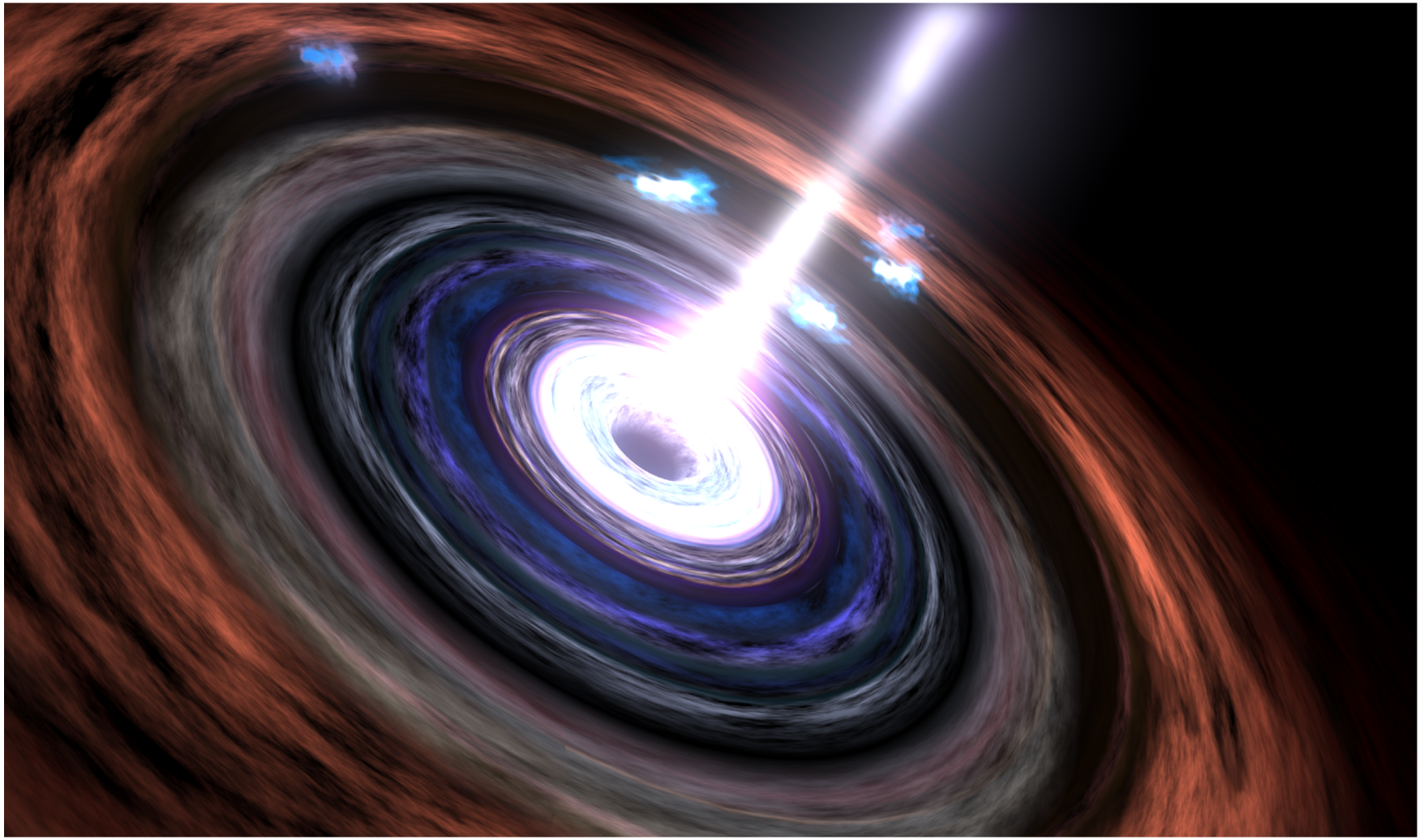
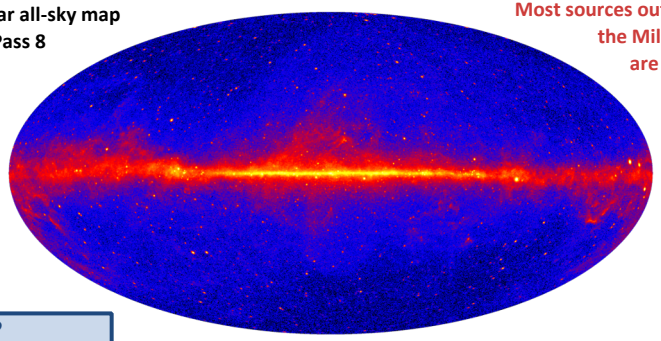
Active Galactic Nuclei



NASA/Goddard Space Flight Center Conceptual Image Lab

New Insights into AGN Physics from *Fermi* LAT

LAT 9-year all-sky map
Pass 8



Most sources outside of the Milky Way are blazars

Active Galactic Nuclei (AGNs) are compact regions, powered by supermassive black holes, at the centers of some galaxies. A fraction of these AGNs accelerate particle jets that can stretch up to hundreds of kpc outside the host galaxies to velocities near the speed of light. AGNs that happen to have their jets pointed to Earth are known as **blazars**. Blazars are one of the most extreme astronomical sources in the Universe. They are characterized by being both very luminous across the whole electromagnetic spectrum and variable at time scales as short as minutes.

AGNs detected with the LAT

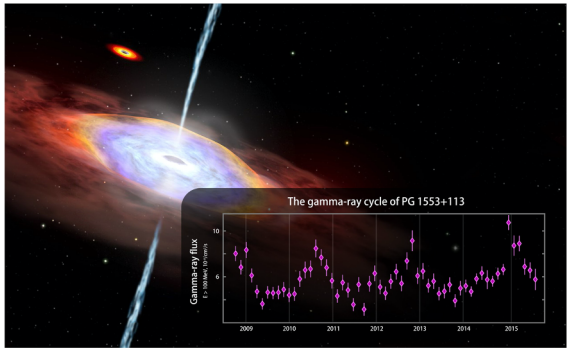
The Large Area Telescope (LAT) on board the *Fermi Gamma Ray Space Telescope* observes gamma rays in the 30 MeV – 300 GeV energy band. Fifty-eight percent of all the sources *Fermi*-LAT has detected, and almost all the gamma-ray sources from outside the Milky Way, are AGNs.

The Third *Fermi* LAT AGN Catalog (3LAC) contains 1563 gamma-ray sources associated with AGNs. This is the **largest catalog** of gamma-ray-detected AGNs ever made. The 3LAC catalog contains different AGN types although the big majority are blazars. Other AGNs that are included are classified as misaligned blazars (or radio galaxies), narrow-line Seyfert 1 and starbust galaxies.

Blazars are highly variable sources on timescales as short as minutes. In fact, the extragalactic gamma-ray sky never looks the same two days in a row. This makes the **all-sky coverage of the LAT** a valuable tool for studying AGNs. As a consequence of this, the LAT has monitoring programs that search for interesting flaring episodes in the sky.

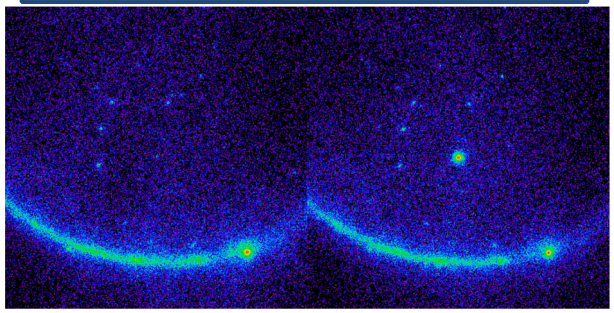
Do supermassive black holes come in pairs? Clues from possible cycles of Gamma-ray activities

Fermi observations suggest possible **years-long cyclic changes** in gamma-ray emission from the blazar PG 1553+113. The graph in the inset below shows *Fermi* LAT data from August 2008 to July 2015 for gamma rays with energies above 100 million electron volts (MeV). For comparison, visible light ranges between 2 and 3 electron volts. One possible explanation for the gamma-ray cycle is an **oscillation of the jet produced by the gravitational pull of a second massive black hole**.



The Record Flare from Blazar 3C 279

3C 279 is a famous blazar. On 2015 June 14, the pulse of high-energy light produced by a great disturbance near the monster black hole at the center of 3C 279 set off detectors aboard *Fermi* and other satellites. This flare was the most dynamic outburst *Fermi* has seen, becoming 10 times brighter overnight. It conveyed information about the size of the emitting region, which cannot be larger than the distance light can travel during the flare.



The images show the historic gamma-ray flare by comparing a week-long exposure ending June 10, before the eruption (left) and an exposure for the following week, including the flare (right). 3C 279 is brighter than the Vela pulsar, normally the brightest object in the gamma-ray sky.

The Most Extreme Blazars Yet

Fermi has identified the most distant gamma-ray blazars, revealing light that began its journey to us when the universe was 1.4 billion years old, or nearly 10 percent of its present age. This discovery triggers the main question of how these huge black holes could have formed in such a young universe. The question is particularly intriguing because these five new gamma-ray blazars are likely just the tip of the iceberg, the first examples of a galaxy population that previously has not been detected in gamma rays,

Fermi Gamma-ray Space Telescope

NASA's Fermi mission is an astrophysics and particle physics partnership managed by NASA's Goddard Space Flight Center in Greenbelt, Md., and developed in collaboration with the U.S. Department of Energy, with important contributions from academic institutions and partners in France, Germany, Italy, Japan, Sweden and the United States.

For more information, visit http://fermi.gsfc.nasa.gov/