Soft X and Gamma ray emission from TeV sources observed with Swift and INTEGRAL

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Abstract

The soft X-ray and soft gamma observations of the new discovered TeV sources by HESS and MAGIC are crucial to discriminate between various emitting scenarios and to fully understand their nature. The INTEGRAL Observatory has regularly observed the entire galactic plane during the first 1000 day in orbit providing a survey in the 20-100 keV range resulted in a soft gamma-ray sky populated with more than 200 sources. In the case of HESS J1813-178 INTEGRAL found the hard X-ray counterpart IGR J18135-1751 and Swift/XRT Telescope performed follow-up observations on this source. Here we present the soft/hard X-ray spectral study. We reported on the INTEGRAL observation of LS 5039, the first microquasar that have been observed by HESS up to now.

Key words: high energy sources, cosmic accelerators

1 Introduction

HESS (High Energy Steroscopic System) collaboration have reported results of the first sensitive TeV surveys of the inner part of our Galaxy (1), revealing the existence of a population of high energy gamma-ray objects, several of which previously unknown or not yet identified at lower wavelength. Different types of galactic sources are known to be cosmic particle accelerators and potential sources of high energy gamma rays: isolated pulsars/pulsar wind nebulae (PWN), supernova remnants (SNR), star forming regions, binary systems with a collapsed object like a microquasar or a pulsar. Detection of X to gamma-ray emission from these TeV sources is very important to discriminate between various emitting scenarios and, in turn, to fully understand their nature. The IBIS gamma-ray imager on board INTEGRAL is a powerful tool to search for their counterpart above 20 keV in

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view of the arcmin Point Source Location Accuracy associated to milli-icrab sensitivity for exposure >1 Ms. In addition SWIFT/XRT allow to obtain the accurate arc-second location of the X-ray/radio counterpart of the HESS sources. This is crucial to obtain secure identification and to perform accurate optical/infrared follow-up.

We discuss here the INTEGRAL and Swift observation of IGR J18135-1751=HESS J1813-178. The INTEGRAL observation of the microquasar LS 5039 is also presented.

2 IGR J18135-1751=HESS J1813-178: New Cosmic High Energy Accelerators from keV to TeV

IGR J18135-1751 was detected in the second IBIS/ISGRI survey with a significance exceeding 10σ at R.A.(2000)= 18h 13m 27.12s and Dec(2000)= -17° 50’ 56” (positional uncertainty of <3’). The averaged 20-100 keV flux was 2.1 × 10⁻¹¹ erg cm⁻² s⁻¹. HESS J1813-178 is one of the previously unknown sources found in the HESS survey of the inner regions of the galactic plane. This TeV source was also confirmed by MAGIC. It is located at R.A.(2000)=18h 13m 37.9s and Dec(2000)=-17° 50’ 34” (positional uncertainty of about 1-2’). The source does not seem point-like although it is only slightly extended (3’), if compared to the HESS point spread function. The statistical significance of the TeV detection is around 9σ. The source is fairly bright above 200 GeV with a flux of 12 × 10⁻¹² photons cm⁻² s⁻¹. No obvious counterparts were found within the source extension. At soft X-ray energies, we found a possible counterpart in the ASCA archive data: AGPS273.4-17.8 at R.A.(2000) = 18h 13m 35.8s and Dec(2000) = -17° 49’ 43.35” with an associated uncertainty of 1’. In the X-ray band the source is fairly bright showing a 2-10 keV flux (corrected for absorption) of 1.8 × 10⁻¹¹ erg cm⁻² s⁻¹.
The position of AGPS273.4-17.8 are both contained within the internal IBIS/ISGRI contour. Also shown are the location (and extension) of W33 and the 4 nearest radio pulsars (PSR J1814-1744, PSR J1812-1733, PSR J1815-1738 and PSR J1811-1736).

The ASCA-SIS image is shown as an insert on the top right side of the figure. The box covers an 8’x8’ region centred on the ASCA source position; the contour levels (1, 2 and 3 counts/pixel) provide marginal evidence of extended emission. GX13+1 and the transient source SAX J1818.6-1703 also are visible in the image, but contribute no contamination to region around IGR J18135-1751. We find a bright NVSS (NRAO VLA Sky Survey), radio source within the ASCA positional uncertainty; NVSS J181334-174849 with coordinates R.A.(2000)=18h 13m 34.32s and Dec(2000)=-17° 49' 52.4". It is contained within both the IBIS/HESS circles, and possibly associated to the ASCA source. The two observations of HESS J1813-178 performed with Swift/XRT clearly show a point like object (RA: 18h 13m 34s.9s, DEC: -17° 49' 53") compatible with ASCA/INTEGRAL error boxes. In the left panel in Figure 1, Swift/XRT 0.3-10 keV image of the region surrounding HESS J1813-178 is shown. The extension of the TeV source is shown by the ellipse. The XRT source is almost at the center of the SNR shell G1282-0.02. Contamination from a very bright source (GX 13+1) is also visible in the image. The XRT source has a possible counterpart in a 2 MASS/DENIS object at RA: 18h 13m 35s.06s, DEC: -17° 49' 52.4". The XRT spectrum is compatible with that from ASCA but a factor of 2 lower.

HESS J1813-178 has a point like X-ray counterpart with a power law emission from 2 to 100 keV and an associated radio counterpart. It is a non-thermal source, possibly accelerating electrons and positrons which radiate through synchrotron and inverse Compton mechanism. This is suggestive of the presence of a PWN/SNR, as already found in most newly detected TeV objects that have been clearly associated with either shell-type or plerion-type supernova remnants, like AX J1838-0655/HESS J1837-069. The lack of strong X/Gamma variability is IGR J1813-178 as well as AX J1838-0655, makes unlikely the scenario in which the TeV emission is due to a binary system with a pulsar as compact object as observed in HESS J1303-631/PSR B1259-63.
(3). In Figure 2 we plotted the SED of both sources together with the SED of Crab nebula. The shape of the curves is similar although with a quite different ratio X-ray to TeV gamma rays. Also for PWNs, the ratio between the luminosity in X-ray and that in radio is still an open issue: there are sources of this type with X-ray luminosities similar to the Crab but with radio fluxes 2 to 3 order of magnitude weaker (17). Finally the observed X-ray, soft gamma and TeV luminosities (4, 3.4, (1.2-1.9) ×10^{34} erg/s for IGR J1813-178 and 10.32 and 4×10^{34} erg/s for AX J1838-0655) are similar to the values observed in the few HESS sources which have been clearly identified with PWNs or shell type SNRs.

3 Very high energy gamma rays from micro-quasar:LS 5039

The detection of microquasar in very high energy gamma rays by HESS and MAGIC provide clear evidence that these objects are capable of accelerating particles to TeV energies. LS 5039 is a binary system composed by an O6.5 V-type donor star and a compact object (probably a black hole) and it is the only microquasar detected at TeV emission by HESS up to now (2). In the Figure 3 we show the IBIS/ISGRI 20-100 keV mosaic of 900 Ks centered on LS 5039. The flux in 20–40 keV and 40–100 keV is (1.0±0.1)mCrab ((7.0 ± 0.7) ×10^{-12} erg cm^{-2} s^{-1}) and (1.7±0.2)mCrab ((1.6 ± 0.2) × 10^{-11} erg cm^{-2} s^{-1}). These flux are in good agreement with the extrapolation of RXTE/PCA data. In the scenario of accretion-powered model, the high energy emission is due to Inverse Compton (IC) with the electrons of the jet of a seed photon field (produced by Synchrotron processes or by the optical-UV photons of the donor star). The different energy losses processes, synchrotron, Thomson IC or Kleyn-Nishina IC, produce different ratio between X-ray and GeV-TeV emission. A modeling of multiband data is then crucial, it was been recently presented by (11). Their major conclusion was that the soft X-ray photons and the TeV photons are coming from different regions while hard X-ray are due to synchrotron emission by the same relativistic electrons that produce TeV radiation through IC. Simultaneous broad-band observation will be crucial to characterize the relativistic electrons distribution, the seed photon field and the magnetic field.
4 Conclusions

Ground based Cerenkov telescopes have discovered an increasing population of TeV emitters, so far clustered in the Galaxy disk. The first sensitive survey by HESS have initially revealed several objects, most of which without any obvious counterpart, though suggesting the existence of a new class of peculiar objects powered “exotic” or non standard acceleration processes. More recently, the discovery of counterparts at radio, IR, X and soft-gamma Ray energies has partially clarified the scenario suggesting that a large fraction of the TeV emitting sources have lower energies counterparts, often associated with Pulsar Wind Nebulae. Nevertheless, different classes of galactic sources can generate very high gamma-ray photons via different acceleration processes. Among them SNR, Binary and isolated pulsars, extragalactic objects. Finally at least two micro-quasars had been clearly detected: LS 5039/RX J1826.2-145 (2) and LS I +61 303/V615 Cas (3). Both of them are associated with massive binary systems (O6.5 V and B0 Ve, coupled with a NS or BH compact companion) with short period (4 and 26.5 day respectively) and have counterparts in the IBIS/INTEGRAL soft gamma-Ray domain. A plausible scenario is that the high energy emission is due to particles accelerated in the moderately relativistic double sided radio jets colliding via Inverse Compton scattering with photons supplied by the star or by synchrotron emission process, then boosting their energies in the hundreds of GeV to the TeV range.

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