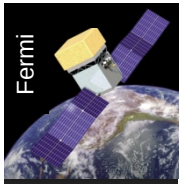


LAT 1st Year Science Highlights and Collaboration Plans for Year 2 of Science Operations

Peter F. Michelson
Fermi LAT Collaboration Spokesperson
Stanford University

Fermi LAT Collaboration

- **France**
  - CEA/Saclay, IN2P3
  - ASI, INFN, INAF
- **Japan**
  - Hiroshima University
  - ISAS/JAXA
  - RIKEN
  - Tokyo Institute of Technology
- **Sweden**
  - Royal Institute of Technology (KTH)
  - Stockholm University
- **United States**
  - Stanford University (SLAC, KIPAC, and HEPL/Physics)
  - University of California at Santa Cruz – SCIPP
  - Goddard Space Flight Center
  - Naval Research Laboratory
  - Sonoma State University
  - Ohio State University
  - University of Washington

also members from Australia, Germany, Great Britain, Spain

Sponsoring Agencies

Department of Energy
National Aeronautics and Space Administration

CEA/Saclay	ASI
IN2P3/CNRS	INFN
MEXT	K. A. Wallenberg Foundation
KEK	Swedish Research Council
JAXA	Swedish National Space Board

construction managed by
SLAC National Accelerator Laboratory,
Stanford University

Host for LAT Operations Center

current collaboration demographics (Sept 2008)

Country	membership category		
	Full Member	**Affiliated Scientist**	**Postdoc**
France	**17**	**11**	**4**
CEA	5	4	1
CNRS/IN2P3	12	7	3
Italy	**22**	**28**	**15**
ASI	3.5	19	2
INFN	18.5	9	13
Japan	**8**	**4**	**5**
Sweden	**3**	**4**	**2**
USA	**59**	**41**	**23**
DOE	36	12	12
NASA	19	17	11
other	4	12	0
Australia		**1**	
Germany	**1**	**4**	**1**
Great Britain		**2**	
Spain	**1**		**2**
Total	**111**	**95**	**52**

current collaboration demographics (Sept 2009)

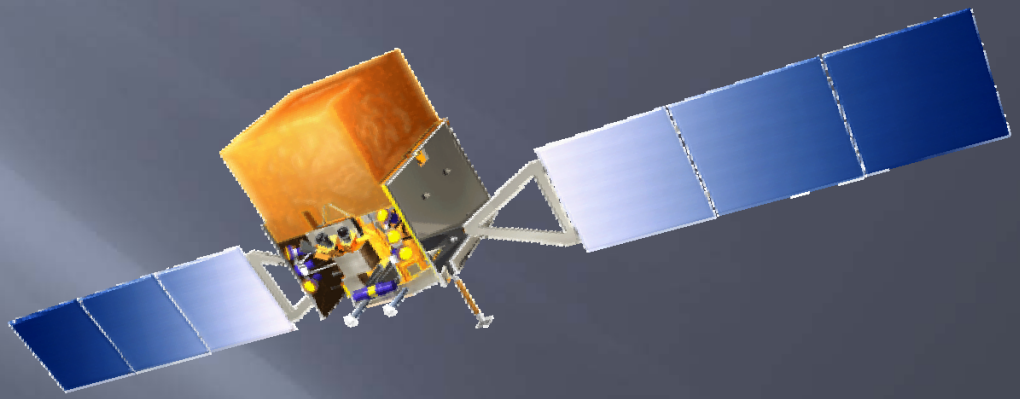
Country	membership category		
	Full Member	**Affiliated Scientist**	**Postdoc**
France	**16**	**9**	**4**
CEA	4	3	1
CNRS/IN2P3	12	6	3
Italy	**23**	**26**	**18**
ASI	5	19	3
INFN	18	7	15
Japan	**9**	**6**	**4**
Sweden	**3**	**7**	**4**
USA	**64**	**50**	**29**
DOE	39	15	14
NASA	21	18	15
other	4	17	0
Australia		**1**	
Germany	**1**	**7**	**1**
Great Britain		**2**	
Spain	**1**		**2**
Total	**117**	**108**	**62**

LAT Collaboration science groups

LAT Science Group	Current Coordinators	Coordinators beginning October-November 2009
Catalog	Dave Thompson	Dave Thompson
	Isabelle Grenier	Isabelle Grenier
	mgr: J. Ballet	mgr. J. Ballet
Diffuse	Troy Porter	Jean-Marc Cassadjian
	Andy Strong	Marcus Ackermann
Galactic Sources	David Smith	David Smith
	Eric Grove	Eric Grove
Extragalactic Sources	Gino Tosti	Gino Tosti
	Elisabetta Cavazutti	Elisabetta Cavazutti
	Benoit Lott	
Gamma-ray Bursts	Valerie Connaughton	Chip Meegan
	Fred Piron	Fred Piron
Solar	Francesco Longo	Francesci Longo
	Igor Moskalenko	Igor Moskalenko
Dark Matter & New Physics	Jan Conrad	Steve Ritz
	Simona Murgia	Simona Murgia
Calibration & Analysis	Anders Borgland	Anders Borgland
	Luca Latronico	Riccardo Rando

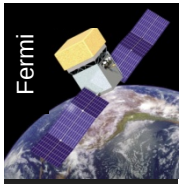
On January 1, Seth Digel will be the Analysis Coordinator

Fermi has had a great year!



Many new results from 1st year in orbit

- **Pulsars, globular clusters, binaries**
- **active galaxies, starburst galaxies, LMC**
- **gamma-ray bursts**
- **diffuse radiation and $e^+ + e^-$ spectrum**



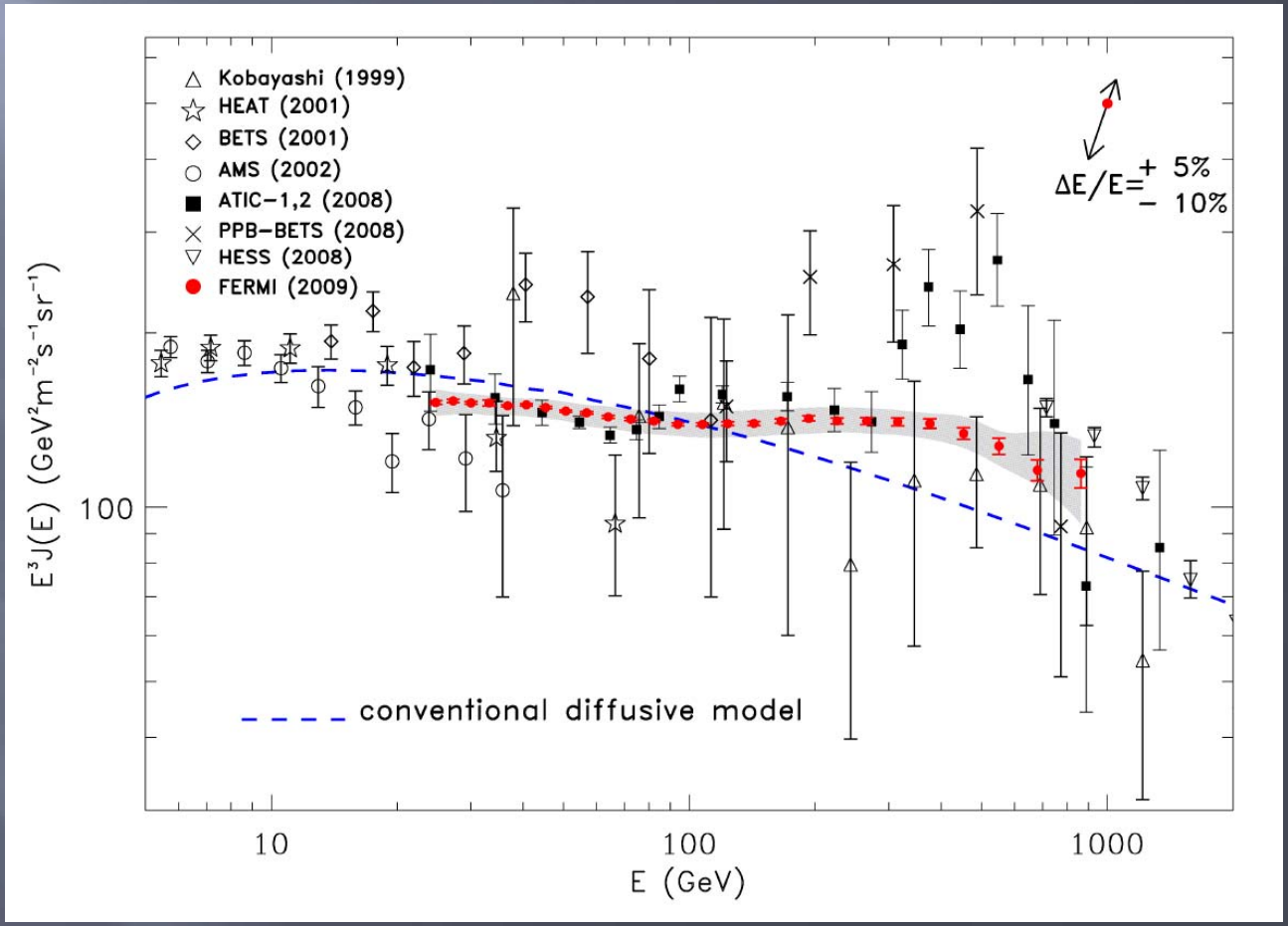
Fermi has had a great year!

	# citations
• "Measurement of the Cosmic Ray $e^+ + e^-$ Spectrum from 20 GeV to 1 TeV with the Fermi Large Area Telescope" (05/2009) – Cited across a broad range - cosmic-ray, astronomy, particle physics (D0, BABAR)	163
• "The Large Area Telescope on the Fermi Gamma-Ray Space Telescope Mission" (09/2008)	95
• "Fermi/Large Area Telescope Bright Gamma-Ray Source List" (07/2009)	78
• "Fermi Observations of High-Energy Gamma-Ray Emission from GRB 080916C" (03/2009)	66
• "Bright Active Galactic Nuclei Source List from the First Three Months of the Fermi Large Area Telescope All-Sky Survey" (07/2009)	57
• "The Fermi Gamma-Ray Space Telescope Discovers the Pulsar in the Young Galactic Supernova Remnant CTA 1" (11/2008)	35

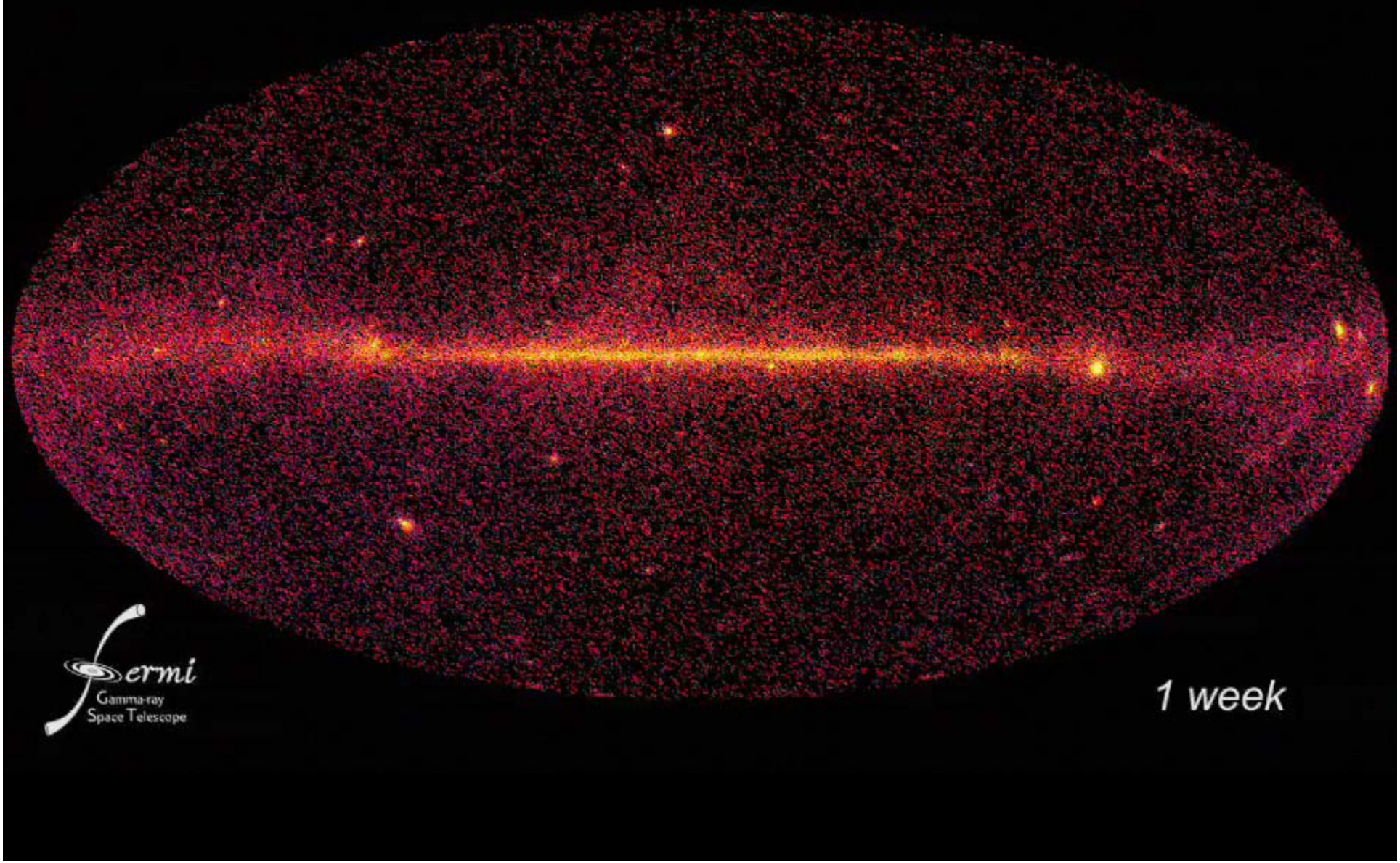
Fermi LAT: $e^+ + e^-$ spectrum

- no prominent spectral features between 20 GeV and 1 TeV; significantly harder spectrum than inferred from previous measurements

- events for e^+ e^- analysis required to fail ACD vetoes for selecting γ events; resulting γ contamination < 1%
- further cuts distinguish EM and hadron events; rejection 1:10^3 up to 200 GeV; ~1:10^4 at 1 TeV
- energy reconstruction aided by shower imaging capability of calorimeter
- more than 4x10^6 e^- e^+ events in selected sample



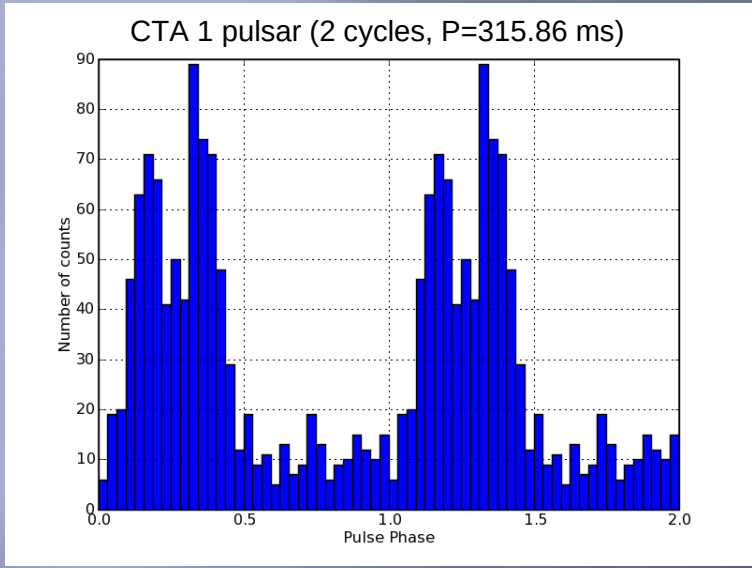
LAT observes the sky on timescales from fractions of a second, to days, months …




Fermi


Science
14 August 2009 | $10
Fermi
Detecting Gamma-Ray Pulsars
AAAS

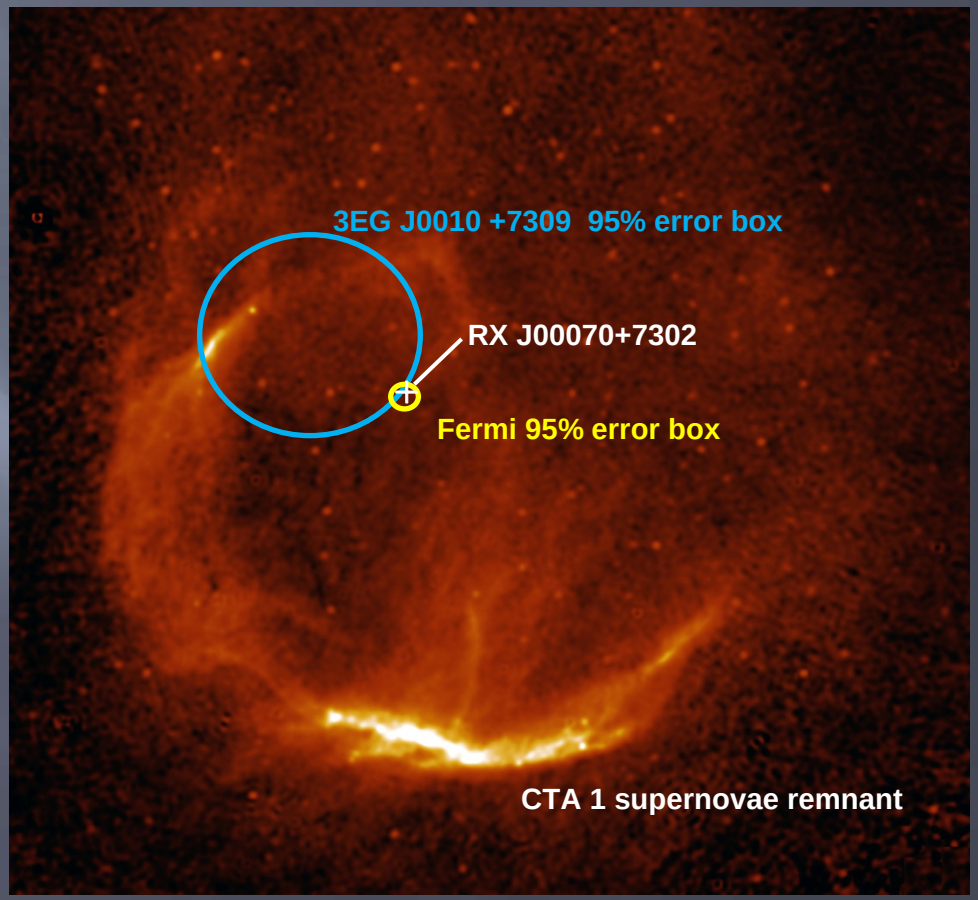
Pulsar in CTA 1



- exhibits all characteristics of a young high-energy pulsar (characteristic age ~1.4 x 10^4 yr), which powers a synchrotron pulsar wind nebula embedded in a larger SNR.

- spin-down luminosity ~10^{36} erg s^{-1}, sufficient to supply the PWN with magnetic fields and energetic electrons.

Science 322,1218 (2008)

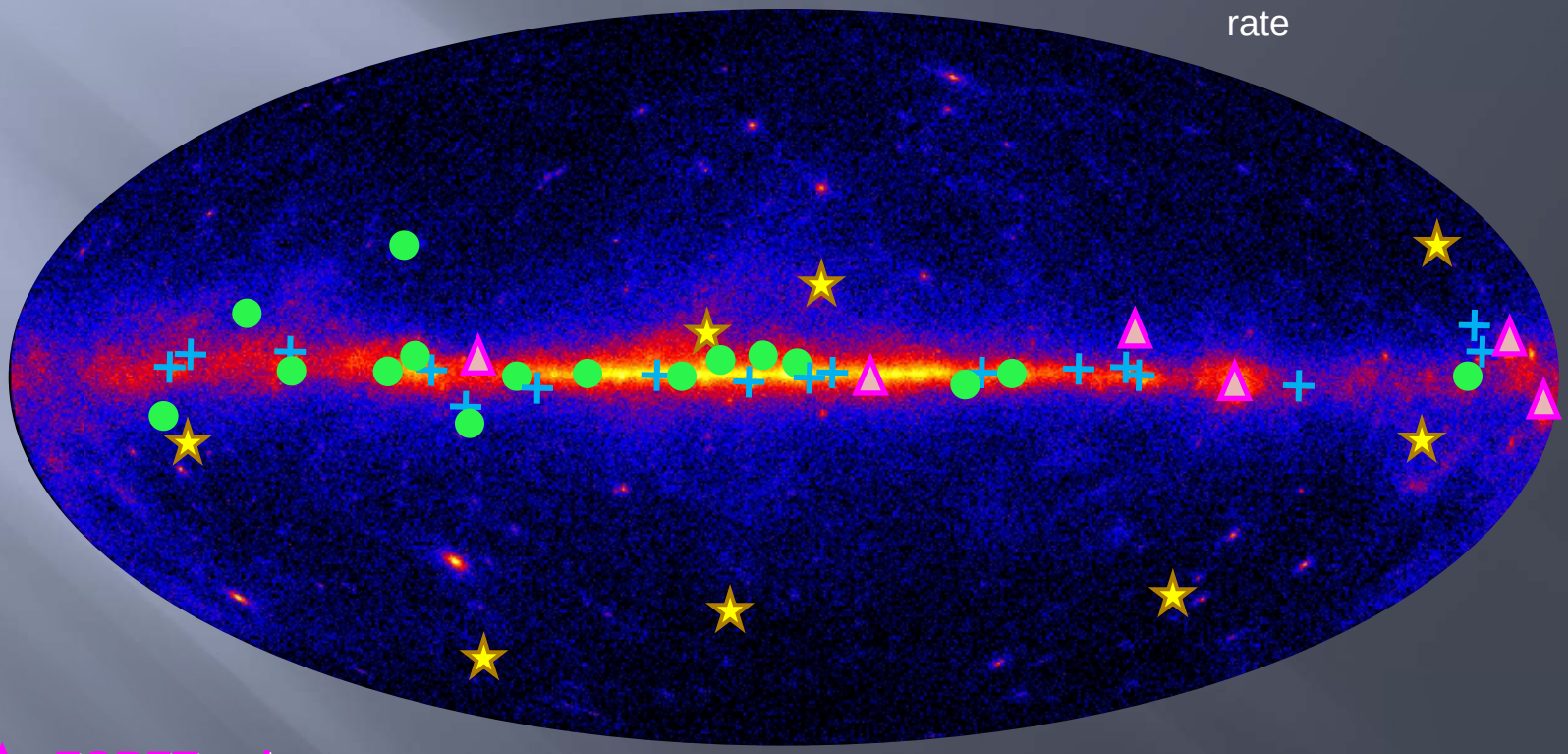


- γ-ray source at *l,b* = 119.652, 10.468; 95% error circle radius =0.038° contains the X-ray source RX J00070+7302, central to the PWN superimposed on the radio map at 1420 MHz.

- pulsar off-set from center of radio SNR; rough estimate of the lateral speed of the pulsar is ~450 km/s

Fermi Pulsars

Pulses at 1/10th real rate



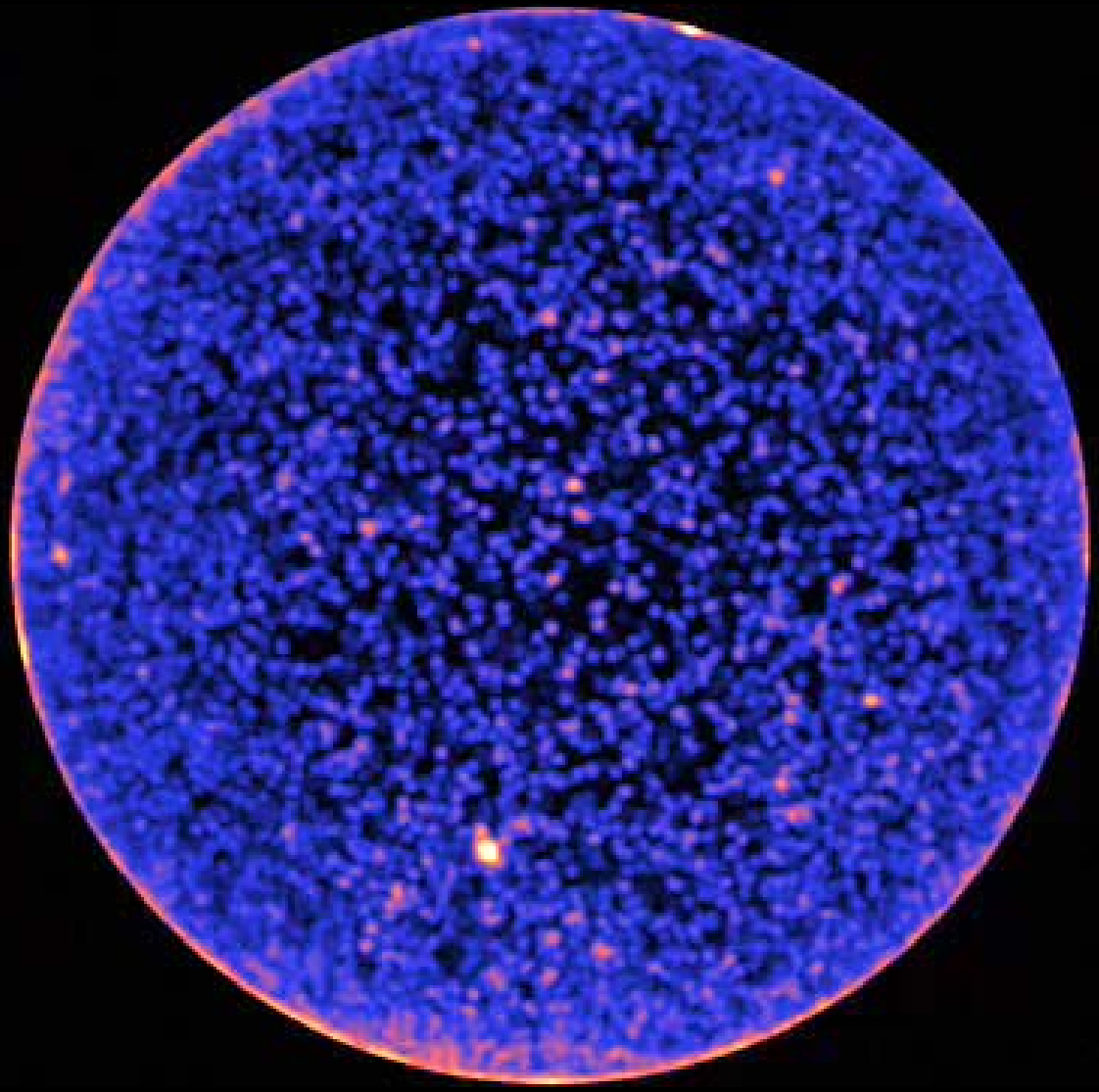
EGRET pulsars

young pulsars discovered using radio ephemeris

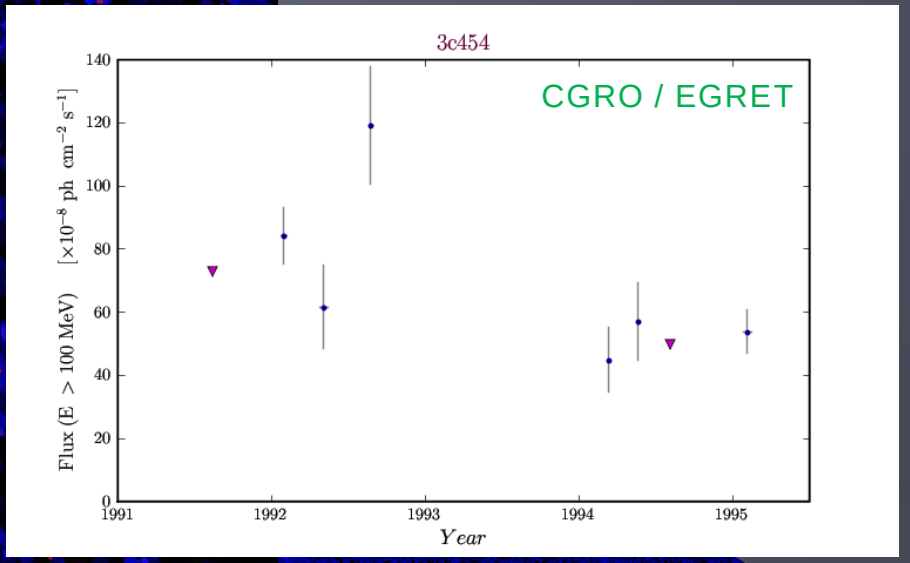
pulsars discovered in blind search

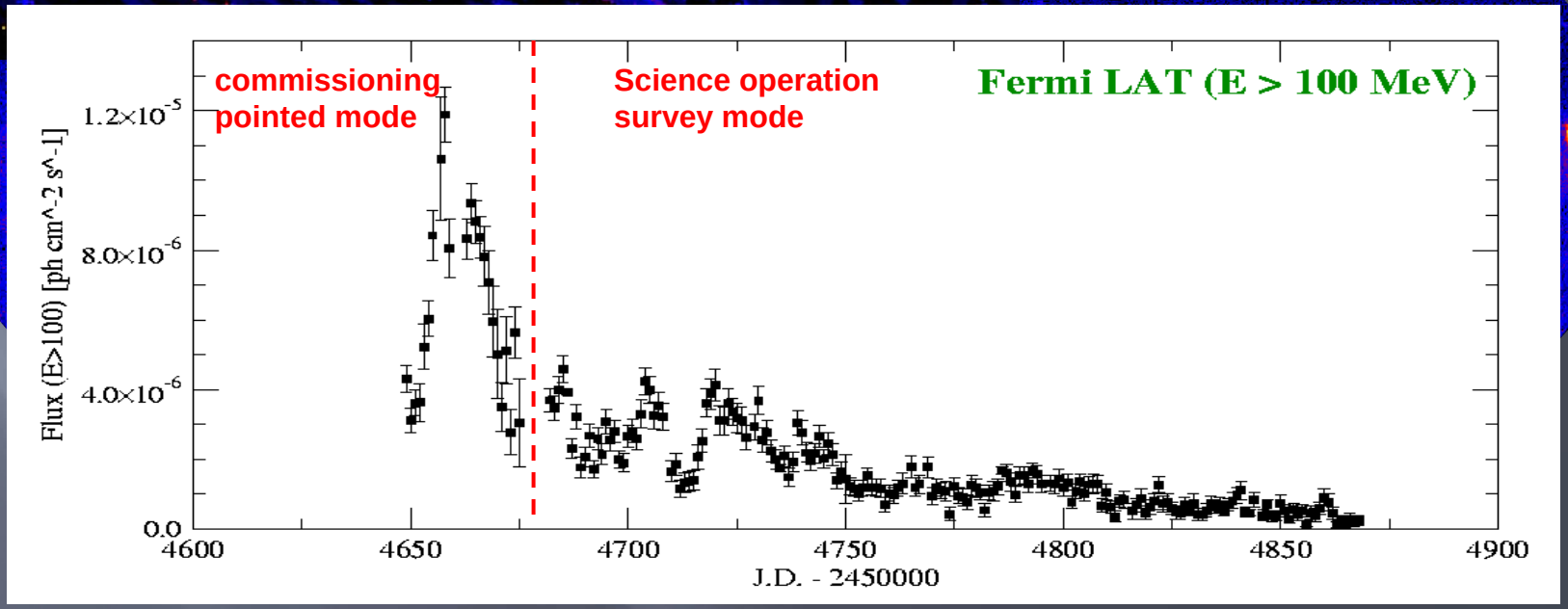
millisecond pulsars discovered using radio ephemeris

The Northern Galactic sky



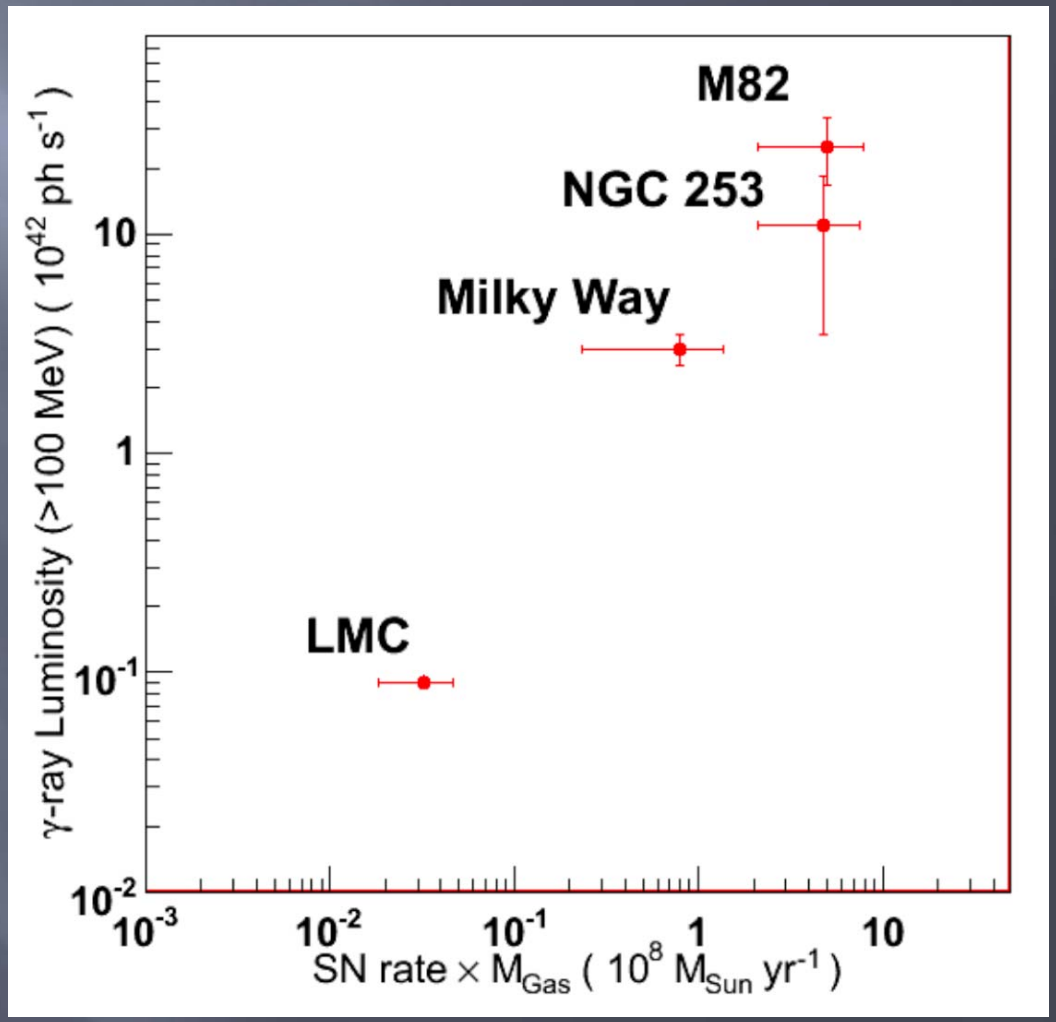
3C454.3
Supermassive black hole
8 billion light-years from us





Cosmic Rays and galaxies

Fermi has detected GeV emission from starburst galaxies for the first time



nature news

Published online 28 October 2009 | Nature | doi:10.1038/news.2009.1044

News

An intergalactic race in space and time

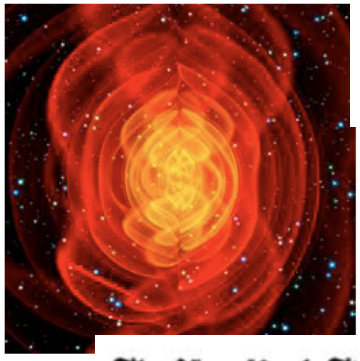
A burst of γ-rays lets scientists test quantum theories of gravity.

Geoff Brumfiel

Astronomers have used a high-energy burst of light from a distant galaxy to test the fabric of space and time. The work is the best test yet of attempts to create a 'theory of everything'.

At present, two separate theories dominate the world of physics. General relativity explains gravity and the motion of large objects such as planets, stars and galaxies, whereas quantum-mechanics explains the behaviour of very small things such as atoms.

Both theories do well at explaining their respective worlds, but they don't fit together mathematically. The problem is as fundamental as it gets: the two see space and time very differently, according to Giovanni Amelino-Camelia, a theoretical physicist at the University of Rome La Sapienza in Italy.



Space-ti
theory of

Chris F

Mail Online

Einstein was right! Nasa Fermi telescope uncovers proof of famous space-time theory

By Daily Mail Reporter
Last updated at 2:53 AM on 31st October 2009

Racing across the Universe for the last 7.3-billion-years, two highly charged particles have arrived at Nasa's Fermi Gamma-ray Space Telescope within a second of one another. Excited scientists believe this could be evidence of Einstein's space-time theory.

The photons were launched on their marathon during a short gamma-ray burst, an outpouring of radiation likely generated by the collision of two neutron stars, the densest known objects in the Universe.

One of the photons possessed a million times more energy that the other but they arrived at almost the same time.

The New York Times

Space & Cosmos

WORLD | U.S. | N.Y. / REGION | BUSINESS | TECHNOLOGY | SCIENCE | HEALTH | SPORTS

ENVIRONMENT | SPACE & COS

7.3 Billion Years Later, Einstein's Theory Prevails

By DENNIS OVERBYE
Published: October 28, 2009

Astronomers said Wednesday that a race halfway across the universe had ended in a virtual tie. And so the champion is still Albert Einstein — for now.

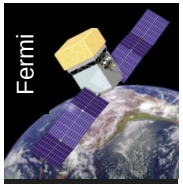
SIGN IN T
RECOMM

TWITTER

SIGN IN T
RECOMM

Collaboration during year 2

- Extensive discussions at September collaboration meeting about collaboration in year 2 and beyond
  - High-level photon data released to scientific community on August 11, 2009 and continues
  - Collaboration has remained active and intact. Members generally recognize value of being in the LAT Collaboration
  - Consistent with collaboration membership and publication policies, there will be significantly more CAT 2 papers in year 2; there will also be many CAT 1 papers as well.
    - CAT 1 papers are for discovery results and initial papers on key projects



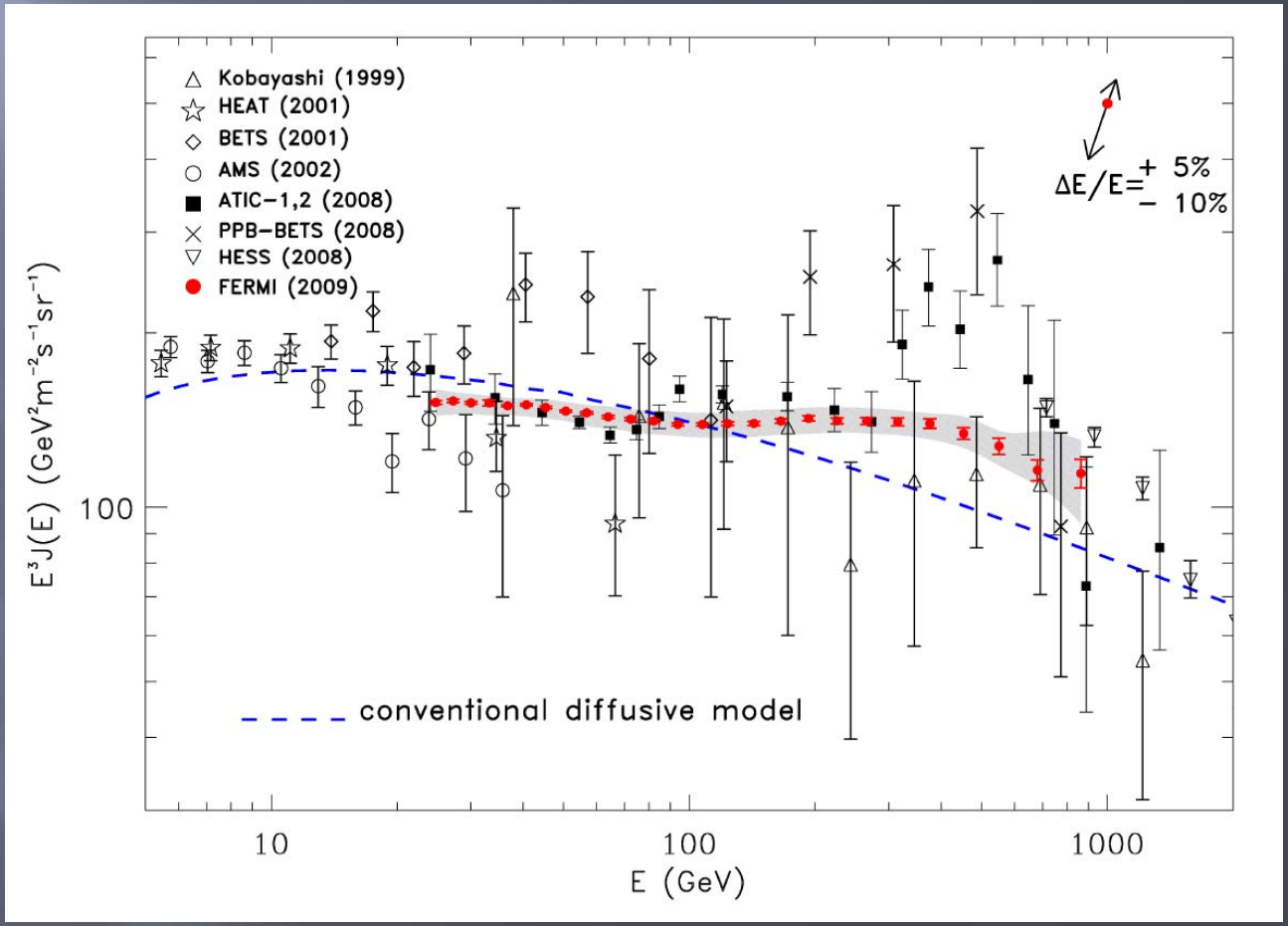
Fermi has had a great year!

	# citations
• "Measurement of the Cosmic Ray $e^+ + e^-$ Spectrum from 20 GeV to 1 TeV with the Fermi Large Area Telescope" (05/2009) – Cited across a broad range - cosmic-ray, astronomy, particle physics (D0, BABAR)	163
• "The Large Area Telescope on the Fermi Gamma-Ray Space Telescope Mission" (09/2008)	95
• "Fermi/Large Area Telescope Bright Gamma-Ray Source List" (07/2009)	78
• "Fermi Observations of High-Energy Gamma-Ray Emission from GRB 080916C" (03/2009)	66
• "Bright Active Galactic Nuclei Source List from the First Three Months of the Fermi Large Area Telescope All-Sky Survey" (07/2009)	57
• "The Fermi Gamma-Ray Space Telescope Discovers the Pulsar in the Young Galactic Supernova Remnant CTA 1" (11/2008)	35

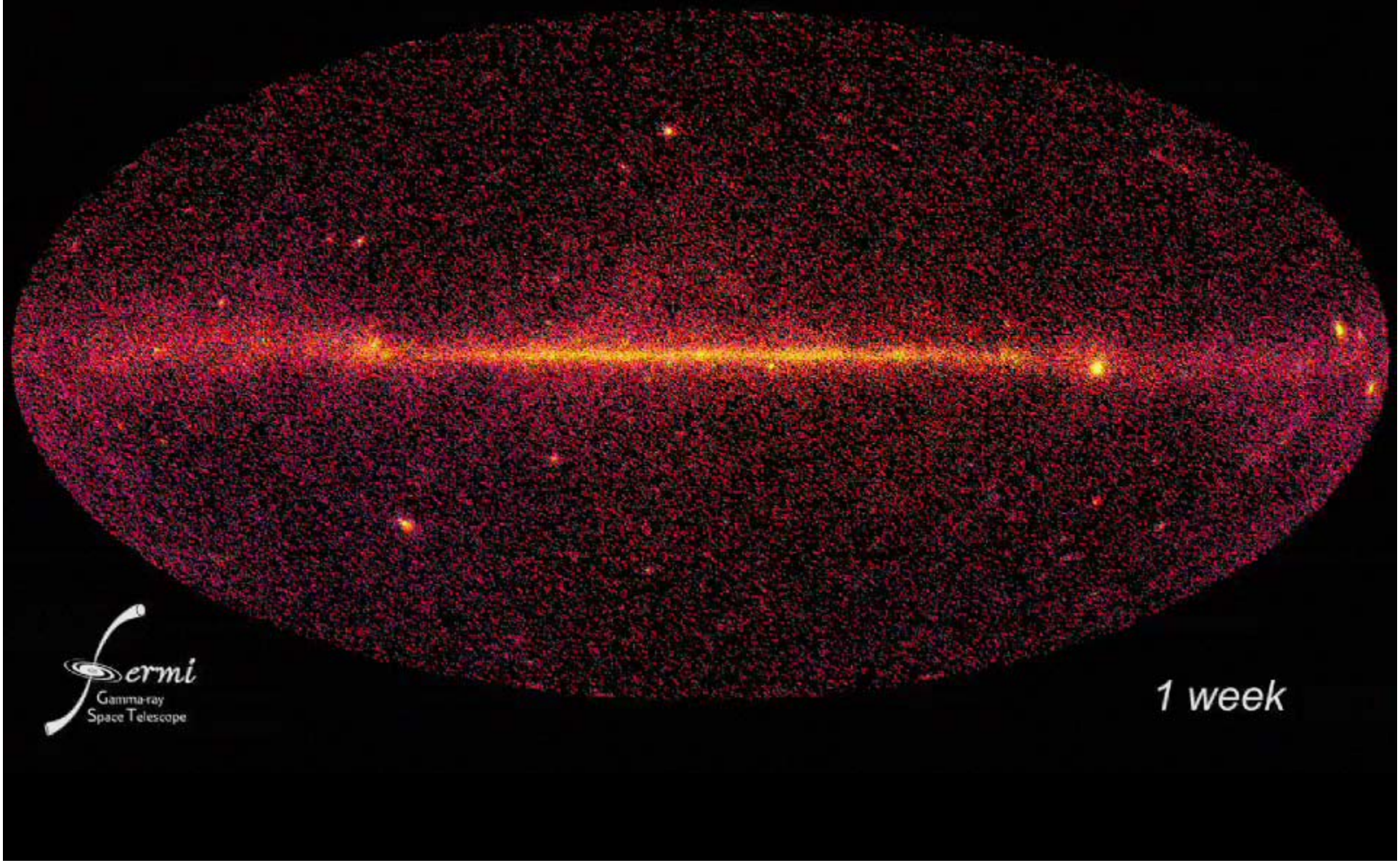
Fermi LAT: $e^+ + e^-$ spectrum

- no prominent spectral features between 20 GeV and 1 TeV; significantly harder spectrum than inferred from previous measurements

- events for e^+ e^- analysis required to fail ACD vetoes for selecting γ events; resulting γ contamination < 1%
- further cuts distinguish EM and hadron events; rejection 1:10^3 up to 200 GeV; ~1:10^4 at 1 TeV
- energy reconstruction aided by shower imaging capability of calorimeter
- more than 4x10^6 e^- e^+ events in selected sample



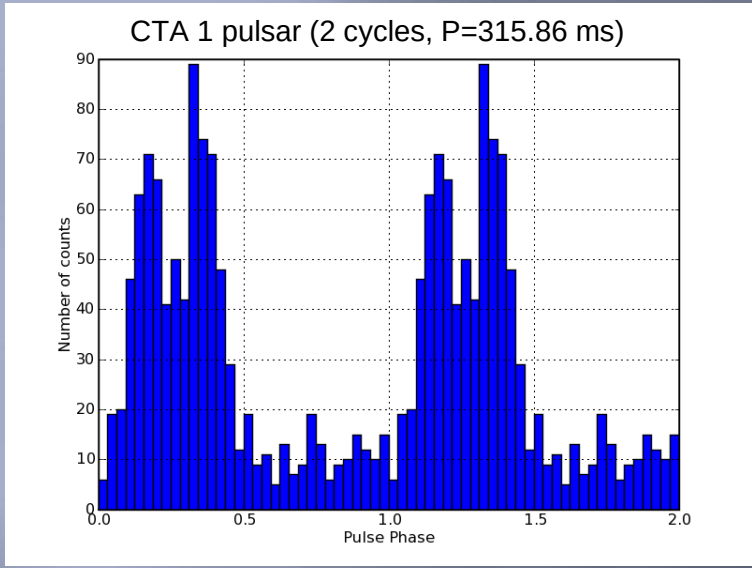
LAT observes the sky on timescales from fractions of a second, to days, months …




Fermi


Science
14 August 2009 | $10
Fermi
Detecting Gamma-Ray Pulsars
AAAS

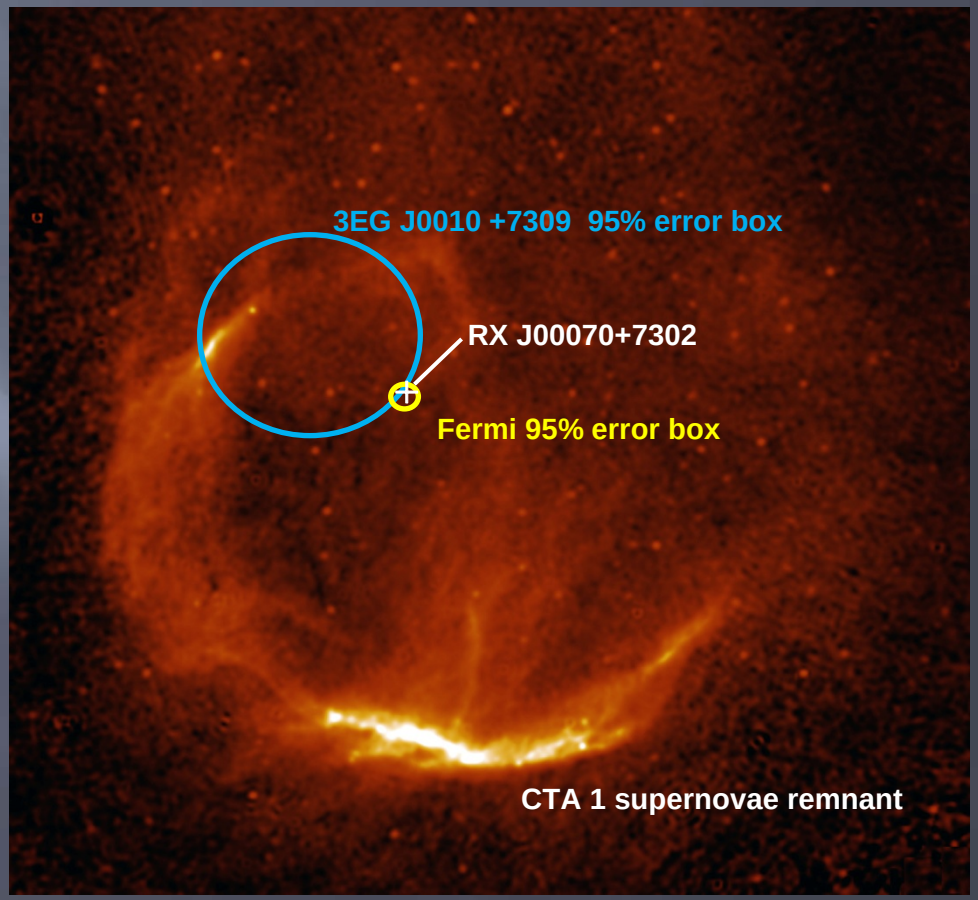
Pulsar in CTA 1



- exhibits all characteristics of a young high-energy pulsar (characteristic age ~1.4 x 10^4 yr), which powers a synchrotron pulsar wind nebula embedded in a larger SNR.

- spin-down luminosity ~10^{36} erg s^{-1}, sufficient to supply the PWN with magnetic fields and energetic electrons.

Science 322,1218 (2008)

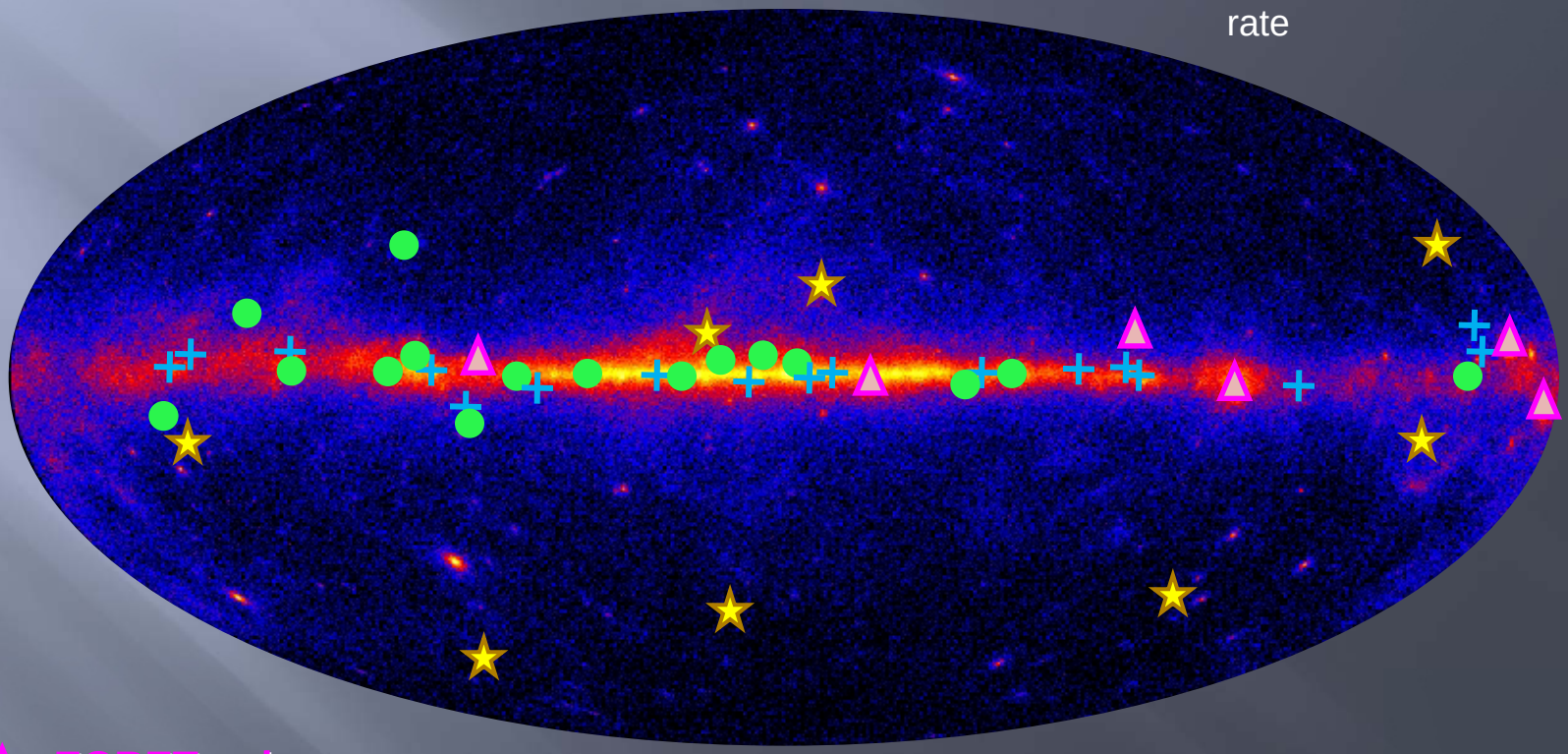


- γ-ray source at *l,b* = 119.652, 10.468; 95% error circle radius =0.038° contains the X-ray source RX J00070+7302, central to the PWN superimposed on the radio map at 1420 MHz.

- pulsar off-set from center of radio SNR; rough estimate of the lateral speed of the pulsar is ~450 km/s

Fermi Pulsars

Pulses at 1/10th real rate



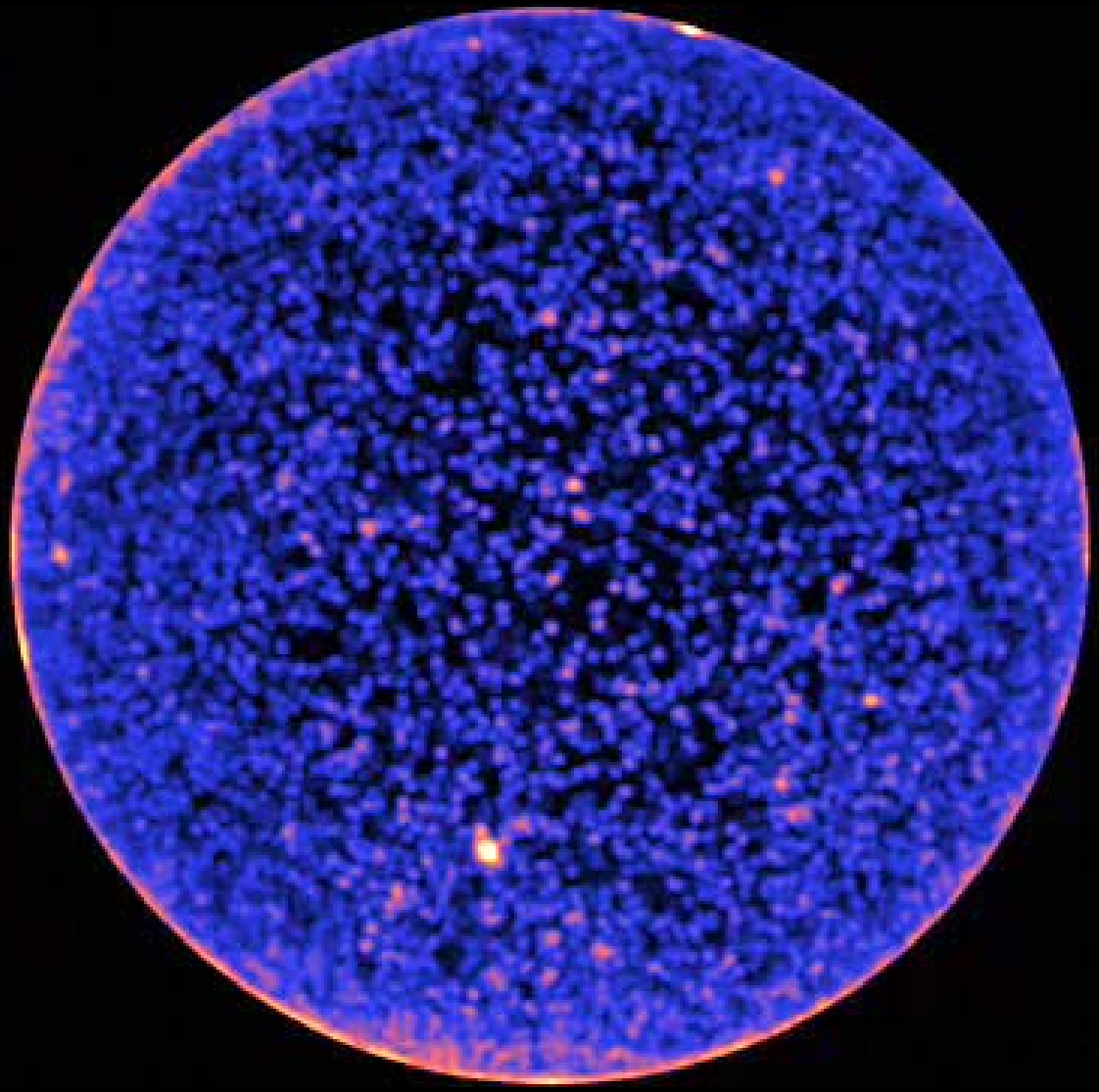
EGRET pulsars

young pulsars discovered using radio ephemeris

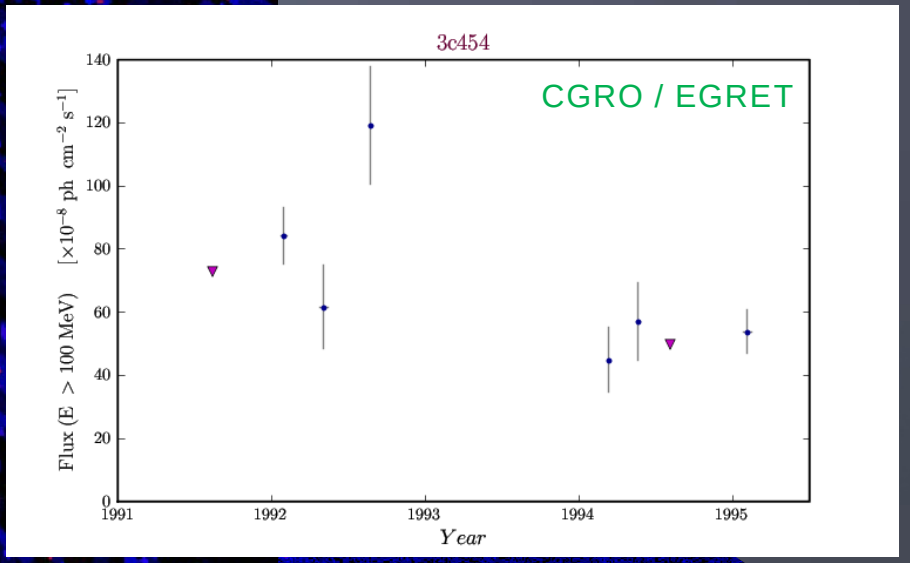
pulsars discovered in blind search

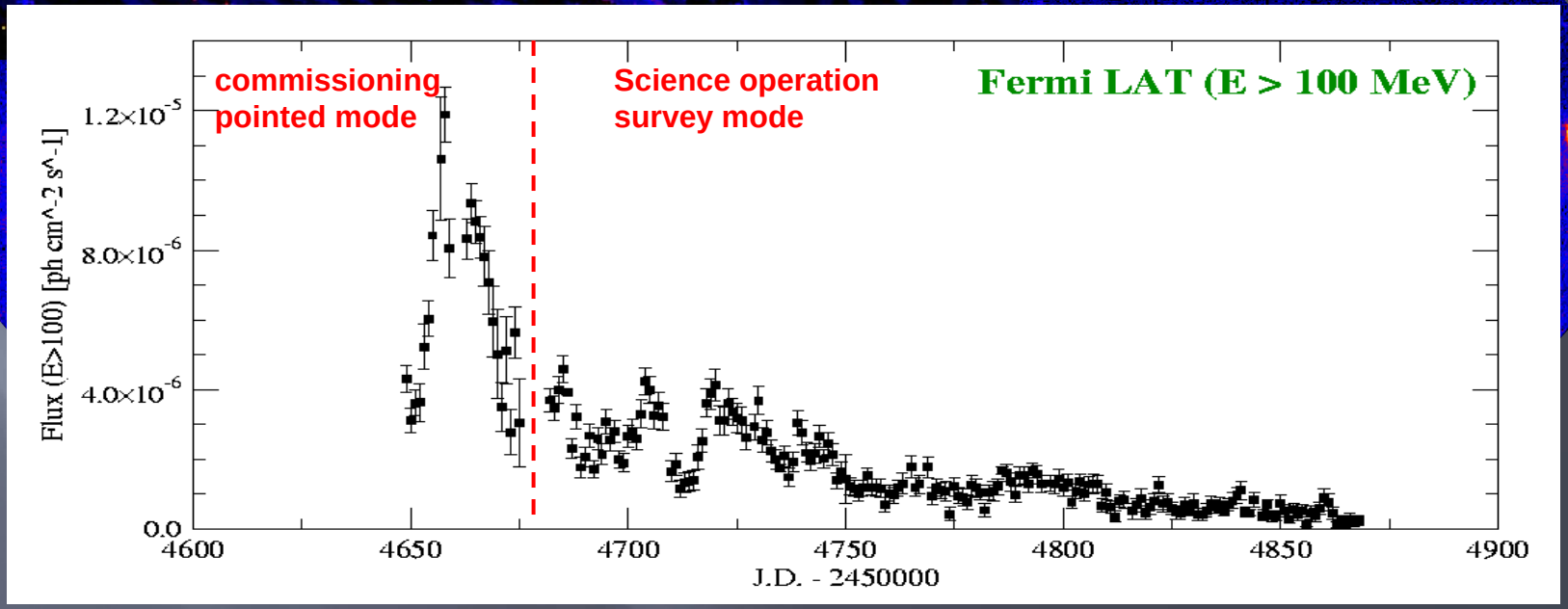
millisecond pulsars discovered using radio ephemeris

The Northern Galactic sky



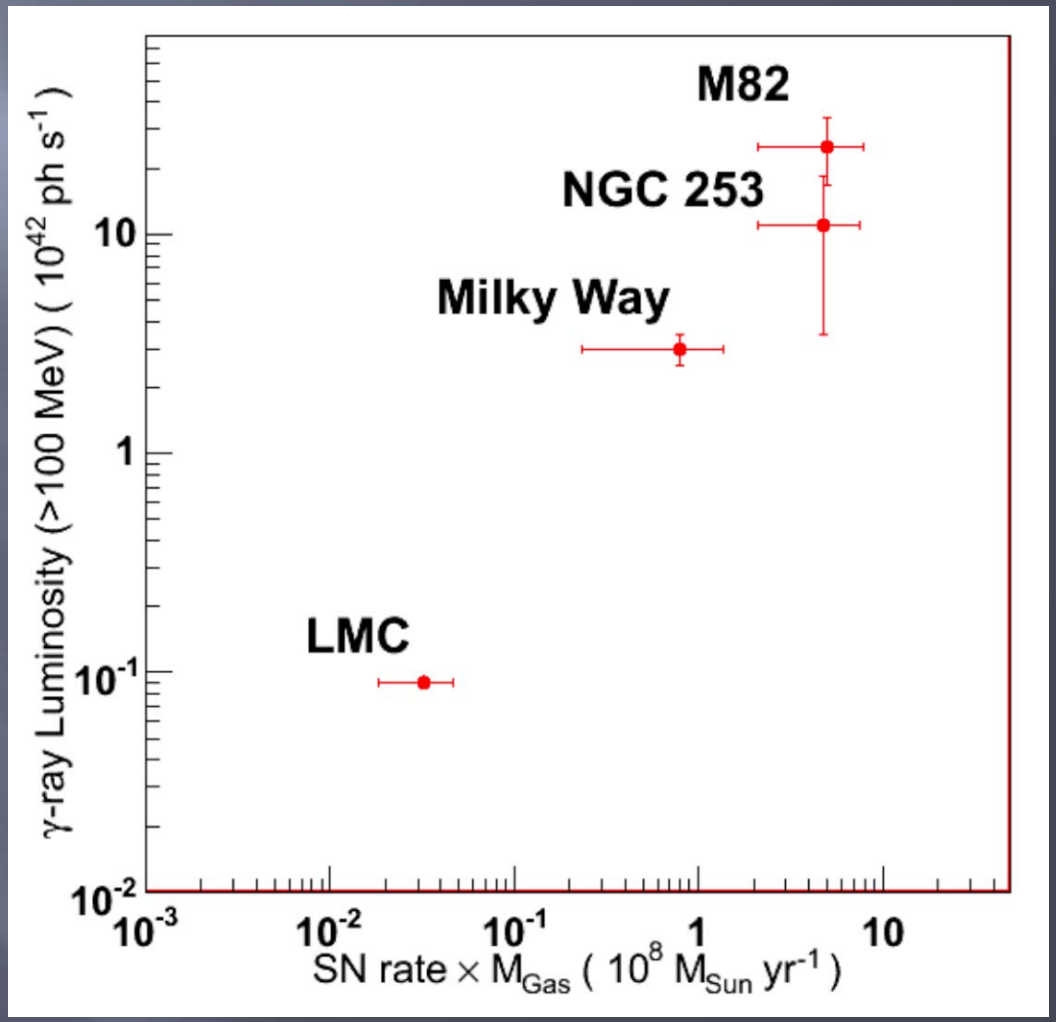
3C454.3
Supermassive black hole
8 billion light-years from us





Cosmic Rays and galaxies

Fermi has detected GeV emission from starburst galaxies for the first time



nature news

Published online 28 October 2009 | Nature | doi:10.1038/news.2009.1044

News

An intergalactic race in space and time

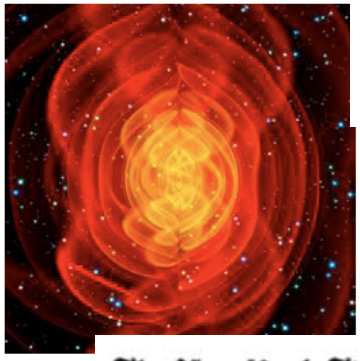
A burst of γ-rays lets scientists test quantum theories of gravity.

Geoff Brumfiel

Astronomers have used a high-energy burst of light from a distant galaxy to test the fabric of space and time. The work is the best test yet of attempts to create a 'theory of everything'.

At present, two separate theories dominate the world of physics. General relativity explains gravity and the motion of large objects such as planets, stars and galaxies, whereas quantum-mechanics explains the behaviour of very small things such as atoms.

Both theories do well at explaining their respective worlds, but they don't fit together mathematically. The problem is as fundamental as it gets: the two see space and time very differently, according to Giovanni Amelino-Camelia, a theoretical physicist at the University of Rome La Sapienza in Italy.



Space-ti
theory of

Chris F

Mail Online

Einstein was right! Nasa Fermi telescope uncovers proof of famous space-time theory

By Daily Mail Reporter
Last updated at 2:53 AM on 31st October 2009

Racing across the Universe for the last 7.3-billion-years, two highly charged particles have arrived at Nasa's Fermi Gamma-ray Space Telescope within a second of one another. Excited scientists believe this could be evidence of Einstein's space-time theory.

The photons were launched on their marathon during a short gamma-ray burst, an outpouring of radiation likely generated by the collision of two neutron stars, the densest known objects in the Universe.

One of the photons possessed a million times more energy that the other but they arrived at almost the same time.

The New York Times

Space & Cosmos

WORLD | U.S. | N.Y. / REGION | BUSINESS | TECHNOLOGY | SCIENCE | HEALTH | SPORTS

ENVIRONMENT | SPACE & COS

7.3 Billion Years Later, Einstein's Theory Prevails

By DENNIS OVERBYE
Published: October 28, 2009

Astronomers said Wednesday that a race halfway across the universe had ended in a virtual tie. And so the champion is still Albert Einstein — for now.

SIGN IN T
RECOMM

TWITTER

SIGN IN T
RECOMM

Collaboration during year 2

- Extensive discussions at September collaboration meeting about collaboration in year 2 and beyond
  - High-level photon data released to scientific community on August 11, 2009 and continues
  - Collaboration has remained active and intact. Members generally recognize value of being in the LAT Collaboration
  - Consistent with collaboration membership and publication policies, there will be significantly more CAT 2 papers in year 2; there will also be many CAT 1 papers as well.
    - CAT 1 papers are for discovery results and initial papers on key projects