I hereby declare that the thesis titled ‘General Physical Characteristics of γ-ray Emitting Beamed AGNs in Fermi Era’ is an authentic record of the research work carried out by me under the supervision of Prof. C. S. Stalin, IIA and Dr. C. D. Ravikumar, Department of Physics, University of Calicut. No part of this work has formed the basis for award of any other degree or diploma in any university or institution.

Vaidehi Sharan Paliya
The research work presented in this thesis is aimed to provide a detailed understanding of the radiative processes powering the jets of the blazars, a class of AGNs with jet pointed towards the line of sight to the observer. Another important aim of this work is to study the multi-frequency properties of a new class of $\gamma$-ray emitting narrow-line Seyfert 1 ($\gamma$-NLSy1) galaxies using various observational tools and to compare them with that known from powerful blazars.

The goal of understanding the physical characteristics of blazars is achieved by studying the broadband flux variability and spectral energy distribution (SED) modeling of a carefully selected sample of blazars. The aim of the broadband variability study is to provide a general physical scenario, which allows one to put the observed variation from blazars across several decades of frequencies in a coherent context. Extremely fast hr scale flux variations are observed from all the sources studied here, including nearby BL Lac object Mrk 421 ($z = 0.03$) which showed minute scale hard X-ray (3–79 keV) flux variability during its 2013 April X-ray outburst. Moreover, by adopting a SED modeling approach, attempts are made to understand the causes of high amplitude $\gamma$-ray flux variations observed from these objects. To do this, a simple one zone leptonic emission model was also developed during the course of the thesis. The main reason of the 2014 April and 2015 June $\gamma$-ray outbursts of 3C 279 ($z = 0.536$) and 2011 December $\gamma$-ray flare of distant blazar S5 0836+71 ($z = 2.17$) is found to be due to sudden acceleration of the jet. On the other hand, minute scale variability seen from Mrk 421 is explained on the basis of magnetic energy dissipation and reconnection events.

The multi-wavelength observations of 3C 279 revealed that a single zone leptonic emission model successfully reproduces the $\gamma$-ray flares of 2014 April and 2015 June, however, it fails to explain the uncorrelated flux variations and a hard $\gamma$-ray spectrum seen during 2013 December event. A two zone leptonic emission model is used to match the observations. All these observations hint for the presence of a
variety of the radiative processes working in the 3C 279 jet (and possibly in other sources as well) and their dominance over each other, as seen during different high activity periods.

The launch of the *Fermi* Gamma-ray space telescope in the year 2008 led to the first detection of γ-ray emission with high confidence from about half-a-dozen radio-loud NLSy1 galaxies. This discovery clearly indicates the presence of relativistic jets in these sources similar to that of blazars. With the motivation to understand the nature of γ-NLSy1 galaxies vis-a-vis blazars, few diagnostic tests are carried out, namely, intranight optical variability (INOV), γ-ray spectral properties, and broadband SED modeling. It is found that: (1) these sources show large amplitude (>3%) INOV with a duty cycle of about 80%, (2) their γ-ray spectra exhibit a significant curvature, and (3) their broadband SEDs have the typical double hump structure and the high energy hump can be explained due to external Compton process. Thus, based on the observations covering a wide range of the electromagnetic spectrum, it can be concluded that γ-NLSy1 galaxies have all the properties similar to blazars and could well be the low black hole mass counterparts of flat spectrum radio quasars.
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This research has made use of data, software and/or web tools obtained from NASAs High Energy Astrophysics Science Archive Research Center (HEASARC). Part of this work is based on archival data, software, or online services provided by the ASI Science Data Center (ASDC). This research has made use of the XRT Data Analysis Software (XRTDAS) developed under the responsibility of the ASDC, Italy. This research has also made use of the NuSTAR Data Analysis Software (NuSTARDAS) jointly developed by the ASI Science Data Center (ASDC, Italy) and the California Institute of Technology (Caltech, USA). Steward Observatory spectropolarimetric monitoring project is supported by Fermi Guest Investigator grants NNX08AW56G, NNX09AU10G, and NNX12AO93G. This research has made use of up-to-date SMARTS optical/near-infrared light curves. This research has made use of data from the OVRO 40-m monitoring program (Richards et al., 2011) which is supported in part by NASA grants NNX08AW31G and NNX11A043G, and NSF grants AST-0808050 and AST-1109911. The CRTS survey is supported by the U.S. National Science Foundation under grants AST-0909182 and AST-1313422. This research has made use of the Palermo BAT Catalogue and database operated at INAF – IASF Palermo.
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List of Publications

Refereed Publications:

1. *Broadband Observations of the Gamma-Ray Emitting Narrow Line Seyfert 1 Galaxy SBS 0846+513*

2. *A Hard Gamma-ray Flare from 3C 279 in 2013 December*

3. *Violent Hard X-ray Variability of Mrk 421 Observed by NuSTAR in 2013 April*

4. *Fermi-Large Area Telescope Observations of the Exceptional Gamma-ray Flare from 3C 279 in 2015 June*

5. *The High Redshift Blazar S5 0836+71: A Broadband Study*

6. *Awakening of the High Redshift Blazar CGRaBS J0809+5341*

7. *Multi-Wavelength Observations of 3C 279 during the Extremely Bright Gamma-ray Flare in 2014 March-April*
8. *Fermi Monitoring of Radio-loud Narrow Line Seyfert 1 Galaxies*

9. *The Peculiar Radio-loud Narrow Line Seyfert 1 Galaxy 1H 0323+342*


11. *Intranight Optical Variability of γ-ray Loud Narrow-Line Seyfert 1 Galaxies*

Refereed Conference Proceedings:

1. *Lepto–Hadronic Origin of γ-ray Outbursts of 3C 279*
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