IL NUOVO CIMENTO **40 C** (2017) 63
DOI 10.1393/ncc/i2017-17063-0

COLLOQUIA: IFAE 2016

Status of the measurement of the e^- and e^+ in Cosmic Rays with the AMS-02 experiment

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received 17 October 2016

Summary. — The Alpha Magnetic Spectrometer (AMS-02) is a Cosmic Ray (CR) detector, installed on the International Space Station (ISS) on 19 May 2011. The large statistics of events collected and the high resolution of the detector allow a precision measurement of rare component of CR, like e^- and e^+. The latest results of e^+, e^- together with the used analysis technique will be discussed.

1. – Introduction

Electrons (e^-) and positrons (e^+) are a rare component of the Cosmic Ray (CR), representing only 1% and 0.1%, respectively, of the total CR flux, dominated by protons (90%) and alpha particle (8%). Due to their low mass, $e^\pm$ suffer higher energy losses than those of hadronic CR, during the interaction with the InterStellar Medium (ISM). In the most common astrophysical models, e^- are mainly of primary origin, produced and accelerated in astrophysical sources, whereas e^+ are mostly produced in the interactions of protons and nuclei with the ISM, e^+ flux is expected to extinguish more rapidly with increasing energy with respect to that of e^-. Naturally rare, e^+ are a good channel to study deviation from propagation trend, so they are a good channel for indirect Dark Matter detection or to search new astrophysical sources.

2. – Analysis technique

Figure 1 on the left shows the three key AMS-02 sub-detectors used for the $e^\pm$ analysis. In the Transition Radiation Detector (TRD) the signal collected in the 20 layers of proportional tubes are combined in a *TRD Classifier*, discriminator based on a likelihood approach. An *ECAL Classifier*, based on a Boosted Decision Tree (BDT) algorithm [1], is constructed using the information of the 3D shower shape development in the Electromagnetic CALorimeter (ECAL). In the Silicon Tracker the rigidity sign and the ratio between energy and rigidity (E/R) are used for the separation between positive and negative particle. The recent $e^\pm$ measurement published by AMS-02 shows the e^- and e^+ fluxes in 0.5–700 GeV and in 0.5–500 GeV energy interval, respectively [2], the all-electron flux ($e^+ + e^-$) in 0.5 GeV–1 TeV energy range [3] and the precision measurement

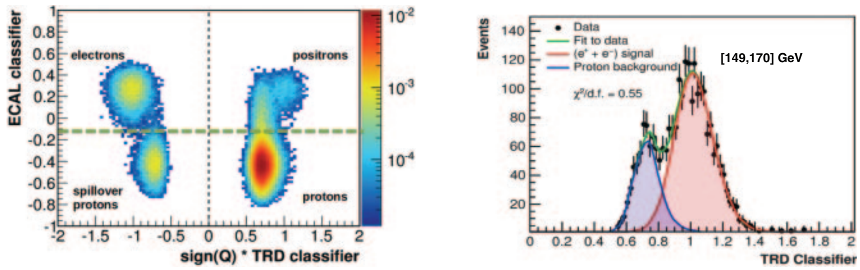

Fig. 1. – On the left: The ECAL, TRD and Tracker discriminator are combined to separate the $e^{\pm}$ signal from the p background very effectively. On the right: Example of the template fit to the TRD classifier distribution in 149–170 GeV energy range. The area of the reference spectra, fitted to the data (black points), give the number of electrons (red) and protons (blue) [3].

of the positron fraction $e^+/(e^+ + e^-)$ in the 0.5–500 GeV energy interval [4]. The analysis technique used to perform e^-, e^+ fluxes and $e^+/(e^+ + e^-)$ is the same employed in $(e^+ + e^-)$ flux adding the request on the charge sign that allows to separate between e^+ and e^-.

The flux is measured in each energy bin E, of width ΔE, as

$$\Phi^{e^{\pm}}(E) = \frac{N_{obs}^{e^{\pm}}(E)}{\Delta E\ T_{exp}(E)\epsilon_{trig}(E)A_{geom}(E)\epsilon_{sel}(E)(1+\delta)}. \tag{1}$$

The number of observed $e^{\pm}$ events ($N_{obs}^{e^{\pm}}$) is obtained using a template fit technique applied to the TRD Classifier distribution on data, after an efficient removal of the proton component using the ECAL identification capabilities, as shown in fig. 1 on the right. A_{geom} is the geometrical acceptance [5] evaluated from electron Monte Carlo simulation (MC) [6], δ is a correction factor applied to the acceptance that takes into account the DATA-MC discrepancy, ϵ_{trig} and ϵ_{sel} are, respectively, the trigger efficiency and selection efficiency and T_{exp} is the exposure time.

3. – Conclusion

The data taken during the first 30 months of the AMS-02 operations in space have been analyzed. The results, reported in [7], show an excess of positrons above 20 GeV, in contrast with a model that take into account only the secondary production of e^+. This excess point towards the existence of an additional fresh source of e^+, e^-. Due to the 5 years of data already collected, AMS-02 is planning to extend the energy range of the electron component measurement in order to identify which hypothetical primary source of e^+ and e^- is dominating the observed overabundances.

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