Analysis of the H.E.S.S. observations of the Composite supernova remnant Kes 75

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The cosmic ray energy spectrum

- **Cosmic rays:** high-energy charged particles and atomic nuclei which move through space at nearly the speed of light.
- A question of astroparticle physics the origin of cosmic rays
- A remarkable power law in energy over several orders of magnitude
- A break in energy at a few PeV $\Rightarrow$ the knee
- SNRs the most plausible candidates of PeVatrons
- Kes 75 contains the youngest known pulsar in the Milky Way Galaxy

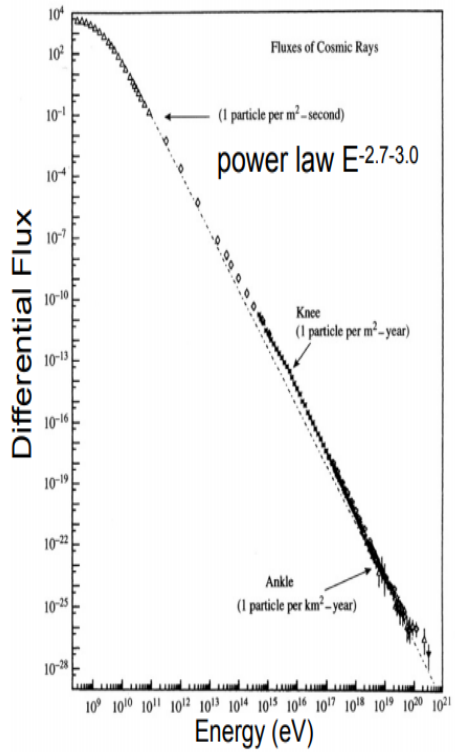
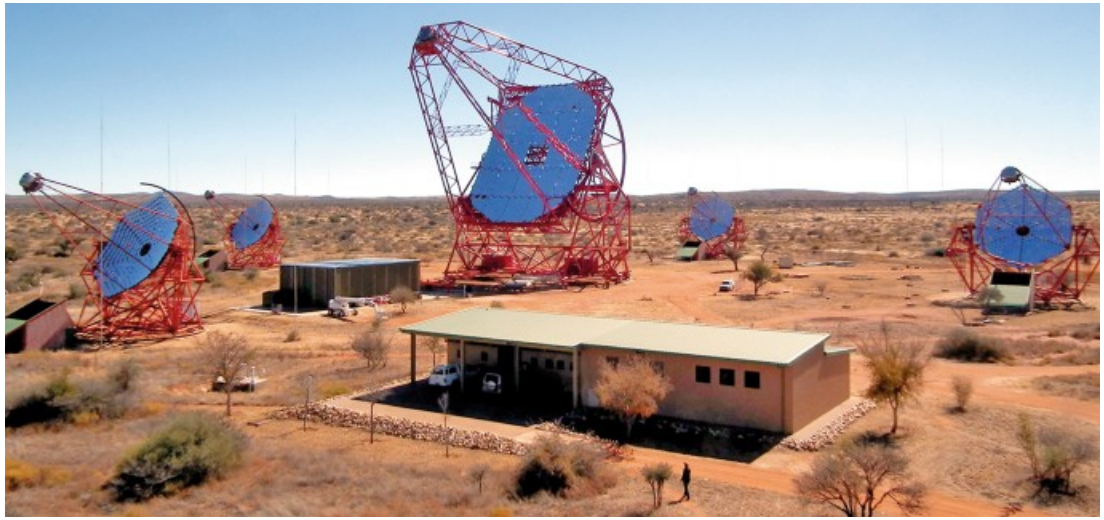


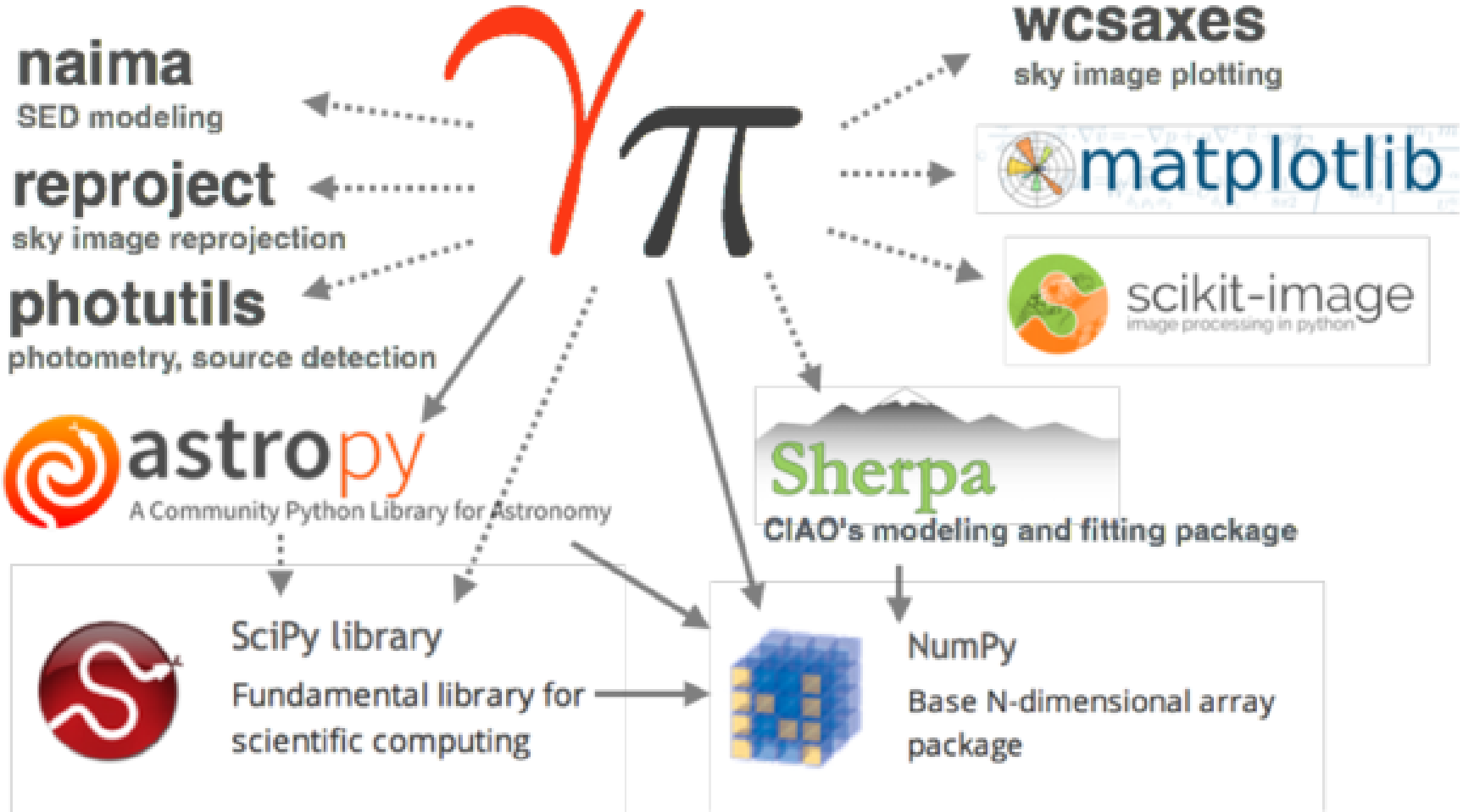
Figure: The cosmic ray energy spectrum.

H.E.S.S.



- Imaging Atmospheric Cherenkov Telescopes able to investigate cosmic gamma-rays in the energy range from 10s of GeV to 10s of TeV
- H.E.S.S. detects Cherenkov light emitted by charged particles in an electromagnetic extensive air shower initiated when a primary photon of sufficient energy enters Earth's atmosphere.
- Air showers simultaneously observed by several telescopes, under different viewing angles
- Telescopes combined to a large system $\Rightarrow$ increase in the effective detection area for gamma-rays

Gammapy

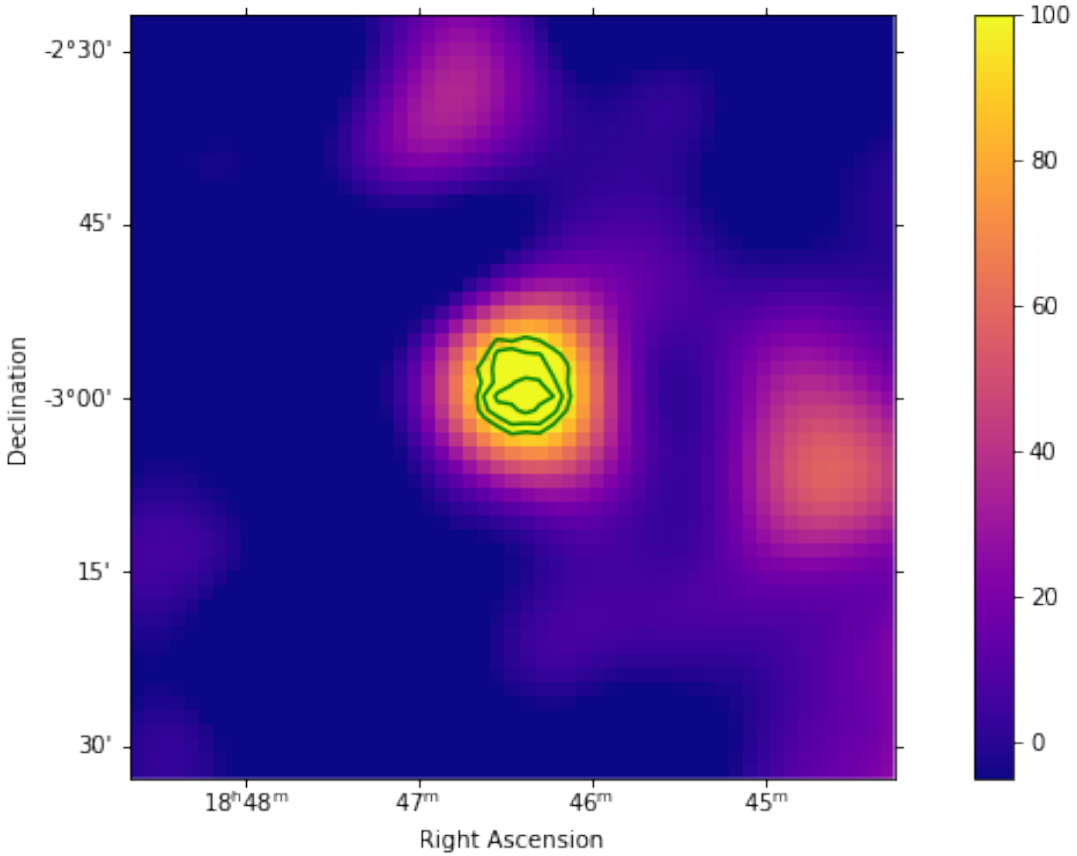

naima
SED modeling
reproject
sky image reprojection
photutils
photometry, source detection
wcsaxes
sky image plotting
matplotlib
scikit-image
image processing in python
astropy
A Community Python Library for Astronomy
Sherpa
CIAO's modeling and fitting package
SciPy library
Fundamental library for scientific computing
NumPy
Base N-dimensional array package

The Composite supernova remnant Kes 75

- Located about 19,000 light years from Earth
- It contains a pulsar $\Rightarrow$ the rapid rotation and the strong magnetic field of this pulsar have generated a wind of energetic matter and antimatter particles that flow away from the pulsar at near the speed of light

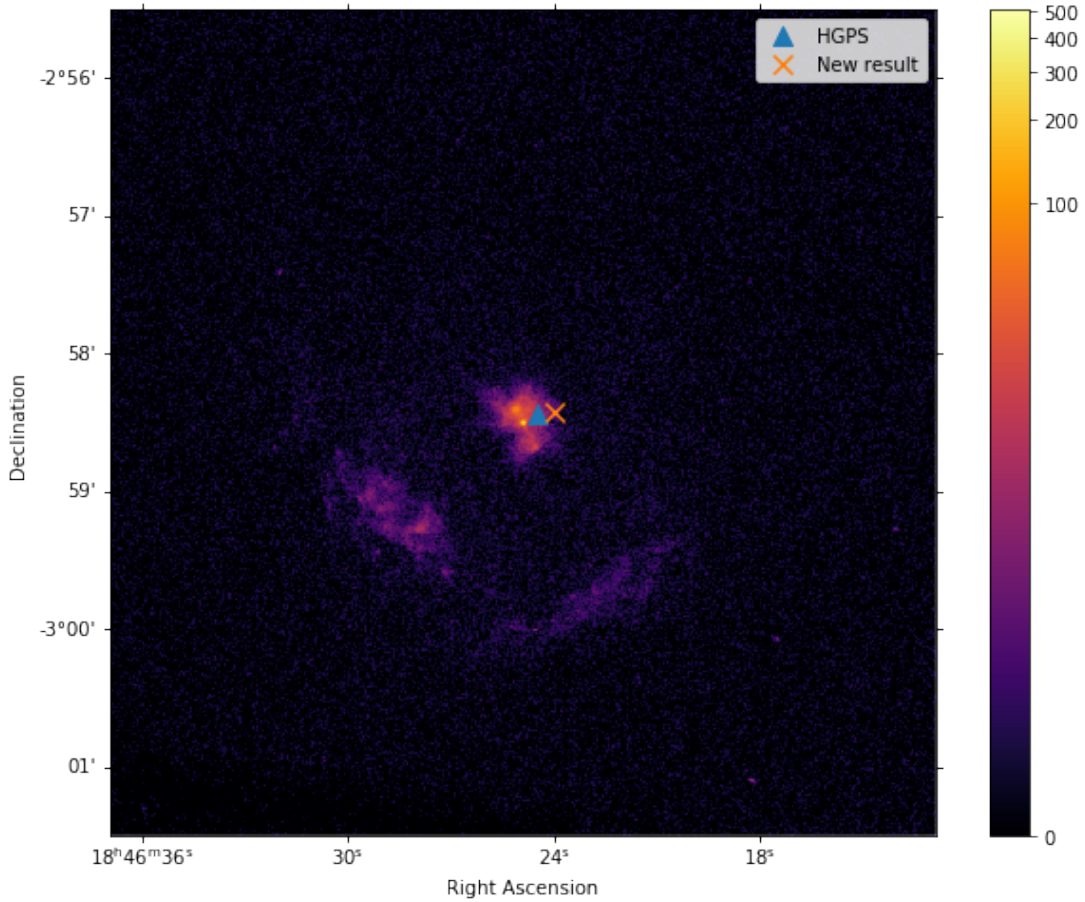
- This pulsar wind has created a large, magnetized bubble of high-energy particles $\Rightarrow$ pulsar wind nebula
- Changes in the pulsar wind nebula $\Rightarrow$ the outer edge is expanding at a remarkable 1 million meters per second

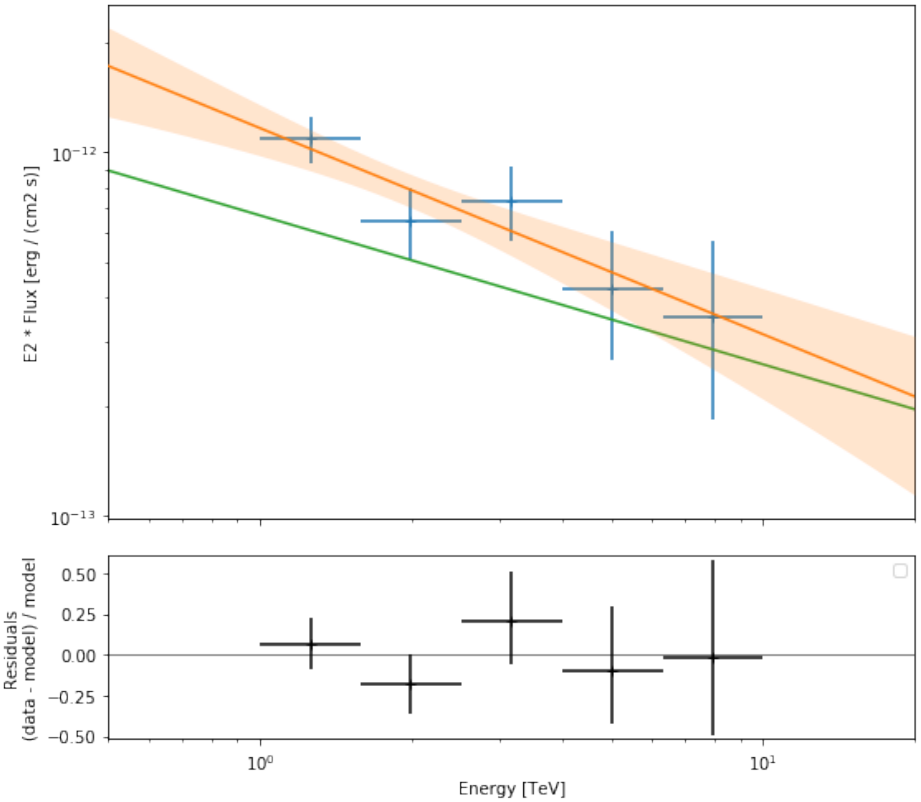
Results



- H.E.S.S. observations
- Observation filter $\Rightarrow$ 210 observations selected
- Smoothed excess map centered on the Kes 75 SNR position
- Significance contours

- Fitting $\Rightarrow$ the best-fit values of parameters (index, amplitude, reference, longitude, latitude)
- Chandra 2-10 keV image of Kes 75
- Markers that indicate the pulsar position





- Flux points - Spectral fit
- Spectral energy distribution (HGPS)
- Power Law Function:

$$\Phi(E) = \frac{dN}{dE} = \Phi_0 * (\frac{E}{E_0})^{-\gamma}$$

- Spectral fit is slightly different comparing to HGPS

Conclusions

- Kes 75 was reanalyzed with gammapy software.
- The results are consistent with previous analysis except for the indexes (we found an index a little higher) and thus the power law functions.
- The PWN hypothesis is confirmed, no evidence for SNR emission.
- The framework for the detailed analysis is set up.

Thank you for your attention!

References

- The cosmic ray energy spectrum image: https://indico.desy.de/event/30430/contributions/104931/attachments/68066/85461/20210811-Astroparticle.pdf
- H.E.S.S. telescopes image: https://www.nature.com/articles/s41550-018-0513-1/figures/1
- Gammapy image: https://www.arxiv-vanity.com/papers/1509.07408/
- The Composite SNR Kes 75 image: https://chandra.harvard.edu/photo/2018/kes75/
- The last image: https://darkskytourism.com/namibia/