Recent Results from the VERITAS Galactic Science Program

GREGORY T. RICHARDS
29 JULY 2019
ICRC 2019
Selected Topics

Periastron passage of the 50-yr-period binary PSR J2032+4127 / MT91 213 (*see also* GA16e)

Following up HAWC detections in 2HWC

Searching for VHE emission from young gamma-ray pulsars

(more interesting stuff is going on; too much for a short talk)
About VERITAS

Four 12 m Imaging Atmospheric Cherenkov Telescopes (IACTs)
Effective energy range: 85 GeV – >30 TeV (“VHE band”)
Field of view = 3.5⁰; angular resolution = 0.08⁰ @ 1 TeV
1% Crab Nebula in < 25 hr
PSR J2032+4127 / MT91 213: Monitoring Periastron Approach
J2032+4127

Young, gamma-ray pulsar recently (2015) found to be in a long-period binary (approx. 50 years)

Periastron occurred in November 2017

VHE campaign coordinated to monitor periastron in 2017 (VERITAS & MAGIC)
Emergence of VHE emission from PSR J2032+4127
Emergence of VHE emission from PSR J2032+4127
Emergence of VHE emission from PSR J2032+4127
Emergence of VHE emission from PSR J2032+4127
Emergence of VHE emission from PSR J2032+4127
Emergence of VHE emission from PSR J2032+4127
Emergence of VHE emission from PSR J2032+4127
VERITAS & MAGIC: Observations During Periastron Passage 2017

VHE light curves from Abeysekara et al. (2018)

See also GA16e T. Williamson
HAWC Source Follow-Ups with VERITAS & Fermi-LAT
Following-up 2HWC Sources with Fermi & VERITAS

Synergy between Fermi, VERITAS, and HAWC
- Adjacent / overlapping $E$ ranges
- Survey vs. pointed observations

2HWC catalog: 39 VHE gamma-ray sources
- 19 not previously known at VHEs
- Searched for emission from 14 of 19 with VERITAS
- 1 VERITAS detection
  
Abeysekara et al. (2018)
Following-up 2HWC Sources with Fermi & VERITAS

Synergy between Fermi, VERITAS, and HAWC
- Adjacent / overlapping $E$ ranges
- Survey vs. pointed observations

2HWC catalog: 39 VHE gamma-ray sources
- 19 not previously known at VHEs
- Searched for emission from 14 of 19 with VERITAS
- 1 VERITAS detection

Abeysekara et al. (2018)
Ex.: DA 495 Region

Two 2HWC sources (blue circles)

72-hr VERITAS observation

VERITAS detection of J1953+294; no detection of J1955+285

- No pulsations found in X-ray or GeV gammas for J1953; compact object seen in X-rays

Abeysekara et al. (2018)
VHE Pulsar Searches
The Crab and Vela Pulsars

Motivation: Crab pulsar

Crab pulsar seen to emit up to ~1.5 TeV by MAGIC

Vela pulsar recently detected by H.E.S.S. up to ~100 GeV and at a few TeV
  ◦ Another power law from GeV energies?
  ◦ New TeV component (inverse-Compton)?

Geminga pulsar seen by MAGIC; tail of GeV spectrum best fit by power law (GAI2g M. Lopez)

PSR B1706-44 seen by HESS-II in 10-80 GeV range (GAI2a M. Spir-Jacob)

Theory of pulsed VHE emission remains unsettled

Can we find more VHE pulsars out there?
Search for VHE Emission from 13 “Archival Pulsars”

13 young gamma-ray pulsars appear in archival VERITAS data
  ◦ Mostly from PWN searches

Over 450 hr total exposure

Includes 8 of the top 12 northern-hemisphere pulsars ranked in $\frac{\dot{E}}{d^2}$
  ◦ First VHE search for all 13

No detections!

<table>
<thead>
<tr>
<th>Pulsar</th>
</tr>
</thead>
<tbody>
<tr>
<td>J0007+7303</td>
</tr>
<tr>
<td>J0205+6449</td>
</tr>
<tr>
<td>J0248+6021</td>
</tr>
<tr>
<td>J0357+3205</td>
</tr>
<tr>
<td>J0631+1036</td>
</tr>
<tr>
<td>J0633+0632</td>
</tr>
<tr>
<td>J1907+0602</td>
</tr>
<tr>
<td>J1954+2836</td>
</tr>
<tr>
<td>J1958+2846</td>
</tr>
<tr>
<td>J2021+3651</td>
</tr>
<tr>
<td>J2021+4026</td>
</tr>
<tr>
<td>J2032+4127</td>
</tr>
<tr>
<td>J2229+6114</td>
</tr>
</tbody>
</table>

Archer et al. (2019)
Search for VHE Emission from 13 “Archival Pulsars”

13 young gamma-ray pulsars appear in archival VERITAS data
  - Mostly from PWN searches

Over 450 hr total exposure

Includes 8 of the top 12 northern-hemisphere pulsars ranked in \( \frac{\dot{E}}{a^2} \)
  - First VHE search for all 13

No detections!

Archer et al. (2019)
Ex.: PSR J2021+3651

Search at 3 different energy thresholds

Phase gates defined based on Fermi 2nd pulsar catalog light curves

Limits constrain potential VHE flux to be below Crab pulsar level

Archer et al. (2019)
Summary

VERITAS has a robust Galactic science program

See ICRC contributions *GA16f, GA16c, PS1-84* for more about LS I +61 303 and HESS J0632+057