New physics Air-Shower simulations for UHECR above 50 TeV

Romanopoulos Stylianos[1,*,†]
Ph.D. Candidate at the Institute of Astrophysics, FORTH
University of Crete

Assoc. Prof. Pavlidou Vasiliki[2,*,†], Prof. Tomaras Theodore[3,†]

1: sromanop@physics.uoc.gr
2: pavlidou@physics.uoc.gr
3: tomaras@physics.uoc.gr
*: Institute of Astrophysics, FORTH
†: Department of Physics and ITCP, University of Crete

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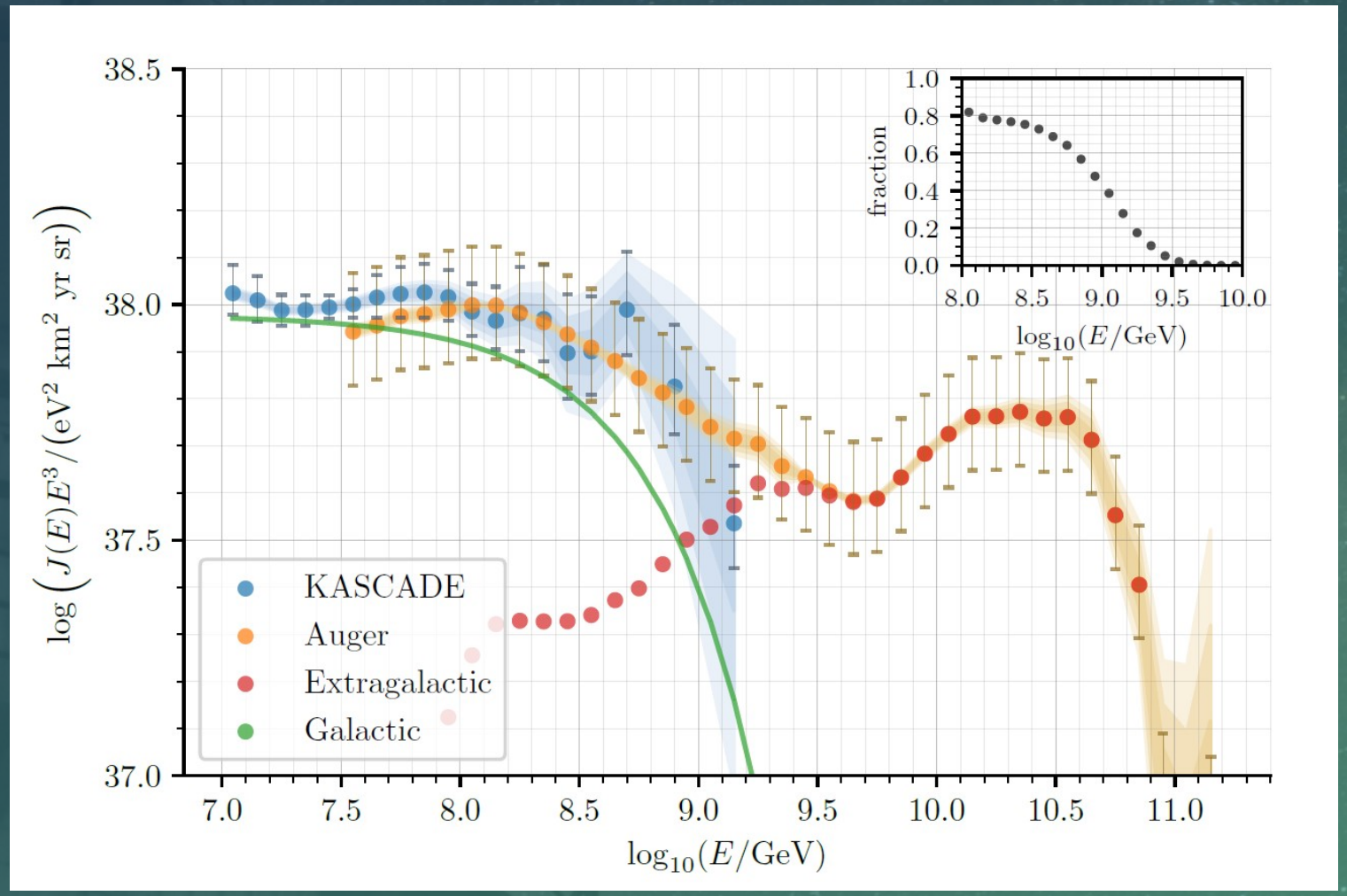
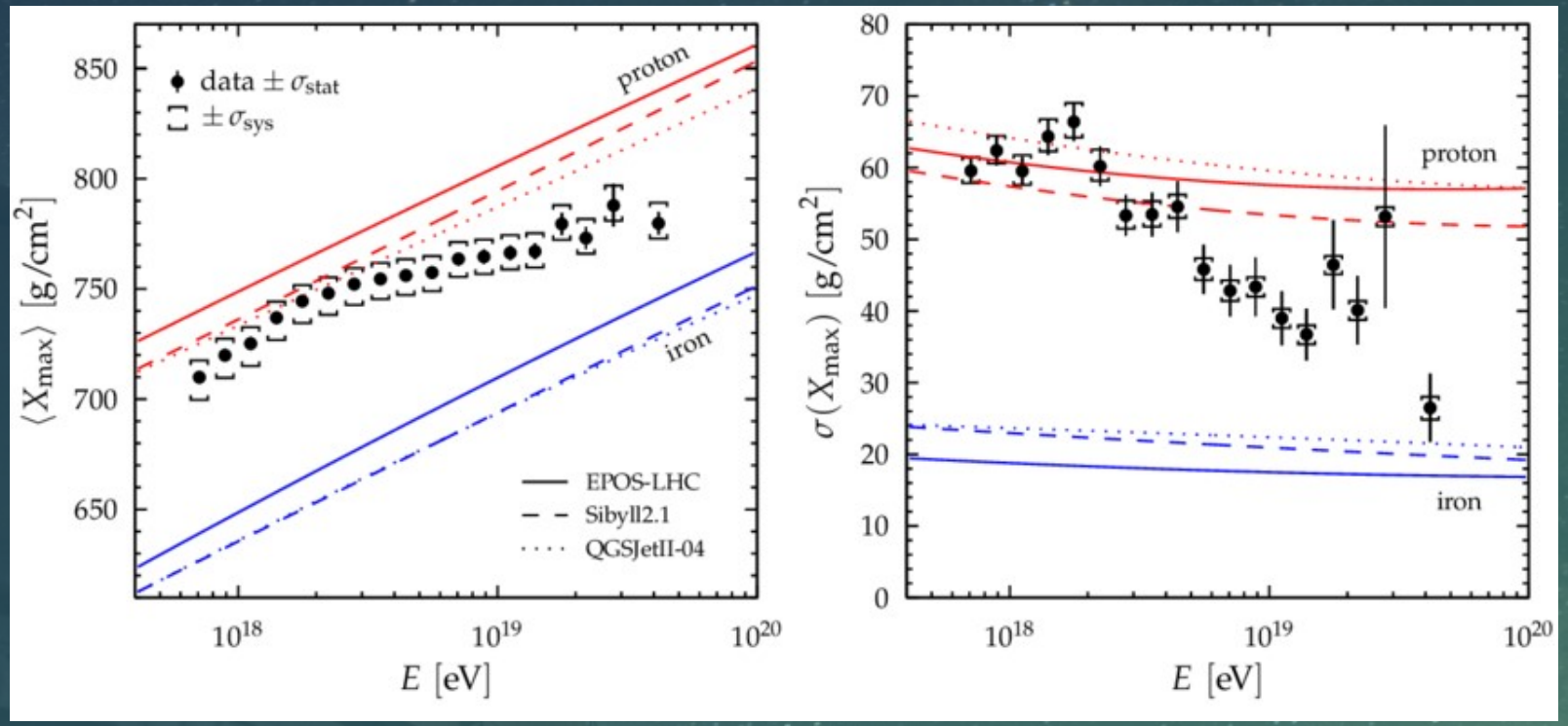

38.5
38.0
37.5
37.0
7.0
7.5
8.0
8.5
9.0
9.5
10.0
10.5
11.0
$\log\left(J(E)E^3/(\mathrm{eV}^2\ \mathrm{km}^2\ \mathrm{yr\ sr})\right)$
$\log_{10}(E/\mathrm{GeV})$
KASCADE
Auger
Extragalactic
Galactic
fraction
1.0
0.8
0.6
0.4
0.2
0.0
8.0
8.5
9.0
9.5
10.0
$\log_{10}(E/\mathrm{GeV})$



Credit: Pierre Auger Collaboration

$$\langle X_{\rm max} \rangle = \langle X_{\rm int} \rangle + \langle X_{\rm long} \rangle$$

First Interaction

$$\langle X_{\rm int} \rangle = \frac{\bar{m}_{\rm Air}}{\sigma^{\rm new}_{\rm CR\text{-}Air}}$$

$$\sigma^{\rm new}_{\rm CR\text{-}Air} = s_0 + \beta(1+\delta)\log\varepsilon$$

Longitudinal Development

$$\langle X_{\rm long} \rangle = X_0 + \alpha \log \frac{\varepsilon}{n}$$

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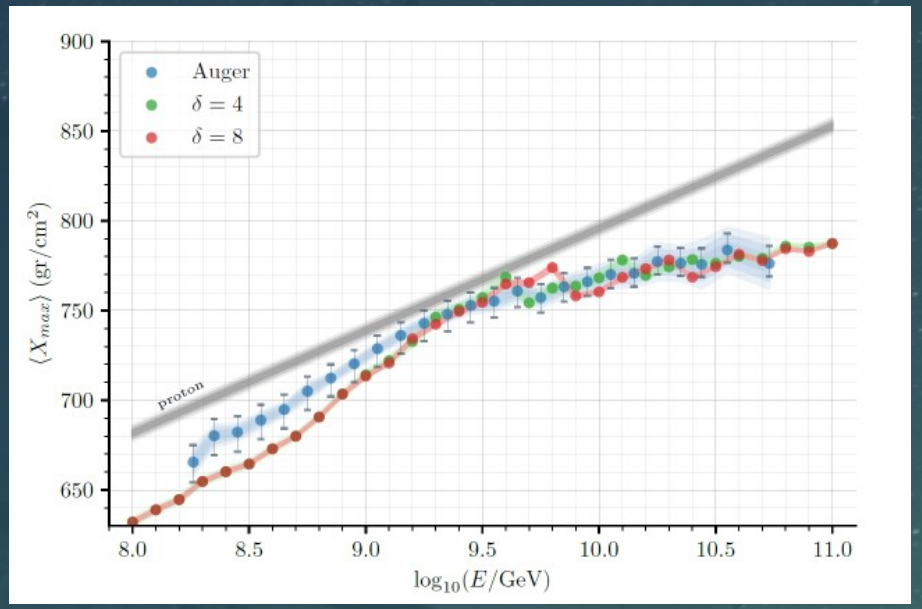
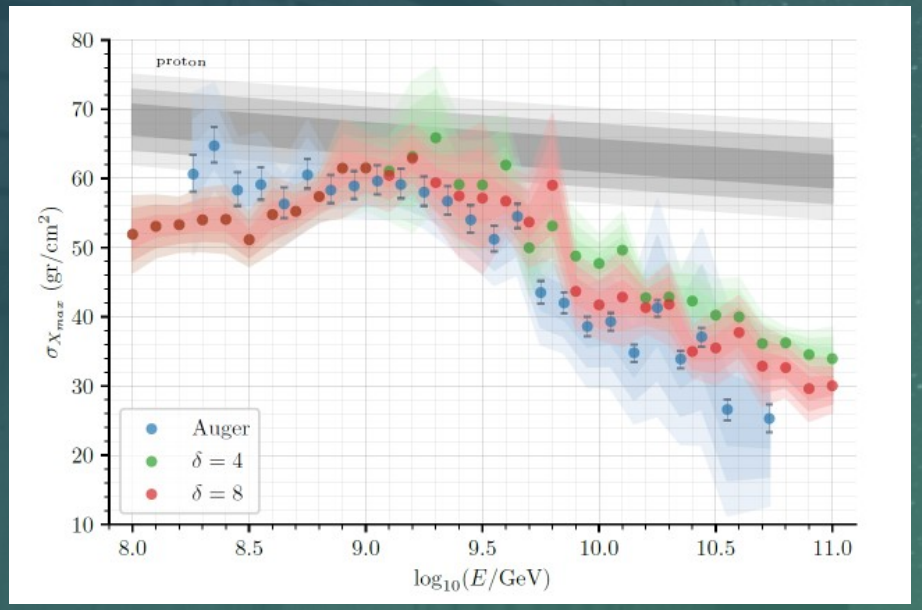
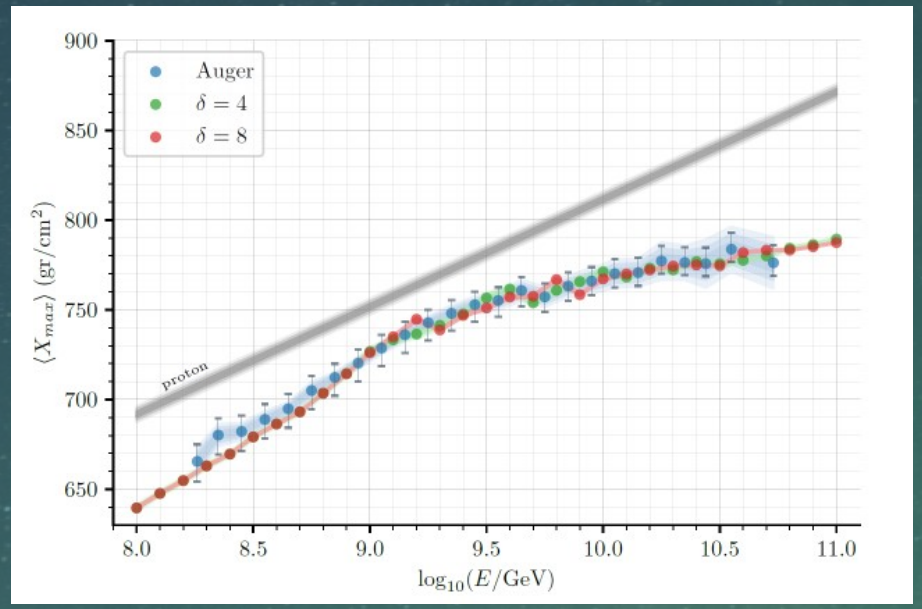
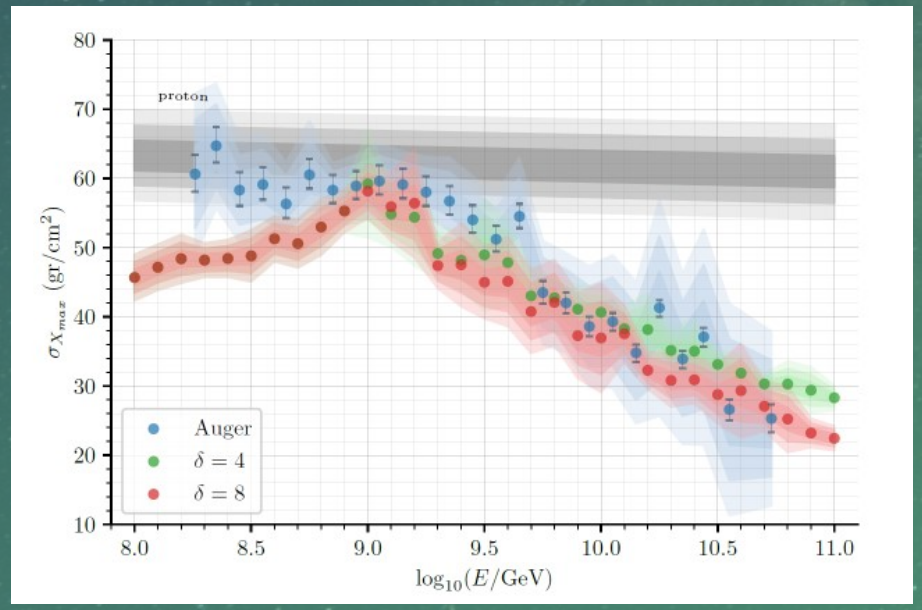




EPOS LHC





What $\delta = 8$ means?

For energies of 10^{10} GeV (140 TeV CM energy)

- Cross-Section 800 mb
- twice as many secondary particles

Photo: Night Sky at Skinakas Mountain, Crete