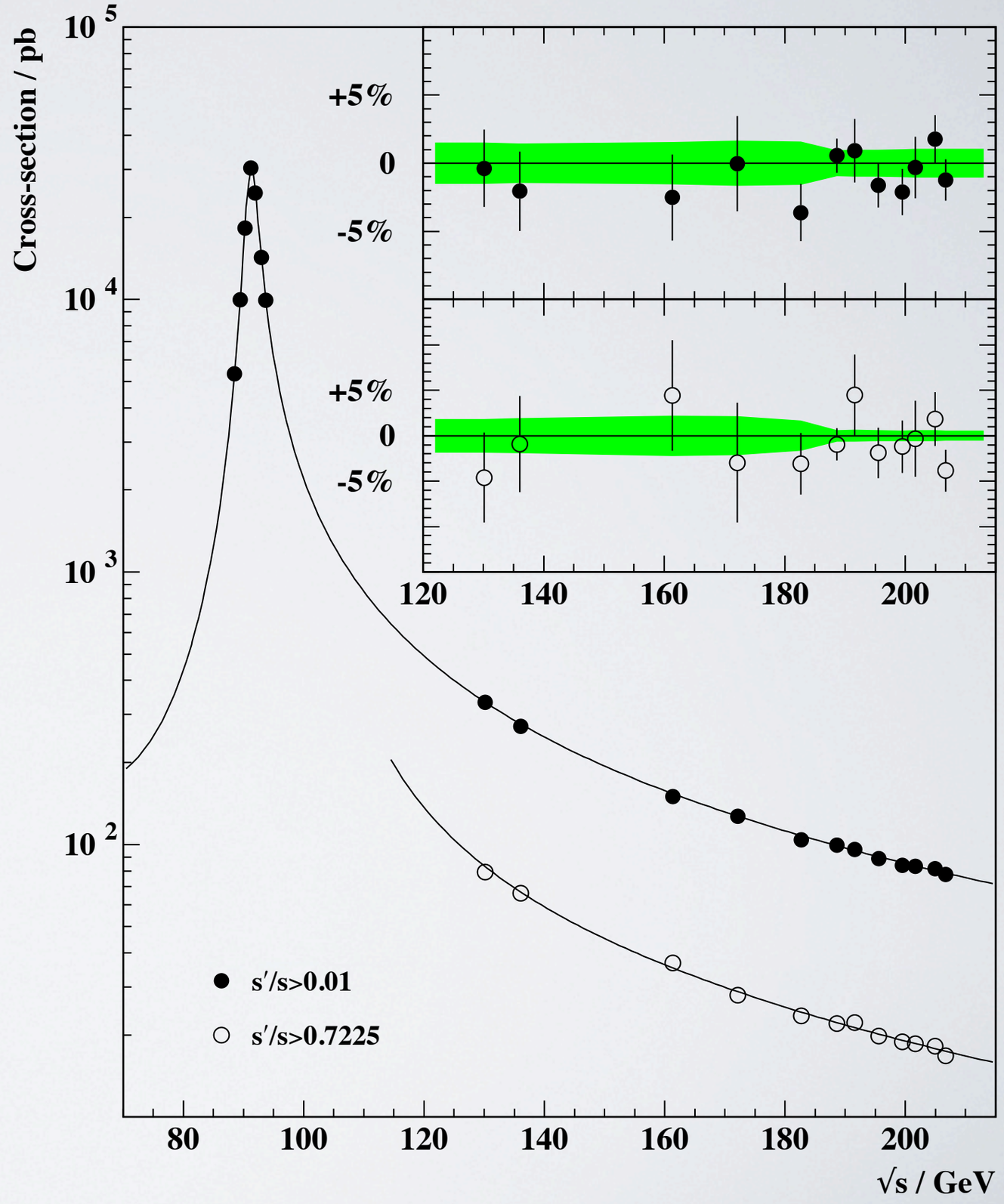
- Electroweak constraints
  - asymmetry measurements

$$\frac{d\sigma}{d\Omega} \propto c_1 \cos\theta + c_2 \cos^2\theta$$



Experiments

- LEP II (OPAL/DELPHI)
  - Differential bhabha scattering
  - Hadronic cross sections

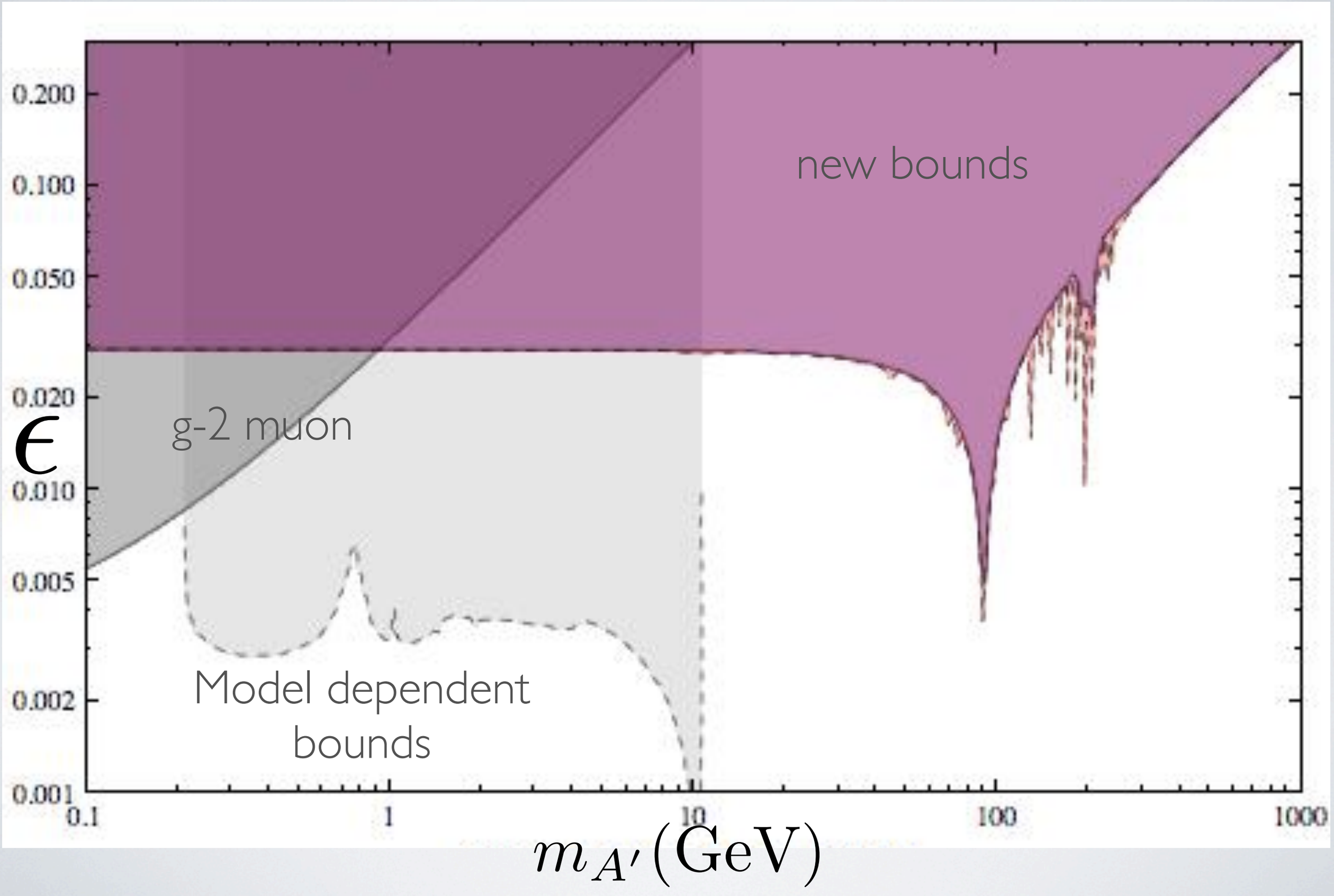


Experiments

- LEP I / SLD
  - Differential bhabha scattering
  - Hadronic cross section
  - charm, bottom, muon and tau asymmetry measurements
  - Mass of the Z

- TASSO / CELLO / TRISTAN
  - Differential bhabha scattering with energies 14 - 58 GeV

Results


new bounds
g-2 muon
Model dependent
bounds
0.200
0.100
0.050
0.020
0.010
0.005
0.002
0.001
ϵ
0.1
1
10
100
1000
$m_{A'}(\mathrm{GeV})$

Conclusion

- Kinetic Mixing: well motivated SM extension
  - plethora of unexplained anomalies

- Model Independent bounds are important and are $\epsilon \sim 10^{-2}$