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# Search for new supernova remnant shells in the Galactic Plane with H.E.S.S.

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**Summary.** — It has been a long-standing question whether supernova remnants (SNRs) can account for the acceleration of the bulk of galactic cosmic rays up to the knee in the cosmic ray spectrum. TeV-selected SNRs are interesting sources to probe this hypothesis and the entire H.E.S.S. phase I data set of the Galactic Plane, collected over the past decade, constitutes a unique archive to scan. The idea of the presented work is to systematically search for new SNR candidates in the sky maps produced for the latest H.E.S.S. Galactic Plane Survey (HGPS), on the basis of their morphological shell-like appearance in the TeV band.

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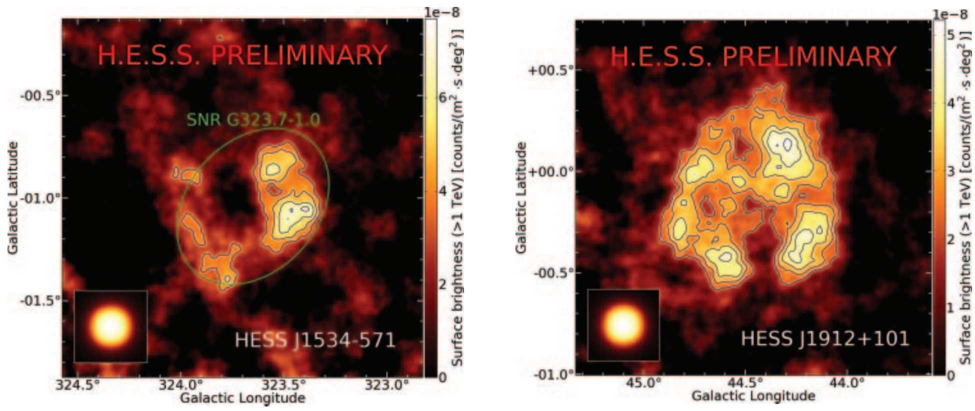


Fig. 1. – Left: TeV surface brightness map of HESS J1534-571, with 3,4,5,6 $\sigma$ significance contours overlaid; null-hypothesis $H_0$ probability (Gaussian morphology) $p = 6.4 \times 10^{-3}$. The green contour indicates the outer boundary of the radio SNR candidate G323.7-1.0, detected in the 2nd MOLONGLO Galactic Plane Survey [1]. Given the presence of a matching radio counterpart the source was successfully identified as a supernova remnant. Right: TeV surface brightness map of HESS J1912+101, with 3,4,5,6,7 $\sigma$ significance contours overlaid; $H_0$ probability $p = 1.7 \times 10^{-6}$. This source currently lacks detected non-thermal emission in lower energy bands and has therefore been classified as SNR candidate; for the time being it is likely the first TeV SNR without known counterparts in other wavebands.

## 1. – Introduction

Between 2004 and 2013 H.E.S.S. I(1) carried out a survey program that covered the Galactic Plane at longitudes $65° < l < 250°$ and latitudes $|b| \lesssim 3.5°$. Survey and pointed observations in the survey regions add up to around 3000 hours of data after quality selection, in the range $0.1 \lesssim E \lesssim 100$ TeV [2]. Depending on the analysis configuration, the point spread function for reconstructed $\gamma$-rays of the H.E.S.S. I array ranges from $\sim 0.05°$ to $0.1°$; together with a large field-of-view with $\varnothing \simeq 3°$ flat $\gamma$-ray acceptance, this makes the instrument particularly suited for the discovery and study of extended TeV $\gamma$-ray sources in our Galaxy with typical sizes $\lesssim 0.5°$ [3].

## 2. – Search for TeV-SNR candidates: methodology

In order to search for new SNR candidates on the HGPS maps, a two-step approach was followed [4]: first, the survey maps were scanned on a $0.02° \times 0.02°$ grid and, at each grid point, a shell model (projected 3D shell, homogeneously emitting between $R_{in}$ and $R_{out}$) was tested against a 2D Gaussian null hypothesis $H_0$. With this method, all known TeV SNR shells falling in the HGPS region (RX J1713.7-3946, Vela Jr., HESS J1731-347, RCW 86) were re-identified with high significance. Second, new significant shell-like structures that emerged from this search were individually re-analysed.

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(1) H.E.S.S. (High Energy Stereoscopic System) is a system of Cherenkov telescopes operated in the Khomas Highlands in Namibia. H.E.S.S. phase I started in 2003 with four 12 m telescopes. H.E.S.S. phase II started in 2012 with the commissioning of the additional fifth, 28 m telescope that has been operated together with the other telescopes.

Since the two models are non-nested, the Akaike Information Criterion (AIC) was used to compare them [5]. Figure 1 shows two new shell-like structures that emerged from the grid search. If the source shows a significant shell-like structure in TeV but lacks of a counterpart in lower energy bands, it is classified as TeV SNR candidate. If a strong SNR candidate counterpart at lower energy bands can be associated to the TeV source, it is then identified as new SNR.

## 3. – Conclusions

As highlighted also in the presented work, the current generation of TeV instruments allows the detection of new SNRs. Studying SNRs emitting at TeV is particularly interesting, as the $\gamma$-ray emission from these objects might stem from hadronic processes. However, since the emission could also be caused by inverse Compton scattering of electrons off low-energy photons, looking for the presence (absence) of a non-thermal X-ray component would help in ruling out one of the two scenarios. For the time being, no X-ray counterpart could be clearly associated to the presented sources; their re-observation at X-ray energies will help to establish the nature of the parent population whose $\gamma$-ray emission is observed in the TeV band.

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