The Legacy of EGRET on CGRO (1)

Gottfried Kanbach, MPE for the EGRET collaboration

The ‘founding’ Co-PIs

R. Hofstadter (1915-1990) Stanford University
Carl Fichtel (NASA/GSFC)
Klaus Pinkau (MPE)

25 years CGRO, GSFC 2016
The roots of γ-ray astronomy: 1960-1980

- **1979**: HEAO-3 Discovery of radioactive $^{26}$Al in the Galaxy
- **1975**: COS-B 1975-81 First detailed map of Milky way revealing the first high-energy source catalogue with 24 objects
- **1972**: OSO-7 First detection of solar flare γ-ray lines
- **1971**: APOLLO-15
- **1968**: SAS-2 1972-73 High-energy γ-ray images from parts of the sky, discovery of Geminga eV-bump in the diffuse cosmic background spectrum.
- **1968**: OSO-3 1968 First detection of high-energy γ-rays >100 MeV from the Milky Way
- **1967**: ERS-18 First detection of solar flare continuum gamma rays
- **1961**: EXPLORER-11 Discovery of the burst phenomenon
- **1961**: VELA SATELLITES First detection of high-energy γ-rays from space and Earth atmosphere
GSFC: Carl Fichtel and his team

SAS-2 1972-73

25 years CGRO, GSFC 2016
MPE: Sparkchamber Development
Pinkau, Schönfelder, Mayer-Hasselwander, Reppin, Sommer

COS-B (ESO): 1975-1982
Energetic Gamma-Ray Experiment Telescope (EGRET):  

Energy Range: 30 MeV – 30 GeV  
Sensitive Area: ≈ 1200 cm² (>100 MeV)  
Angular resolution: 0.1° - 0.4°  
Energy resolution: ≈ 15%  
Field of View: 40° dia.  

Sensitivity improvement ≈30 times

1991

1989

1987

1981

1977

Clarifies cosmological origin of γ-ray bursts

First high resolution images (13' resolution) of sky regions in the hard x-ray/soft γ-ray range

First credible detection of a TeV-gamma-ray source (Crab Nebula) by an atmospheric Čerenkov telescope

Extensive studies of solar flare γ-ray and neutron emission, discovery of $^{56}$Co-lines from SN 1987a

First detection of solar flare continuum gamma rays

Discovery of the burst phenomenon

25 years CGRO, GSFC 2016
Compton Gamma-Ray Observatory (1991-2000): a 'Great Observatory' for a complete sky survey at high energies
EGRET Subsystems:
Tracking detector: gas filled wire spark chamber w. trigger telescope
  ➔ image pair conversion events: γ-ray direction
Total Absorption Shower Counter: NaI Scintillator
  ➔ energy measurement (calorimeter)
Anticoincidence detector: plastic scintillator
  ➔ veto shield against charged particle background
Everybody seems to be happy with the successful completion and calibration of the instrument (MPE, Dec 1987)

... but the launch was still about 3 years away

25 years CGRO, GSFC 2016
… finally the 5th of April 1991 arrived ...

… eagerly awaited by Gottfried, Gerry, and Corinna
... the sky survey begins with the first recorded gamma-ray

"whole lotta shakin' goin' on" by Jerry Ross and GRO is on the way...
All Sky Survey (Phase 1): Apr 1991 – Nov 1992

25 years CGRO, GSFC 2016
Major discoveries during Phase 1 (Apr 1991 – Nov 1992): (only a subset of all discoveries & publications)

Extragalactic Sources:


Galactic Sources:

• PSR B1706-44: Thompson et al., *Nature* 359, 615, 1992

Various others:

• GRB910503: Schneid et al., *A&A* 255, L13, 1992, more GRBs
• Solar Flare: Kanbach et al., *A&A Suppl.* 97, 349, 1993
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25 years CGRO, GSFC 2016
EGRET Sky Survey
Phase 1:
Apr 1991 – Nov 1992

1EG Catalog:
~ 130 sources
(Fichtel et al., 1994)

Pulsars: 5

Unidentified Sources:
35 at b>10°
43 at b<10°

Blazars: 44

+ LMC, GRB,
Solar Flares
25 years CGRO, GSFC 2016
Outer Gap Emission: multi-\(\lambda\) lightcurves

Prototype: Vela

Polar Cap Emission: multi-\(\lambda\) lightcurves

in phase

Prototype: Crab

25 years CGRO, GSFC 2016
The ‘mysterious other source’ in the gal. anticenter: γ195+5, ‘Geminga’, 2CG 195+4

after ~20 years the mystery was solved with ROSAT & EGRET: it is a pulsar!
Analysis of ROSAT and EGRET data in 1992 revealed Geminga as a pulsar with 0.237 s periodicity.

Geminga in COS-B data (1975-81)

Geminga is an extremely stable 300,000 year old pulsar at a distance of 800 light-years. ➔ Prototype of many Fermi pulsars

The long-duration X-class solar flare on June 11, 1991:

Time profile:
short and long components

Spectrum:
Proton ($\pi^0$ decay) and Electron (Bremsstrahlung)
After 5 years of CGRO, party at MPE...

now... onward and upward... with Dave Thompson