The marked decrease of protons flux in cosmic rays beyond 3 GeV kinetic energy analyzed through a vortex model for the proton.

Osvaldo F. Schilling

Departamento de Física, UFSC, 88040-900, Florianópolis, SC. Brazil

Abstract:

We analyze available data for cosmic rays protons below 10 GeV and find evidence for instability of these particles as their kinetic energy increases beyond about 3 GeV, as expected from our recent model [1] which proposes a parent state at about 3.7 GeV from which protons would condense in the form of flux-confining vortices. As the kinetic energy increases such vortex states lose stability compared to the parent, and thus protons of higher energy become very rare in cosmic rays.

1. **Analysis of cosmic rays data in the light of the vortex model for baryons**.

We have recently developed a field-theoretical model for baryons in which such particles are modelled as vortices confining magnetic flux, which would "condense" from a parent state at about 3.7 GeV, under the effect of electromagnetic instabilities of such state[1,2]. This model has been shown to reproduce the relation of the mass of baryons with their magnetic moments (through an amount of confined flux) in a consistent, quantitative way. Since the particles are assumed to be the result of the creation of states stabilized from a higher energy level(as the Cooper pairs in superconductors condense into a state below the Fermi energy), it should be expected that protons of much higher energies will all but cease to be found in cosmic rays.

In Figure 1 we show data for the flux of protons from cosmic rays with kinetic energies below 10 GeV , taken from Figure 1.1 of ref. [3]. Below about 2 GeV energies the flux reaches a kind of plateau, which is consistent with protons uniformly distributed in energy and space orientation at low kinetic energies. Beyond 2 GeV there is a marked decrease in the flux of protons which reaches 50% of the maximum at 5 GeV and only 10% at 10 GeV, decreasing to much smaller fractions for higher energies[3]. According to our model in ref [1] , protons accelerated beyond 2.7 GeV kinetic energy (the difference between the parent level 3.7 GeV and the proton rest mass of about 1 GeV, i.e., the "energy advantage") should become unstable since the energy difference that would stabilize the vortex state as compared to the parent state disappears. A related effect breaks Cooper pairs in superconductors (the depairing effect) if their kinetic energy gets greater than the pairing interaction provided by phonon-intermediated coupling.

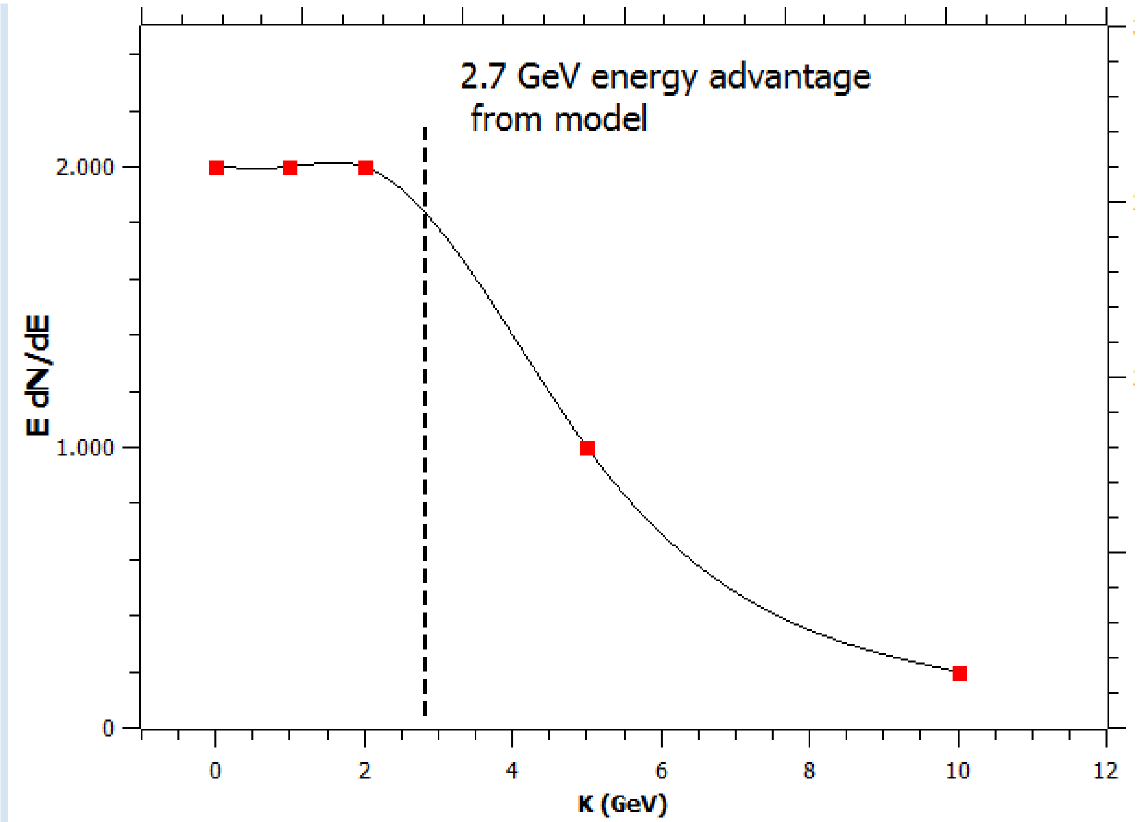

Figure 1: Reproduction of relevant data points on the upper left part of the double-log plots of cosmic ray protons fluxes in Figure 1.1 of ref.[3] (linearized scales used here). The flux of protons is in 10^3 m^{-2} $(sr.\ s)^{-1}$ units, and is plotted against the protons kinetic energy K in GeV. The vertical dotted line is placed at the value of K that corresponds to total loss of the vortex energy advantage compared to the vacuum parent state(see [1]). The solid line is a guide.

2. References

1. O.F.Schilling, Progress in Physics, **15(3)**, 185 (2019). Correction: In eq. 7 one should include "+ m_p^2 c^2" between the curly brackets.
   http://www.ptep-online.com/2019/PP-58-08.PDF
   See also previous work by the author in vixra.org
2. O.F.Schilling, Annales de la Fondation Louis de Broglie, **43**-1, 1 (2018).
3. T.K.Gaisser, R. Engel and E. Resconi, Cosmic Rays and Particle Physics, Cambridge, 2016(see pages 4 and 8).