Fermi Summer School 2017

#fermisummerschool

Options for the Free Day

Week 1

	Tues, May 30	Wed, May 31	Thurs, June 1	Fri, June 2	Sat, June 3
8:15	**Breakfast**	**Breakfast**	**Breakfast**	**Breakfast**	**Breakfast**
9:00	Welcome and Fermi Mission Overview - Julie McEnery	HAWC Instrument and Science - Jordan Goodman	Fermi Observations of Gamma-ray Bursts and Gravitational Wave Counterparts - Judy Racusin	Fermi GBM & LAT GRB Data Analysis - Judy data files example_prompt.xcm specfiles (only if you don't manage to make your own)	Cosmic Rays and Dark Matter - Fiorenza
10:00	Radiation processes and Air Showers - Jordan Goodman	Imaging Atmospheric Cherenkov Telescopes: From ADC counts to gamma-ray images and spectra - Stefan Ohm	Gamma-ray emission from star-forming systems - Stefan	Cosmic Rays and Dark Matter - Fiorenza Donato	Multivariate analysis techniques and machine-learning algorithms - Stefan Links about machine learning
11:00	**Break**	**Break**	**Break**	**Break (Photo!)**	**Break**
11:30	The High-Energy Gamma-ray Sky - Liz Hays	Intro to the Fermi Large Area Telescope - Jeremy Perkins	Student Talks / 1 Slide Summaries	Student Talks / 1 Slide Summaries	Compton Telescopes - Eric Grove
12:30	**Lunch**	**Lunch**	**Lunch**	**Lunch**	**Lunch**
1:30	Basics of Maximum Likelihood - Liz Installation for Fermi VM Science Tools Intro and Data Exploration - Elizabeth Ferrara Students choose a source for analysis.	Likelihood Analysis in LAT - Jeremy Perkins Quiz tool link: kahoot.it	Generating LAT XML Models - Elizabeth Ferrara instructions for using make3FGLxml.py script Advanced Likelihood/fermiPy (data.tgz) fermiPy documentation PDG Statistics review pdf (deltaLL values in Table 38.2 on page 29)	Advanced Topics LAT Analysis Checklist Student Projects	Advanced Topics: LAT Analysis Checklist Pulsar Analysis Galactic source techniques Lightcurve analysis http://fermipy.readthedocs.io/en/latest/advanced/lightcurve.html#lightcurve Student Projects
4:45	End of the Day Tagup	End of the Day Tagup	End of the Day Tagup	End of the Day Tagup	End of the Day Tagup
			~~**NICER launch 5:55 PM**~~ **Crab Feast**		**NICER launch at 5:07 PM**

Week 2

	Mon, June 5	Tues, June 6	Wed, June 7	Thurs, June 8	Fri, June 9
8:15	**Breakfast**	**Breakfast**	**Breakfast**	**Breakfast**	**Breakfast**
9:00	Particle Acceleration Mechanisms I - Yajie Yuan	Particle Acceleration Mechanisms II - Yajie	AGN and Blazars in the gamma-ray sky - Betta	Theory and Modeling of Pulsar Wind Nebulae - Yajie	Summary
10:00	Fermi LAT Catalogs - Elisabetta Cavazzuti	Magnetars - George Younes	Fermi GBM as a Transient Monitor - Colleen Wilson-Hodge	Analyzing GBM Continuous data - Colleen	Project Results and Feedback

11:00	**Break**	**Break**	**Break**	**Break**	**Break**
11:30	Student Talks / 1 Slide Summaries	Dark Matters - Regina Caputo	Student Talks / 1 Slide Summaries	AMEGO - Regina Caputo	Workshop Close Out
12:30	**Lunch**	**Lunch**	**Lunch**	**Lunch**	**Lunch**
1:30	Advanced Topics: Working groups on special topics Student Projects	Free afternoon	On-line analysis tools tutorial - Betta (topcat, 3C 454.3 lc) Advanced Topics: Systematics: Effective Area Student Projects	NICER - Colleen Advanced Topics: Student Projects	
4:45	End of the Day Tagup	End of the Day Tagup	End of the Day Tagup	End of the Day Tagup	
			Virden BBQ @ 6:00	**Sunset Dolphin Cruise**	

Student Talks and 1 Slide Schedule

Thursday, June 1

- Donggeun Tak - Thermal and non-thermal emission study in GRB160709A **>>**

  GRB160709A is one of the small sample of short Gamma-ray Bursts detected by both the Gamma-ray Burst Monitor and the Large Area Telescope on-board the Fermi Gamma-ray Space Telescope. We performed a detailed spectral analysis of the Fermi gamma-ray data for this GRB. The spectrum is best described by a combination of thermal and non-thermal spectral components. In time-resolved analysis, a combination of thermal and non-thermal spectral components is observed. A thermal component with a temperature of about 340 keV is dominant in several time-intervals. Two non-thermal components are required. One being a time-varying power-law with exponential cutoff component and the other a hard power-law component with photon index constant in time. This analysis suggests that the emission process producing the hard power law component is independent to other emission processes happening during the prompt phase.
- Divya Palaniswamy - Fast Radio Bursts **>>**

  FRBs are a short duration (~ ms), bright (~ Jy), highly dispersed, and probably polarized radio pulses. Twenty-six FRBs have been reported thus far. The physical interpretation for FRBs remains unclear but is thought to involve highly compact objects hosted in galaxies at cosmological distances. The progenitor source of FRBs has not been identified and is a highly debated topic. Except for one, none of other FRBs have been detected to repeat. There are more progenitor's models than the FRB themselves! I will briefly talking about the current state of the art in FRB world and my work at UNLV.
- Tang Qingwen
- Orel Gueta
- Israel Martinez

Friday, June 2

- Suttiwat Madlee - Earth's gamma-ray emission in geographical coordinates with Fermi-LAT data **>>**

  The Earth's gamma ray emission is produced from the interactions between cosmic rays (CRs), high-energy particles in space, and the Earth's upper atmosphere. These gamma rays are measured by the Large Area telescope (LAT), the instrument onboard the Fermi Gamma-ray Space Telescope (Fermi) which was launched in 2008 to orbit the Earth at the altitude of ~540 km. Here we present preliminary results of the Earth's gamma-ray intensity, which for the first time has been analyzed in geographical coordinates, using the latest version of LAT data. This study will provide better understanding of the geomagnetic field, the Earth's upper atmosphere, and CRs.
- Carlo van Rensburg - Spatially-Dependent Modelling of Pulsar Wind Nebula G0.9+0.1 **>>**

  We present results from a leptonic emission code that models the spectral energy density of a pulsar wind nebula by solving a Fokker-Planck-type transport equation and calculating inverse Compton and synchrotron emissivities. We have created this time-dependent, multi-zone model to investigate changes in the particle spectrum as they traverse the pulsar wind nebula, by considering a time and spatially-dependent magnetic field, spatially-dependent bulk particle speed implying convection and adiabatic losses, diffusion, as well as radiative losses. Our code predicts the radiation spectrum at different positions in the nebula, yielding the surface brightness versus radius and the nebular size as function of energy. We compare our new model against more basic models using the observed spectrum of pulsar wind nebula G0.9+0.1, incorporating data from H.E.S.S. as well as radio and X-ray experiments. We show that simultaneously fitting the spectral energy density and the energy-dependent source size leads to more stringent constraints on several model parameters.
- Tyler Williamson
- Laila Vleeschower
- Sheridan Lloyd

Monday, June 5

- Janeth Valverde - B2 1215+30 Long Term Gamma-ray Study with Fermi-LAT & VERITAS **>>**

  We characterize the blazar B2 1215+30 (z=0.131) in the high (HE) and very high (VHE) gamma- ray energy domains. Blazars are a type of active galactic nucleus, very powerful systems with a super massive black hole at their center that outshines the rest of the galaxy, and whose relativistic jets point approximately in the direction of the Earth. These extreme objects are prolific gamma-ray emitters and all their subclasses are particularly variable at all wavelengths. The study of blazar variability at different wavelengths is crucial to test models attempting to identify the nature of the jet particles and the scale of the gamma-rays emission zones. For B2 1215+30, the largest HE flares detected by Fermi-LAT occurred in Oct. 2008 and Feb. 2014, this last one having its brightest counterpart at VHE detected by VERITAS.

  We will report on our progress on the temporal and spectral analysis of the BL Lac blazar B2 1215+30, with all the Fermi-LAT and VERITAS available data, from year 2008 to 2016. The detailed Fermi-LAT light curve we have obtained will allow us to run variability tests, which in turn might provide us with some clues about the physical processes underneath.
- Marcin Marculewicz - Weak emission-line quasars (WLQ) **>>**

  Weak emission-line quasars (WLQ) are objects with enormous weak emission-lines (e.g. EW (Ly a) 10Å ; Diamond-Stanic et al. 2009). The properties of WLQs are different from those of BL Lac objects but consistent with normal AGNs (Plotkin et al. 2010). There are several explanations of weakness ofemission- lines. The first possibility is existence of a cold accretion disk (Laor & Davis 2011) or a radiatively inefficient accretion flow (Yuan & Narayan 2004). The next explanation is a presence of shielding gas, which could be a part of a slim disk. This part prevents ionizing photons from reaching the broad emission-line region(BELR). The following description provides Shemmer et al. (2010) who propose the BELR is built anemic. Hryniewicz et al. (2009) proposed the next explanation that perhaps in all weak emission line quasars the activity has just started. Any explanation of WLQ phenomena is still not given.

- Fabio Carfado
- Monica Breed
- Hannes Thiersen

Wednesday, June 7

- Brent Limyansky - Analyzing Pulsar “Glitches” Using the Fermi LAT **>>**

  Pulsars are rapidly rotating neutron stars which produce pulsed emission across the electromagnetic spectrum. Abrupt and unpredictable changes in emission frequency are known as “glitches”. In young pulsars, theory predicts that glitches are the result of a starquake-induced change in geometry of the neutron star’s crust. These types of glitches have the potential to produce gravitational waves, although they are not believed to be detectable with current technology. In rotation-powered pulsars, glitches are believed to come from interactions between surface and interior regions of the neutron star. Glitches are challenging to observe with pointed instruments, as the time of their occurrence cannot be predicted. The Fermi LAT, which continually monitors over 200 gamma-ray pulsars, is not hindered in this manner and is therefore well suited to observation and study of glitches. In this project, I will examine previously detected pulsars over the full time range of the mission. Glitches will be identified and catalogued, with subsequent analysis having the potential to investigate the glitching mechanism, the nature of neutron star interiors, and glitches as a source of gravitational waves.
- Tiffany Lewis - A First-Principles Radiative Transport Model for Steady-State Blazar Spectra **>>**

  Blazars are luminous sources across the entire electromagnetic spectrum, but the spectral formation mechanisms in these sources are not well understood. We have developed a new model for blazar spectra in which we numerically integrate the first-principles electron transport equation to generate the electron number distribution with respect to energy. Our transport model considers shock acceleration, adiabatic expansion, stochastic acceleration due to MHD waves, Bohm diffusion, synchrotron radiation, and inverse-Compton radiation. We implement the full Klein-Nishina cross-section for interactions with photons from dust and 26 individual lines from the broad line region. We use the solution for the electron distribution to predict multi-wavelength SED spectra for 3C 279. This new self-consistent model provides an unprecedented view into the jet physics at play in this source, especially the relative strength of the shock and stochastic acceleration components and the size of the acceleration region. We show that our new Compton + synchrotron blazar model is the first to successfully fit the FermiLAT gamma-ray data for this source based on a first-principles physical calculation.
- Sambid Wasti
- Hester Schutte
- Cori Fletcher
- Tiaan Bezuidenhout
- Tejaswita Sharma
- Isabella Mereu

Supporting Material

Liz's favorite page on livetime and exposure: [http://fermi.gsfc.nasa.gov/ssc/data/analysis/documentation/Cicerone/Cicerone_Likelihood/Exposure.html]

Glossary of Fermi and related jargon

Example ipython notebook from Eric Charles' lecture for statistics in astronomy grad course: Guest Lecture of Applications in Astro Statistics (zipped archive)

Interesting repositories for Fermi analysis

- https://github.com/fermiPy/ and documentation at http://fermipy.readthedocs.io/en/latest/
- https://github.com/rsnemmen

Interesting links for machine learning

- Andrej Karpathy's webpage: http://cs.stanford.edu/people/karpathy/
- Deep learning in the browser: http://cs.stanford.edu/people/karpathy/convnetjs/
- Deep NNs playing ATARI games: http://www.nature.com/nature/journal/v518/n7540/full/nature14236.html
- Examples of scikit-learn: http://scikit-learn.org/stable/auto_examples/index.html
    - Can be installed within Fermi School VM by typing `pip install scikit-learn`.

Group Photos

DropBox link