

the diffuse fluxes of high-energy neutrinos and gamma rays

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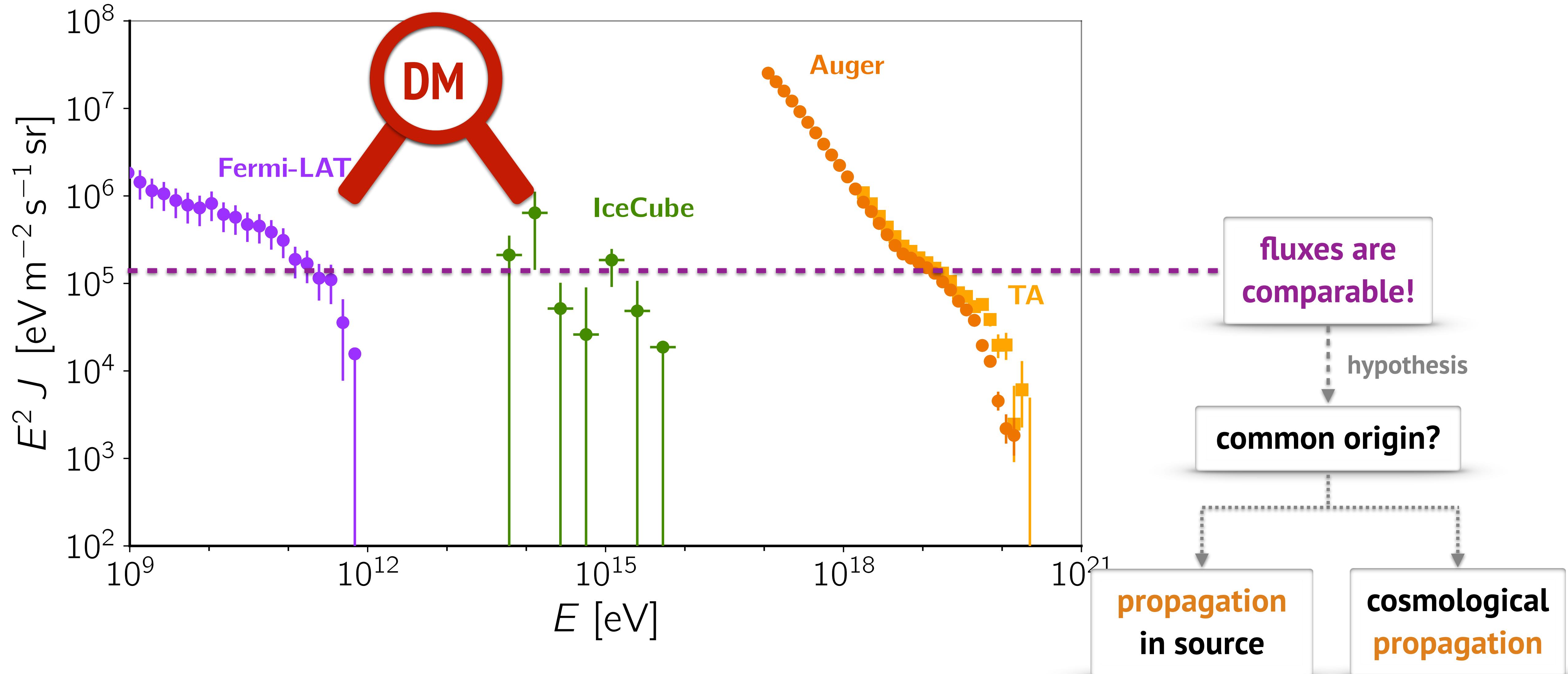
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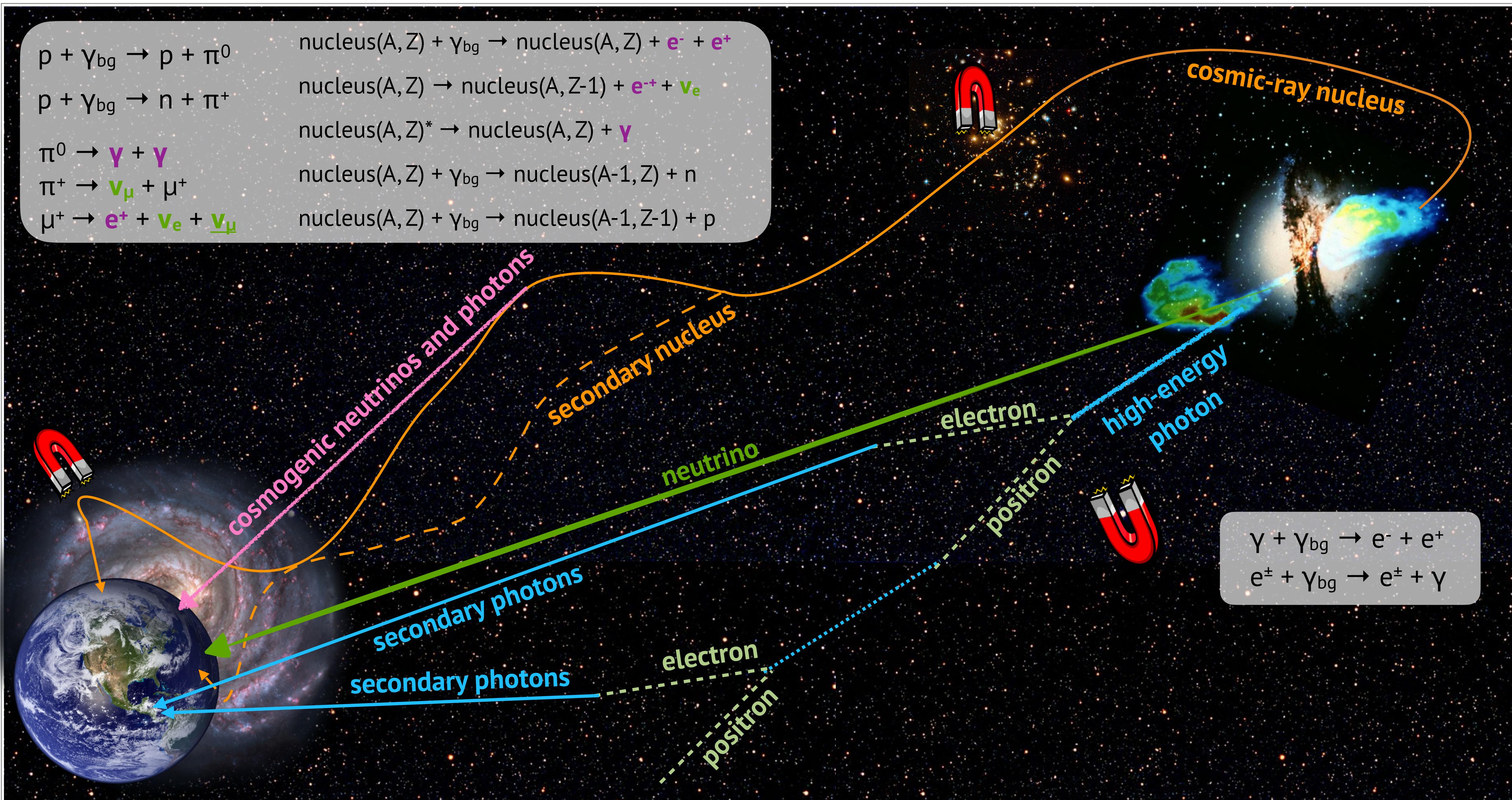
MultiDark Workshop
23-25 May 2022

high-energy multimessenger landscape



neutrinos and photons from UHECRs

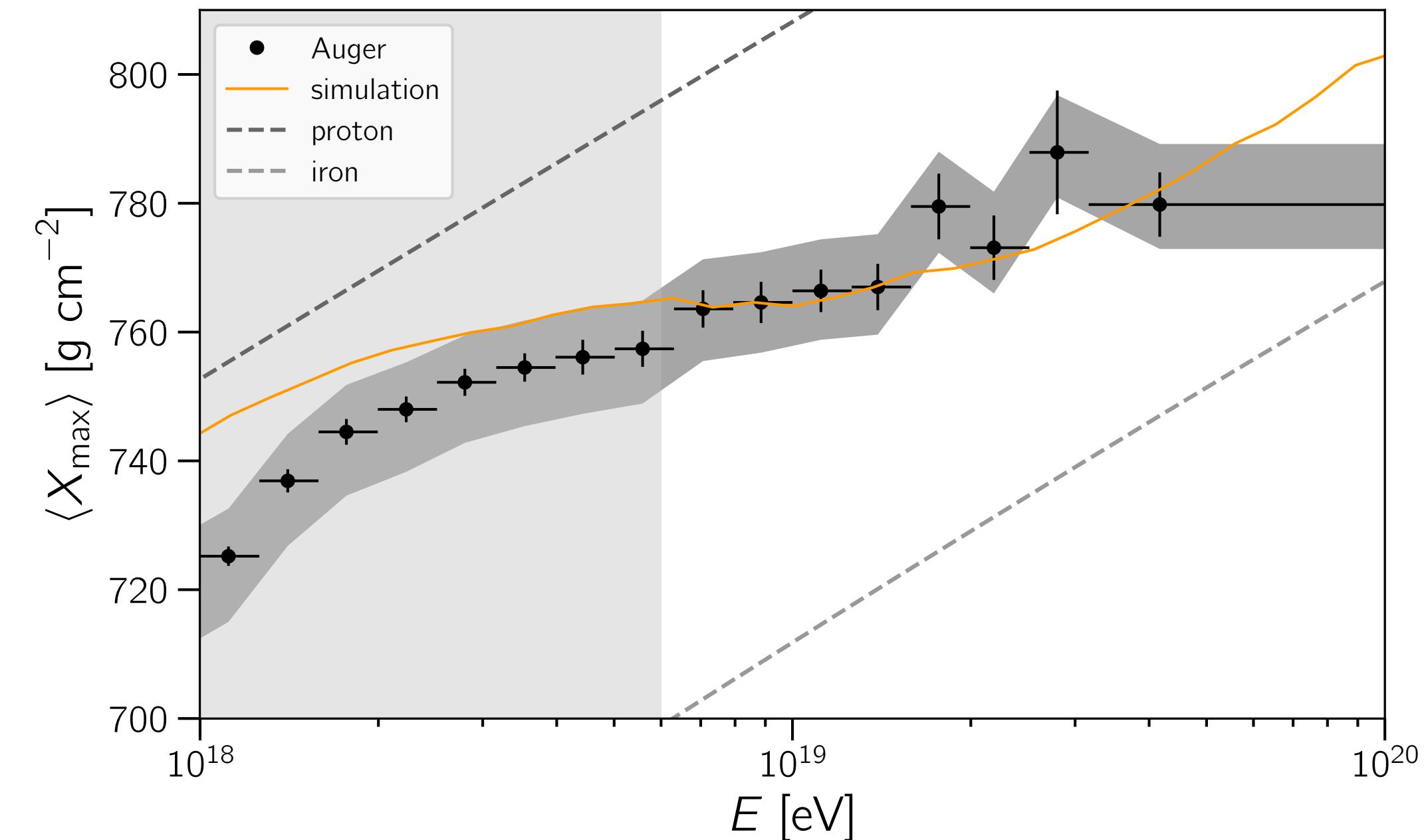
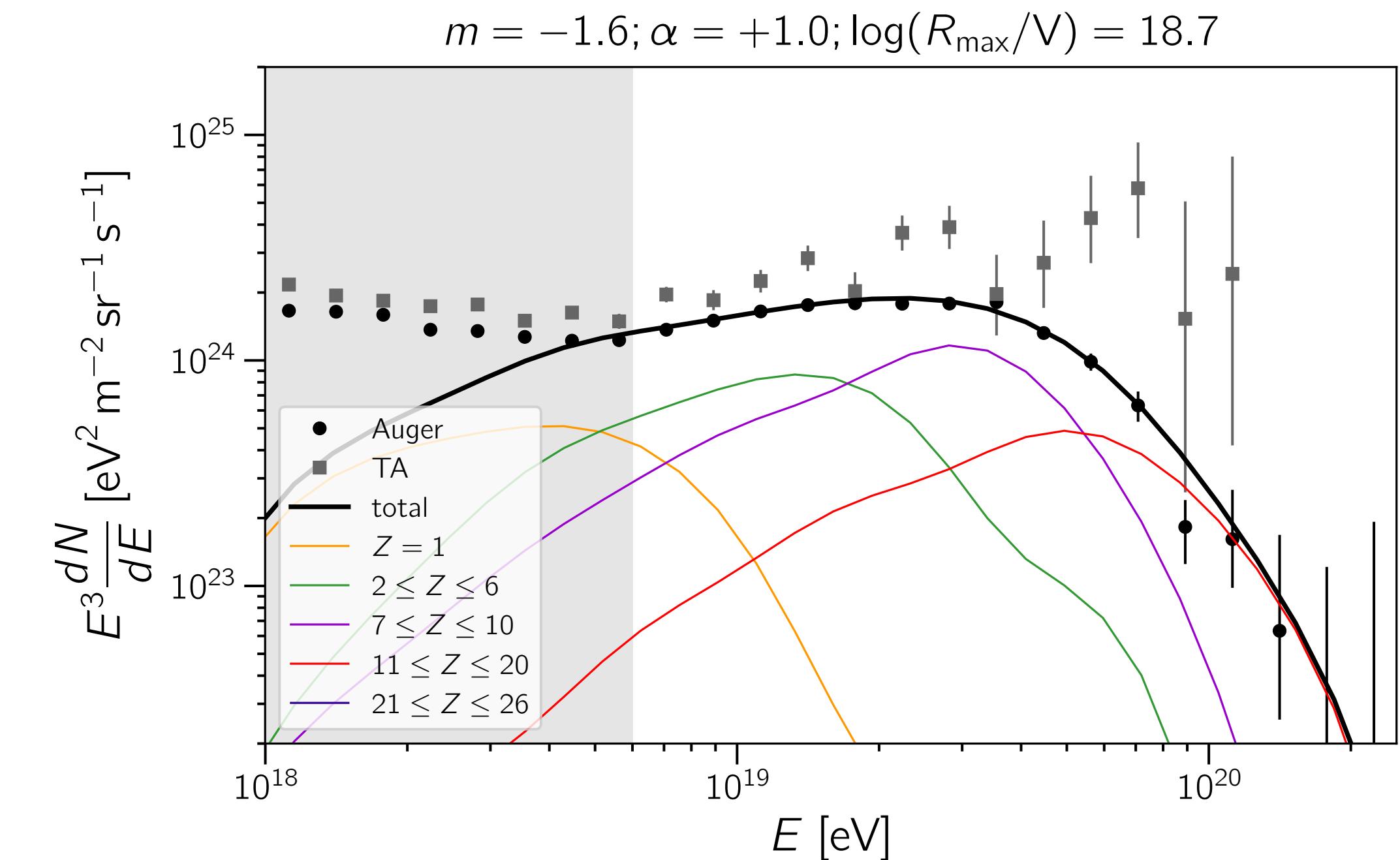
propagation picture

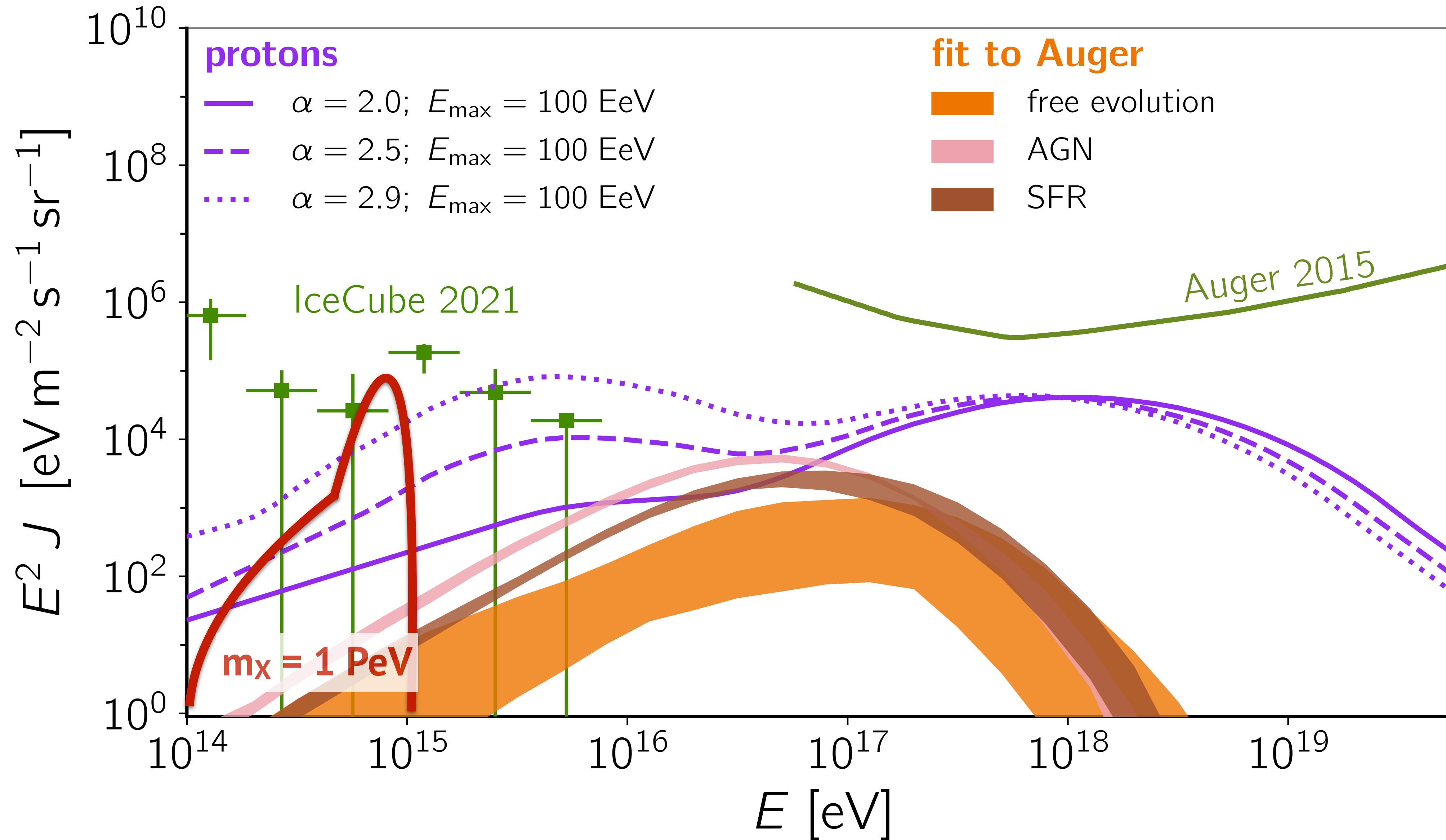


cosmogenic neutrinos and photons

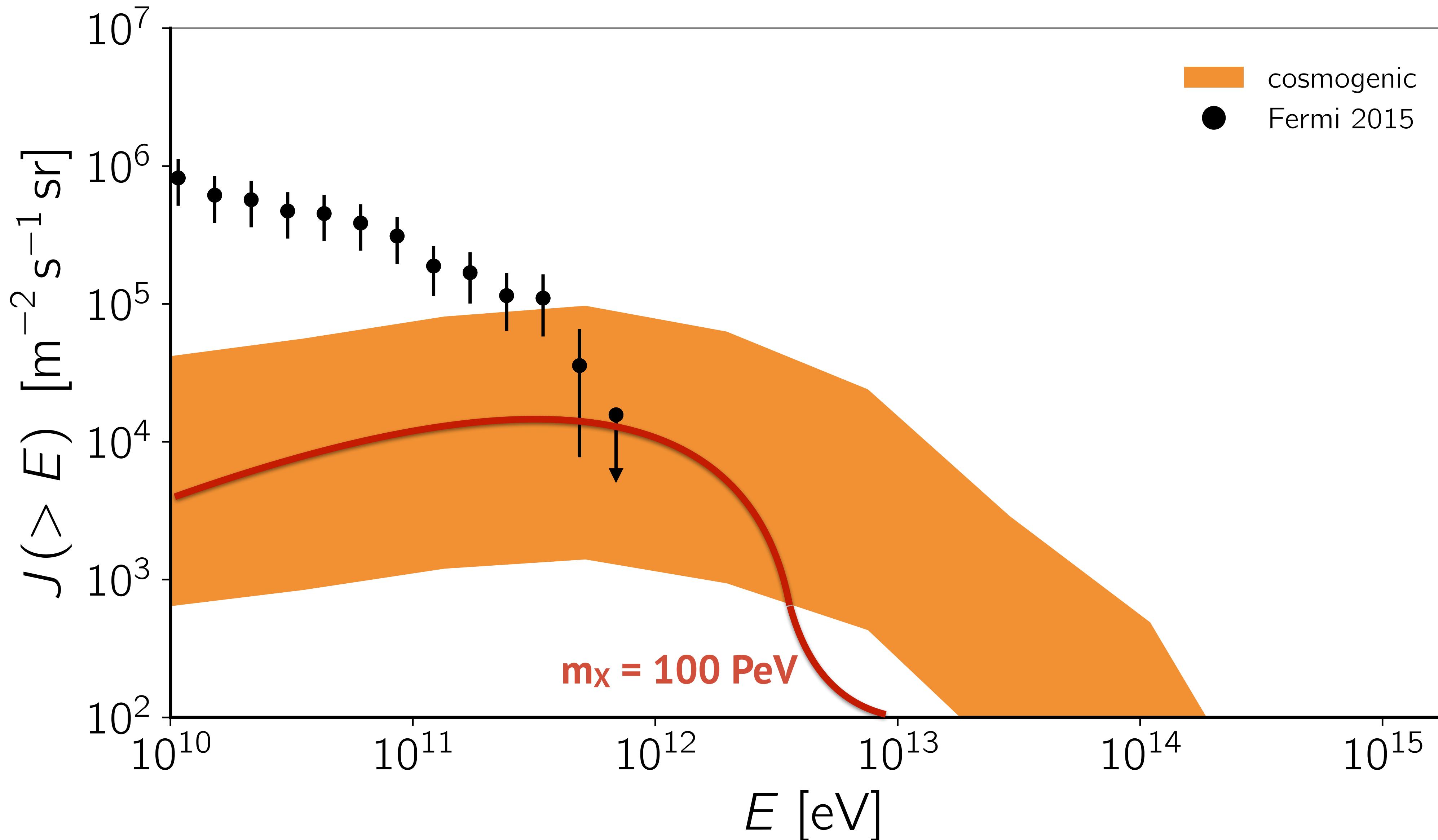
Alves Batista, de Almeida, Lago, Kotera. JCAP 01 (2019) 002. arXiv:1806.10879

- ▶ goal: for a family of source models, find the best match to the measurements
 - ◆ use pessimistic assumption: no magnetic fields, ignore high-redshift sources
- ▶ compute cosmogenic fluxes
- ▶ under these conservative assumptions, ***UHECRs cannot explain the diffuse fluxes of neutrinos***, measured by IceCube, and of gamma rays, measured by Fermi-LAT





the diffuse gamma-ray background



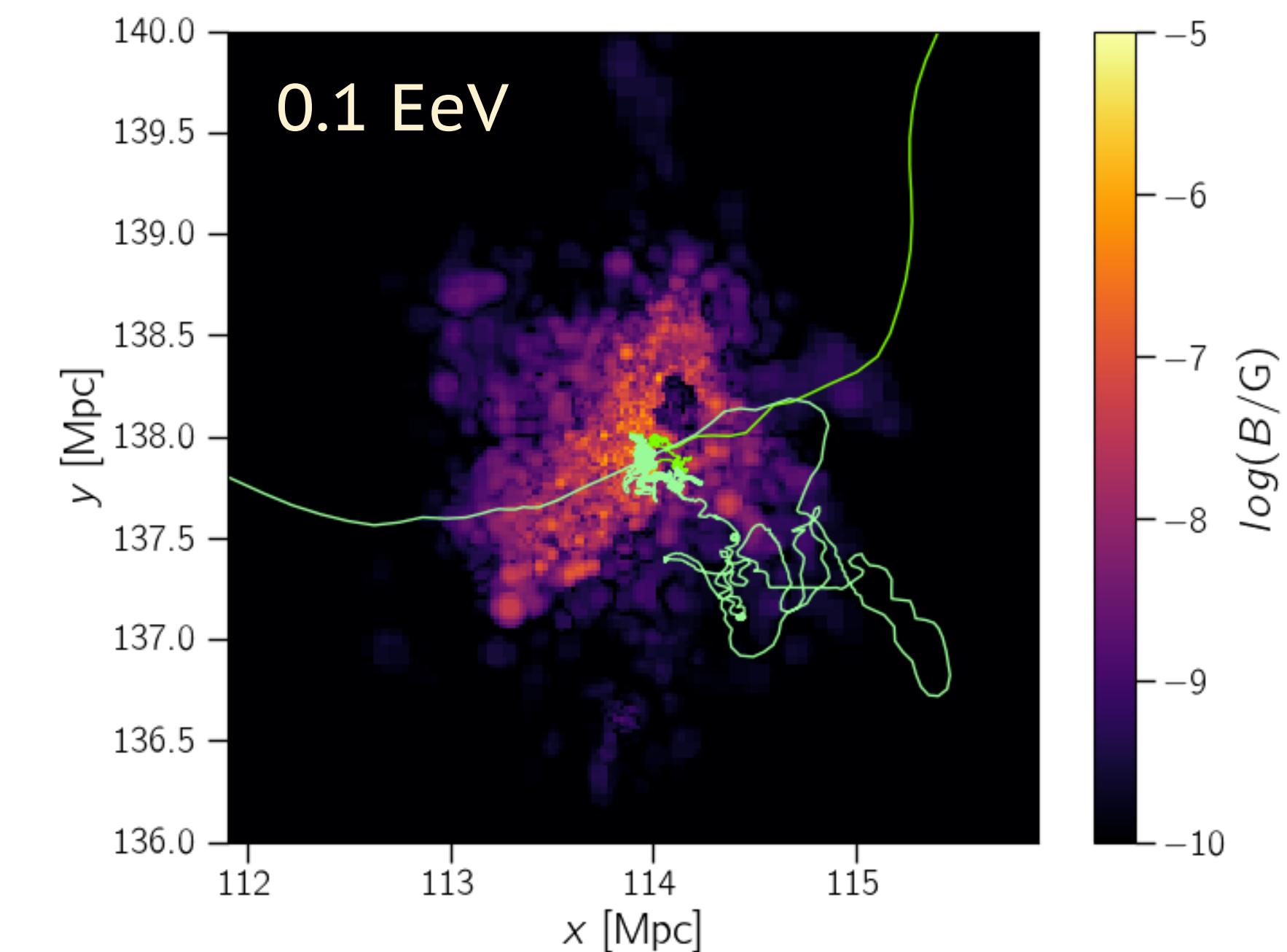
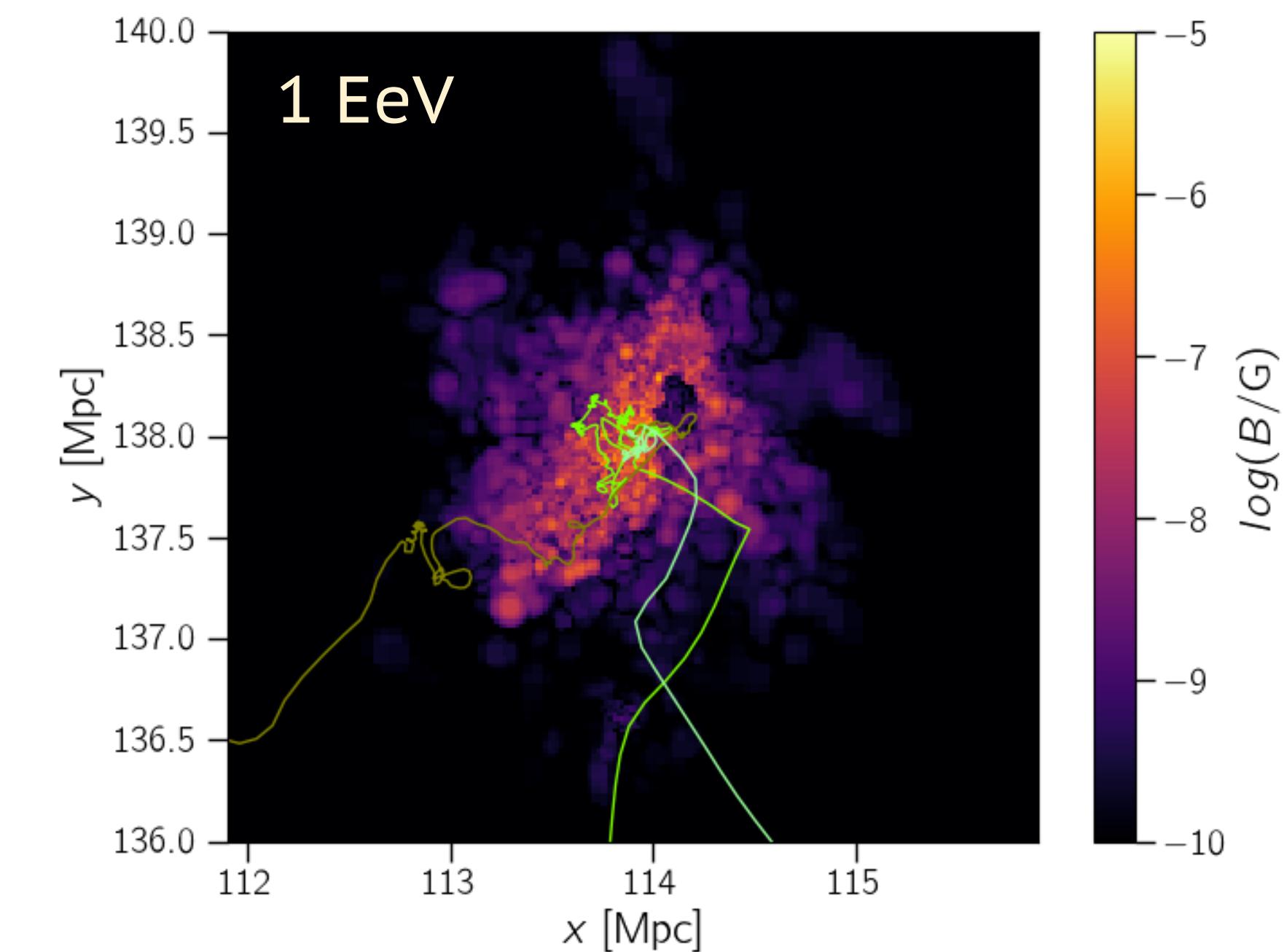
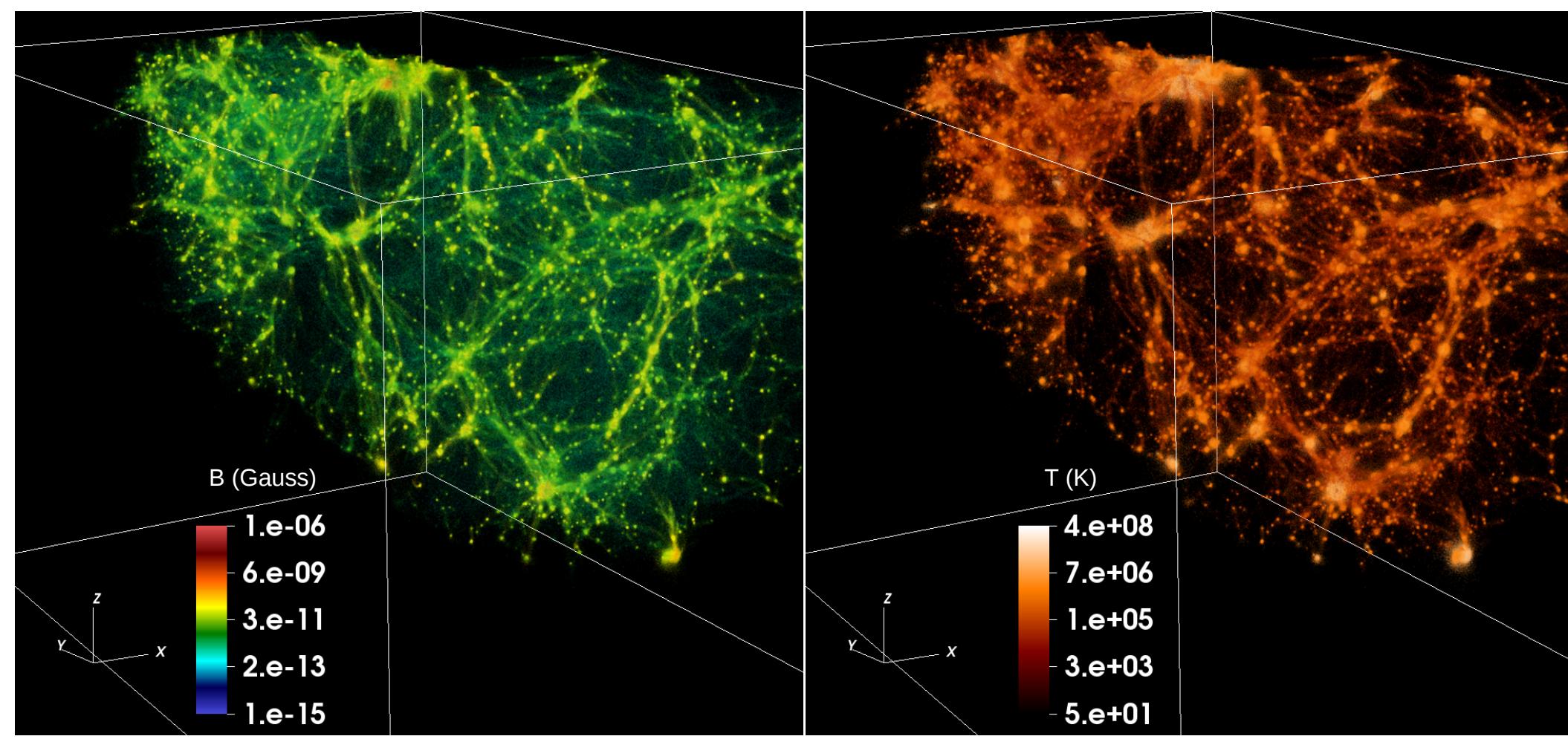
neutrinos and photons from galaxy clusters

cosmic-ray propagation in galaxy clusters

Hussain, Alves Batista, de Gouveia Dal Pino, Dolag. MNRAS 507 (2021) 1762. arXiv:2101.07702

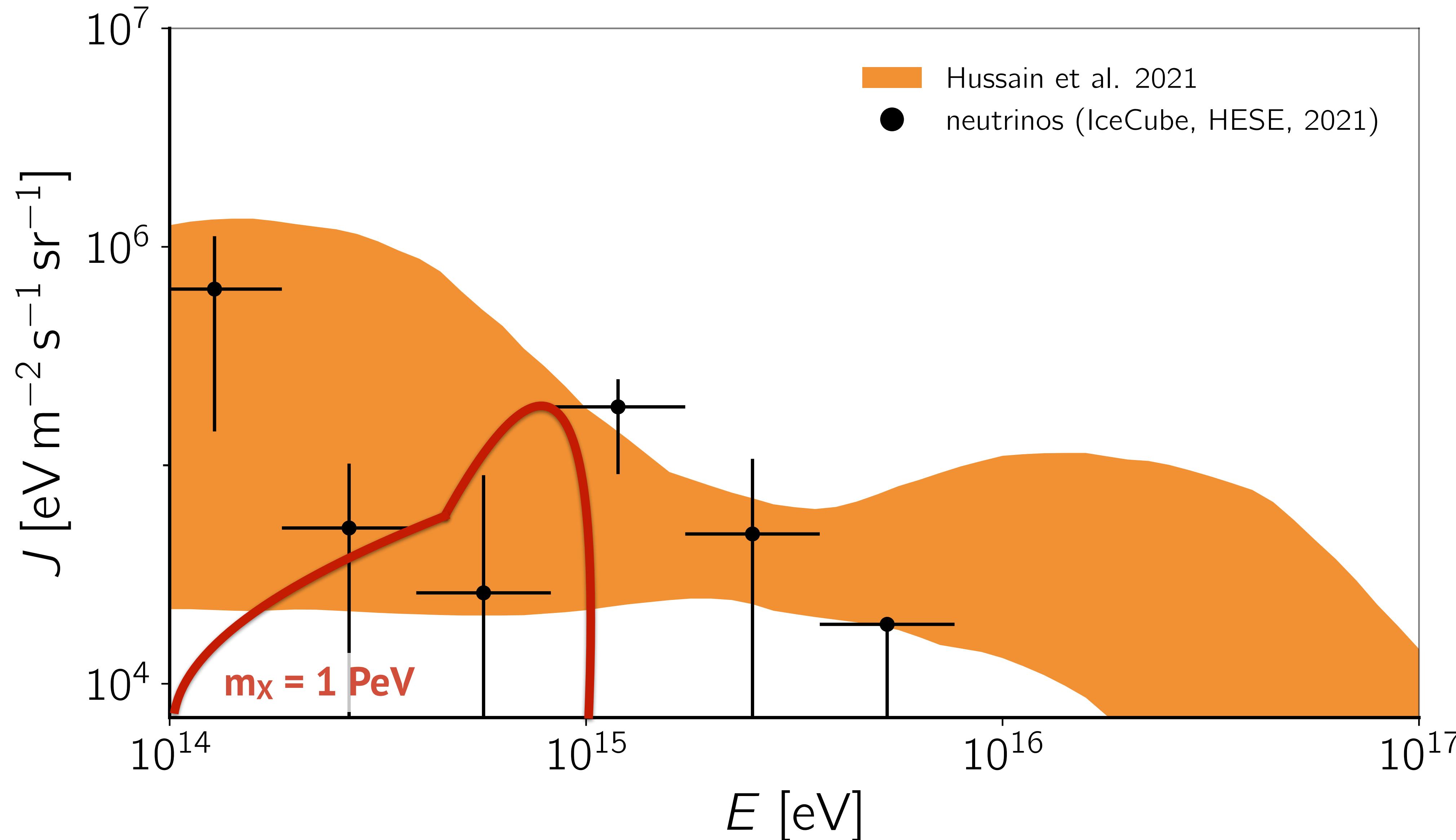
Hussain, Alves Batista, de Gouveia Dal Pino, Dolag. arXiv:2203.01260

- ▶ high-energy neutrinos are produced via hadronic processes
- ▶ cosmic rays are affected by magnetic fields
- ▶ rate of CR interactions increases if magnetic fields are strong
- ▶ CRs are essentially *guaranteed* to interact with the cluster gas, radiation, and magnetic fields → HE neutrinos and photons will certainly be produced



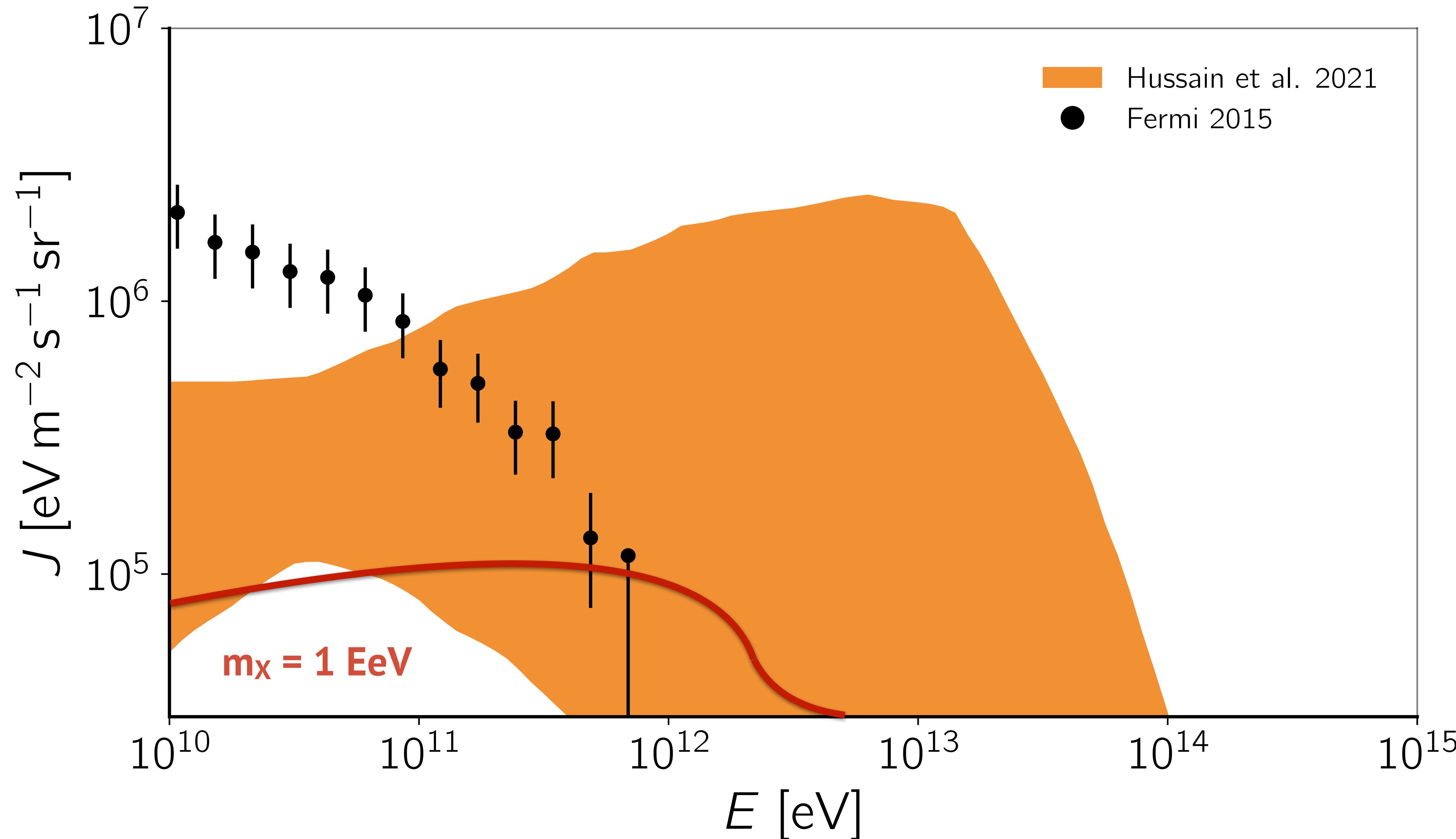
hadronically-produced neutrinos from galaxy clusters

Hussain, Alves Batista, de Gouveia Dal Pino, Dolag. MNRAS 507 (2021) 1762. arXiv:2101.07702



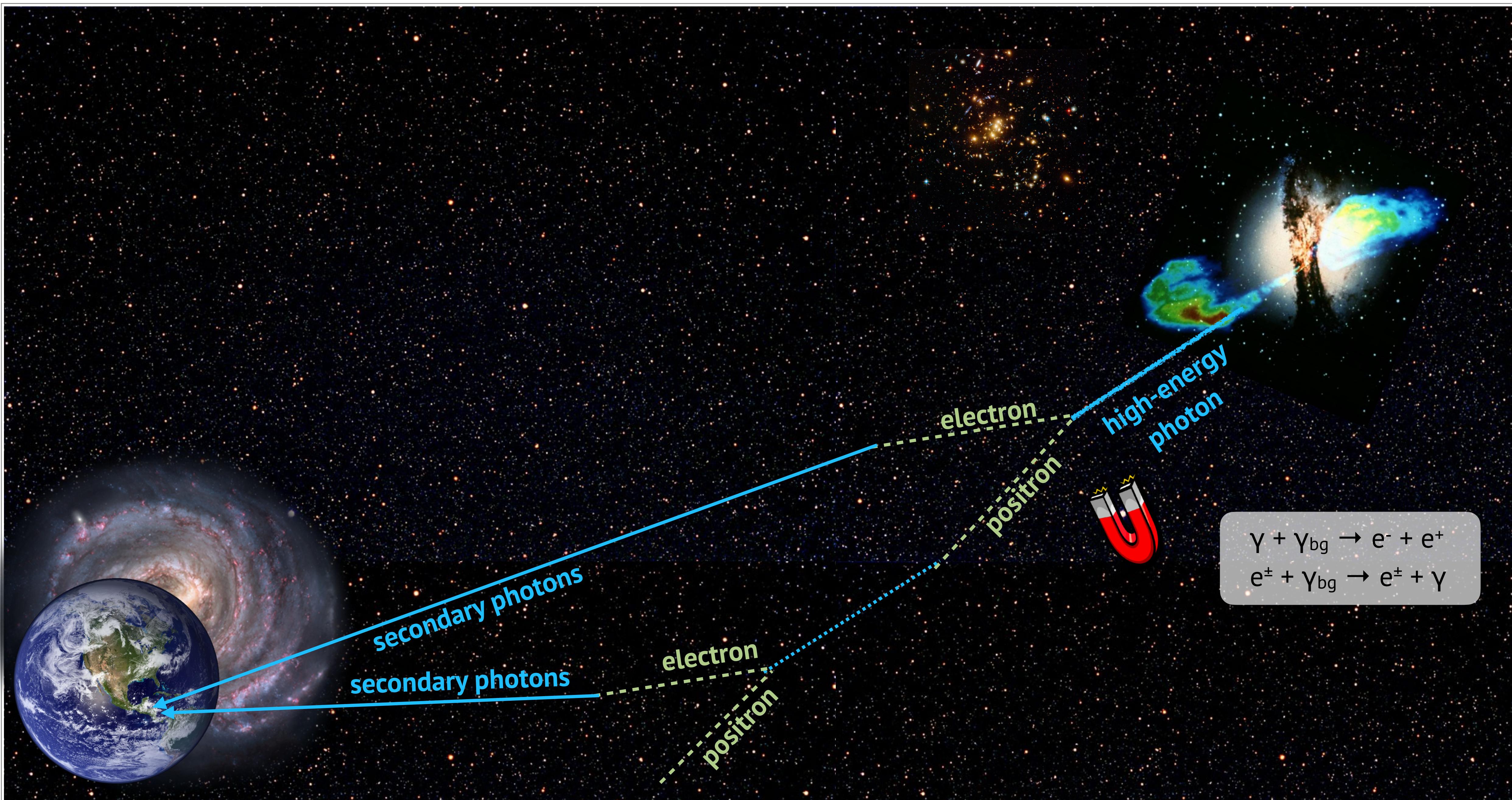
hadronically-produced gamma rays from galaxy clusters

Hussain, Alves Batista, de Gouveia Dal Pino, Dolag. arXiv:2203.01260



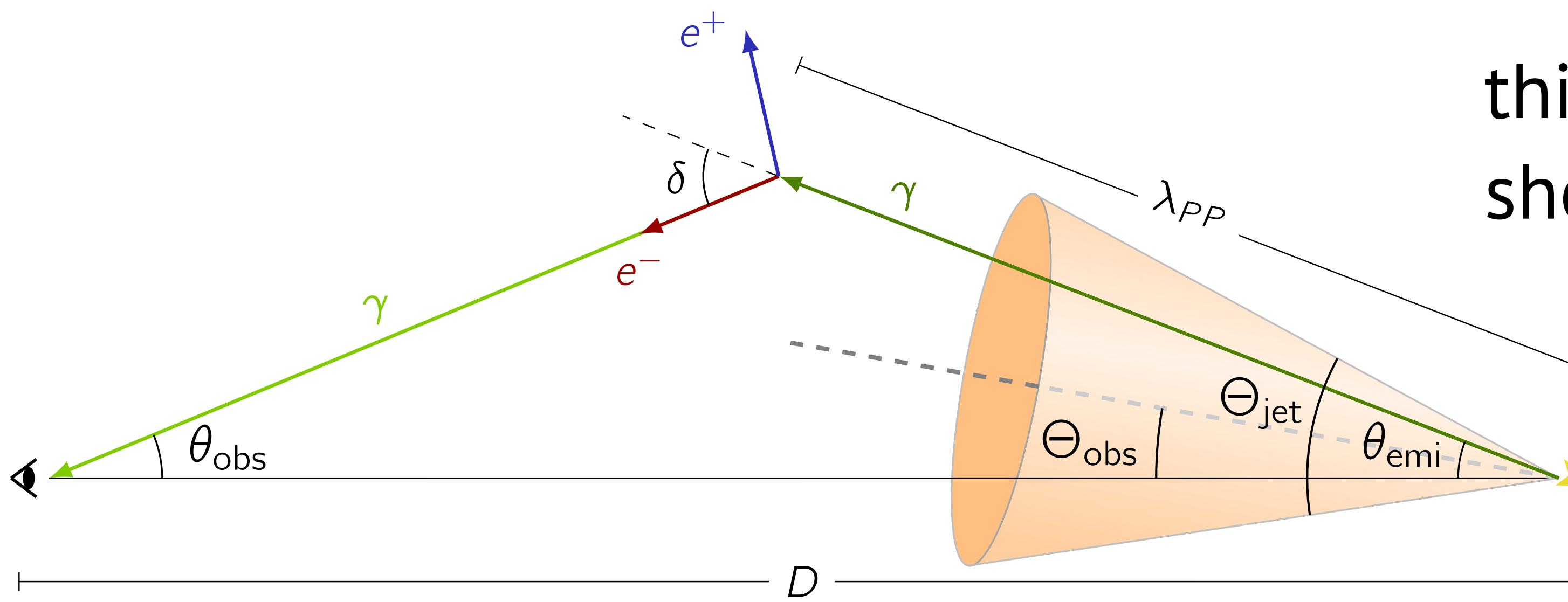
intergalactic magnetic fields

propagation picture: electromagnetic cascades

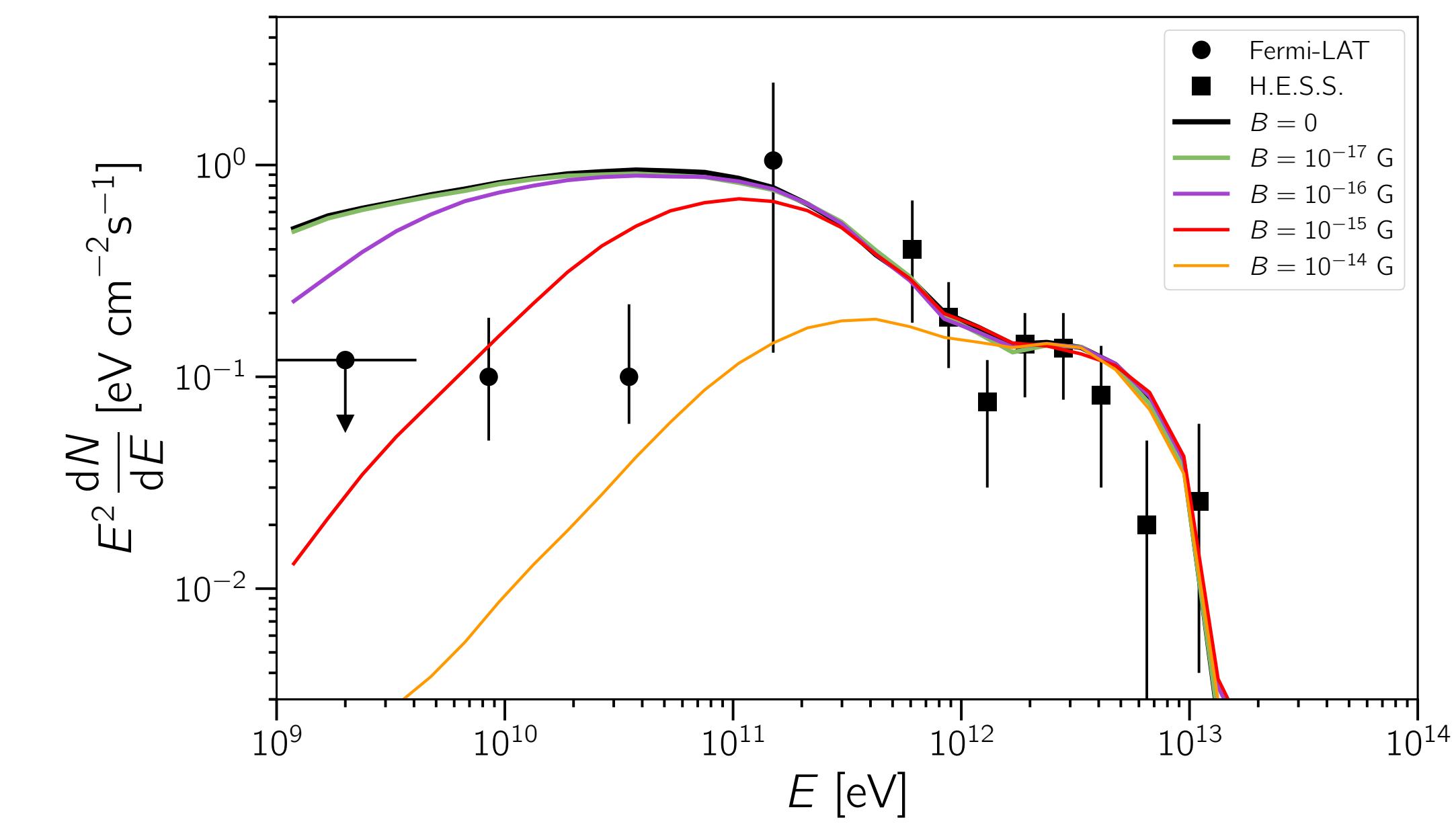
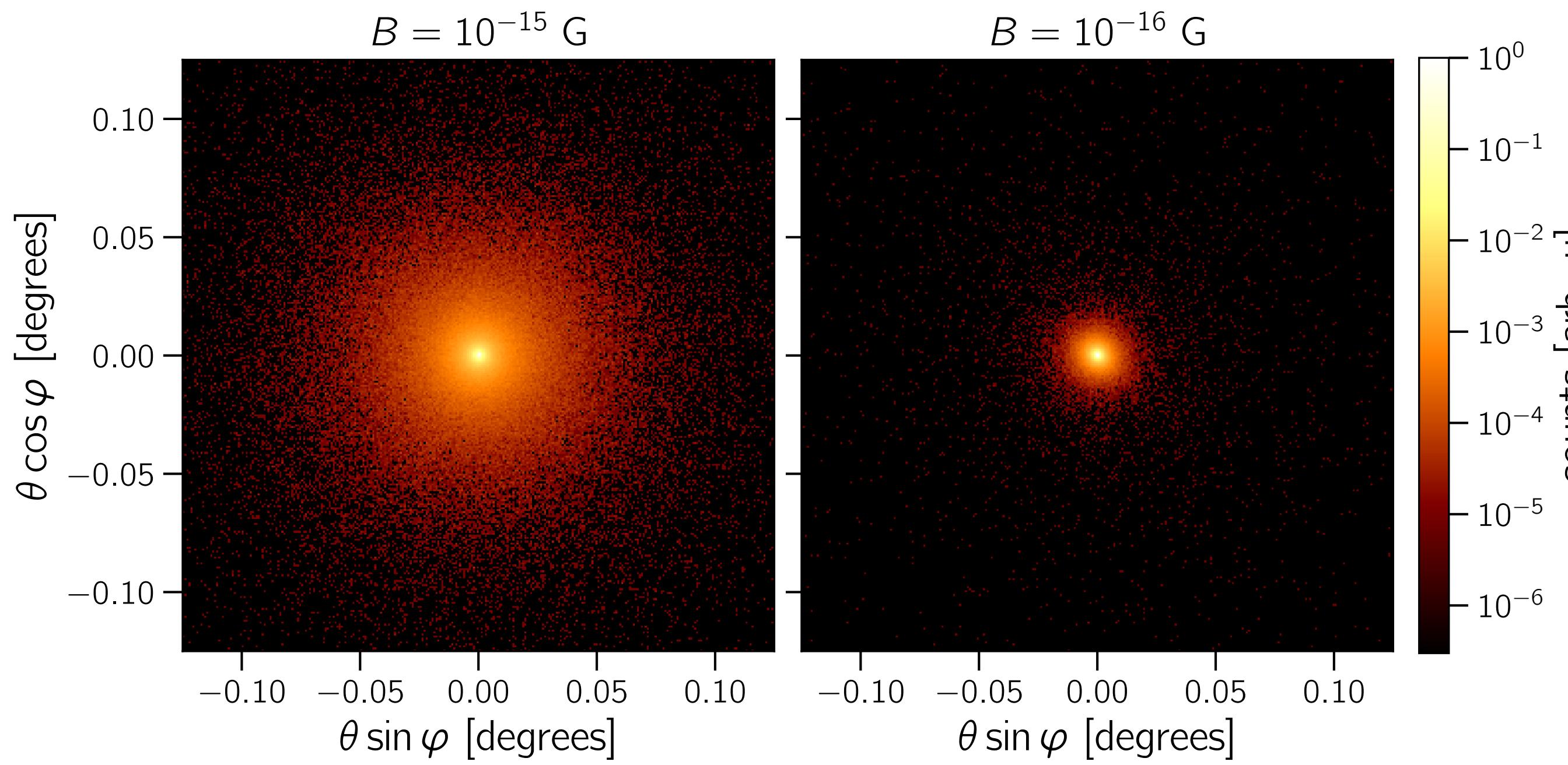


intergalactic magnetic fields: effects on high-energy gamma rays

Alves Batista & Saveliev. Universe 7 (2021) 223. arXiv:2105.12020



this is for a single source; the same
should happen with the DGRB

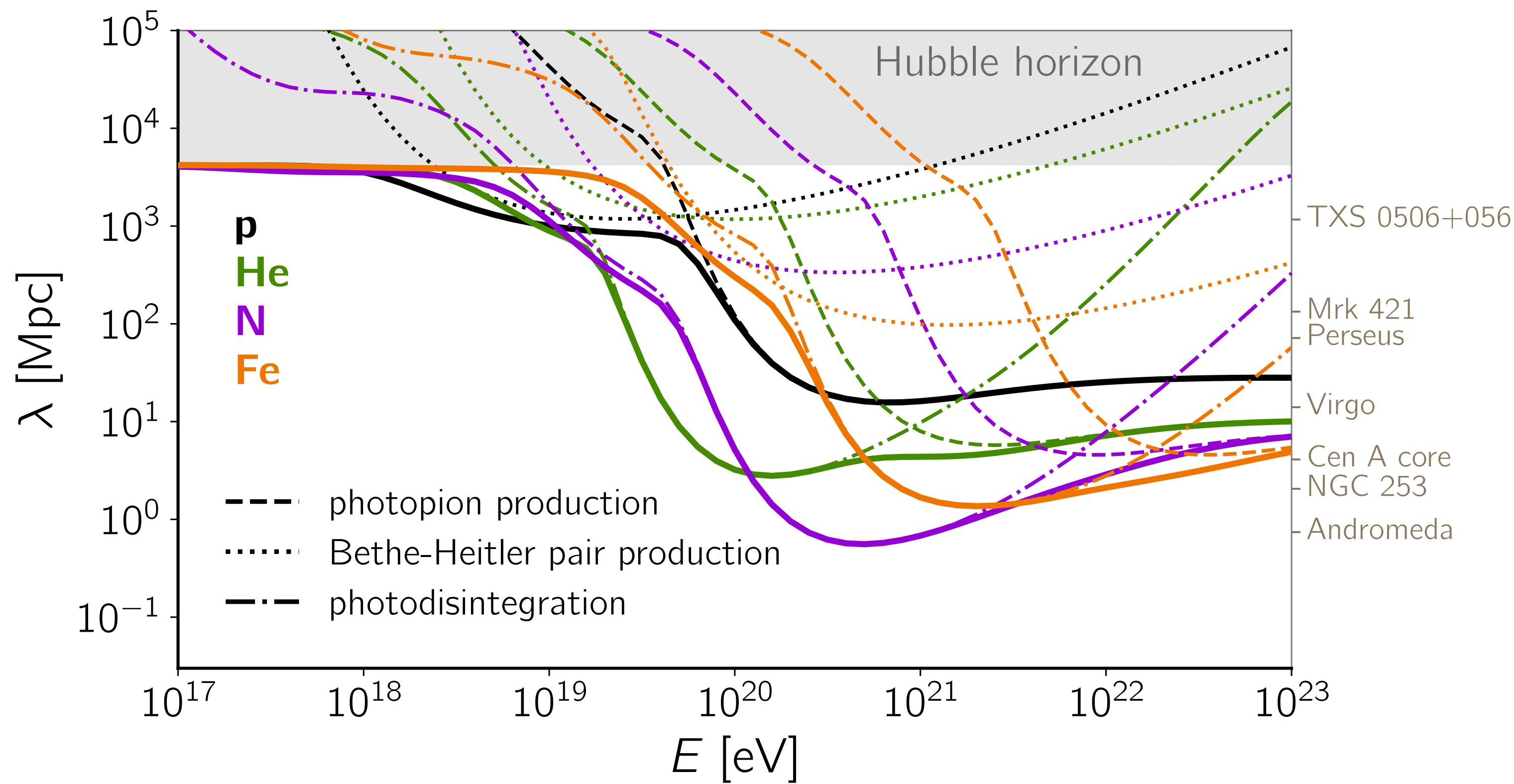


outlook & summary

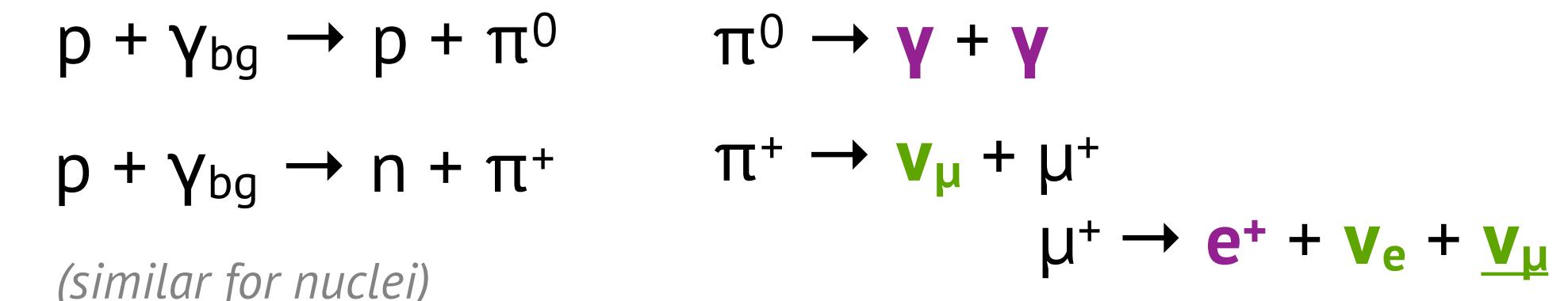
- ▶ there are many astrophysical backgrounds of high-energy neutrinos and photons
- ▶ two **guaranteed** contributions to the diffuse backgrounds of gamma rays and neutrinos
 - ◆ cosmogenic neutrinos and photons produced from UHECR interactions
 - ◆ neutrinos and gamma rays produced in CR interactions in clusters
 - ◆ parameter space available for DM shrinking
- ▶ it is not trivial to estimate fluxes of high-energy gamma rays: magnetic fields can play a major role and are highly uncertain
- ▶ these **diffuse fluxes affect dark matter searches**
 - ◆ no claim of discovery can be done if these backgrounds are not understood
- ▶ ***how to improve DM searches then?***

back-up

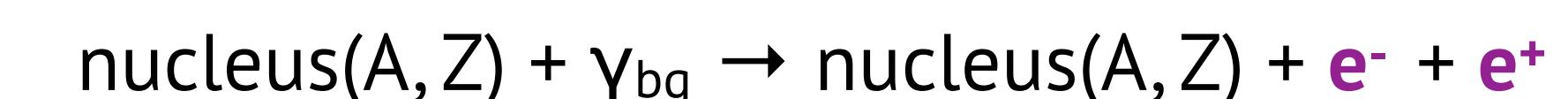
UHECRs: interactions



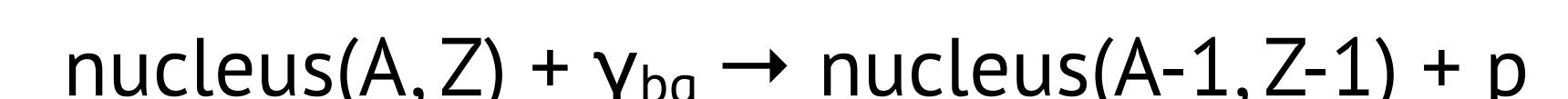
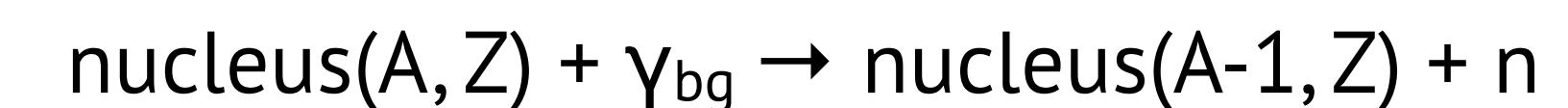
photopion production



Bethe-Heitler pair production



photodisintegration



...

nuclear decays

