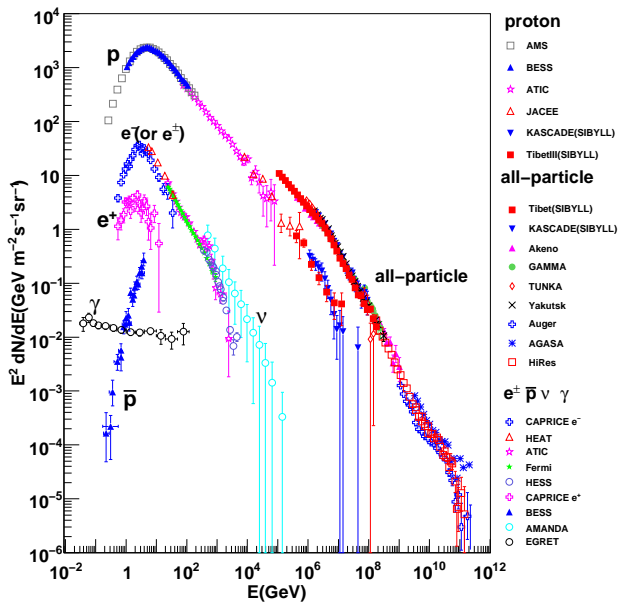


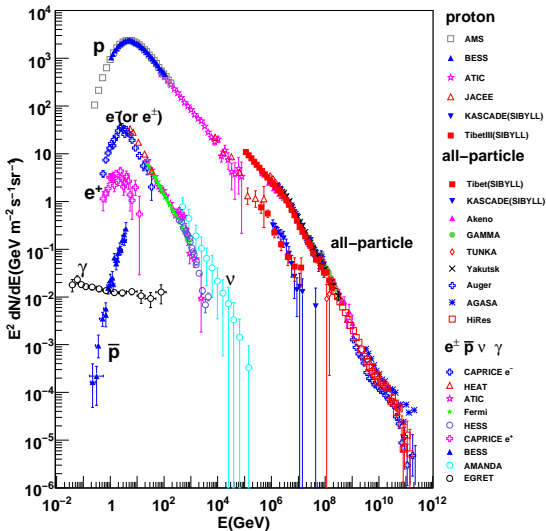
# Cosmic Ray Introduction

Joachim Kopp

Max Planck Institut für Kernphysik, Heidelberg

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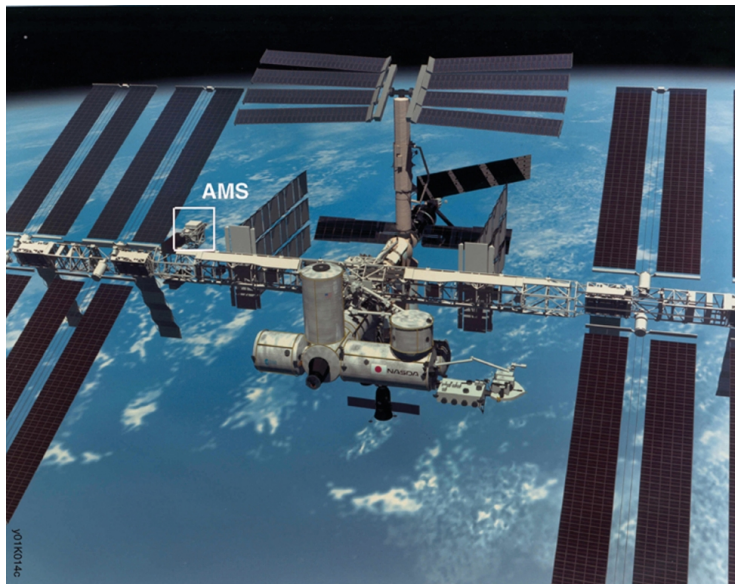


- Flux at 100 GeV:  
~ 1 particle/m<sup>2</sup>/sec
- Flux at 10<sup>6</sup> GeV (“knee”):  
~ 1 particle/m<sup>2</sup>/year
- Flux at 10<sup>10</sup> GeV (“ankle”):  
~ 1 particle/km<sup>2</sup>/year
- At 10<sup>11</sup> GeV: endpoint  
 (“GZK cutoff”, see later)

# Tools for studying cosmic rays

- Space-based experiments
  - ▶ PAMELA, AMS-02, Fermi, ...
  - ▶  $E \lesssim 10^3$  GeV
  - ▶ Clean measurement, long observation times

# AMS-02 (Alpha Magnetic Spectrometer)



# Tools for studying cosmic rays

- Space-based experiments
  - ▶ PAMELA, AMS-02, Fermi, ...
  - ▶  $E \lesssim 10^3$  GeV
  - ▶ Clean measurement, long observation times
- Balloon experiments
  - ▶  $E \lesssim 10^6$  GeV
  - ▶ Only short observation periods
  - ▶ Atmospheric distortions
- Imaging Air Čerenkov Telescopes
  - ▶ HESS, MAGIC, VERITAS, ...
  - ▶  $10 \text{ GeV} \lesssim E \lesssim 10^6 \text{ GeV}$

# H.E.S.S. (High Energy Stereoscopic System)



# Tools for studying cosmic rays

- Space-based experiments
  - ▶ PAMELA, AMS-02, Fermi, ...
  - ▶  $E \lesssim 10^3 \text{ GeV}$
  - ▶ Clean measurement, long observation times
- Balloon experiments
  - ▶  $E \lesssim 10^6 \text{ GeV}$
  - ▶ Only short observation periods
  - ▶ Atmospheric distortions
- Imaging Air Čerenkov Telescopes
  - ▶ HESS, MAGIC, VERITAS, ...
  - ▶  $10 \text{ GeV} \lesssim E \lesssim 10^6 \text{ GeV}$
- Air shower detectors
  - ▶ Pierre Auger observatory, ...
  - ▶  $10^5 \text{ GeV} \lesssim E \lesssim 10^{12} \text{ GeV}$



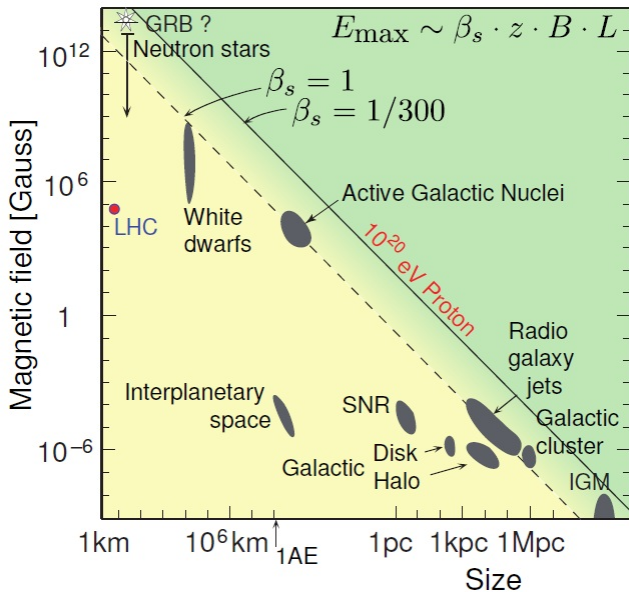
# Pierre Auger Observatory



# Pierre Auger Observatory



# Hillas Plot



# Pulsars

