PROCEEDINGS OF SCIENCE

GeV gamma-ray narrow-line Seyfert 1 galaxies and the *Fermi* LAT Flare Advocate service

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Since August 2008 the *Fermi* LAT Flare Advocate service (also known as all-sky Gamma-ray Sky Watcher, FA-GSW) is providing for a quick look and review of the gamma-ray sky observed day by day by the *Fermi* Large Area Telescope (LAT). The FA-GSW duty is based on high level automatic software pipelines and on shifters compiling analysis and summaries about the gamma-ray sources of the day, their detection and flux/spectral/variability status, their multi-frequency/multi-messenger associations and properties. The first detection of a GeV gamma-ray emitting narrow-line Seyfert 1 (NLSy1) galaxy, with a beamed relativistic jet during the first three months of *Fermi* LAT observations in 2008, was a milestone for AGN science. About twenty NLSy1 galaxies are claimed to be detected at energies E>100 MeV. Beyond time-integrated LAT catalogs, the detection of daily/weekly scale gamma-ray variability, flares and larger outbursts episodes from radio-loud, jetted, NLSy1 galaxies, is an important discovery, where FA-GSW service played a useful role since about 2010. Some historical remarks on GeV gamma-ray NLSy1 galaxies are here reported, highlighting the *Fermi* LAT contribution.

Revisiting narrow-line Seyfert 1 galaxies and their place in the Universe - NLS1-2018
9-13 April 2018
Padova Botanical Garden, Italy

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PoS(NLS1-2018)020

1. Seyfert galaxies and narrow-line Seyfert 1 (NLSy1) galaxies

Active Galactic Nuclei (AGN, $\sim 10\%$ are radio-loud) are compact objects in the gravitational center of galaxies that shows evidence for a strong non-stellar continuum emission. Such active galaxies, with an AGN, are believed to be well below 10% of all the galaxies in the Universe, but the percentage increases looking to higher redshifts. Seyfert galaxies ($\sim 2\%$ of all spiral galaxies) are AGN less luminous than quasars but closer, therefore allowing detailed observations. For example E. A. Fath, already in 1908, discovered strong emission lines in M 77 (a.k.a. NGC 1068, 3C 71).

Seyfert galaxies (divided into type 1 and 2, basing on orientation effects with respect to the obscuring dusty torus) represent a rich and multifaceted astrophysical phenomenon, where ultraviolet emission and absorption lines provide the best diagnostics for the composition of the surrounding material. In general AGN display narrow emission lines, with gas velocities between 300 and 1000 km s^{-1} originating in the Narrow Line Region (NLR) with sizes of hundreds of parsec, located above (and below) the plane of the obscuring dust. Specifically Seyfert galaxies have luminous active cores, narrow narrow (< 1000 km s^{-1}) and broad (> 1000 km s^{-1}) lines, high-ionization emission regions (NLR and BLR), accreting central supermassive black holes and detectable spiral host galaxies. Beyond M 77/NGC 1068, the Circinus galaxy (a.k.a ESO 097-G013, PKS 1409-651) and NGC 7742 are other famous examples. In this view Seyfert galaxies represents an optimal target for the *Swift* UVOT space telescope, for the XMM-*Newton* OM (optical monitor telescope with UV filters[1]), the UVIT instrument on board of the Astrosat Indian satellite[2] (launched on September 2015), the next Russian and full-dedicated UV satellite SPECTR-UF now renamed World Space Observatory UV[3] (WSO-UV, to be launched around 2025), and the future NASA flagship project for the large satellite LUVOIR[4] (with a high-resolution UV spectro-polarimeter named POLLUX) to be constructed after 2030, as a large IR-Optical-UV successor of JWST.

A subclass of Seyfert galaxies, called narrow-line Seyfert 1 (NLSy1 or NLS1) galaxies, with unusually narrow permitted lines (FWHM(Hβ) < 2000 km s^{-1}) in the optical band [59] is intensively studied. Typical characteristics of NLSy1 galaxies are steep X-ray spectra, a strong Fe II emission spectral bump, ratio [O III]$\lambda 5007/\mathrm{H}\beta < 3$, very high (about Eddington) accretion rates, morphological pseudo-bulges and bars, and properties that in some cases are similar to blazars. Extreme gaseous outflows affecting a large part of the high-ionization NLR is sometimes observed in radio-loud and jetted NLSy1 galaxies [10, 48]. Only a small fraction ($< 3.7\%$) of NLSy1 are radio-loud [61]. Relativistic jets are there claimed in the case of extremely high brightness temperatures, core-jet radio structure and flat radio spectra. Sometimes NLSy1 galaxies are tentatively defined as young AGN with relatively small but growing SMBHs, with possible links to Seyfert 2 or ultraluminous infrared galaxies. They could be considered a new, standalone, class of AGN, emitting MeV-GeV peaked gamma-ray emission, under an evolutionary interpretation, or instead a part of a larger AGN class observed under particular geometry and inclinations of the line of sight.

The discovery of GeV gamma-ray NLSy1 galaxies has intriguing consequences for theories about galaxy evolution and the formation of powerful jets. Further debated questions are related

[1]https://www.cosmos.esa.int/web/xmm-newton/technical-details-om

[2]http://astrosat.iucaa.in/?q=node/15

[3]http://www.wso-uv.es

[4]https://asd.gsfc.nasa.gov/luvoir/

to the differences between radio-quiet and radio-loud objects, the level of observational selection effects given by incomplete population samples, the relationship between gamma-ray NLSy1 galaxies and the nominal gamma-ray blazars (i.e. flat-spectrum radio quasars, FSRQs, and BL Lacertae-type objects, BL Lacs). There are also proposed new definitions, for example "jetted-NLSy1" galaxies [55].

2. Discovery of a GeV gamma-ray jet from the NLSy1 galaxy PMN J0948+0022

The known extragalactic gamma-ray sky is dominated by blazars (FSRQs, BL Lacs) and a few radio galaxies. The surprising discovery in 2008 of high-energy ($E > 100$ MeV) gamma-ray emission from a radio-loud, jetted, narrow-line Seyfert 1 (NLSy1) galaxy , namely PMN J0948+0022, by the Large Area Telescope (LAT) onboard the *Fermi* Gamma-ray Space Telescope [3, 37, 4], immediately questioned the need for large BH masses ($> 10^8$ $M_\odot$) and large bolometric power and luminosity, to build and launch relativistic jets in these AGN. GeV gamma rays, i.e. relativistic beamed jet oriented along the line of sight, discovered in NLSy1 galaxies, thought to be hosted in spiral galaxies with a BH mass typically of $10^6 - 10^7$ $M_\odot$, challenges the current knowledge on how these powerful cosmic particle accelerator structures are generated and developed: either relativistic jets in NLSy1 are produced by a different mechanism, or the BH masses in NLSy1 is largely underestimated because of radiation pressure or projection effects.

The first gamma-ray NLSy1 galaxy discovered was PMN J0948+0022, with redshift $z =$ 0.5846 and also known as MG1 J094856+0023, RX J0948.8+0022 and GB6 J0948+0022. It is also a member of the RGB, CGRaBS, CRATES, Roma-BZ, and *Fermi* 0,1,2,3FGL catalogs, and shows (FWHM(Hβ)$\sim$ 1500 km s^{-1}) strong permitted lines. The radio loudness and variability of the compact radio core, the gamma-ray loudness and variability, the hard X-ray spectrum, all indicates the presence of a relativistic jet.

Under a recent and short historical point of view (for a more detailed historical report see [40]), in year 2008 the *Fermi* LAT reported the detection of PMN J0948+0022 in the first list of bright gamma-ray sources built with the first 3 months of LAT all-sky survey data (Aug.4-Oct.30 2008, 0FGL catalog and the related LAT bright AGN source list (LBAS) [1, 2]). However, the classification reported in the early 0FGL and LBAS catalogs was wrong (FSRQ classification), but two papers dedicated to this source clarified the issue by correcting the classification as a NLSy1 galaxy [3, 37] A dedicated multiwavelength campaign set up soon after the early detection, confirmed the association of the gamma-ray source with the radio couterpart PMN J0948+0022 (Abdo, A.A., et al., 2009, ApJ, 707, 727). written the same year [3]. Large gamma-ray variations and outburst were observed after by the *Fermi* LAT since 2010, promptly alerted with Astronomer's Telegrams (ATels) [34, 36, 20, 22] thanks also to the *Fermi* LAT Flare Advocate and Gamma-ray Sky Watcher (FA-GSW) service [19]. In 2011, PMN J0948+0022 was detected also by AGILE [52] after a new flaring activity announced by the LAT [20], while the LAT was discovering a gamma-ray outburst from a second jetted NLSy1 galaxy, SBS 0846+513 ($z = 0.5835$, a.k.a. 87GB 084622.1+511959) [35, 39, 21, 57].

PMN J0948+0022 could be considered the archetypal object of a new class of gamma-ray emitting AGN, therefore several multifrequency campaigns were performed to investigate in detail its characteristics over the whole electromagnetic spectrum, obtaining important multifrequency data and results [4, 38, 44, 41, 46, 24, 27, 56, 65].

PMN J0948+0022 shows roughly all the characteristics of the blazar class, with a spectral energy distribution (SED) analog to that of more massive and more powerful FSRQs, modeled as synchrotron emission and an external Compton scattering of seed photons from the BLR varying by changing both the electron distribution parameters and the magnetic field. The calculated power carried out by its jet (protons, electrons, radiation, magnetic field) is quite similar to that of FSRQs. The presence of short (<3 days) doubling time scale in gamma-ray variability, curvature in the gamma-ray spectrum, the observed gamma-ray luminosity of $\sim 10^{48}$ erg s^{-1}, the presence of resolved soft X-ray emission partly produced by blurred reflection or Comptonization of the thermal disc, the presence of intra-day radio polarization variability and VLBI data similar to FSRQs, are other results about PMN J0948+0022.

3. Discovery of further GeV gamma-ray emitting jetted NLSy1 galaxies

After the first year of *Fermi* LAT operations, four NLSy1 galaxies were detected at high-energy ($E > 100$ MeV) gamma rays: in addition to PMN J0948+0022, there were also 1H 0323+342 (a.k.a. H 0321+340, B2 0321+33B, TXS 0321+340), PKS 1502+036 and PKS 2004-447 [5] In the first 48-months (4.Aug.2008-31.Jul.2012) time-integrated, and 100 MeV-300 GeV energy range, all-sky survey data, namely the *Fermi* LAT Third Source Catalog (3FGL, [7]) published on 2015, five gamma-ray jetted NLSy1 galaxies were reported: 1H 0323+342 (a.k.a. H 0321+340, B2 0321+33B, TXS 0321+340), SBS 0846+513, the prototype PMN J0948+0022, PKS 1502+036 and PKS 2004-447, with a redshift between 0.061 and 0.585. Four of these (with the exception of SBS 0846+513) were already reported in the 1FGL catalog [6]. Several new GeV gamma-ray jetted NLSy1 galaxies were discovered thanks to the further years of *Fermi* all-sky survey data collection, longer integration timescale and the use of full-reprocessed Pass-8 LAT data. A list is reported in Table 1, where H/I/L/SP mean high/intermediate/low frequency peak of the multifrequency synchrotron spectral energy distribution (SED) component. To be noted that the new jetted NLSy1 galaxies included in [58] and [64] are reported in such papers with the rather anonymous NVSS or SDSS catalog names, even if already well known with their proper historical/discovery radio or optical names (for example 3C 232). More NLSy1 galaxies are expected to be published in the forthcoming *Fermi* 4FGL catalog.

4. GeV gamma-ray flux variability and flares of jetted NLSy1 galaxies and the *Fermi* LAT Flare Advocate service

The archetypal PMN J0948+0022 galaxy shows roughly all the characteristics of the blazar class and has a FSRQs-like SED. Various radio-to-gamma-ray multifrequency observing campaigns performed on some of the other gamma-ray emitting and jetted NLSy1 galaxies discovered after PMN J0948+0022 (Table 1), have confirmed the idea that radio-loud jetted NLSy1 galaxies host relativistic jets, with power that is lower or similar to that of average FSRQs.

The *Fermi* Flare Advocate, also known as Gamma-ray Sky Watcher (FA-GSW) monitoring service [19], provided several communications and prompt notes, like ATels, related to gamma-ray

Table 1: The list of known GeV gamma-ray detected NLSy1 galaxies

Proper name	Redshift z	SED type	3FGL name or ref
1H 0323+342 (H 0321+340, B2 0321+33B, TXS 0321+340)	0.061	HSP	3FGL J0325.2+3410
SBS 0846+513	0.584	LSP	3FGL J0849.9+5108
PMN J0948+0022	0.585	LSP	3FGL J0948.8+0021
PKS 1502+036	0.409	LSP	3FGL J1505.1+0326
PKS 2004-447	0.24	LSP	3FGL J2007.8-4429
RX J1644.7+2619 (MG2 J164443+2618, FBQS J1644+2619)	0.145	ISP	[28]
B3 1441+476 (TXS 1441+476)	0.70547	LSP	[51, 29]
NVSS J124634+023808 (PB 04215)	0.36263	LSP	[39]
S4 0929+53 (TXS 0929+533)	0.59719	ISP	[58]
3C 232 (NRAO 0342, OK 393)	0.5306	LSP	[58]
TXS 1419+391 (RX J1421.0+3855, RGB J1421+389)	0.48917	LSP	[58]
TXS 2116-077 (PMN J2118-0732)	0.26002	LSP	[64]
4C +04.42 (PKS 1219+04, TXS 1219+044)	0.966	LSP	3FGL J1222.4+0414
GB6 J0937+5008 (RX J0937.1+5008, RGB J0937+501)	0.276	LSP	3FGL J0937.7+5008
B3 1518+423 (TXS 1518+423)	0.484	ISP	3FGL J1520.3+4209
PMN J2118+0013	0.46293	ISP	3FGL J2118.4+0013
IRAS F16391+3500$^{(*)}$ (SDSS J164100.10+345452.6)	0.16408	LSP	[50]

(*) Not confirmed gamma-ray detection.

flares detected in NLSy1 galaxies. This triggered several simultaneous radio-to-gamma-ray multifrequency observing campaigns dedicated to such beamed jetted NLSy1 galaxies. For example, see [34, 20, 35, 22, 14, 23, 25, 26]. The ToOs to other satellites and ground-based telescopes triggered by FA-GSWs, and the multifrequency observing campaigns organized, often resulted in papers with science results and significant radio to X-ray data that have populated public data archives. For example *Swift*, NuSTAR, radio VLBI, optical photometry, polarimetry or spectroscopic data simultaneous to the LAT ($E > 100$ MeV) survey/monitoring data, and obtained during flares and other interesting variability episodes. For example (and curiosity) one of the first *Fermi* LAT ATel published soon after the beginning of the all-sky nominal survey operations [17] triggered, for example, a serendipitous detection by INTEGRAL in hard-X-rays of the nominal Sy1 galaxy Mkn 841 (a.k.a. PG 1501+106, [63]).

The FA-GSW service provides for a quick look and review of the gamma-ray sky observed daily by the *Fermi* LAT, through on-duty weekly shifts and high level software pipelines, like the LAT Automatic Science Processing (ASP) at the LAT Instrument Science Operation Center (LISOC) at SLAC, Stanford, [15, 12], and the public Fermi All-sky Variability Analysis (FAVA) at the NASA-Goddard Fermi Science Support Center (FSSC-GSFC) [8]. Preliminary results and information about the $E > 100$ MeV gamma-ray sky (on 6-hour, daily, weekly intervals), like the pop up of potential new sources, flaring sources, variability trends, the occurrence of transients, hard spectral states of sources, VHE photons detected, GeV follow-up of multifrequency/multimessenger events, follow up of ATel/GCNs at other electromagnetic energy bands, are reported by the FA-GSW on shift through the compilation of a concise daily summary report, addressed to the internal LAT collaboration science groups. Part of this information is publicly disseminated for potential interest through mailing lists, blogs, ATels, GCNs, and communicated to the multifrequency astrophysics and TeV Cherenkov telescopes communities.

The 10-year baseline of *Fermi* LAT all-sky survey operations from July 2008 to July 2018, under a FA-GSW point of view resulted in 435 ATels and 155 Fermi-Notice type GCNs published, in 517 weekly FAVA public tables, 3566 daily internal reports compiled and in 18972 ASP all-sky software pipeline runs with their interactive tables. More information and technicalities on the FA-GSW tasks, software, science data processing and products are reported in [16, 15, 12, 18, 19, 62].

5. Remarks on gamma-ray jetted NLSy1 galaxy science

NLSy1 galaxies are of primary interest for the big picture and questions related to galaxy evolution and jet formation and fueling. For example, why there are only a minority of AGN with strong, relativistic and beamed jets, accelerating high-energy particles and emitting irregularly variable gamma-ray radiation ?

Rapid gamma-ray and multifrequency, temporal and spectral, variability in jetted NLSy1 galaxies is intriguing, however the three types of aligned gamma-ray AGN (FSRQs, BL Lacs, jetted NLSy1 galaxies) could be consistent with each other, endowed with similar jets, where the observational differences might be explained by scaling factors, when normalized by the mass of the central BH [42, 43, 30]. The 1FGL catalog, built on the first integrated 11 months of LAT survey operations, included already four gamma-ray jetted NLSy1 galaxies [6], but the detection of daily/weekly scale gamma-ray variability and flares/outbursts episodes represents another significant discovery for jetted NLSy1 galaxies, beyond time-integrated catalogs. The *Fermi* LAT FA-GSW service played a useful role for gamma-ray variable and flaring jetted NLSy1 galaxies, helping to catch the best multifrequency science opportunities for these AGN.

The average apparent gamma-ray bolometric and isotropic luminosity of gamma-ray jetted NLSy1 galaxies in the 100 MeV-100 GeV band is between 10^{44} and 10^{47} erg s^{-1}, lower or similar to those of FSRQs and with similar SED shapes. The average $E > 100$ MeV spectral photon index ranges between 2.2 and 2.8, a range of values usually observed for FSRQs and low-energy peaked BL Lacs. In the gamma-ray photon index vs luminosity plane, gamma-ray jetted NLSy1 galaxies lie in the plane region occupied by FSRQs, with the exception of 1H 0323+342, RX J1644.7+2619 and SBS 0846+513. These cited NLSy1 galaxies, however, have the lowest redshift and this might be the reason why their gamma-ray luminosity is lower than the other NLSy1 and FSRQ [29].

The strongest gamma-ray outbursts observed from SBS 0846+513, PMN J0948+0022, PKS 1502+036, and 1H 0323+342 reached a peak of apparent isotropic gamma-ray luminosity of $10^{47} - 10^{48}$ erg s^{-1}, comparable to that of some bright and powerful FSRQs, except for the main outburst episodes of FSRQs. Gamma-ray jetted NLSy1 galaxies are at small viewing angles with respect to the jet axis, with a high beaming bulk factor similarly to blazars. Using Hβ emission line parameters, on average, gamma-ray jetted NLSy1 galaxies have smaller BH masses than FSRQs at similar redshifts [43]. During gamma-ray outburst events the daily time-scale variability was accompanied by a moderate spectral evolution (in SBS 0846+513 and PMN J0948+0022) as observed in bright FSRQs and low-energy peaked BL Lacs.

NLSy1 galaxies are not included in LAT catalogs of hard sources detected above 10 or 50 GeV (i.e. in the 1,2,3FHL catalogs) while > 10 GeV detections of SBS 0846+513 and PKS 1502+036 are claimed in [13]. VERITAS observations of PMN J0948+0022 performed only a few days after the trigger for a gamma-ray outburst announced by the *Fermi* LAT, resulted only in an upper limit for the $E > 200$ GeV energy band. The distance of the source $z = 0.5846$ is relatively large (sub-TeV/TeV emission absorbed by the EBL), VERITAS observations were carried out a few days after the GeV peak of flaring activity, and considering the similarities with FSRQs, an internal pair-production absorbing dense broad line region (BLR) should be present in these NLSy1. Steep GeV gamma-ray photon indexes, similar to values usually observed for FSRQs and MeV-energy gamma-ray peaked SEDs are one important, weakening, aspect for MAGIC, VERITAS, HESS telescopes and the next Cherenkov Telescope Array (CTA). Spectral cutoffs at < 100 GeV energy are likely common in these sources, and even if this may hinder detections by CTA, recent simulations show that, under certain conditions, there are some possibilities for detections with CTA [60]. On the other hand the < 100 GeV spectral cutoff represent an essential and positive fact for the scientific potential of a next generation, high-sensitivity, soft/medium (MeV) gamma-ray energy, space telescope, because the 100 keV - 100 MeV energy band is indeed the most crucial for the study of gamma-ray NLSy1 galaxies, representing the band where their gamma-ray power output is peaked. A future pair/Compton MeV gamma-ray space telescope [32, 33, 53, 45] will represent the best instrument, especially when working in synergy with a next generation UV space telescope, for the science of jetted NLSy1 galaxies.

The X-ray spectral energy distributions of gamma-ray jetted NLSy1 galaxies are harder than those of the other jetted NLSy1 galaxies, with the relativistic jet dominating above some keV [43]. The detection of a weak iron line by XMM-*Newton* in 1H 0323+342 could corroborate the hypothesis of relatively small angle of sight for gamma-ray jetted NLSy1, but larger than blazars ($3 \lesssim \theta \lesssim 10$ degrees). In general jetted NLSy1 galaxies are $< 3.7\%$ of the entire family. High values of radio-loudness $L_{5GHz}/L_{optical} > 100$) are even more sparse ($2 - 3\%$) for NLSy1 galaxies, while $\sim 15\%$ of quasars are radio-loud. Based on a sample of 42 radio-loud jetted NLSy1 galaxies, radio-to-X-ray multifrequency analysis and gamma-ray literature data resulted in a 90% of detected sources in X-ray regime and 17% in $E > 100$ MeV gamma-ray band [43]. NLSy1 galaxies are speculated to be either the low-mass tail of the quasar distribution or to behave as blazar-like objects placed at the low-end of the blazar BH mass distribution.

The historical difficulties in finding jetted NLSy1 galaxies might be due to their low power and to intermittent jet activity. They could be characterized by prolonged, but finite, accretion episodes that can spin-up the BH leading to the relativistic jet formation. The BH mass and mechanism for the formation of a relativistic jets in gamma-ray NLSy1 galaxies is debated. If the BH mass of radio-loud (and gamma-ray) NLSy1 is underestimated, this solves the problem of the minimum BH mass predicted in different scenarios of relativistic jet formation, but rises the host galaxy issue: can spiral galaxies host supermassive BH of $10^8 - 10^9$ $M_\odot$) ? A recent clue is the discovery that at least one gamma-ray jetted NLSy1 source, PKS 1502+036, is hosted in an elliptical galaxy [30, 31] with a BH mass larger than 10^8 $M_\odot$.

It is recently suggested that jetted AGN (i.e. also aligned gamma-ray FSRQs, BL Lacs and jetted NLSy1 galaxies), appear to be more clustered, undergo mergers, reside in more massive, spin-faster, bulge-dominated galaxies than non-jetted AGN [47, 55].

To be noted, anyway, that the jetted NLSy1 galaxy PKS 2004-447 emerged as the first gamma-ray, radio-loud AGN, where a fully developed relativistic jet is launched from a pseudobulge (i.e. disk-like star formation and properties), and grown via slow and steady, secular, processes [49]. Several other cases of spiral or pseudobulges hosts for jetted NLSy1 galaxies are now emerging [49, 54, 47, 11] This is opposite to the grow trough galaxy mergers that characterize elliptical galaxies.

6. Future prospects

As introduced in the first section, Seyfert galaxies in general and radio-loud/gamma-ray, jetted, NLSy1 galaxies in particular, are interesting targets for the current and the next generation of ultraviolet space telescopes and instruments (*Swift* UVOT, XMM-*Newton* OM, Astrosat UVIT, the next SPECTR-UF/WSO-UV satellite, the future LUVOIR project).

On the other hand the hard-X/soft/medium-gamma-ray (100 keV - 100 MeV energy) band is crucial for the science of NLSy1 galaxies. Luminous emission is expected from all jetted NLSy1 galaxies in this hard-X/MeV-gamma-ray band, therefore these AGN represent a topical goal for next generation gamma-ray space telescope projects like the e-ASTROGAM[5] [32, 33] and AMEGO[6] [53, 45]. e-ASTROGAM is a space observatory project with a detector composed by a Silicon tracker, a calorimeter, and an anticoincidence system, dedicated to the study of the nuclear/thermal and non-thermal Universe in the photon energy range from 0.3 MeV to 3 GeV. The lower energy limit can be pushed to energies as low as 150 keV for the tracker and to 30 keV for calorimetric detection, and the instrument has gamma-ray spectral line sensitivity and polarimetry capabilities. Crucial MeV gamma-ray continuun/line spectral, temporal and polarimetry data can be obtained from jetted NLSy1 galaxies observations. At least $\times 30$ better sensitivity in the 300 keV-3 GeV band is expected with respect to previous MeV instrument COMPTEL. MeV polarization measurements are possible for the brightest NLSy1 targets and flares. The different interplay

[5] http://eastrogam.iaps.inaf.it and https://www.facebook.com/eastrogam/
[6] https://asd.gsfc.nasa.gov/amego/

and dominance of external-Compton (EC) and synchrotron self-Compton (SSC) processes, both with detailed spectral and polarization measurements at MeV energies, can be disentangled, clarifying the relativistic jet and very high accretion rates are both present, this in comparisons with X-ray binary star system theory [43].

Compact-steep sources (CSS) radio galaxies, that are classified as high excitation radio galaxies (HERG), are recently suggested to be the parent population (i.e. how do they appear when observed under different and misaligned angles) of flat spectrum radio-loud NLSy1, and therefore also of the little subfamily of gamma-ray jetted NLSy1 [9]. This parent population is expected with a very steep gamma-ray spectrum below 100 MeV, therefore they represent another and unique potential target for e-ASTROGAM and AMEGO. In addition to radio-loud NLSy1 galaxies and to HERG-CSS, the soft/medium-energy gamma-ray can be essential for the observation of the tail end of the sharp cut-off (at energies around few MeV) expected in the SEDs of nearby, radio-quiet and optically bright, nominal Seyfert galaxies. Detailed observations of the Seyfert cut-offs can help to understand if this can be applied to the whole radio-quiet AGN population.

Acknowledgements

This conference has been organized with the support of the Department of Physics and Astronomy “Galileo Galilei”, the University of Padova, the National Institute of Astrophysics INAF, the Padova Planetarium, and the RadioNet consortium. RadioNet has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 730562.

Dr. Filippo D’Ammando and Dr. Vaidehi S. Paliya are both thanked for providing useful comments to the revised version of this contribution.

The *Fermi* LAT Collaboration acknowledges generous ongoing support from a number of agencies and institutes that have supported both the development and the operation of the LAT as well as scientific data analysis. These include the National Aeronautics and Space Administration and the Department of Energy in the United States, the Commissariat à l’Energie Atomique and the Centre National de la Recherche Scientifique / Institut National de Physique Nucléaire et de Physique des Particules in France, the Agenzia Spaziale Italiana and the Istituto Nazionale di Fisica Nucleare in Italy, the Ministry of Education, Culture, Sports, Science and Technology (MEXT), High Energy Accelerator Research Organization (KEK) and Japan Aerospace Exploration Agency (JAXA) in Japan, and the K. A. Wallenberg Foundation, the Swedish Research Council and the Swedish National Space Board in Sweden. Additional support for science analysis during the operations phase is gratefully acknowledged from the Istituto Nazionale di Astrofisica in Italy and the Centre National d’Études Spatiales in France.

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