

# First detection of the Binary System PSR B1259-63 at TeV Energies with H.E.S.S.



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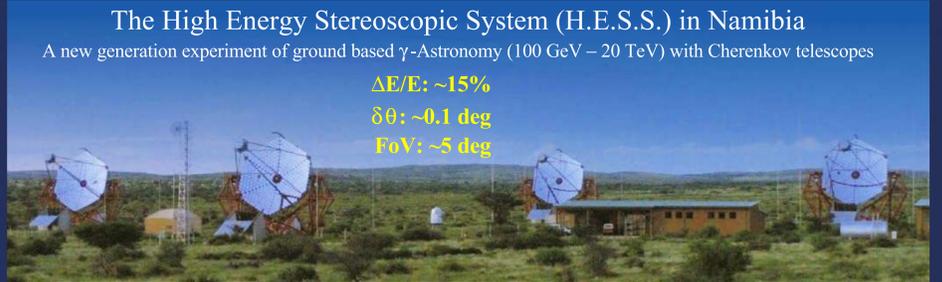
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## Abstract

In February/March 2004 the binary system PSR B1259-63/SS 2883, consisting of a 48ms pulsar orbiting its Be companion star on a highly eccentric orbit, was for the first time detected at TeV energies with the H.E.S.S. Cherenkov telescopes. Following this detection close to the periastron passage of the binary system, the observation campaign on this unique object has been extended up to June 2004. The recorded lightcurve shows clear variations making PSR B1259-63 the first variable galactic source detected at TeV energies. Contemporaneous observations at other wavelengths have been triggered by the H.E.S.S. detection.



## The PSR B1259-63/SS 2883 binary system

The PSR B1259-63/SS2883 binary system exhibits a complex and exceptional system geometry (see Fig.1 for a schematic view):

- Orbital period: 3.4 years (eccentricity: 0.87)
- PSR B1259-63: ~48 ms radio pulsar
- SS2883: Be companion star with strong stellar winds and equatorial disk-like mass outflow
- Very small distance pulsar <--> companion at periastron: ~23 R<sub>comp</sub>

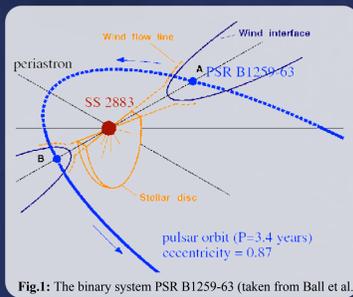


Fig.1: The binary system PSR B1259-63 (taken from Ball et al.)

- Varying distance between pulsar and companion star: interesting laboratory for studying pulsar wind interactions with a temporal varying environment.
- Possible production of GeV/TeV photons with a flux depending on the orbital phase: Different models in which the high energetic pulsar wind interacts with the surrounding environment of the companion star. [Kirk et al. *Astropart. Phys.*, 10, 31 (1999)], [Ball et al. *Astropart. Phys.*, 12, 335 (2000)]
- CANGAROO observations at TeV energies during the 1994/1997/2000 periastrons: Upper limits on the 10%-50% flux level of the Crab nebula. [Kawachi et al., *ApJ*, 607, 949 (2004)]

## First detection of PSR B1259-63 at TeV energies

The binary system PSR B1259-63/SS 2883 has been observed between February and June 2004 with the array of imaging Cherenkov telescopes operated by the H.E.S.S. Collaboration in Namibia.

- February:** first detection at TeV energies by H.E.S.S. → triggering observations at other wavelengths [IAU circular #8300, ATEL #249/#250]
- observations were extended up to June 2004

Fig 3: Distribution of excess events as a function of  $\Delta\theta^2$  (measured between shower direction and object position) for PSRB1259-63 (all H.E.S.S. data taken between February and June 2004).

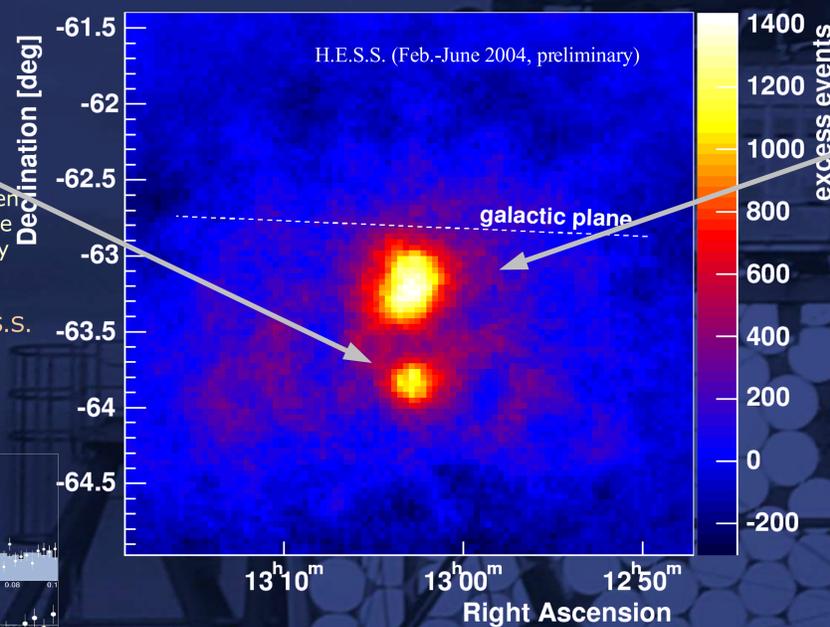
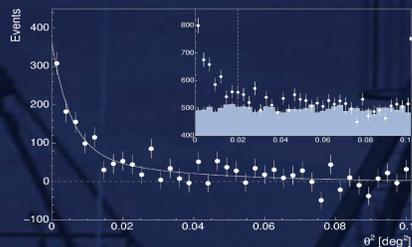


Fig 2: Discovery skymap showing both TeV sources in the field of view: the binary system PSR B1259-63/SS2883 and the unidentified TeV source HESS J1303-631

## Serendipitous discovery of HESS J1303-631

More information about the discovery of the unidentified TeV source HESS J1303-631 can be found on: poster #2405

## PSR B1259-63 as seen by H.E.S.S.

**Total Excess:**  
~1000 events (~14σ)

**Lightcurve:**  
Clear TeV flux variations, first variable galactic TeV object ever (see Fig. 4)

**Energy spectrum:**  
Overall spectral index:  
 $\Gamma = 2.7 \pm 0.2_{\text{stat}} \pm 0.2_{\text{sys}}$

Data subsets: no spectral variations within statistics.  
Flux level: varying: 0-10% of Crab

**MWL observations:**  
Radio, x-ray, partially triggered by the H.E.S.S. Detection.

**Comparison to TeV models:**  
Possible with respect to:  
• absolute flux level  
• spectral shape  
• time-dependency of the flux  
• MWL correlations

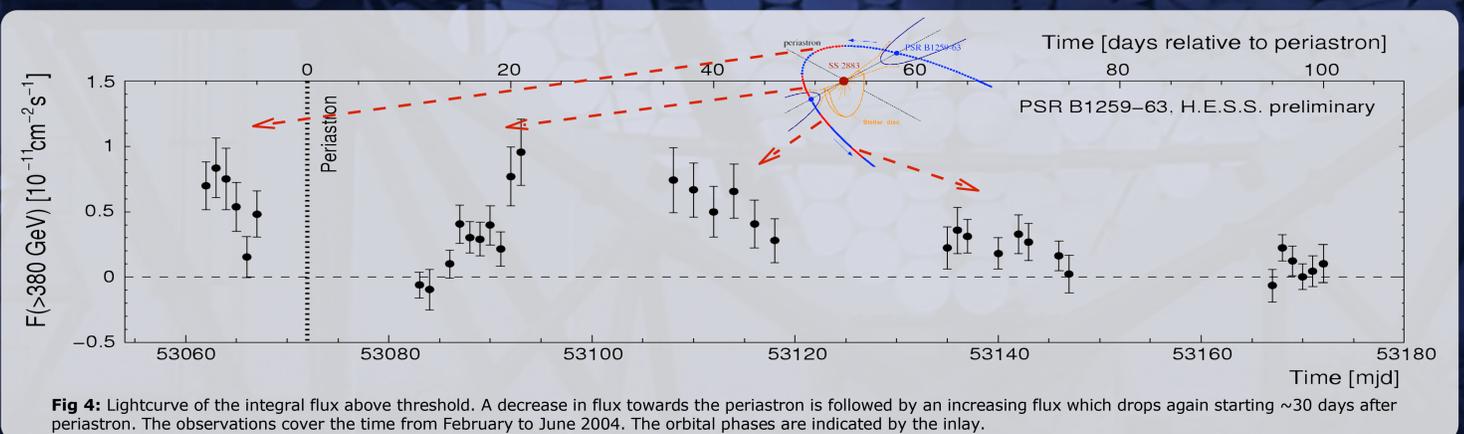


Fig 4: Lightcurve of the integral flux above threshold. A decrease in flux towards the periastron is followed by an increasing flux which drops again starting ~30 days after periastron. The observations cover the time from February to June 2004. The orbital phases are indicated by the inlay.

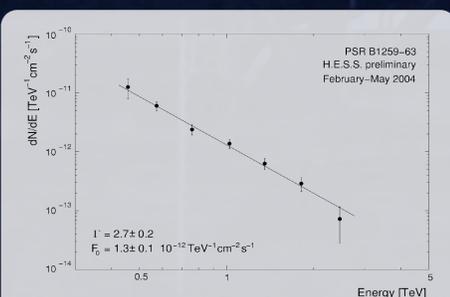


Fig 5: Differential energy spectrum (complete dataset)

## Conclusions

The unique binary system PSR B1259-63/SS 2883 has been detected for the first time at TeV energies by the H.E.S.S. In the following months, a detailed TeV lightcurve with clear flux variations has been recorded, making it the first variable galactic TeV gamma-ray source detected.

## Acknowledgements

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