

ORIGINS 2021 PhD Award #2



group of Elisa Resconi

Technische Universität München
Physik-Department
Experimental Physics with Cosmic Particles
and
TUM Institute for Advanced Study



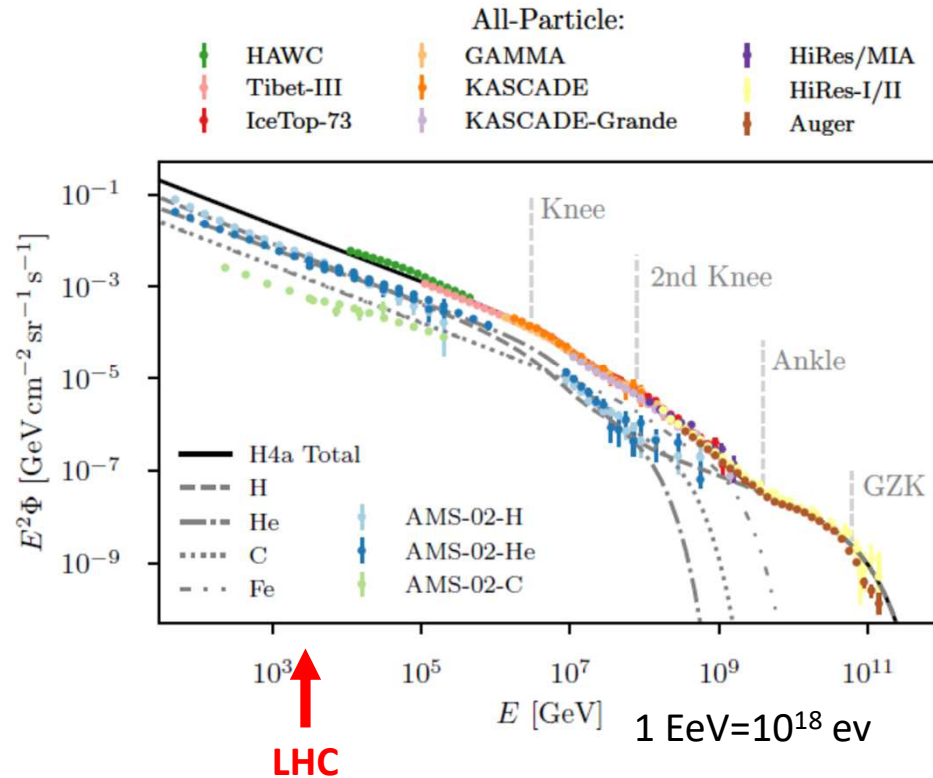
IAS fellow Paolo Giommi

The Origin of High-Energy Cosmic Particles: IceCube Neutrinos and the Blazar Case

Probing multi-messenger data by combining techniques from astrophysics, machine learning, and statistics

Theo Glauch

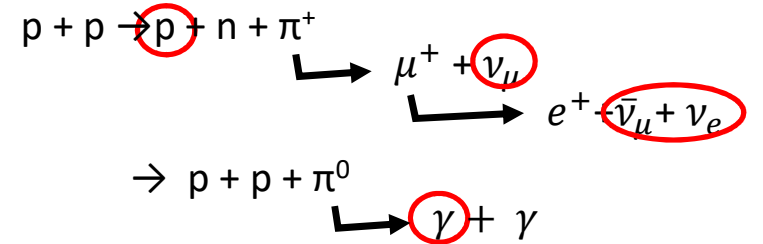
Spectrum of cosmic ray particles:



How generated?
Sites of production?

Multi-messenger perspective

(examples)

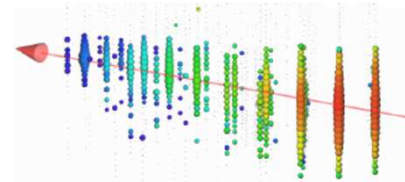


Connection: cosmic rays, gammas, neutrinos

associate: high-energy neutrinos ↔ gamma-source

Only one established case:

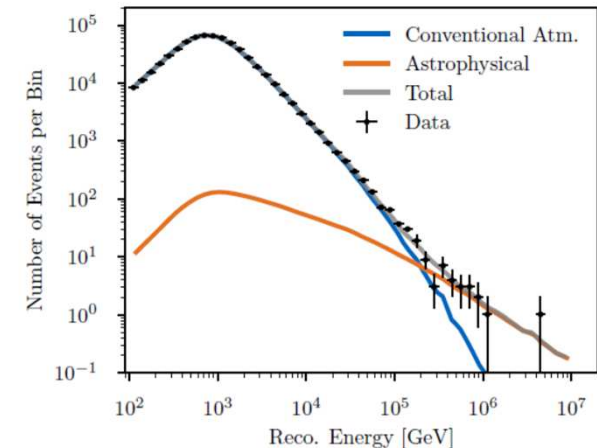
IceCube17090A ↔ TXS0506+056
(Blazer, AGN with jet)



Achievement of thesis of Theo Glauch:

- improve selectivity for astrophysical neutrinos in Ice Cube detector
 - on-line (fast trigger) → alert γ -ray searches for counter part
 - off-line -> search data base to identify sources and objects of interest (like Blazars), population analysis
- Discover new sources (see talk of Theo Glauch)

ν -flux in IceCube

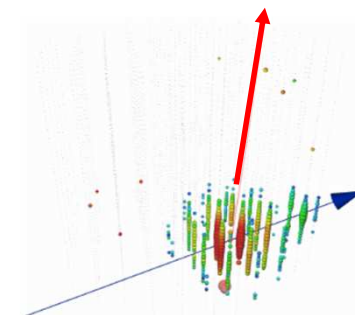


Important innovation: use of neural networks (**deep learning neural networks DNN**)

- > classify event type (tracks, direction, starting, stopping)
- > determine energy of neutrino

Significantly increase efficiency and and discovery potential of a very large experiment

Conventional determination of direction



Direction with help of DNN

Artificial intelligence (AI).

Today almost every little algorithm is artificial intelligence. Soon we will be obsolete.

Theo Glauch's thesis shows, how difficult it is to come even near real intelligence.

- Design structure of the net:
 - deep NN (several hidden layers),
 - convoluting NN (reduction of parameters, avoid danger of overfitting), recurring NN
- Careful analysis how to introduce weights and statistical properties, choose priors
- Training the NN (learning, supervised, unsupervised), choose learning material (here MC)
- Learning slow, but application very fast (msec), on-line filter

NN now used in many fields of physics and outside (era of big data)

Glauch's thesis is excellent example, how can be used efficiently, and demonstrates power and discovery potential

However, natural neural networks NNN (as our brain) are still useful, and seem to work particularly well with Theo Glauch!

Criteria of selection of PhD award: scientific quality

radiance (particularly within cluster)

prospects for the future

} Perfect score in all categories!

Congratulations Theo Glauch and all the best for the future!