OBSERVATIONS OF SNR CANDIDATE HESS J1614-518 WITH FERMI-LAT

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INTRODUCTION

It is widely believed that supernova remnants (SNRs) are the main accelerators of Galactic cosmic rays (CRs) with energies up to the knee. This is supported by the non-thermal X-ray emission detected in many SNRs, which indicates the acceleration of electrons to hundreds of TeV energies. The GeV gamma-ray observations of SNR W44 and IC 443 found the evidence of the acceleration of nuclei.

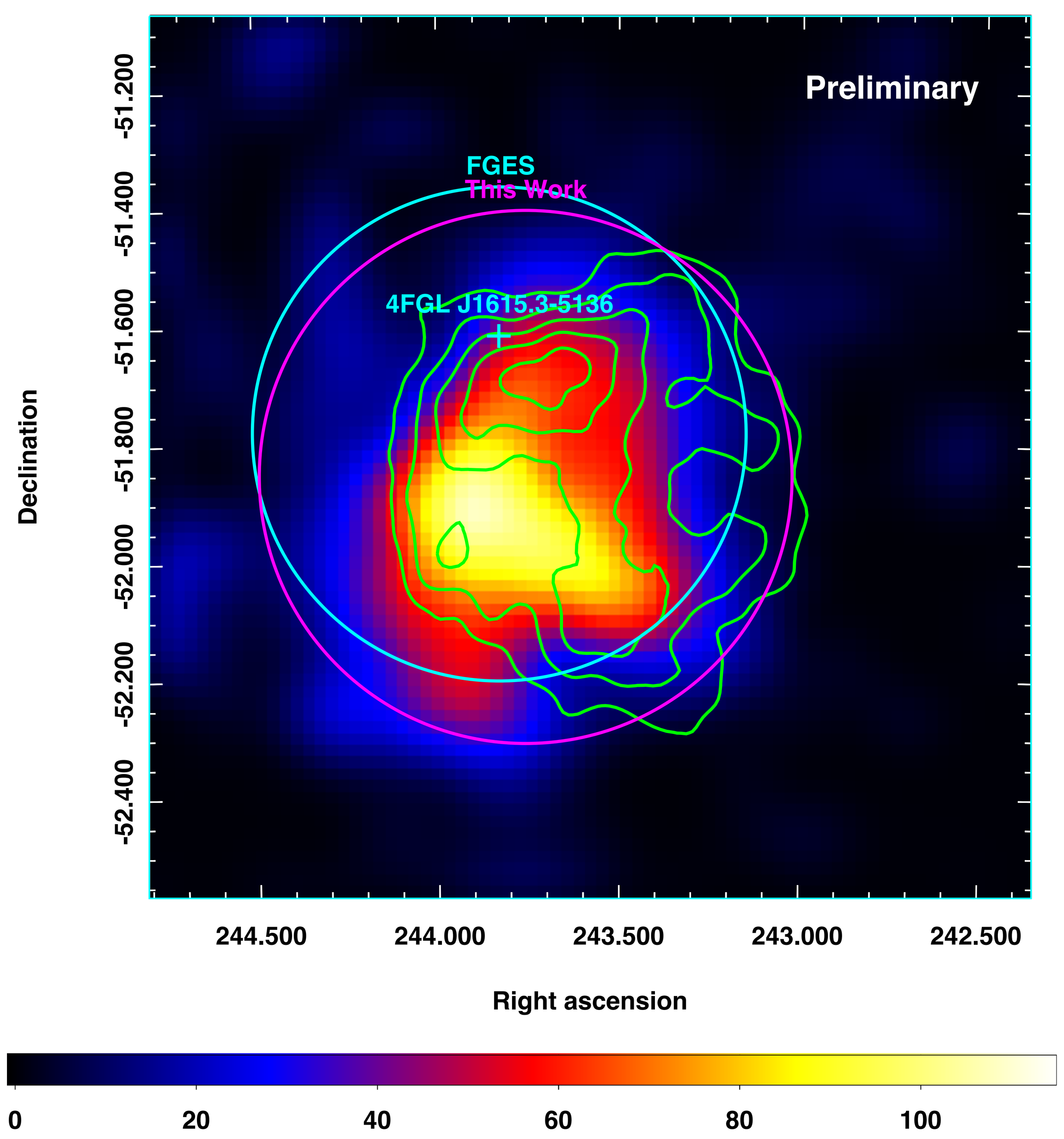
HESS J1614-518 was first discovered in the survey of the Galactic plane of H.E.S.S., and considered to be a "dark" particle accelerator without plausible counterpart at other wavelength. The very high energy (VHE, $E > 100$ GeV) gamma-ray emission from HESS J1614-518 was also detected by CANGAROO-II. Recently, H.E.S.S. performed detailed observations of this region, and found shell-like morphology from the TeV gamma-ray emission. Thus, HESS J1614-518 is considered to be a SNR candidate.

FERMI-LAT DATA REDUCTION AND RESULTS

We select the Pass 8 version of the *Fermi*-LAT data recorded from August 4, 2008 to January 4, 2021. The events in the energy range of 10-800 GeV are used. The analyses are performed with *Fermitools* and the binned likelihood analysis method. The model includes all nearby sources listed in the Fermi-LAT 10-year source catalog (4FGL-DR2), Galactic and isotropic diffuse gamma-ray backgrounds.

After fitting the data, we create a TS map centered at HESS J1614-518 (see Figure 1). We notice that there is a new point source 4FGL J1615.3-5136, which is not included in 3FGL and considered to be associated with pulsar PSR J1615-5137. In addition, the GeV emission from HESS J1614-518 does not fully overlap with the TeV image, and the peak of the GeV emission does not coincide with that of TeV observations. Moreover, the GeV emission extends southeast beyond the TeV source.

FIGURE 1



$1.5^\circ \times 1.5^\circ$ TS maps centered on the position of HESS J1614-518 for the data above 10 GeV. The cyan plus indicates the position of 4FGL J1615.3-5136, and the cyan circle is the spatial template given by FGES. The magenta circle describes the 68% containment radius (r_{68}) of the best-fit 2D Gaussian template. And the green contours represent the TeV image observed by H.E.S.S..

MORPHOLOGICAL ANALYSIS

We carry out an extension analysis using more than 12-year data. The extension of GeV gamma-ray emission is refined with *Fermipy*. A shell structure defined by H.E.S.S. and the TeV image are also tested. The TS values for different spatial models are listed in Table 1. We found that a 2D Gaussian model with $\sigma \sim 0.30^\circ$ gives the highest TS value. In the following analysis, the 2D Gaussian template is used as the spatial model of HESS J1614-518.

TABLE 1

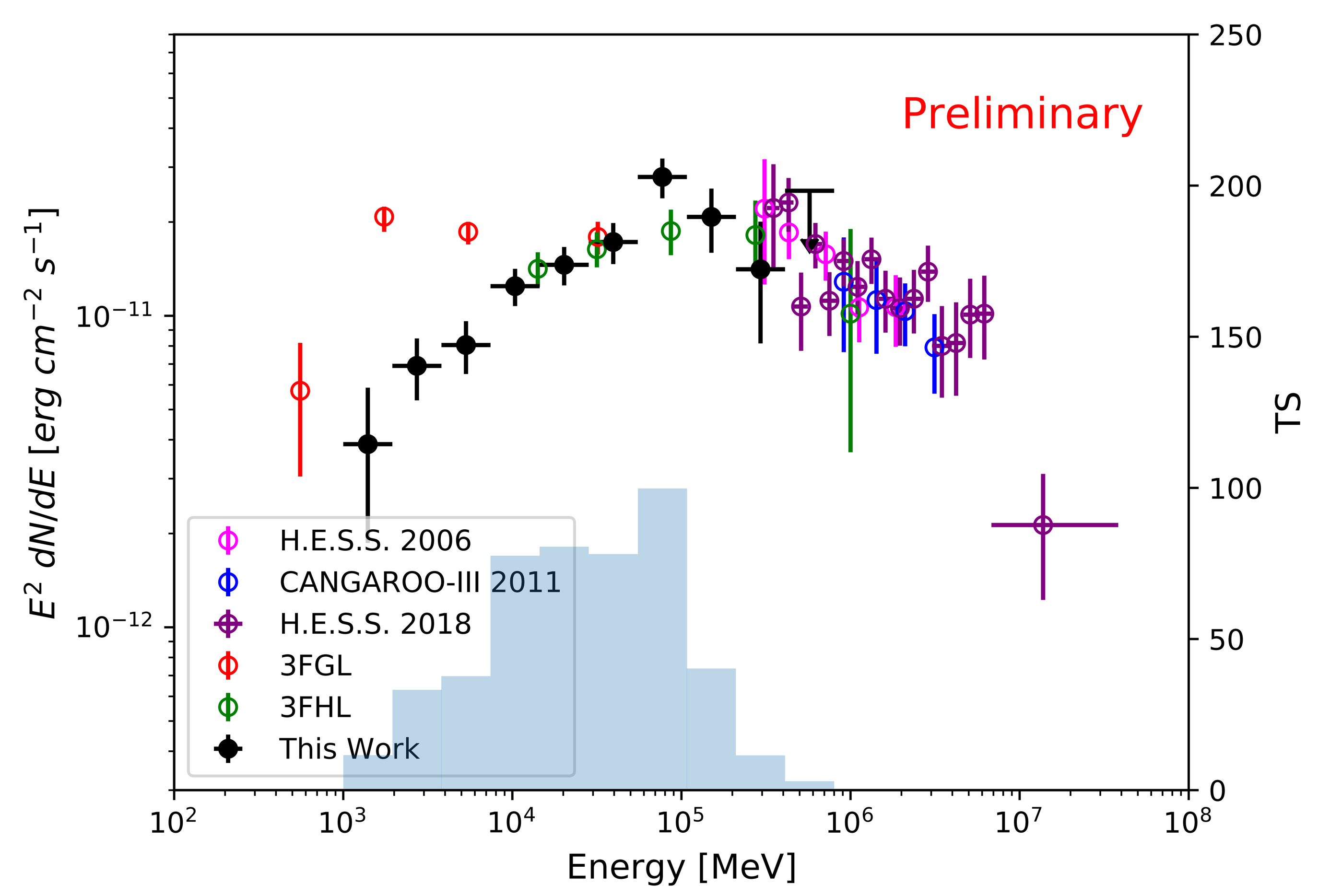
Spatial Model	TS.	dof
0.42° Uniform Disk (FGES)	317	6
0.49° Uniform Disk	336	6
2D Gaussian	353	6
Shell	271	7
TeV Image	307	3

SPECTRAL ANALYSIS

We perform the spectral analysis in the energy range of 1-800 GeV. The spectrum of HESS J1614-518 is described by a LogParabola, and the global fit gives spectral indexes of $\alpha = 1.644 \pm 0.05$ and $\beta = 0.11 \pm 0.03$.

We study the spectral energy distribution (SED) of HESS J1614-518. The results of the SED are shown in Figure 2. The GeV SED connects smoothly with the TeV spectrum of HESS J1614-518, indicating the same origin. In addition, we found that the GeV spectrum is harder than previous work. Such a hard spectrum is similar to SNR RCW 86, RX J0852.0-4622 and HESS J1731-347. Future more multi-wavelength observations will be helpful to explore the radiation mechanism.

FIGURE 2



Gamma-ray SED of HESS J1614-518. The red and green dots present the GeV SED in 3FGL and 3FHL, respectively. The blue, magenta and purple dots are the CANGROO-III and H.E.S.S. observations of HESS J1614-518 in the VHE band.

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