



Fermi Science: Theoretical Overview

27 May 2014

Fermi Science School, Lewes, Delaware

“Not only is the devil in the details,
but he lurks in the background.”

Outline

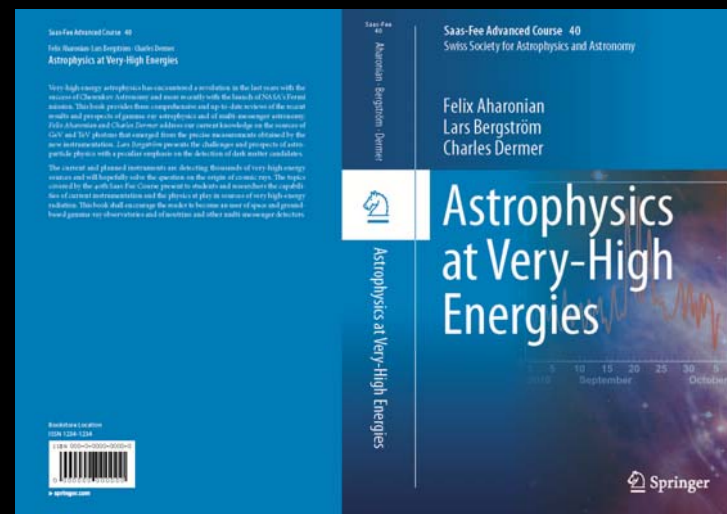
Charles D. Dermer and Govind Menon

HIGH ENERGY RADIATION FROM BLACK HOLES

Gamma Rays,
Cosmic Rays,
and Neutrinos.

PRINCETON SERIES IN ASTROPHYSICS

1. Sources and Subjects
2. Processes
3. Themes



Dr. Charles D. Dermer

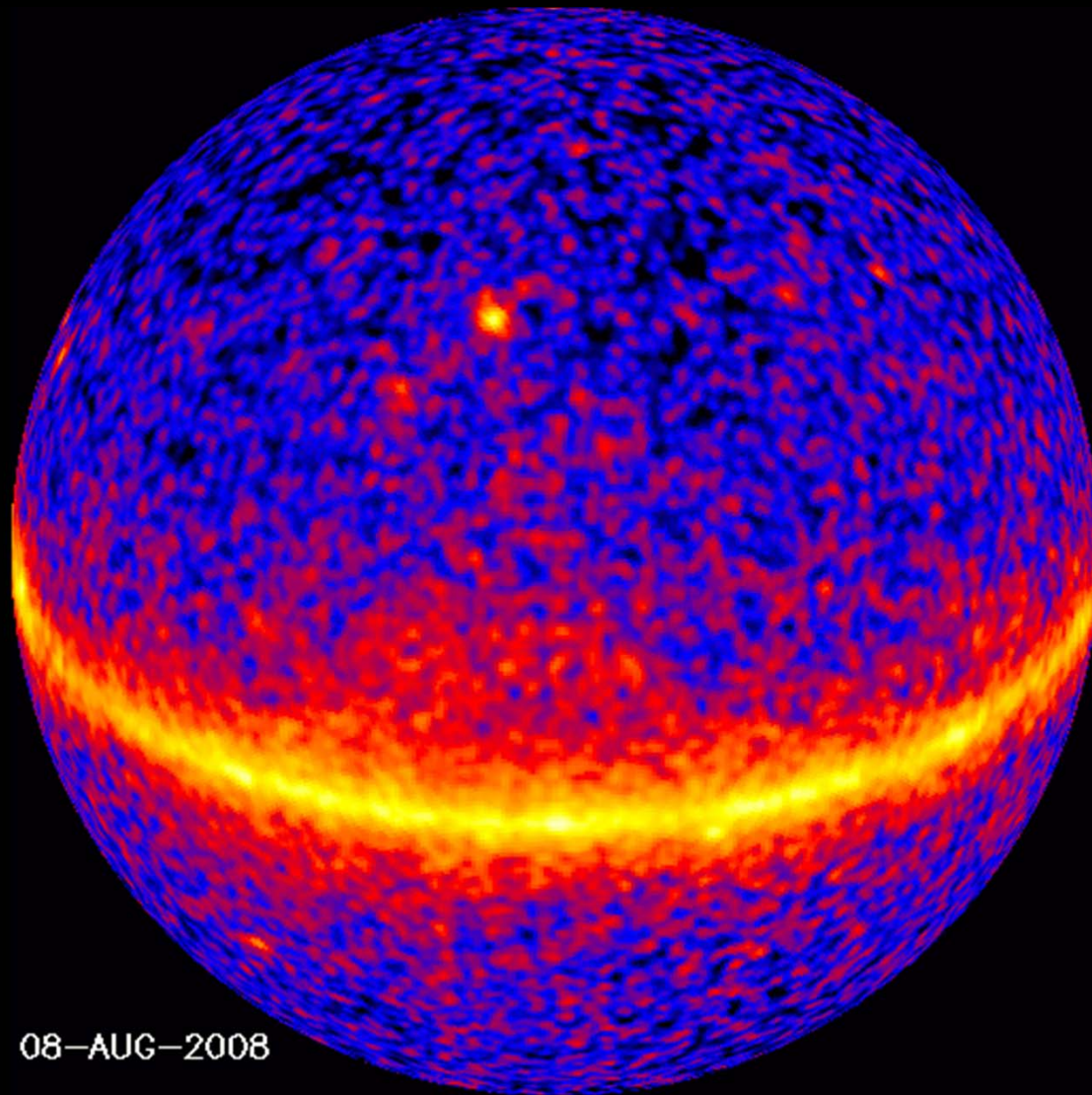
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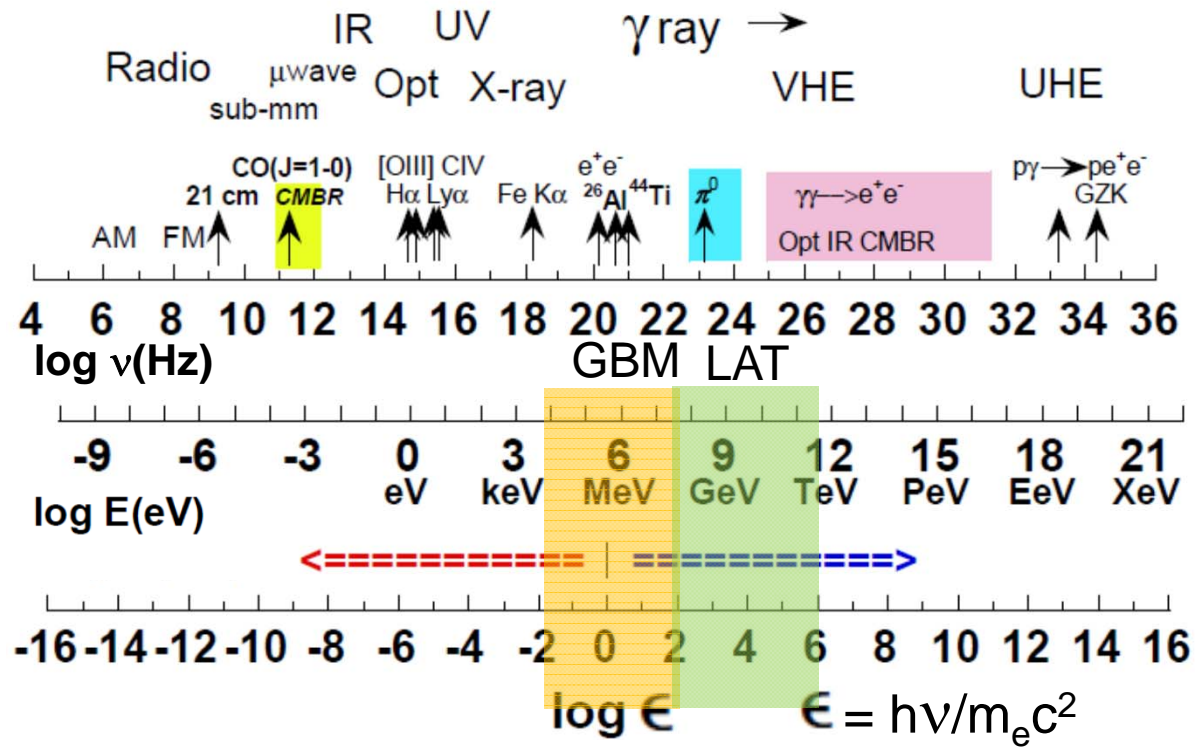
Fermi γ -ray sky



- >100 MeV, 36 months
- Galactic γ -ray glow: accelerated particles meet target gas and photons
- ~80% of the emission is diffuse
- Transient and flaring sources
- Normal and ms pulsars
- Blazars
- GRBs
- Other γ -ray galaxies
- Unidentified sources

08-AUG-2008

Multiwavelength Astronomy



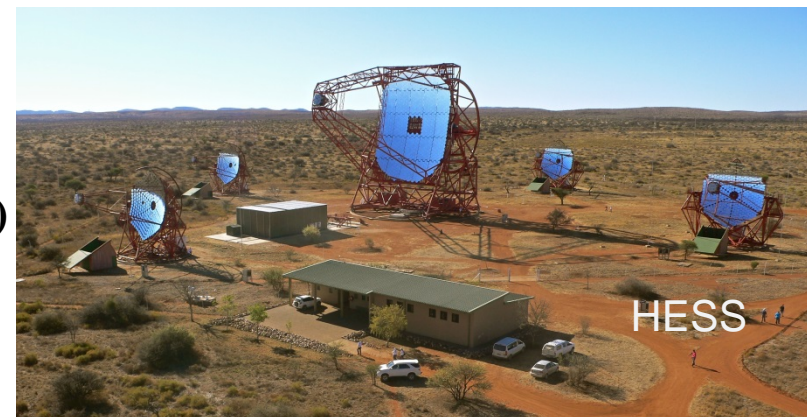
thermal vs. nonthermal

γ rays: particle acceleration or dark matter signatures

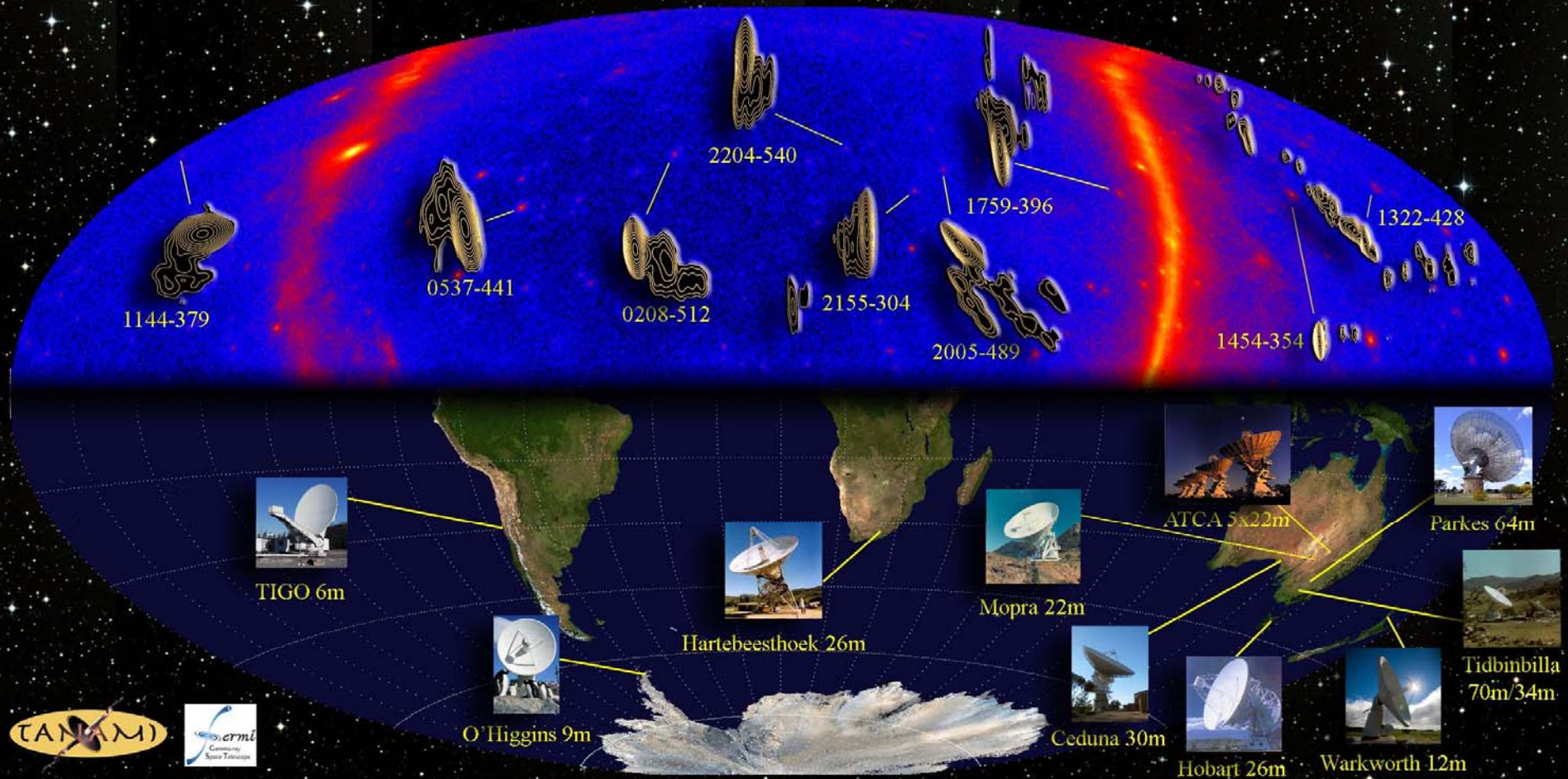
GeV vs. TeV astronomy

High-Energy Observatories

0. **Compton Gamma-Ray Observatory: Pioneering γ -ray space observatory (1991-2000)**
1. **Swift Gamma-ray Burst Explorer (NASA 2004 MidEx)**
2. **High Energy Stereoscopic Observatory (HESS)
(Ground-based γ -ray telescope; Namibia, 2004)**
3. **Very Energetic Radiation Imaging Telescope Array System (VERITAS) (Arizona; 2007)**
4. **Major Atmospheric Gamma-ray Imaging Cherenkov Telescopes (MAGIC)
(Canary Islands; 2004)**
5. **Fermi Gamma-ray Space Telescope (2008)**
 - **High Altitude Water Cherenkov (HAWC)**
 - **Cherenkov Telescope Array (CTA)
Future ground-based γ -ray telescope arrays**



Worldwide Radio Networks of Observers



TANAMI: Tracking AGN with Austral Milliarcsecond Interferometry
MOJAVE: Monitoring of Jets of AGN with VLBA Experiments

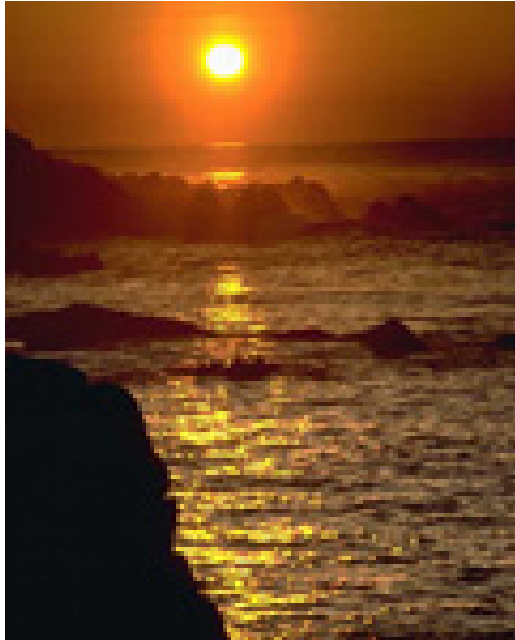
Optical Networks: WEBT-- GASP



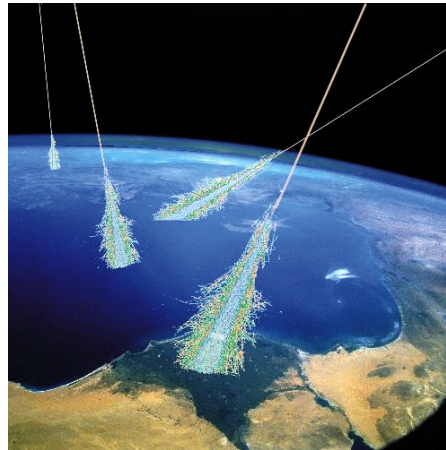
Whole Earth Blazar Telescope
GLAST-AGILE Support Program



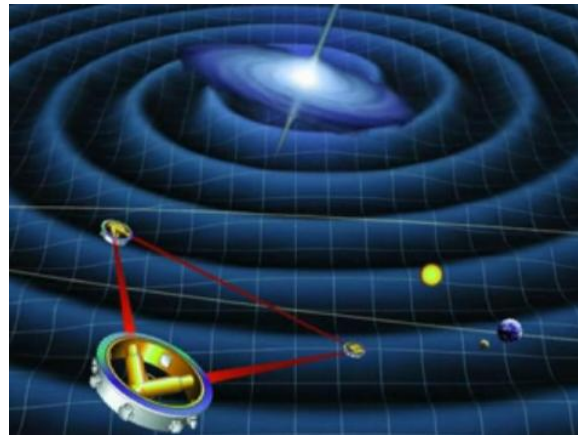
Multimessenger Astronomy



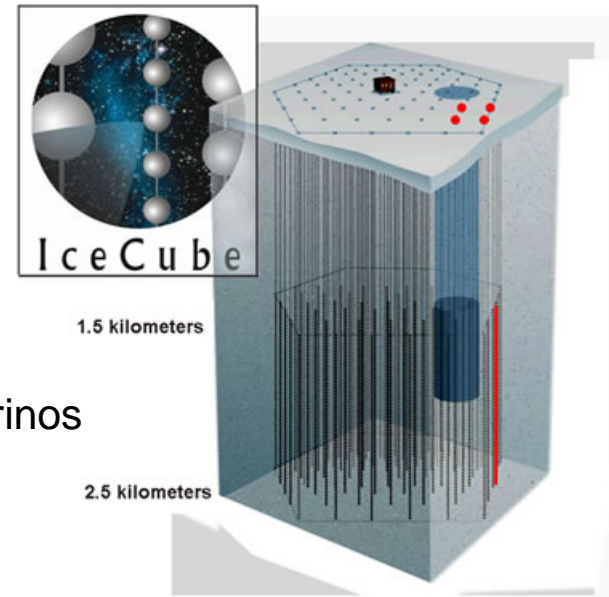
Photons



Cosmic rays

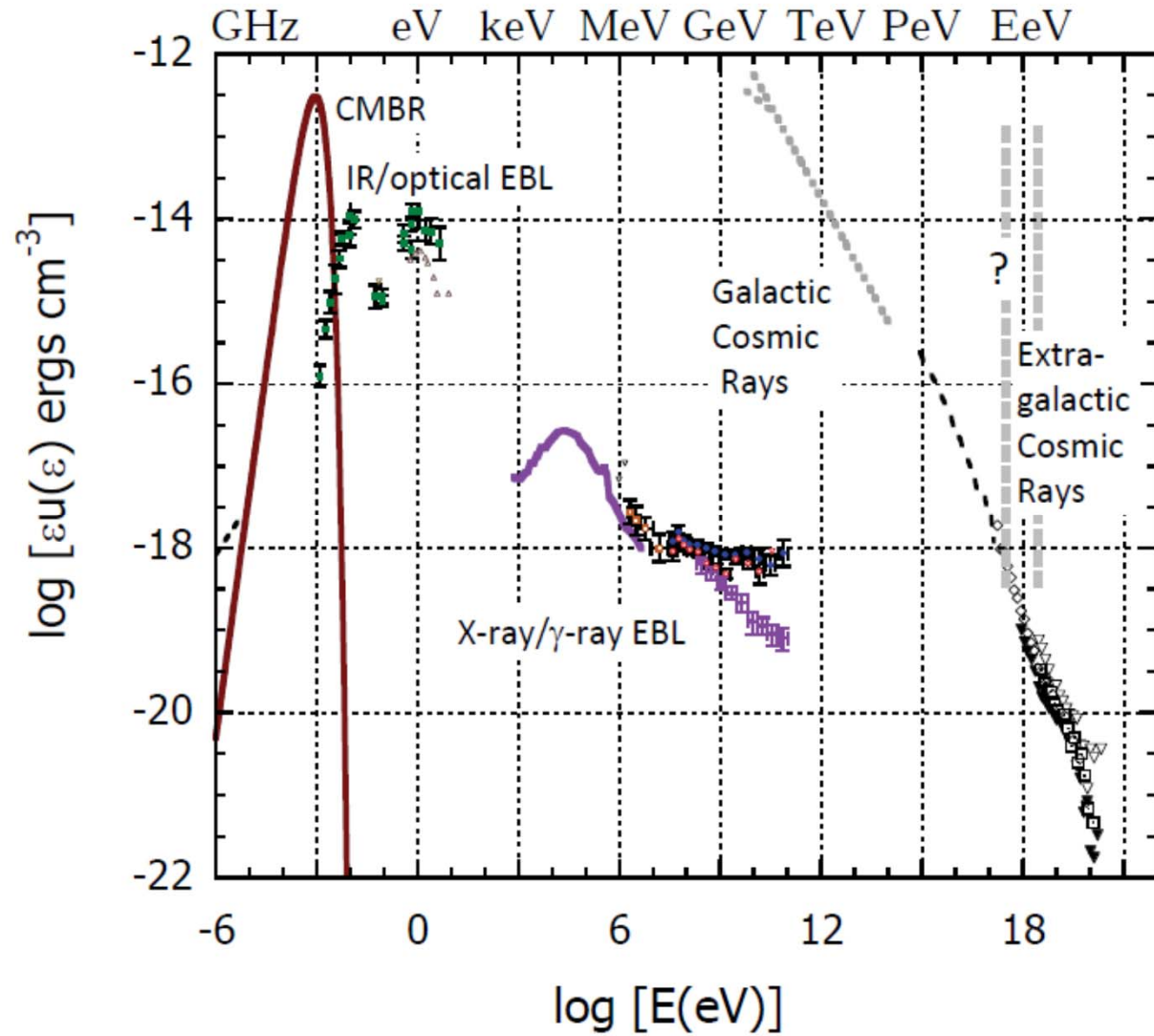


Gravitational waves



Neutrinos

Diffuse Radiations



Fermi LAT: Subjects and Sources

Calibration and Analysis

Energy/Effective Area; FoV; Imaging
LLE/Transient/Source/Diffuse Classes

Catalogs

205 132 1500 700 1900 1017 2100 1450
BSL/LBAS/1FGL/1LAC/2FGL/2LAC/3FGL/3LAC

1st PSR/2nd PSR/GRB/SNR/1FHL/FAVA
45 114 7/28 62/6

Galactic Sources

Pulsars
normal (radio-loud and radio quiet), ms
Pulsar Wind Nebulae/Crab/flares
Globular Clusters
SNRs
High-mass X-ray/gamma-ray binaries
Novae

Diffuse, Molecular Clouds, and Other Galaxies

Diffuse Galactic Emission
Galactic Center/Fermi Bubbles
LMC, SMC, M31
Starburst Galaxies
Cosmic-ray electrons/positrons
EBL
DIGB/EGB

Sources in the Solar System

Earth/CRs
Sun/ Quiescent and Solar Flares
Moon
Jupiter/Zodiacal Light
TGFs

Blazars and other AGNs

Blazars/ FSRQs and BL Lacs
Radio Galaxies
RLNLSy1

Gamma Ray Bursts

Long Soft
Short Hard
SGRs

Dark Matter and New Physics

DM lines and features
Axions
Lorentz Invariance Violation
Primordial Black Hole Annihilation
Magnetogenesis

Fermi: Processes



Particle Interactions and Radiation

Leptonic

e

e

Hadronic

Photons

p (ion)

p (ion)

Magnetic Fields

Cascades

γ

γ

Acceleration Physics

B

B

Fermi Processes

Electrodynamic Acceleration

Magnetic Reconnection

Relativistic Flows

Black Hole Physics

Accretion

Blandford-Znajek Process

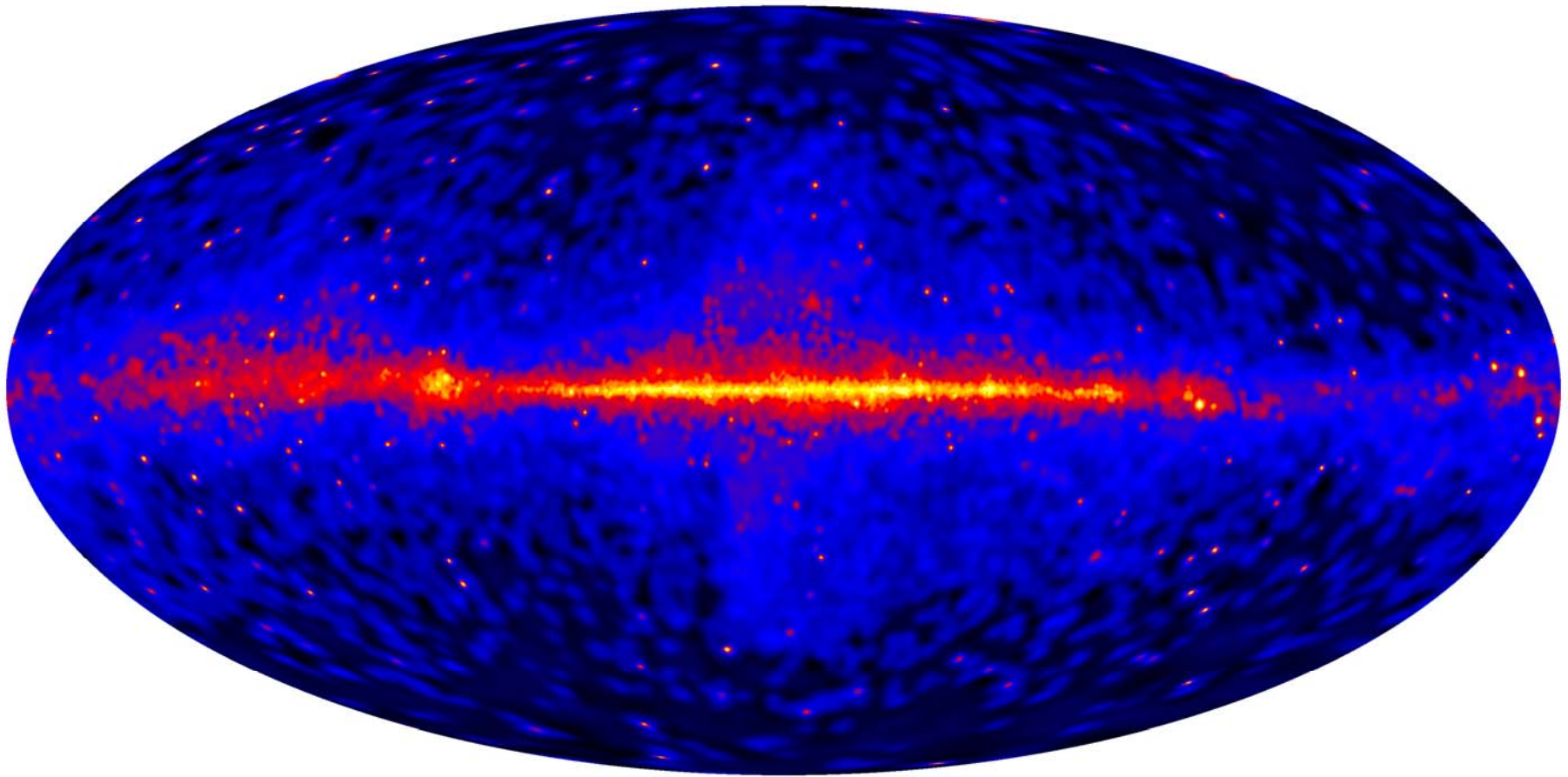
Jet formation

Dark Matter Decay and Annihilation

Fermi: Themes

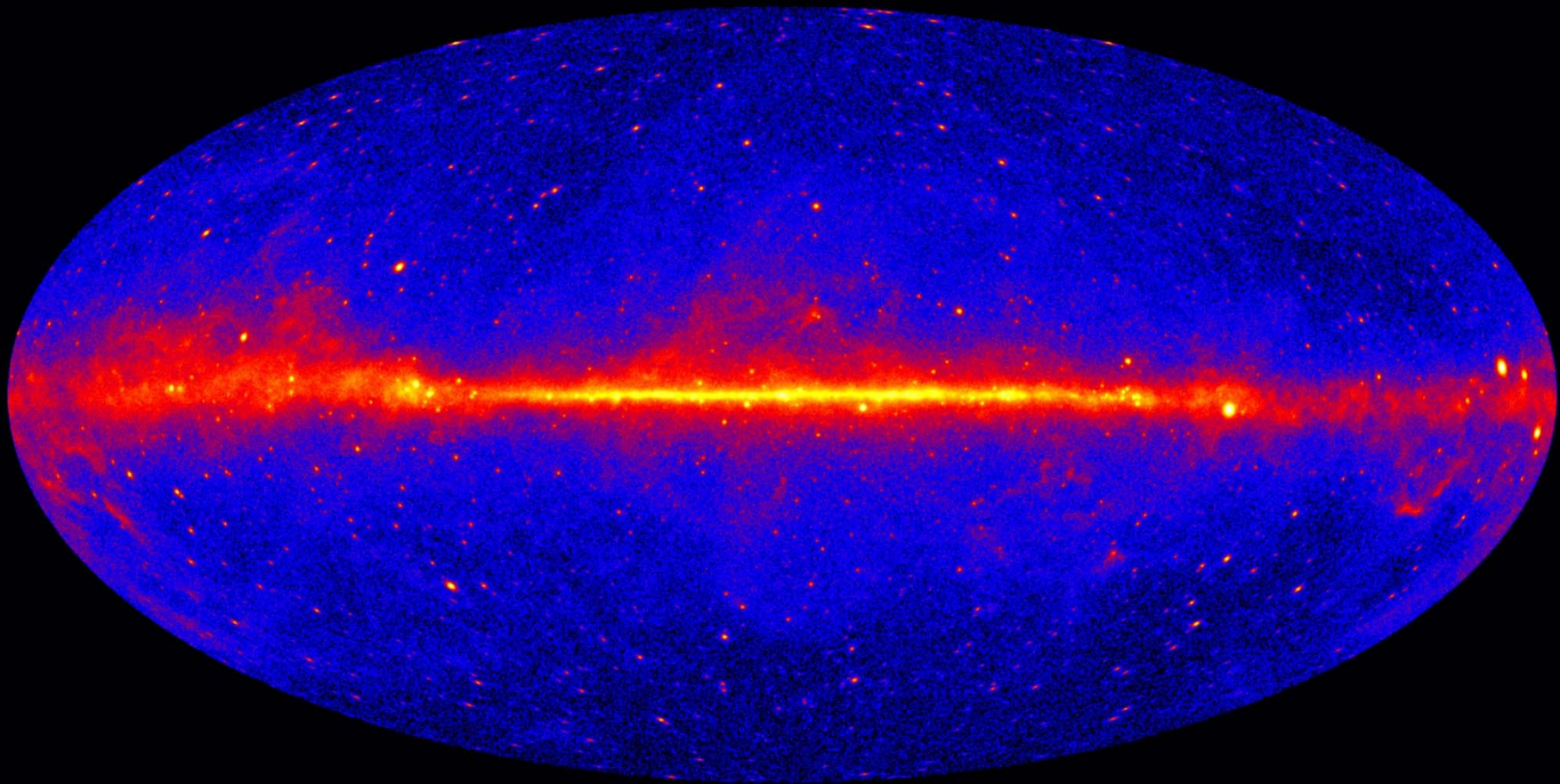
- Cosmic Ray and Ultra-High Energy Cosmic Ray Origin**
- The Search for Dark Matter**
- Extreme Stars and the Endpoints of Stellar Evolution**
- Structure and Content of the Galaxy in γ rays**
- Nonthermal Particle Acceleration in Nature**
- The Black-Hole Universe**
- Radiation and Field Content of the Universe**

Fermi: >10 GeV Skymap





Fermi >1 GeV 5 Year Sky Map



Dermer

Fermi Summer Science School 2014

Lewes, DE