Time dependence of the proton and helium flux measured by PAMELA

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PAMELA experiment

**Spectrometer**
*microstrip silicon tracking system + permanent magnet*

It provides:
- *Magnetic rigidity* → \( R = \frac{pc}{Ze} \)
- *Charge sign*
- *Charge value from dE/dx*

**Electromagnetic calorimeter**
*W/Si sampling (16.3 \( X_0 \), 0.6 \( \lambda_I \))*
- Discrimination e\(^+\) / p, anti-p / e\(^-\) (shower topology)
- Direct E measurement for e\(^-\)

**Neutron detector**
*36 He\(^3\) counters:*
- High-energy e/h discrimination

**Time-Of-Flight**
*plastic scintillators + PMT:*
- Trigger
- Albedo rejection;
- Mass identification up to 1 GeV;
- Charge identification from dE/dX

GF: 21.6 cm\(^2\) sr
Massa: 470 kg
Dimensioni: 130 x 70 x 70 cm\(^3\)
Power Budget: 360 W
PAMELA experiment

Resurs-DKI - multi-spectral imaging of Earth’s surface

PAMELA - is mounted inside a pressurized container of the Resurs DK-1 spacecraft

- Quasi polar and elliptical orbit
- Inclination ~ 70°
- Altitude ~ 300 - 600 km
- From 2010 circular orbit

Quasi polar orbit allows to perform a survey in each direction of the sky

Orbit period ~ 90 min
Cosmic rays
SOLAR CYCLE

- Solar activity rises and falls over an 11 year cycle
- Can be shorter/longer
- Different events during the cycle
- Activity correlates with Sunspot Number

nasa.gov: solarcycle-primer.html

NOAA/Space Weather Prediction Center

PAMELA
The solar modulation

Neutron Monitor counts data from http://cosmicrays.oulu.fi/
Proton flux

Evolution of the proton energy spectrum from July 2006 to December 2009

- SEP removed
- Temporal period: 1 year
- Extended up to 2014


PRELIMINARY
Proton flux

PRELIMINARY

![Graph showing proton flux over rigidity]
Helium nuclei flux

- SEP removed
- Temporal period: 1 year
- Extended up to 2014
- Rigidity range from 800 MV

Work in progress...
Conclusion

*PAMELA* took data:

- for a long period of time – [2006 – 2016]
- over a wide range of energies - [800 MeV – 1.2 TV]
- on different particles – [e\(^-\), e\(^+\), p, He ...]

A sample of helium with very low contamination have been selected.

All steps have been computed over precise time period.

Fluxes over different time periods have been computed.

For protons a study over single CRs is possible to monitor solar modulation with a high precision (in time and rigidity)