



«27-day variation of GCR research
based on PAMELA and ARINA
experimental data in 2007-2008.»

Borkut I.K. Bazilevskaya G.A Krainev M.B.
Malakhov V.V. Mayorov A.G. Rodenko S.A.

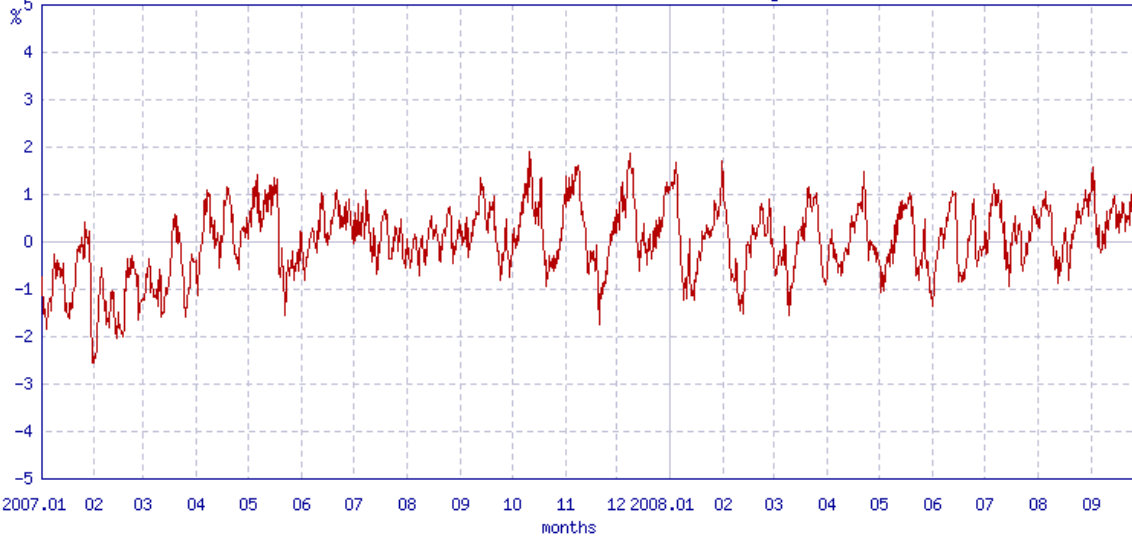


Introduction



Oulu Neutron Monitor

2007/01/01 00:00 - 2008/09/30 00:00 UT. Resolution: 720 mins. Average CR: 6637.67



A common way to analyze 27-day variations is using neutron monitors data.

PAMELA:

p: 100 MeV – dozen of GeV

He: 80 MeV/Nuc – dozen of GeV/Nuc

$\delta E = 5-10\%$

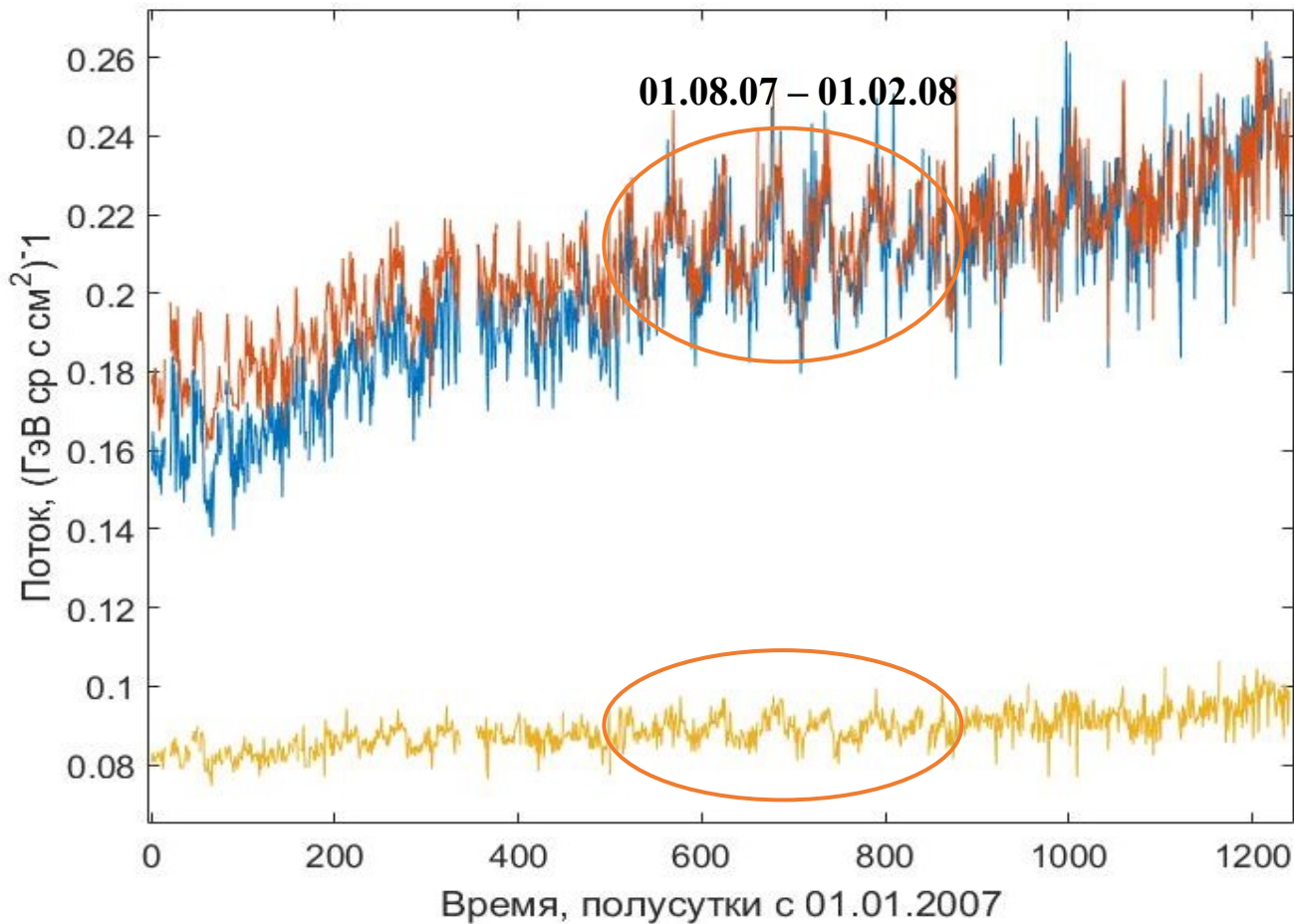
ARINA:

p: 45 – 110 MeV

$\delta E = 15\%$



Data processing



Time series of proton flux obtained in the PAMELA experiment are illustrated in the picture.

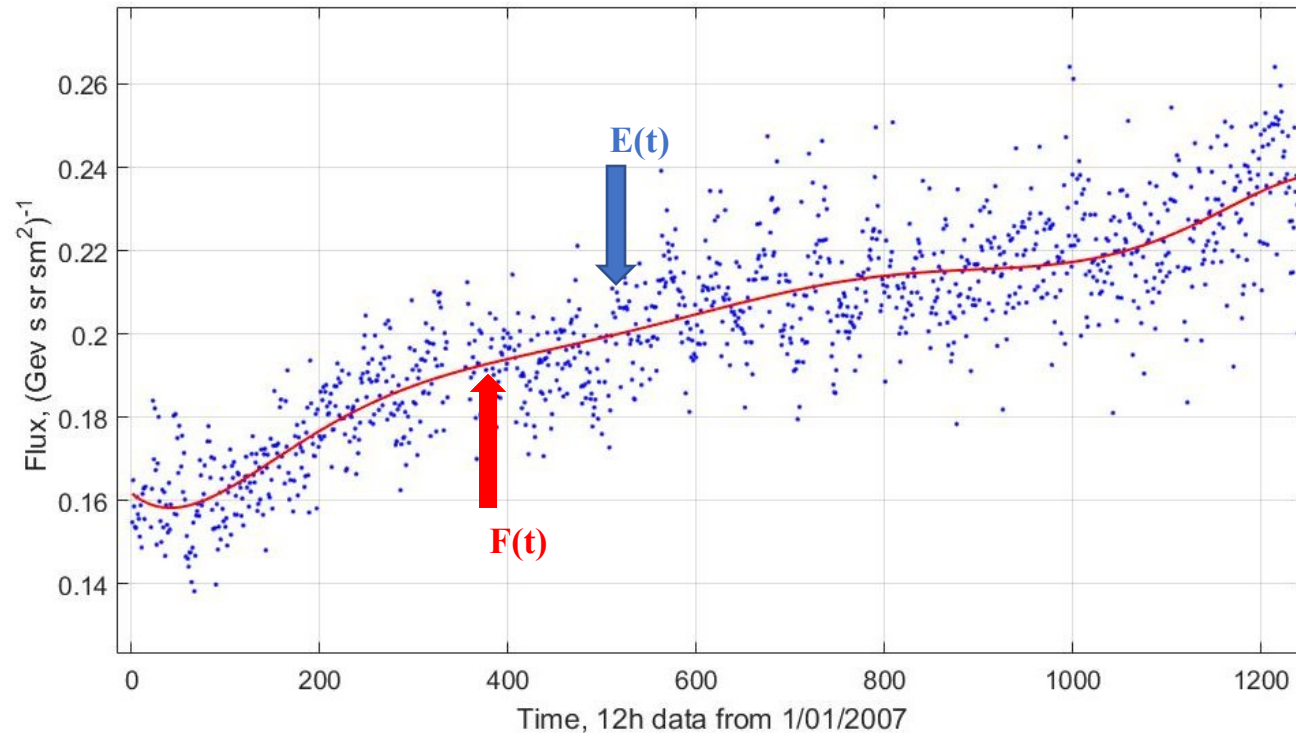
Blue - 0.22 GeV.

Red - 0.5 GeV.

Yellow - 2 GeV.



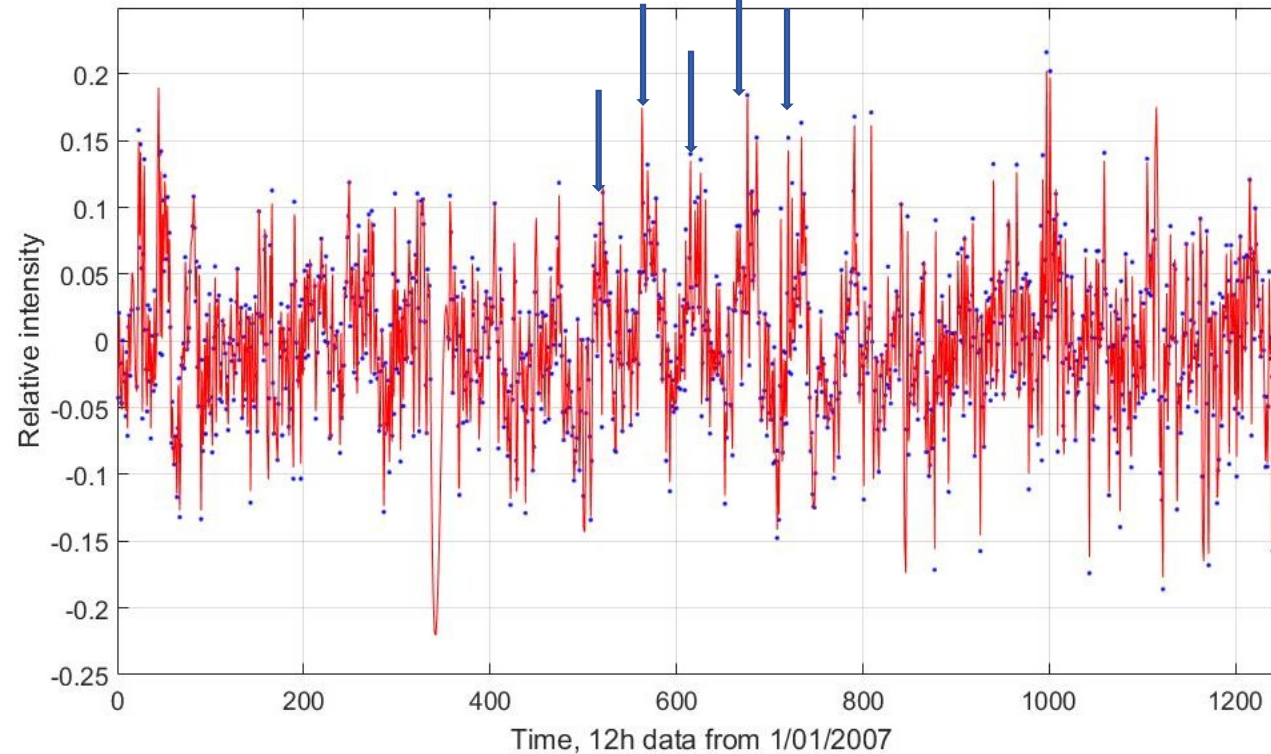
Data processing



We've applied the transformation $E(t)/F(t)-1$, where:
E – time series of proton flux (duty cycle is 12 hours),
F – fit function that describes long-term GCR modulation,
t – time.



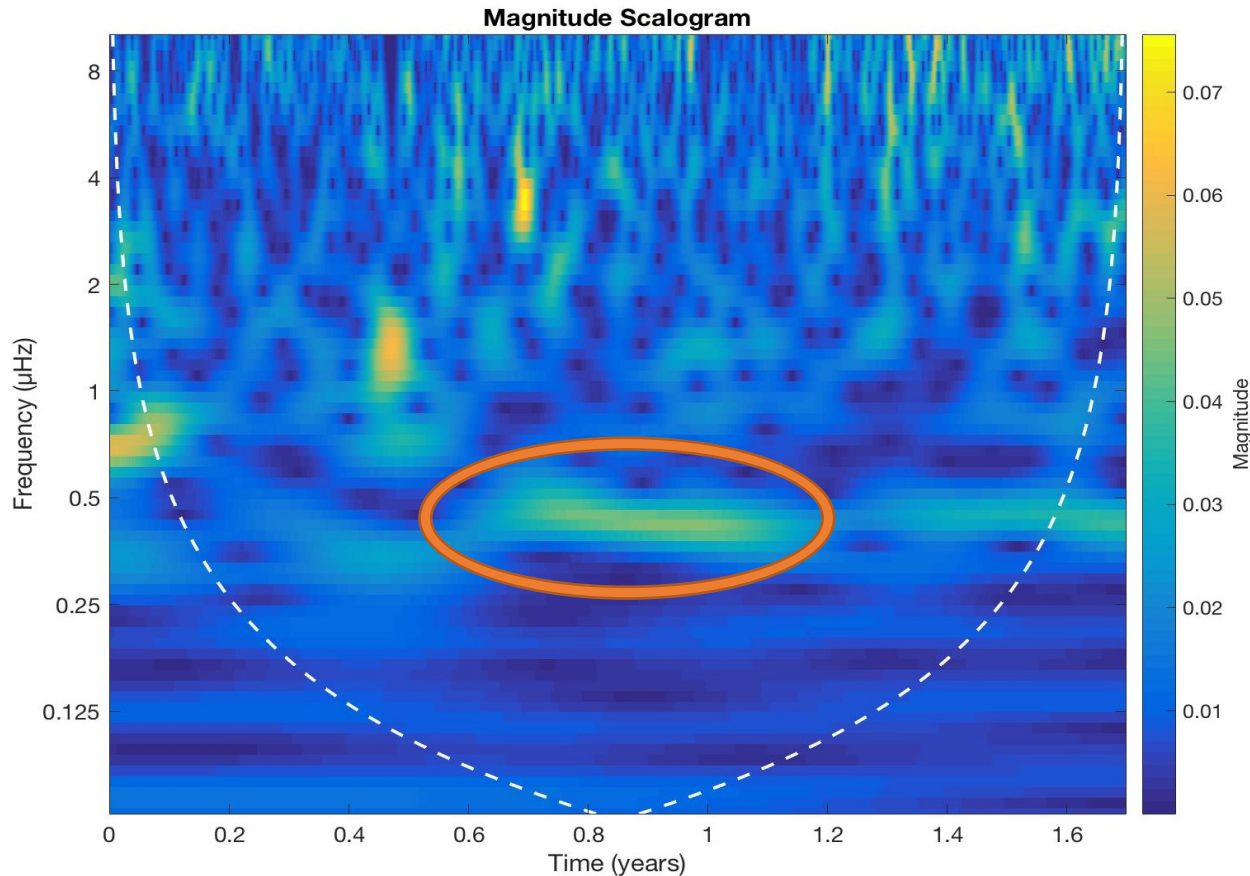
Data preparation for wavelet analysis



Before using wavelet transform we need to apply smoothing spline for data. Smoothing spline function superimposed to normalized experimental data is illustrated in the picture. $RMS = 0.997$ for this spline. The peaks marked with arrows correspond to a period of 27 days.



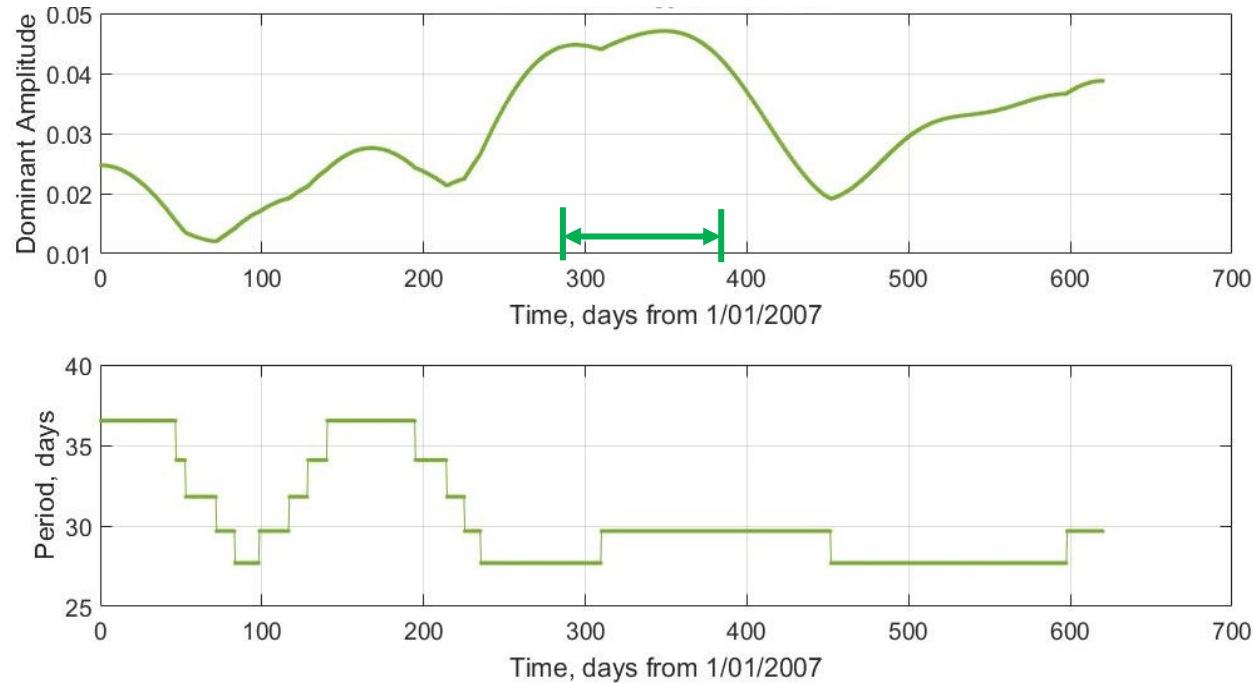
Wavelet-analysis



The magnitude scalogram for protons with energy 0.3 – 0.4 GeV is illustrated in the picture. It shows signal decomposition by frequencies for each time point. The color corresponds to amplitude value. White dashed line shows a cone of influence – region where wavelet transform is not reliable.



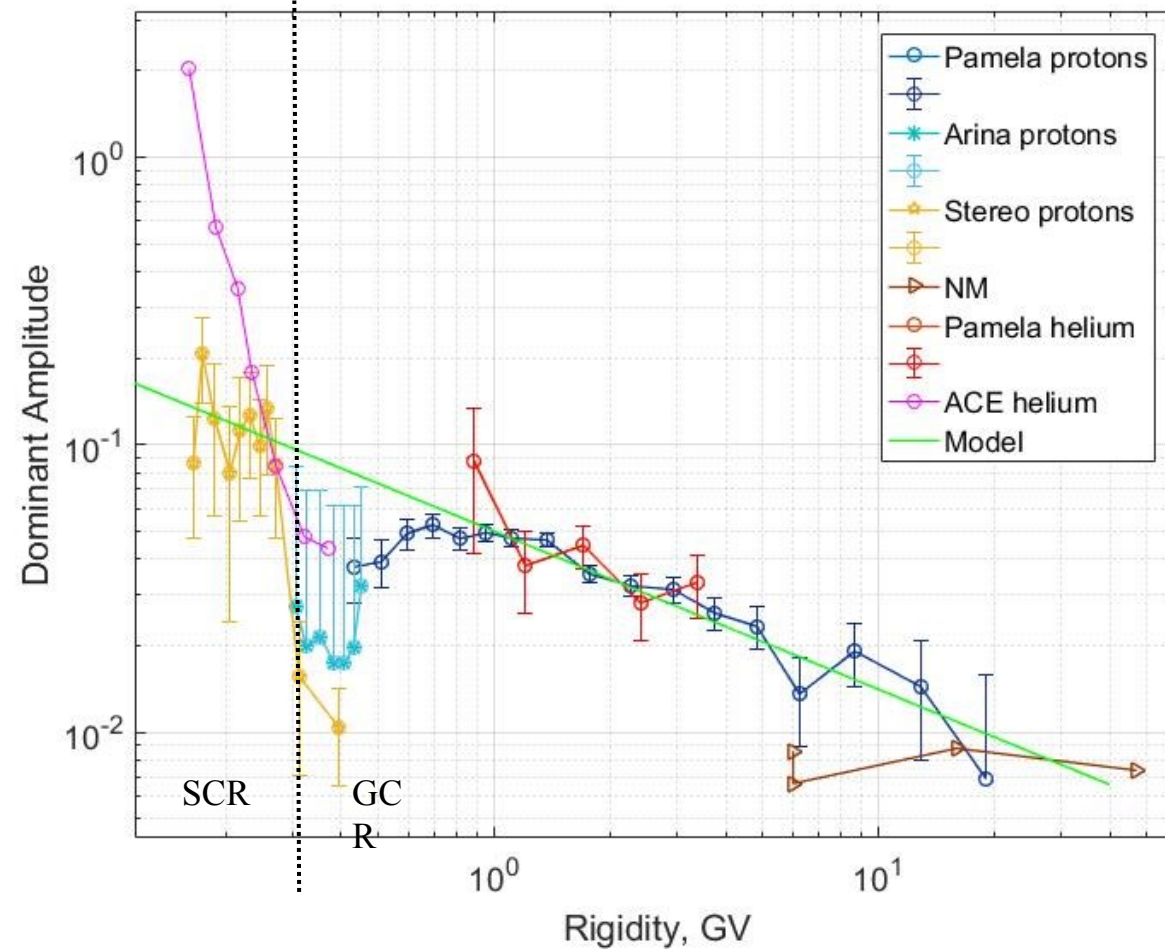
Wavelet-analysis



A dominant amplitude (an upper plot) and period (a down plot) dependencies on time are illustrated in the picture. These plots were created for kinetic energy of 0.3 – 0.4 GeV that correspond to rigidity of $R \sim 0.8$ GV.



Preliminary results

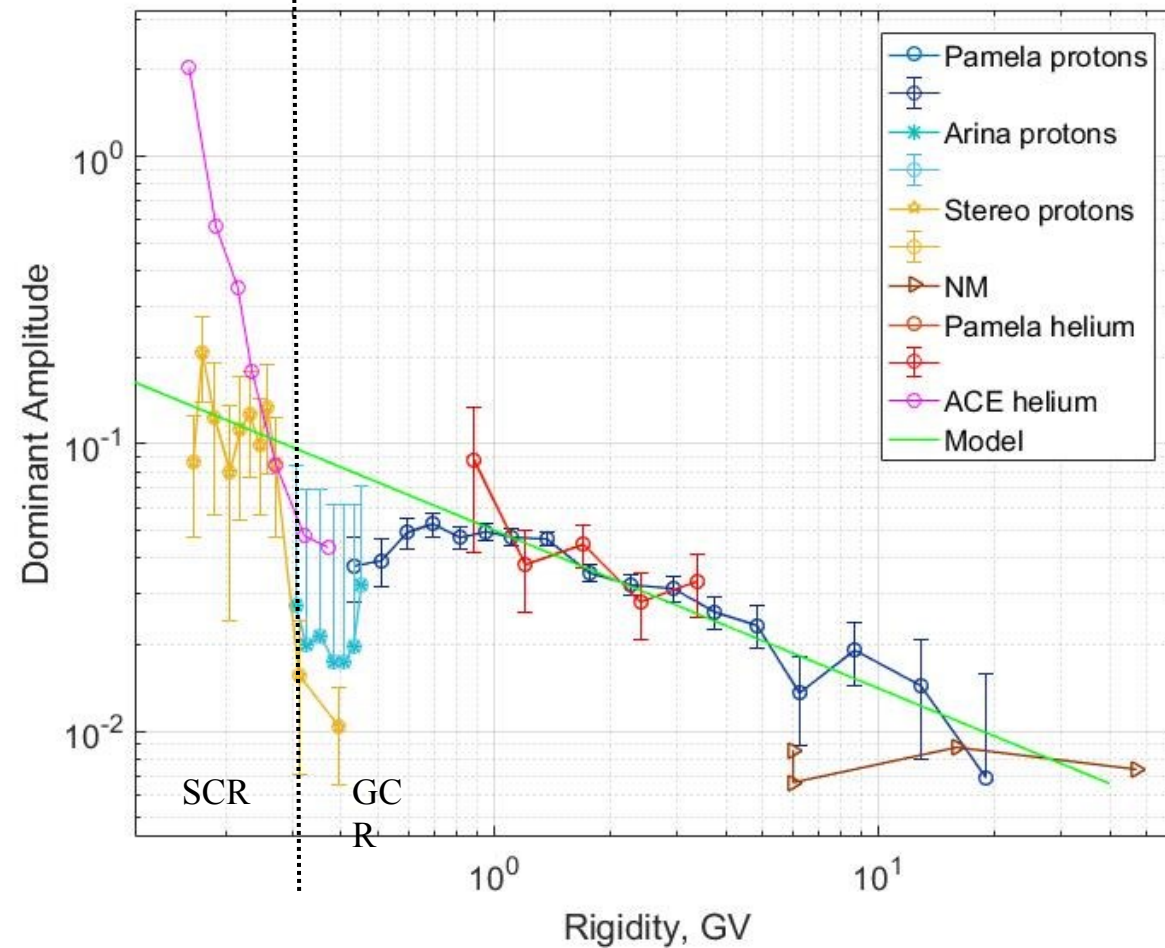


We've compared the obtained results with the data from independent experiments. The final plot is created using the experimental data from PAMELA, ARINA, STEREO, ACE experiments and neutron monitors during the period from 01.08.2007 to 01.02.2008.

Result 1: Proton and helium amplitude-rigidity dependencies coincide.



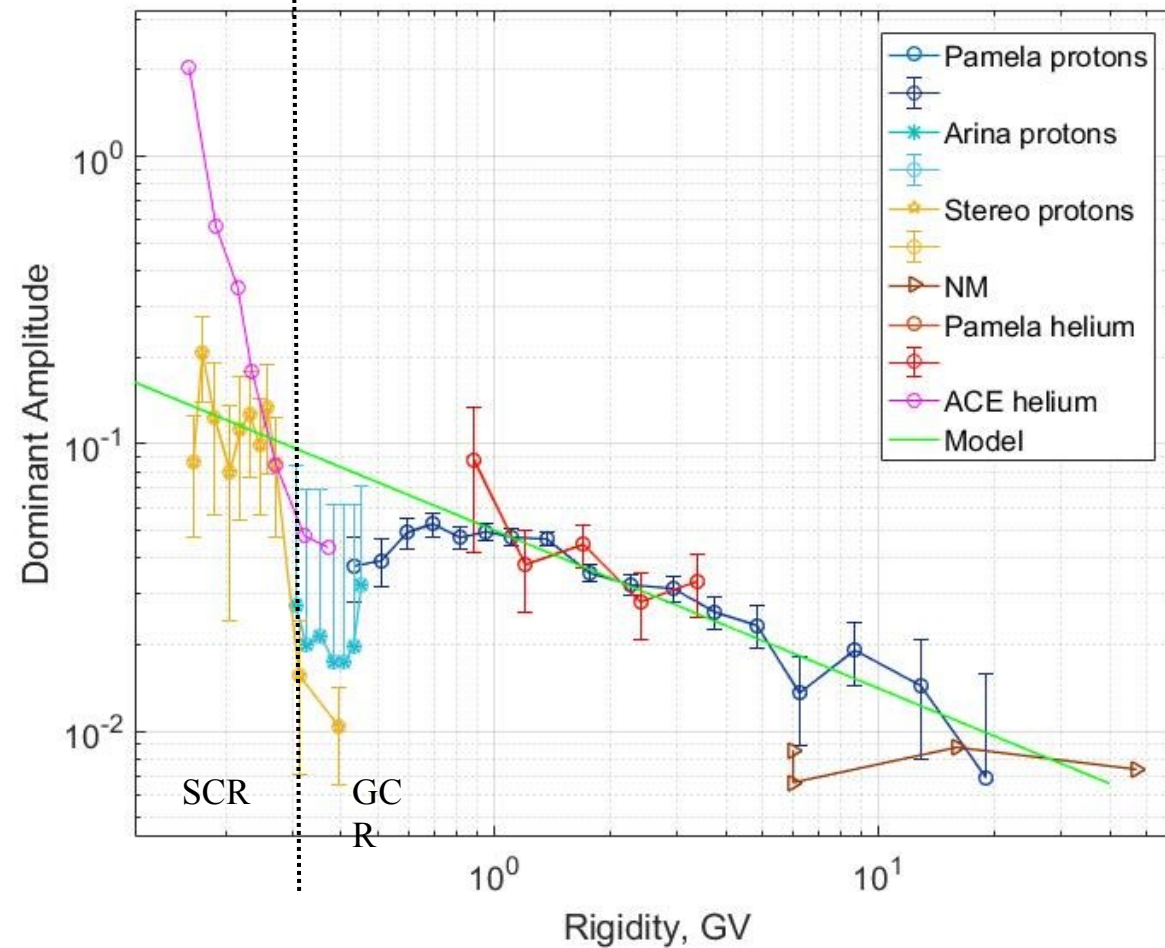
Preliminary results



Result 2: Pamela experimental data covers missing energy range and corresponds to common model (protons & helium).



Preliminary results



Result 3:
Amplitude-rigidity dependence cannot be fitted by a single-power law at the low energies as it was predicted before.

The amplitude decreases in the rigidity range from 0.3 GV to 0.7 GV.



Conclusions



- Data from PAMELA and ARINA experiments were analyzed using wavelet-transform.
- We've obtained amplitude-rigidity dependence for energies ranging from ~ 20 MeV to dozens GeV. The dependencies were compared with independent experiment STEREO and ACE.
- It is shown that amplitude-rigidity dependence cannot be fitted by a single-power law at the low energies as it was predicted before. The amplitude decreases in the rigidity range from 0.3 GV to 0.7 GV.

Thank you for attention!