Imprints of the Galactic Magnetic Field on Gamma-Ray Data

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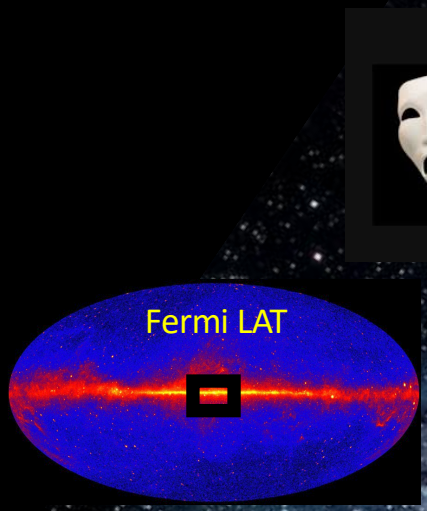
University of Trieste & Stanford University

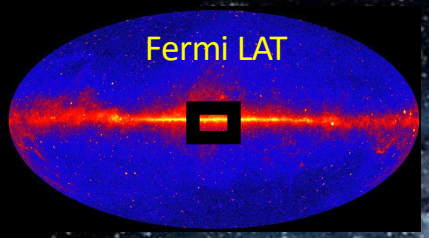
ECRS 2022

Diffuse Interstellar Emission



PROBLEM:
large-scale interstellar model uncertainties

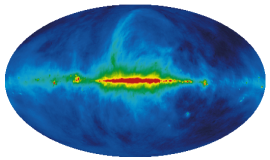
Diffuse Interstellar Emission



Cosmic rays

PROBLEM:
large-scale interstellar model uncertainties

OUR SOLUTION:



Radio Surveys

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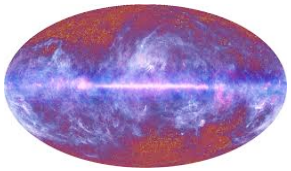

Microwaves

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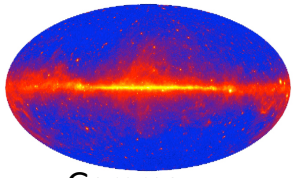

Gamma Rays

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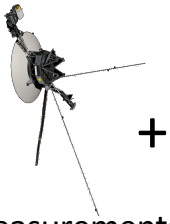

Cosmic Rays Measurements

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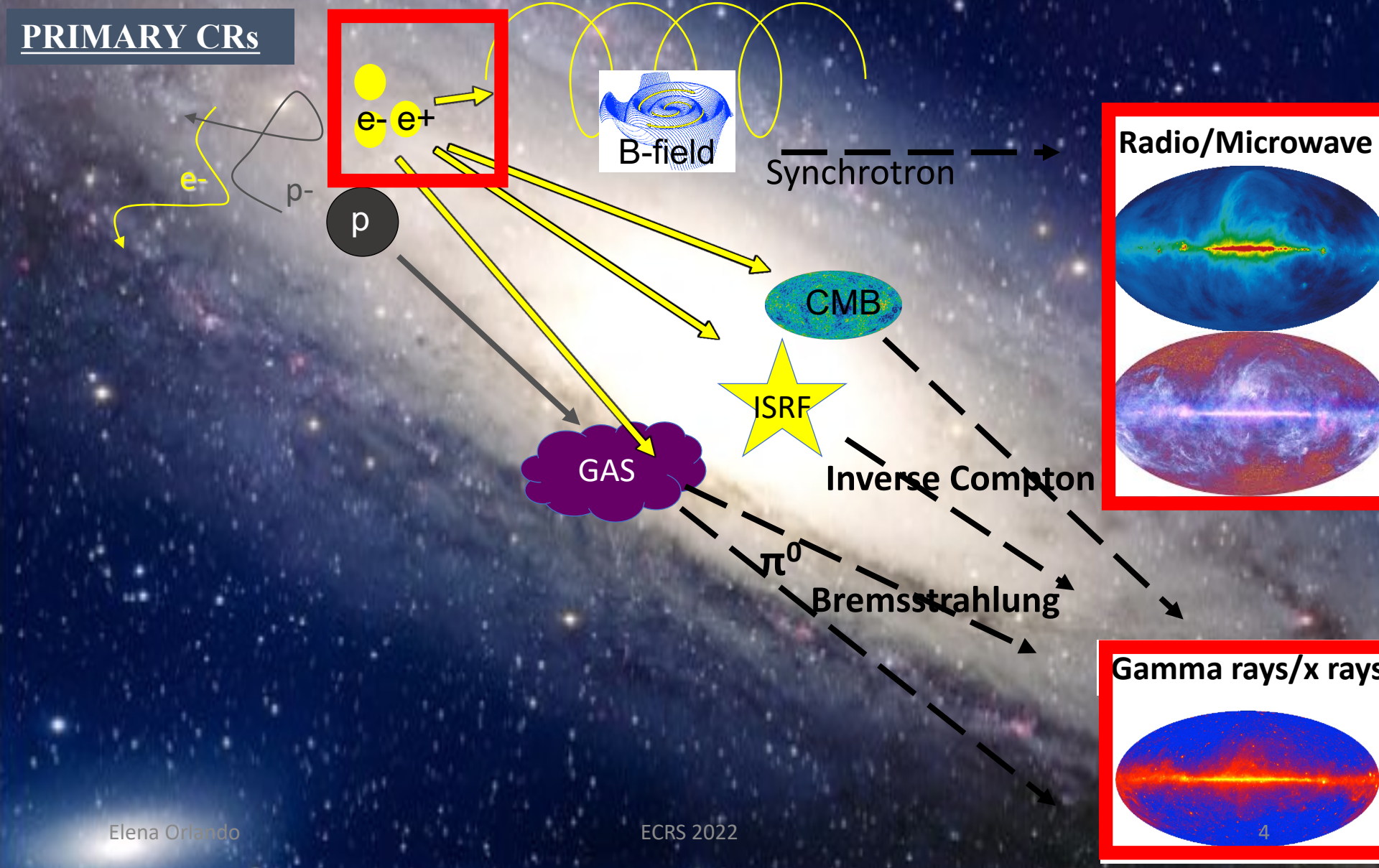
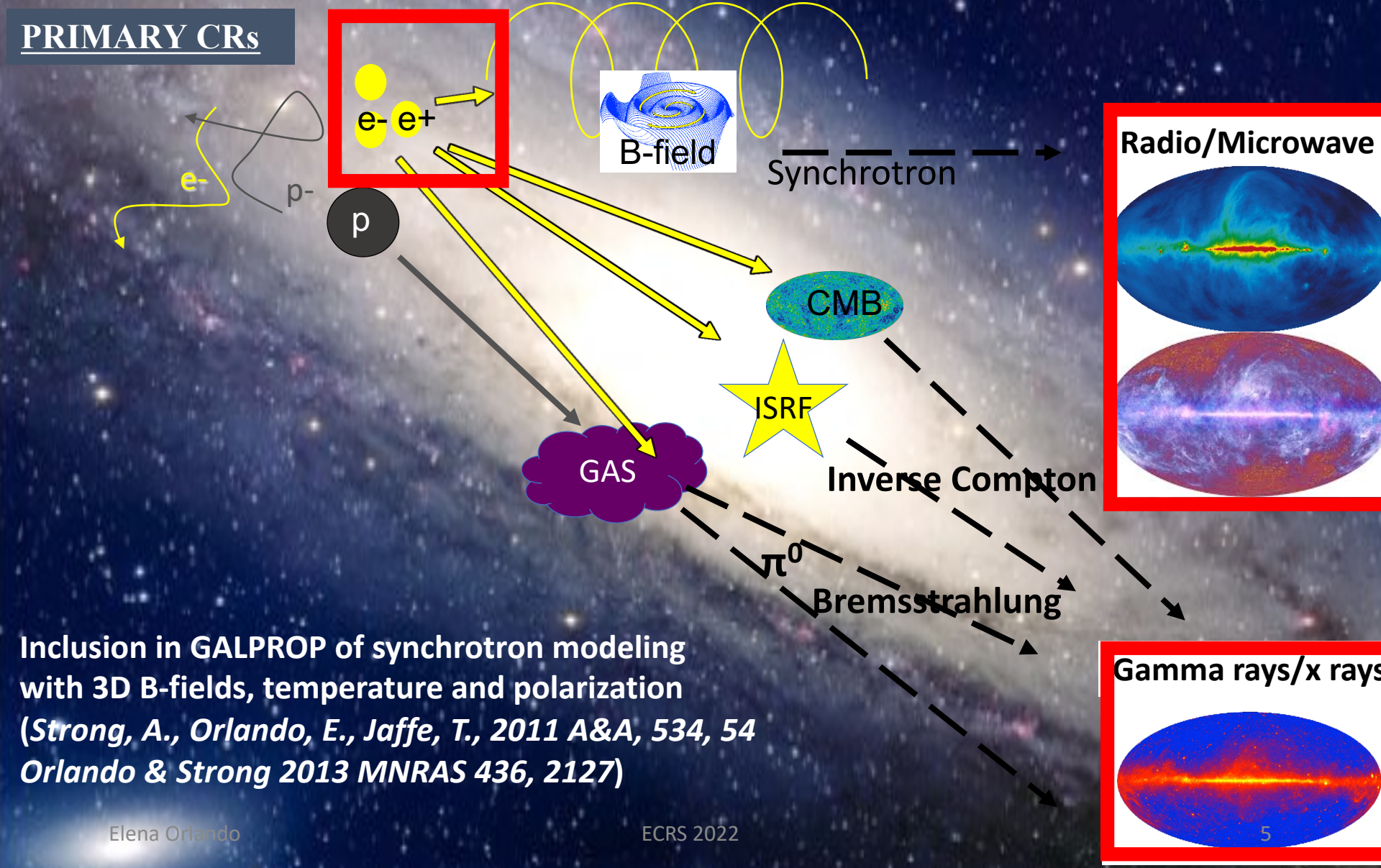
Cosmic-Ray Propagation Models

Diffuse Interstellar Emission



Diffuse Interstellar Emission

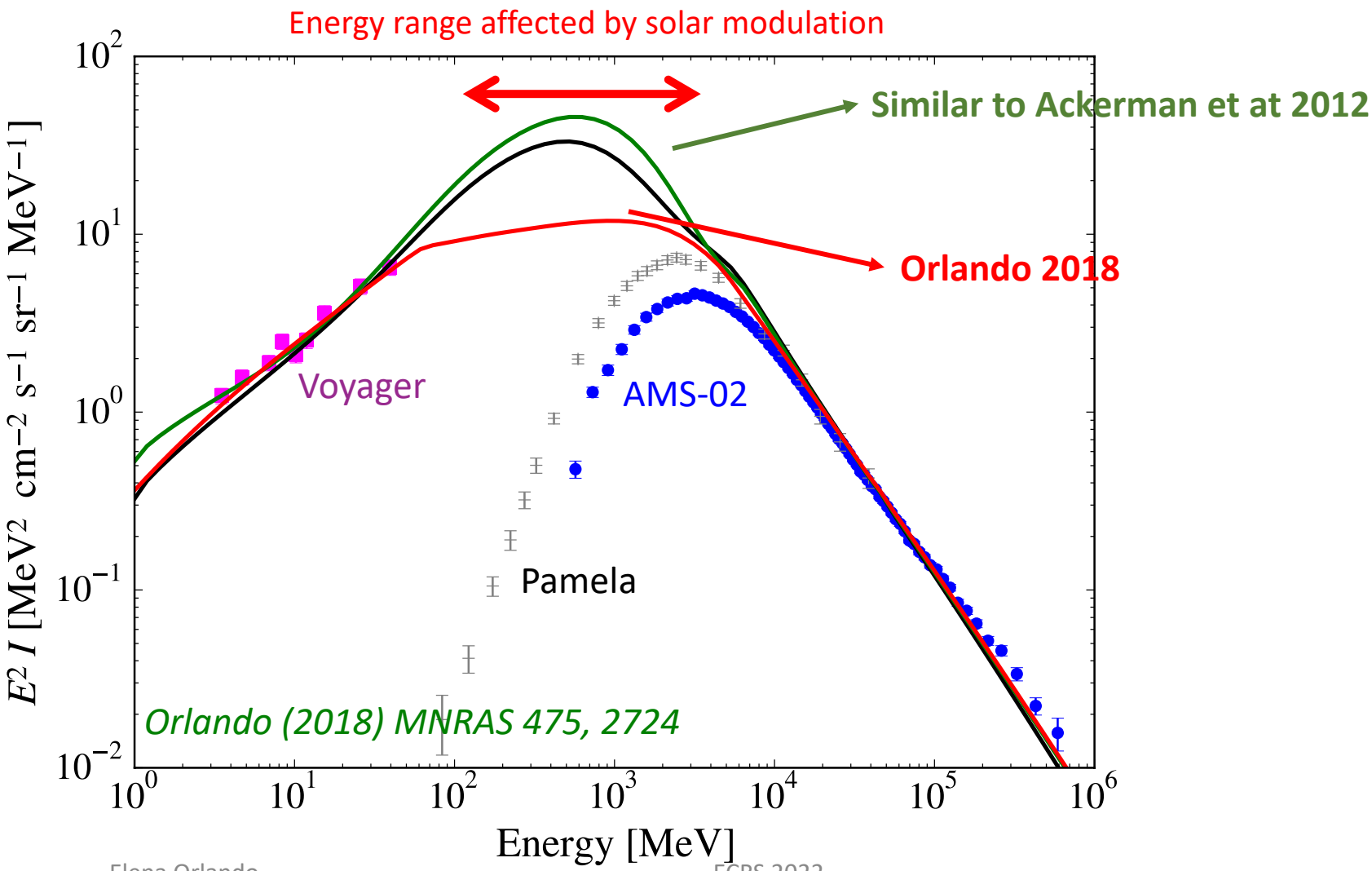


Inclusion in GALPROP of synchrotron modeling with 3D B-fields, temperature and polarization (*Strong, A., Orlando, E., Jaffe, T., 2011 A&A, 534, 54 Orlando & Strong 2013 MNRAS 436, 2127*)

Results:

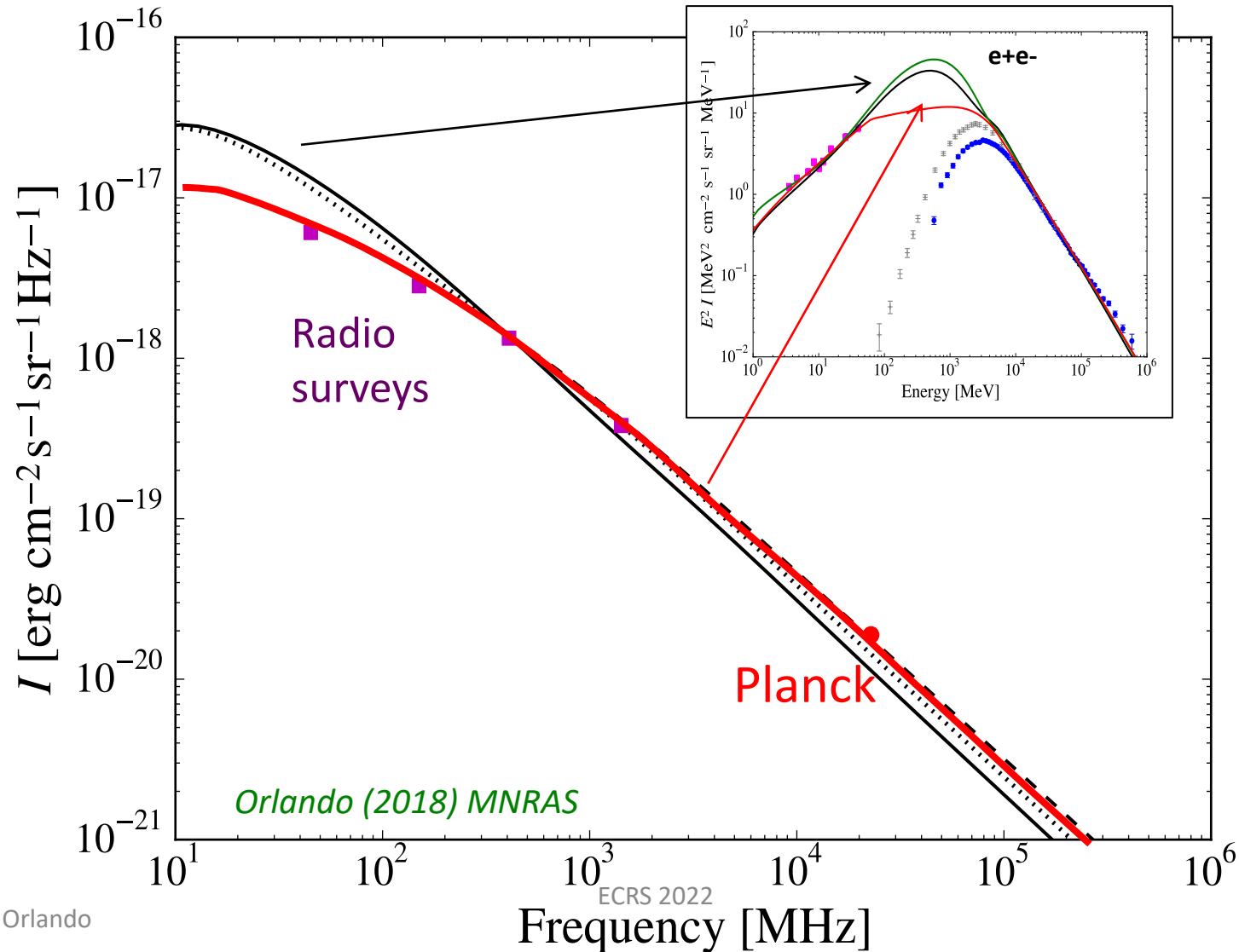
Spectral Effects on the Interstellar Models

Results: Local Interstellar **e+e-** & Different Propagation Scenarios

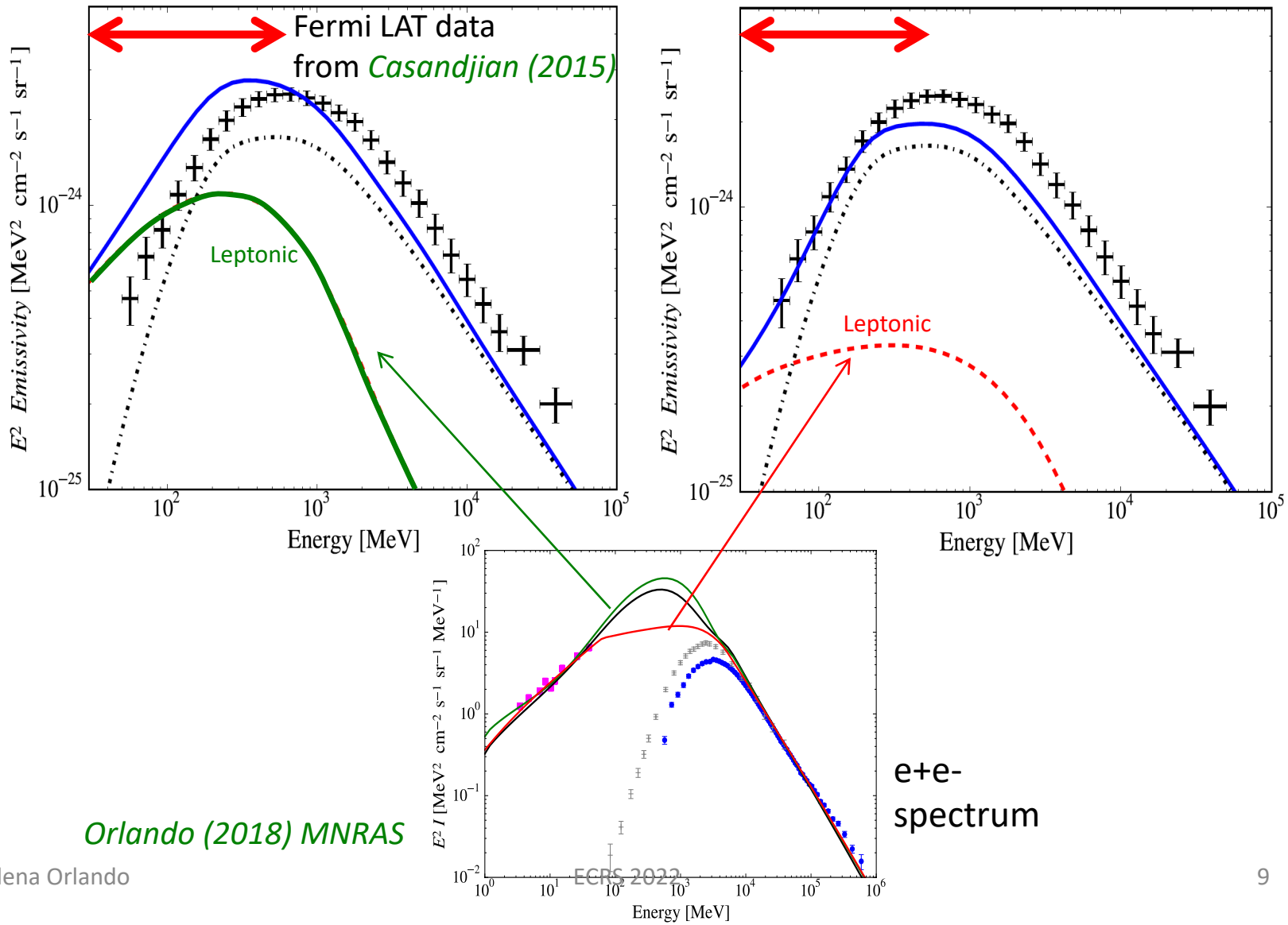


(see also *Strong+ (2011), Orlando & Strong (2013)*)

Synchrotron Spectrum



Local HI Gamma-Ray Emissivity



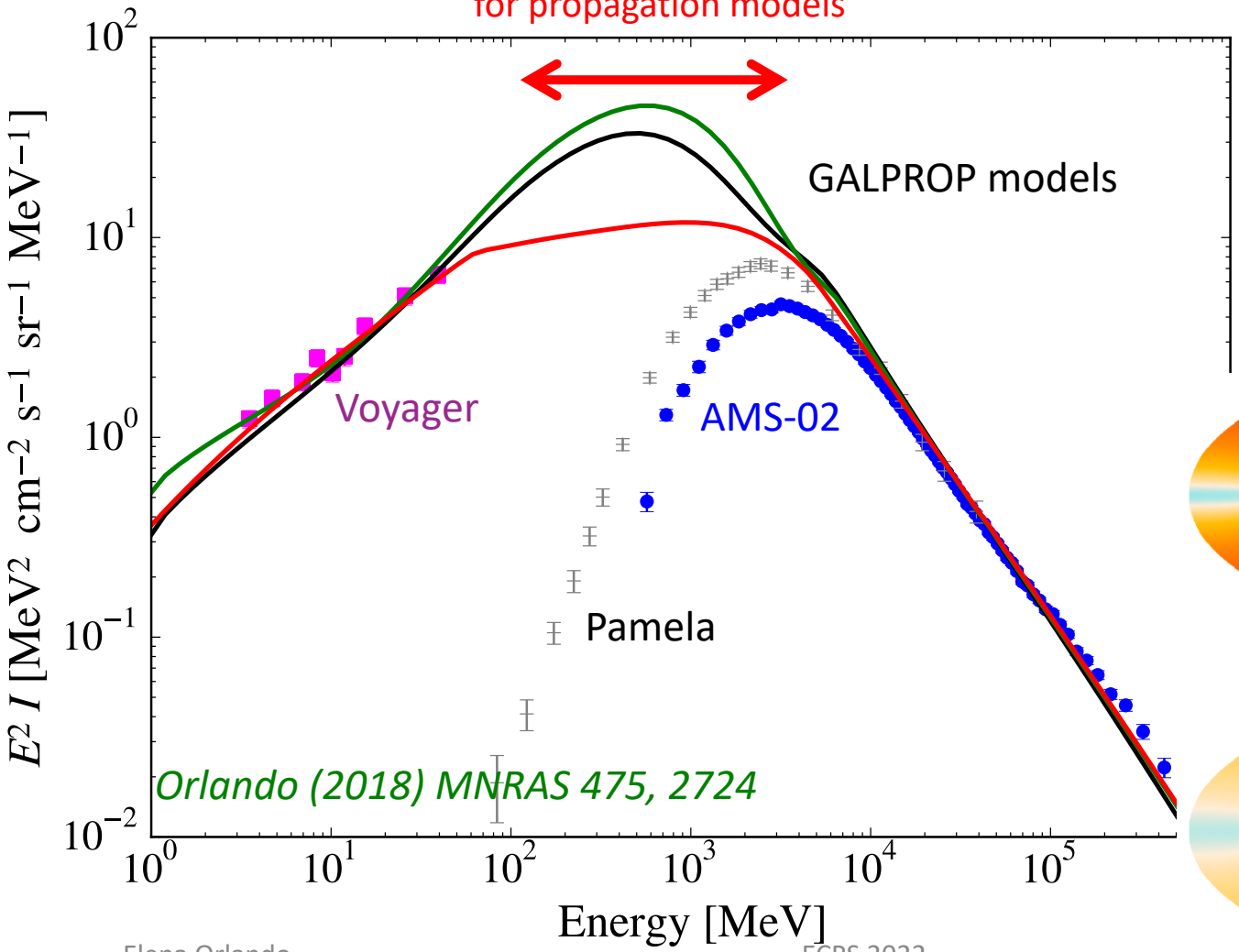
Orlando (2018) MNRAS

Results:

Spatial Effects on the Inverse-Compton Templates

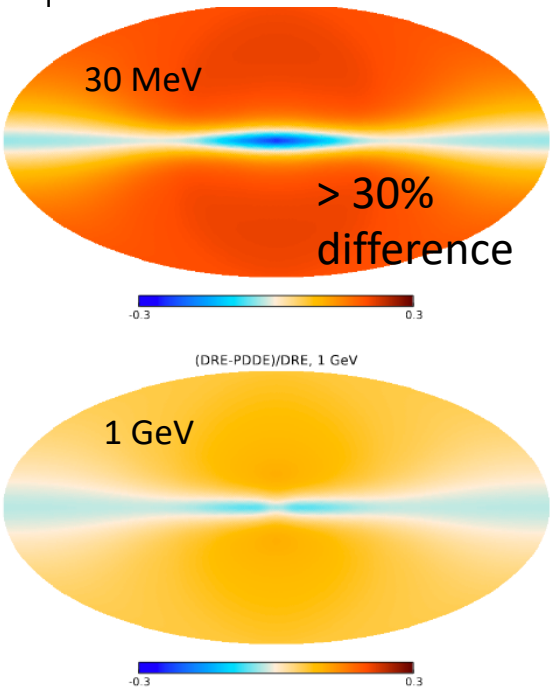
Results: Effect on Inverse Compton (IC)

Energy range important
for propagation models



Orlando (2019) Phys.Rev.D 99, 043007

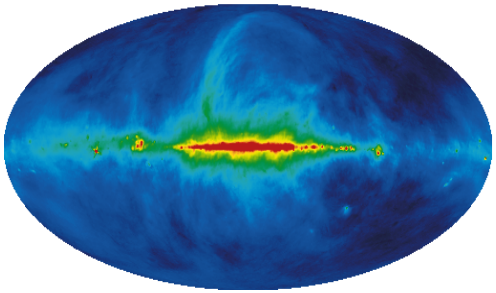
$(IC_{OLD} - IC_{NEW}) / IC_{OLD}$



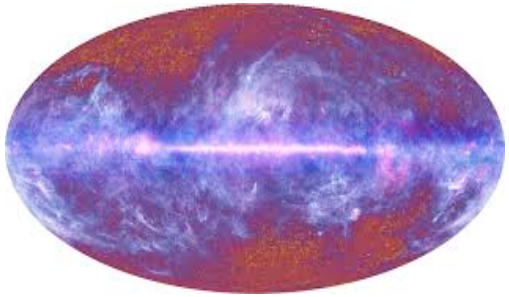
(see also *Strong+ (2011), Orlando & Strong (2013)*)

Results: Cosmic Rays & B-fields

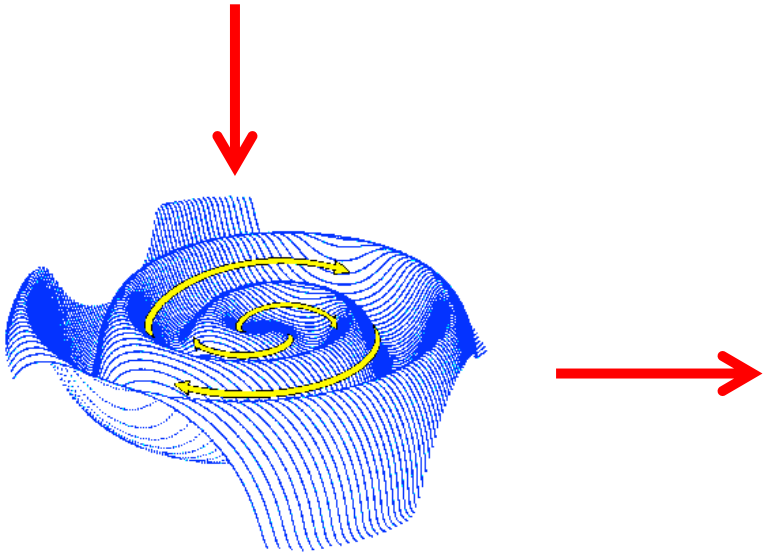
Orlando (2019) Phys.Rev.D 99, 043007

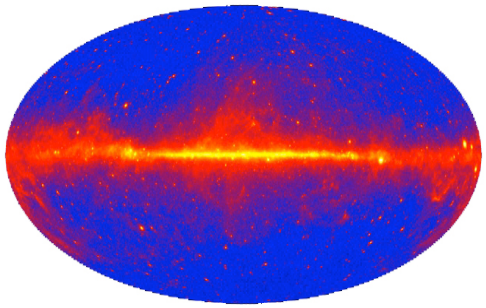


Radio surveys



Planck - microwaves



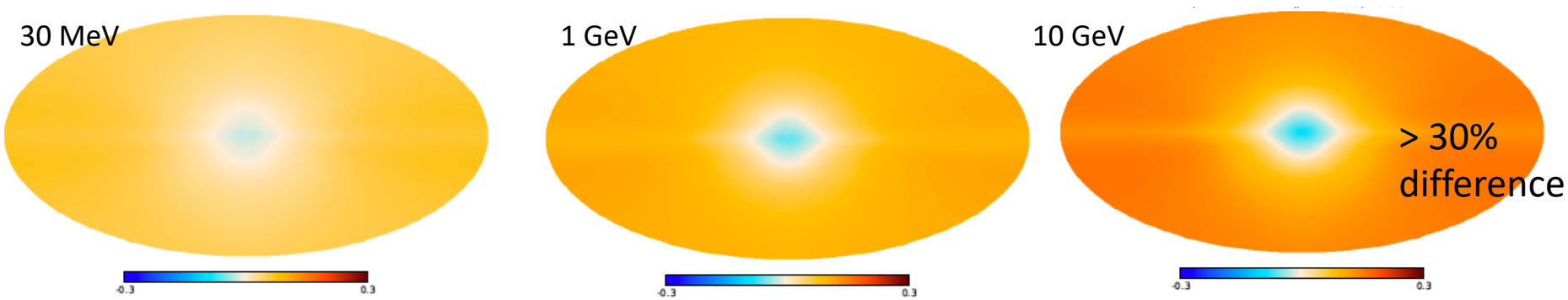


Fermi LAT – gamma rays

Results: Effect on Inverse Compton (IC)

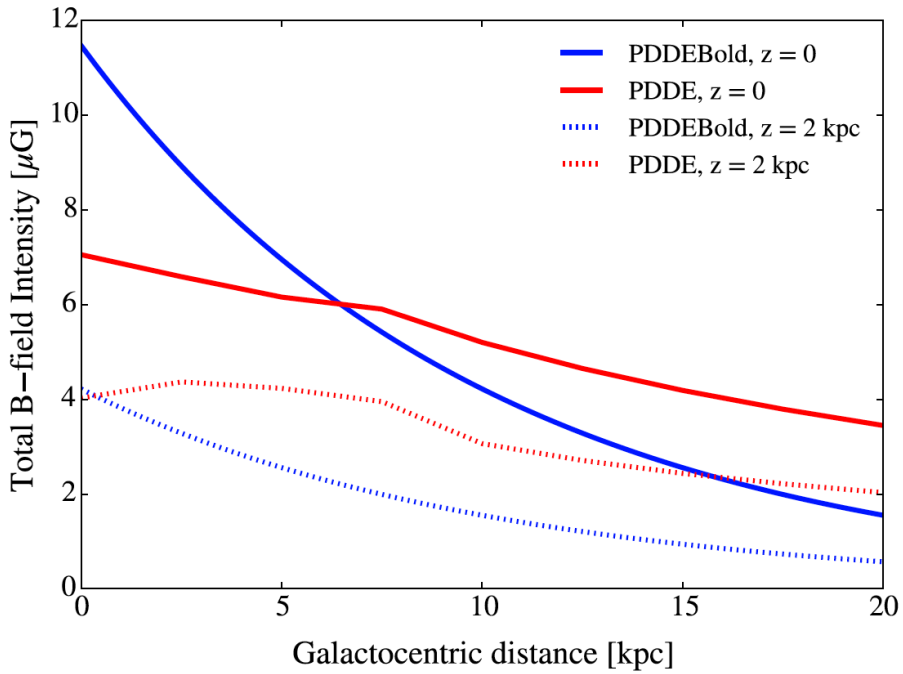
Orlando (2019) Phys.Rev.D 99, 043007

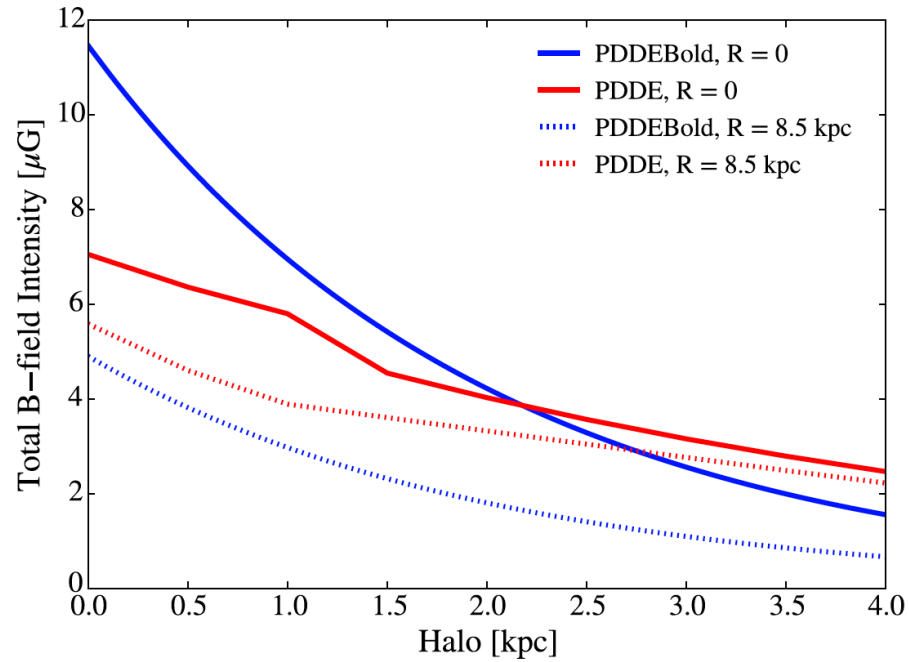
$(IC_{OLD} – IC_{NEW}) / IC_{OLD}$



Updated B-fields produce a brighter IC in the inner Galaxy than predicted by standard models and the difference increases with energy

Total B-field

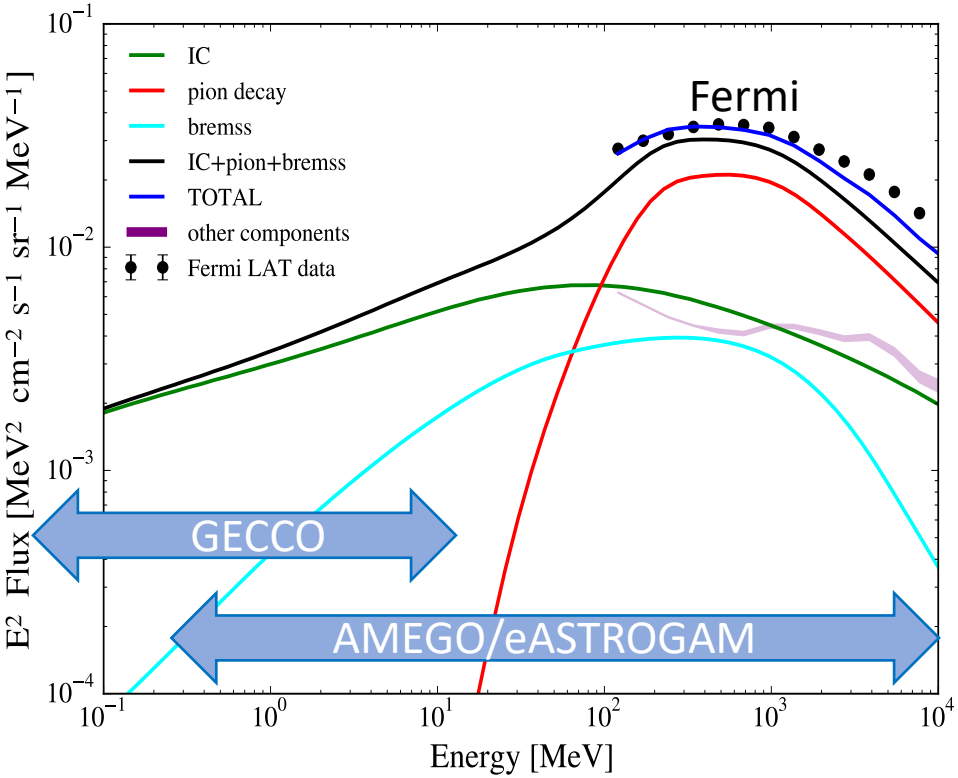


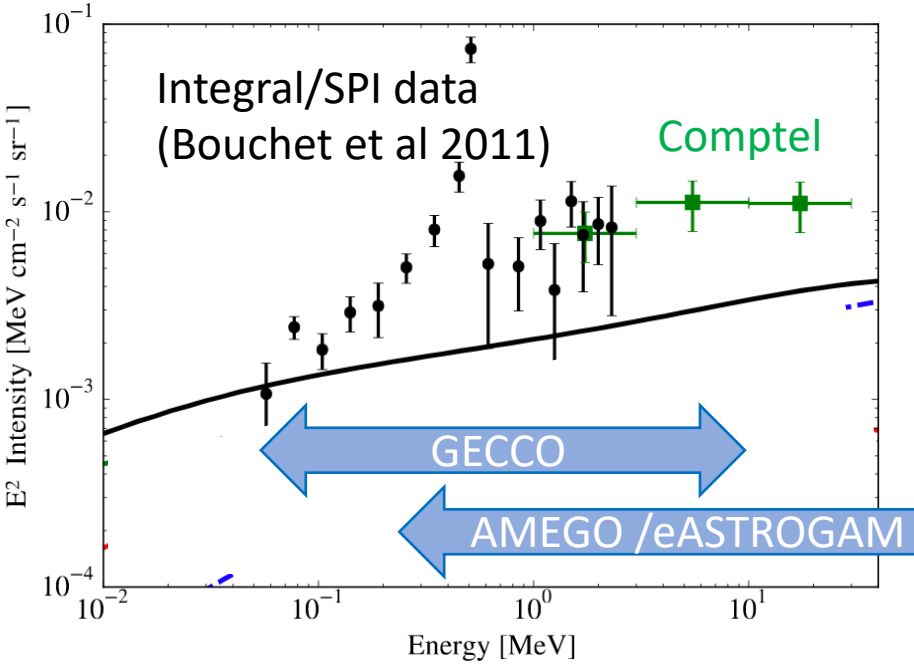


Orlando (2019)

Gamma-Ray Predictions at MeV (e.g. GECCO, AMEGO, etc.)

Inner Galaxy





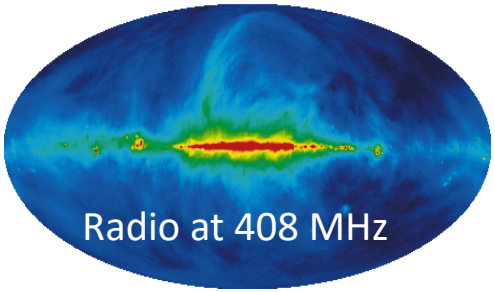
→ **Source contamination!**

see Bottacini's talk on GECCO
see Tibaldo's talk on MeV missions' overview

Orlando (2018) MNRAS 475, 2724

Orlando (2019) Phys.Rev.D 99, 043007

Summary: Our Multimessenger Study



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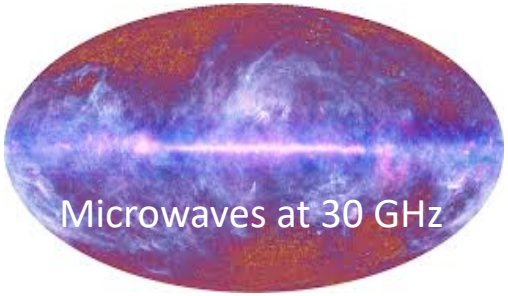

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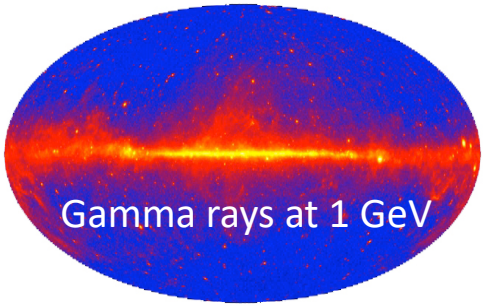

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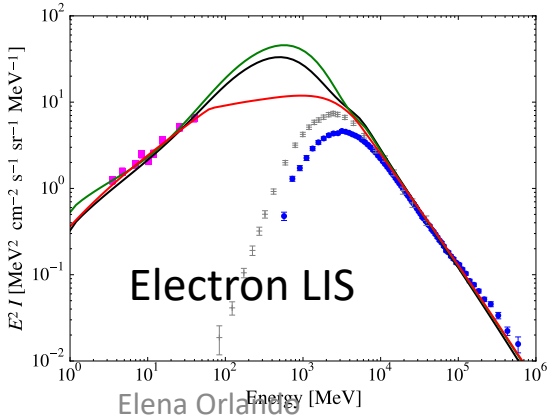
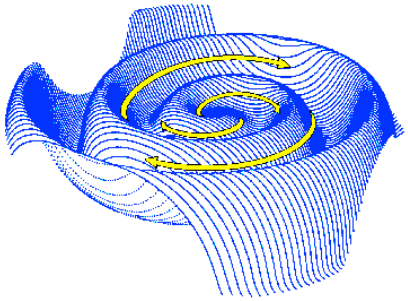
Inclusion in GALPROP of synchrotron modeling with 3D B-fields and polarization
(*Strong, A., Orlando, E., Jaffe, T., 2011 A&A, 534, 54*
Orlando & Strong 2013 MNRAS 436, 2127)

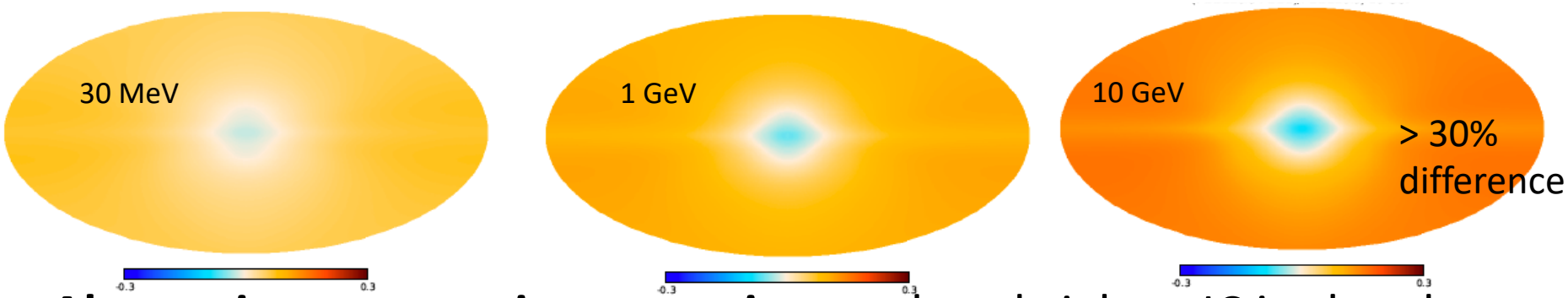




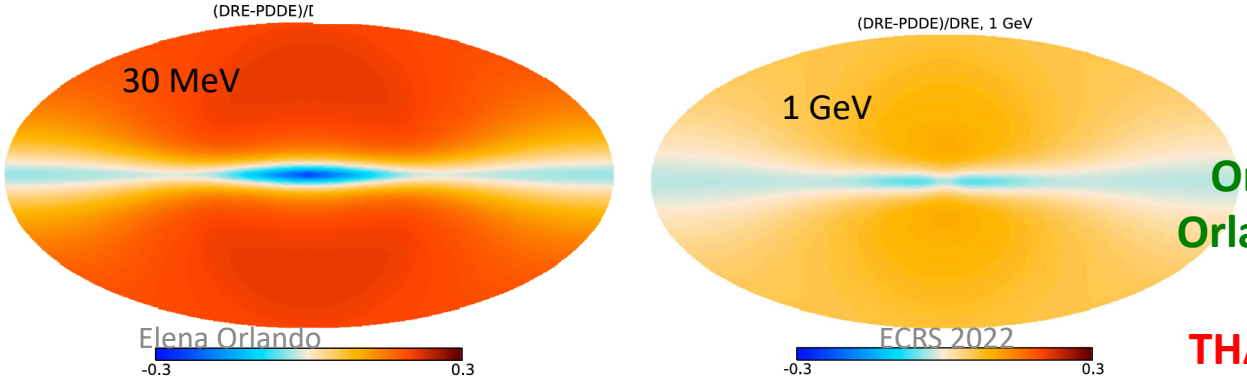
Summary: Effects on the IC spatial templates

Updated B-fields produces a more peaked IC in the inner Galaxy than predicted by previous models for any photon field model used

(IC old – IC new) / IC old



Alternative propagation scenarios produce brighter IC in the plane than predicted by previous models for any photon field model used



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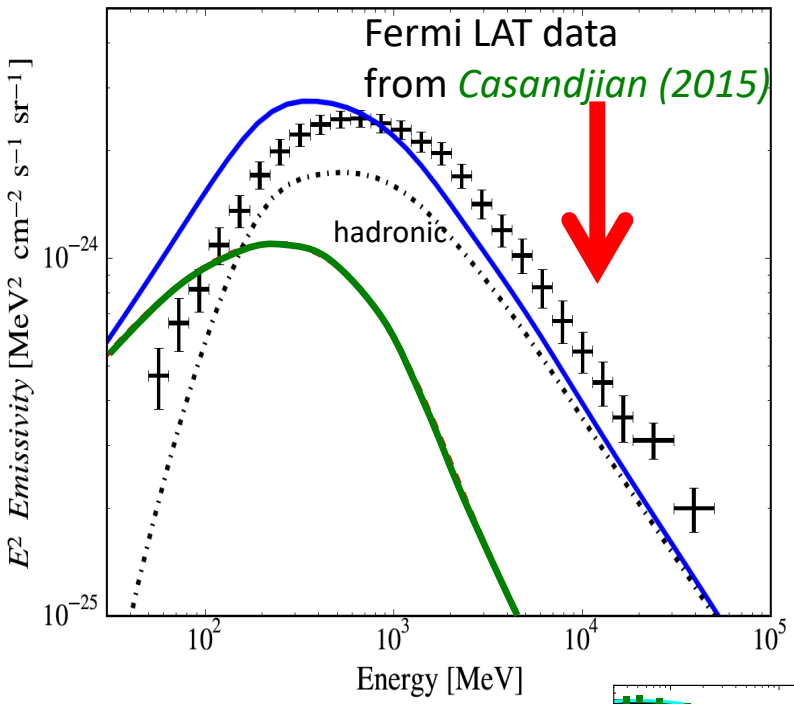
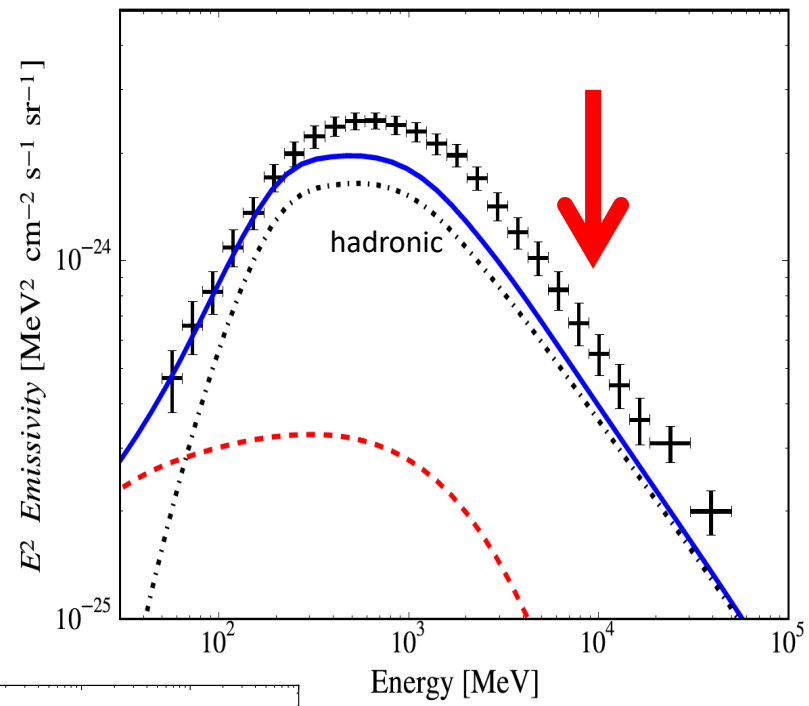
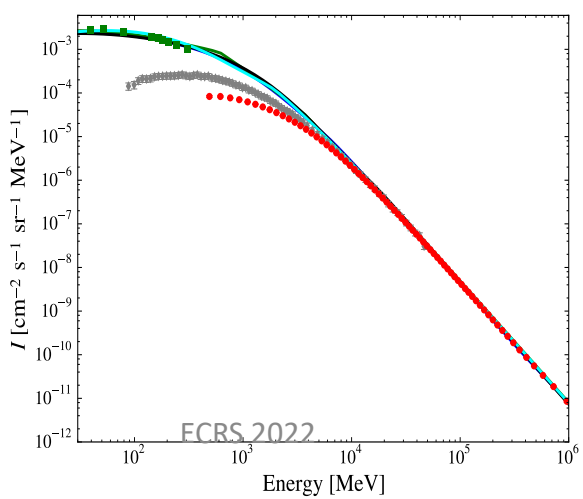
Orlando (2019) Phy.Rev.D 99, 043007

THANK YOU FOR YOUR ATTENTION!

Local HI Gamma-Ray Emissivity





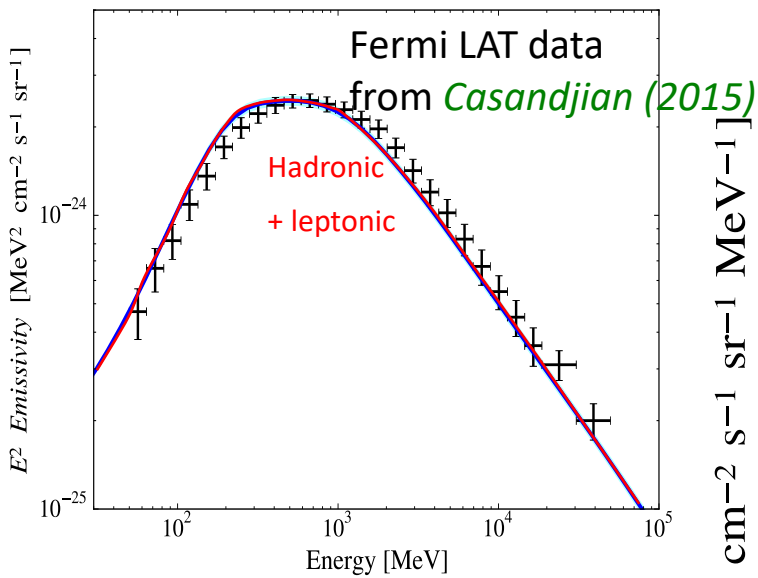


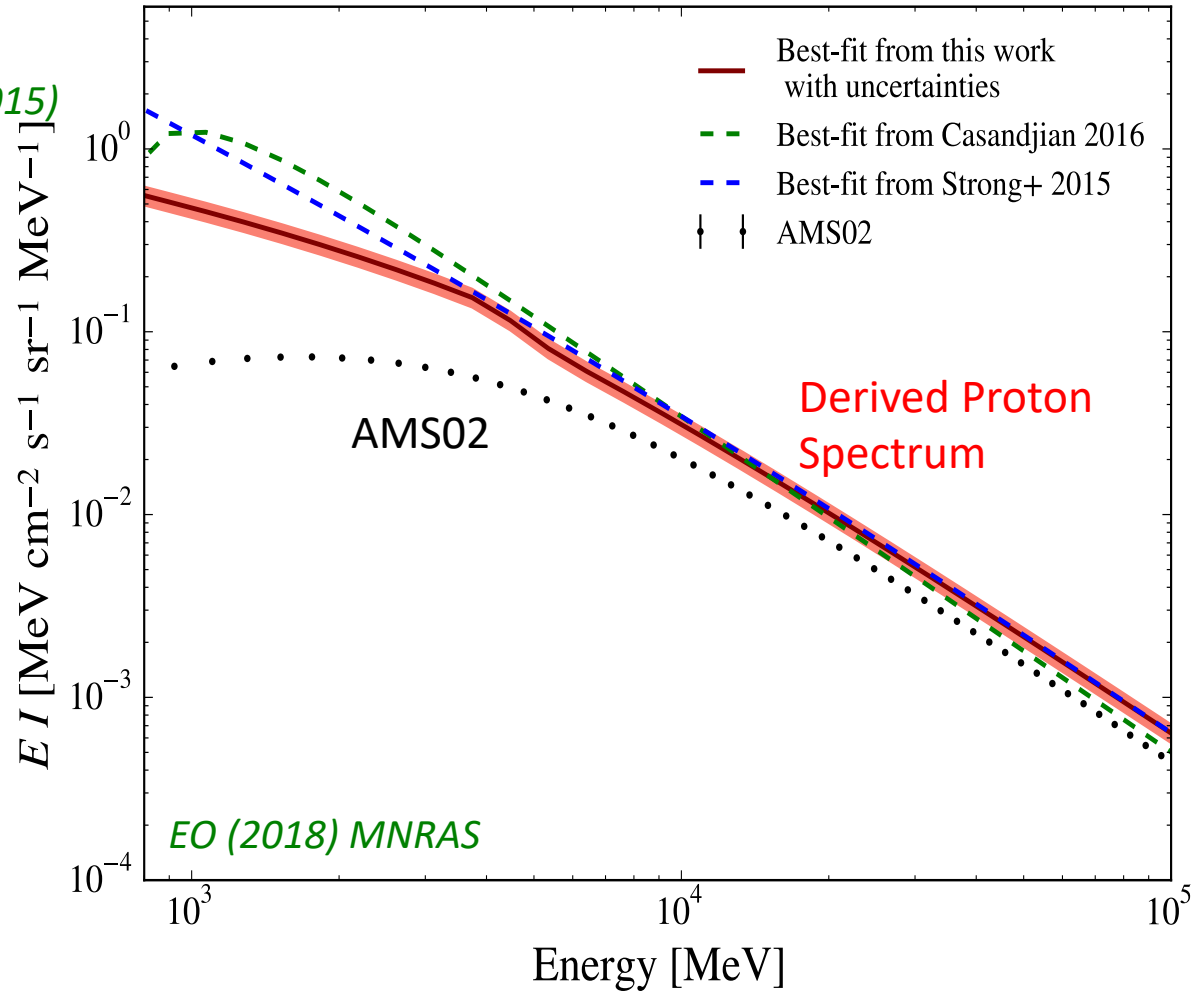
EO (2018) MNRAS

Proton spectrum consistent with *Cummings+ (2016) ApJ* and *Boschini+ (2017) ApJ*

Derived Proton Spectrum

Fit to local HI Gamma-Ray Emissivity





The direct measured proton spectrum may not resemble the local interstellar one