Observations of the Pulsar Wind Nebula HESS J1825-137 with H.E.S.S. II

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15/07/17 35th ICRC, Busan, South Korea
HESS J1825-137: a powerful PWN

- Powered by the pulsar PSR B1823-13
- Spin-down power $2.8 \times 10^{36}$ erg s$^{-1}$
- $\sim$4 kpc distance, $\sim$100 pc extent
- Nebula offset from pulsar
- PWN known for its strong energy dependent morphology
- TeV gamma-ray emission from inverse Compton scattering
- Characterise system morphology
- Specifically: flow direction and nebula extent
- Enables particle transport within the nebula to be studied

HESS J1826-130:
E. O. Anguner et al. (17/07) 14:15
LS 5039: C. Mariaud et al (13-14/07)
This analysis uses two datasets

- HESS I (using telescopes CT1-4)
  ~387 hours livetime
  High statistics
  Data from 2005 – 2016

- HESS II (using telescopes CT1-5)
  ~101 hours livetime
  Low energy threshold
  Good angular resolution
  Data from 2013 – 2016
Morphology: Flow Direction (Major axis of the emission)

- Nebula emission characterised as a function of azimuthal angle
- Other sources in the region, HESS J1826-130 and LS 5039, excluded from the excess emission profile
- Radial bands of 0.2° width centred on the pulsar
- Gaussian fit to the azimuthal profile of each radial band
- Mean of Gaussian determines major axis of the emission
Morphology: Flow Direction (Major axis of the emission)

- Azimuthal emission profiles for all emission from 0° - 1.6° radial distance

- Mean of Gaussian fit to all emission compatible with mean of fits to separate radial bands

- Major axis found at: 214° +/- 4° (stat.) +/- 4° (sys.)

- Compatible between HESS I and HESS II analyses
Characterising the Nebula Extent

- Define a region based on the minor axis of emission (orthogonal to major axis)
- Profile of all emission as a function of distance from the pulsar

Fit with a polynomial function

$$ y = \begin{cases} 
  a(r - r_0)^n + c & (x < r_0) \\
  c & (x \geq r_0)
\end{cases} $$

Take half width at half maximum as distance at which function drops to 50% of the peak emission

0.53° +/- 0.02° (stat.) +/- 0.06° (sys.)
Nebula Spectrum

- Power Law with exponential cut-off favoured

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.8º region</td>
<td>1.88 +/- 0.02</td>
</tr>
<tr>
<td>HESS (2006)</td>
<td>2.10 +/- 0.05</td>
</tr>
<tr>
<td>Index</td>
<td>2.17 +/- 0.02</td>
</tr>
<tr>
<td>2.26 +/- 0.03</td>
<td></td>
</tr>
<tr>
<td>$E_c$ (TeV)</td>
<td>19 +/- 3</td>
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<tr>
<td>25 +/- 7</td>
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</table>
Core Region Spectrum

- Core 0.4° region can account for all of the high energy flux from HESS J1825-137
- Log-Parabola favoured:
  Flux at 1 TeV = \( (0.74 \pm 0.01) \times 10^{-11} \text{cm}^{-2} \text{s}^{-1} \),
  \( \alpha = 2.26 \pm 0.01 \), \( \beta = 0.078 \pm 0.008 \)

- HESS J1825-137 more prominent than HESS J1826-130 at energies above 32 TeV
Conclusions

- Rich dataset enables detailed spectral and morphological studies of the nebula

- Observations with the inclusion of 2016 data enable compatibility between HESS I and HESS II

- Major axis of the emission determined at an angle of 214°

- Characterised radial extent of ~0.53°

- Spectrum of the J1825-137 nebula shows significant emission up to ~O(50) TeV

- Significant high energy emission verified as originating from the core region of the HESS J1825-137 nebula
Thank you for your attention

Any questions?
HESS II dataset results

- Characteristic Half Width extent compatible with HESS I

0.51° +/- 0.04° (stat.) +/- 0.06° (sys.)
Energy Dependent Morphology: 1610.08894