

MAGIC/HEGRA has come a long way.

Wish Ekhart were here.

Something for elementary particle physics—not
astrophysics/cosmology

1) We have reached a rather simple. complete
understanding of VHE pp x-sections. Talk to
Francis H. or me. Or see review

Behavior Of Very High Energy Hadronic Cross
Sections, arXiv:1703.05668; Brief Reviews, Modern
Physics Letters **A32** no. 31, 1730028, (2017)

But Not directly MAGIC related

2) So let's try the following:

VHE* Photonuclear Reactions and a New Mass Scale

Suppose there was a **new** mass scale, say
 $\sqrt{s} \geq 10 \text{ TeV} \dots$

(Since LHC now around **10 TeV** with nothing new)

With **new** interactions....

How to see ??

*VHE=Very High Energy

How to see the New Interaction

- No accelerator in sight

- Cosmic rays :

—p-Air (not much help)

— γ -Air (maybe help)

Why p-Air (or Fe-Air) **not** very useful:

At VHE we have a '**Black Disc**' for hadron-hadron interactions

Anything hitting the nucleus is absorbed...
x-section is '**saturated**' [See 1) above]

$$\sigma = 2\pi R^2$$

Opening a new channel has little or no effect.

Cannot say let's just double the x-section
(partial wave unitarity)

For γ -Air situation is different:

X-section is 'not saturated'

$$\sigma \approx \alpha 2\pi R^2 = \frac{1}{137} 2\pi R^2$$

Standard picture: Photon **only** interacts $\sim 1\%$ of the time traveling thru a nucleus.

X-section has a lot of room to grow!—**New Channel** could have a BIG effect.

Can say let's just double the x-section (without violation of unitarity)

THUS if the new interaction exists, and **affects** photo-nuclear interactions, then observations as with MAGIC, CTA... would be the place to look!

—————What to look for —————

A new photo-nuclear channel would presumably result in pions. Pions lead to muons on the ground.

So would anticipate point—**MAGIC** — sources with a muon **excess**. (Above some energy **threshold**)

A VHE photon-induced shower typically starts with $\gamma \rightarrow e^+e^-$ in the Coulomb field of a nitrogen nucleus

$$\sigma \approx 470mb$$

Interesting coincidence: $\pi R^2 \approx 200mb$ for nitrogen nucleus.

So if γN X-section becomes geometric above some energy, shower has about 1/3 chance of starting as 'hadronic' (with high pion content).

For energies well above the new threshold, secondary photon could do this, so would have showers of 'mixed' character.

The Good News

VHE Photons Natural Way for Revealing New Interaction

AND MAGIC can identify muons

The Bad News

$$E_{cm} \sim 10TeV \rightarrow E_{\gamma} \sim 50PeV$$

Do (enough of) such photons exist?

Do they reach us? (However absorption on ambient photons goes down at VVHE)

Congratulations MAGIC

Keep UP the good work

Many interesting and possibly great things are
coming