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# Exploring Galactic TeV γ-ray sources with H.E.S.S.

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ABSTRACT

The H.E.S.S. array of Imaging Atmospheric Cherenkov Telescopes continues to observe the southern sky with unprecedented sensitivity at very-high-energy (VHE, $E>100$ GeV) γ-rays. This leads to a steady increase in the number of detected VHE γ-ray sources as well as the discovery of sources with fluxes even below 1% of the flux of the Crab nebula. Up to now, well more than 100 VHE γ-ray sources are known, which allow to study not only individual objects, but also whole populations of source classes, such as pulsar wind nebulae (PWNe) and shell-type supernova remnants (SNRs). This paper focuses on Galactic sources, highlighting some aspects of the recent progress in this field.

After discussing the general status and the future of the H.E.S.S. Galactic Plane survey, four individual sources related to recent discoveries are presented in detail in this contribution: (a) the PWNe HESS J1825−137 and HESS J1303−631 which show intriguing energy-dependent morphologies, (b) the formerly unidentified source HESS J1626−490 which is most likely associated to a molecular cloud illuminated with hadronic cosmic rays by a nearby SNR, and (c) Terzan 5 which is the first Galactic globular cluster that features a VHE γ-ray source in direct vicinity.



## 1. Introduction

With the current generation of Imaging Atmospheric Cherenkov Telescopes (IACTs) the observation of very-high-energy (VHE, $E>100$ GeV) γ-rays is now an established and very rich discipline of modern astronomy. By extending the energy range beyond the capabilities of space-borne γ-ray instruments, such as aboard the *Fermi* satellite, IACTs proved to be valuable tools to explore the nature of the Universe's extreme cosmic-ray accelerators. With the IACT arrays MAGIC and VERITAS located on the northern hemisphere and H.E.S.S. in the south, currently the whole sky is observable at VHE γ-rays. Thus, a large variety of highly energetic phenomena of Galactic and Extragalactic origin can be studied in this energy regime. This paper focuses on Galactic VHE γ-ray astronomy, particularly on sources detected in the H.E.S.S. Galactic Plane Scan.

## 2. The H.E.S.S. telescope array

H.E.S.S. is an array of four IACTs located in the Khomas Highland in Namibia at an altitude of 1800 m above sea level [1]. Each telescope has a total mirror area of 107 $m^2$ and is equipped with a camera consisting of 960 photomultiplier tubes. The H.E.S.S. array is sensitive to very-high-energy (VHE) γ-rays with energies between 100 GeV and 50 TeV with an energy resolution of about 15% and an angular resolution of about 0.07°. The effective area at 1 TeV is $\sim 5\times 10^5$ $m^2$ yielding detections with a significance of $5\sigma$ for sources with the flux of 1% of the Crab nebula in an exposure of 25 h. Furthermore, with its large field of view of 5° H.E.S.S. is an ideal survey instrument to systematically scan large areas of the sky to perform blind searches for new VHE γ-ray sources.

## 3. The H.E.S.S. Galactic Plane Scan

Starting in 2004, H.E.S.S. performed a scan of the inner Galaxy. Initially, the longitude range between $330^\circ < l < 30^\circ$ was covered for latitudes of $|b| \leq 3^\circ$ [11]. In the following years the H.E.S.S. Galactic Plane Scan (GPS) leads to a dramatic increase of the number of known Galactic VHE γ-ray sources (see Fig. 1). Following up on the initial discoveries the survey was intensified both in overall sensitivity, longitude and latitude extent, as well as through deep follow-up campaigns on individual sources. Today the H.E.S.S. GPS comprises more than 2300 h of good quality data and encompasses the Galactic coordinate range: $280^\circ < l < 60^\circ$ and $|b| \leq 4^\circ$ [12]. Therefore, the survey now reaches out to the tangents of the Sagittarius–Carina and

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the Scutum–Crux spiral arms at $l \approx 51^\circ$ and $l \approx 310^\circ$, respectively. Apart from regions around individual sources that have received particularly deep exposures, the survey is quite homogeneous with an exposure of at least 30 h for any given region (see Fig. 2). Thus, VHE

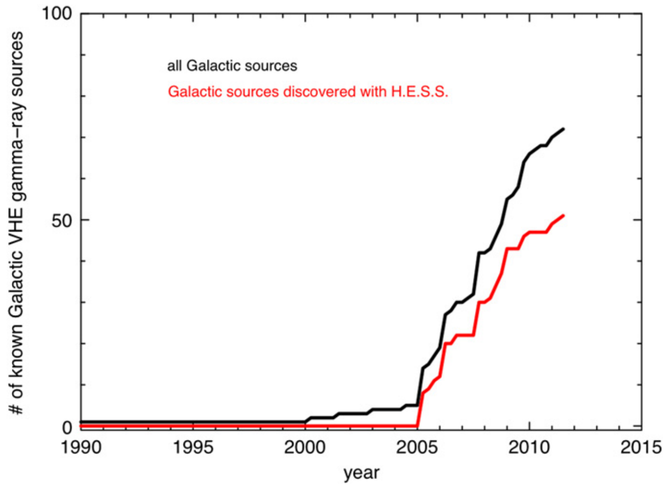


**Fig. 1.** The evolution of the total number of known Galactic VHE γ-ray sources as a function of time. Data taken from TeVCat.

γ-ray sources located within the covered region with a flux of 1% of the Crab nebula flux are detected with a statistical significance of at least 5$\sigma$.

Through the large number of newly discovered VHE γ-ray sources and detailed follow-up studies to uncover the underlying emission scenarios, the H.E.S.S. GPS played a significant role in establishing ground-based γ-ray observations as a new discipline in modern Astrophysics. Today, we know about several distinct populations of Galactic VHE γ-ray emitters. Table 1 provides an overview over the various Galactic source classes detected with H.E.S.S. and gives the number of identified objects as of May 2011 (data according to TeVCat). In this paper some of the most recent discoveries of Galactic VHE γ-ray sources with H.E.S.S. are highlighted with particular focus on their multi-wavelength context.

**Table 1**
Galactic sources discovered with H.E.S.S.

| Source class | Count | Ref. |
|---|---|---|
| Pulsar wind nebulae (PWNe) | 17 | [3] |
| Shell-type supernova remnants (SNRs) | 5 | [4,5] |
| Molecular clouds (MCs) illuminated by SNRs | 7 | [6] |
| Young stellar clusters | 4 | [7] |
| X-ray and γ-ray binaries | 3 | [8,9] |
| Unidentified sources | 17 | [10] |

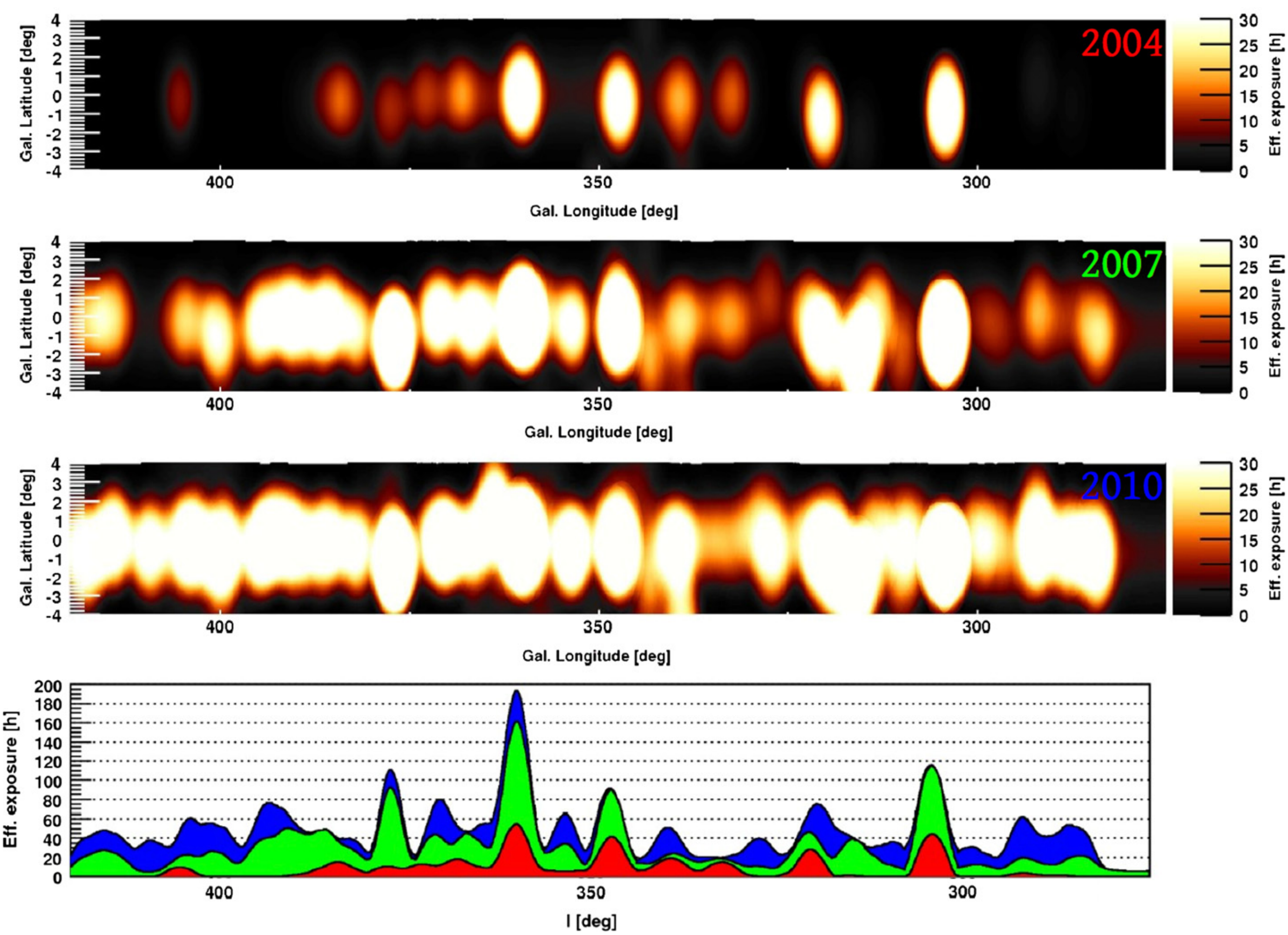


**Fig. 2.** *Top panels*: the exposure of the H.E.S.S. Galactic Plane Scan in Galactic coordinates for three epochs since the start of the scan as indicated in each panel. The third panel in particular shows the exposure as of late 2010. *Bottom panel*: projection of the exposure of the H.E.S.S. Galactic Plane Scan along the Galactic longitude. The three colors correspond to the same epochs as shown in the top panels. Image credit: [2]. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)