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

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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 there exists 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.

Theoretical justification of the approach.

We have recently developed a 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 a state[1,2]. This model has been shown to reproduce the dependence of mass of baryons with their magnetic moments (through an amount of confined magnetic 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, it should be expected that their numbers will decrease in cosmic rays for excessive kinetic energies.

Application to cosmic rays data.

In Figure 1 we show data for the *number* flux of protons from cosmic rays below 10 GeV kinetic energy, taken from Figure 1.1 of ref. [3]. Below about 2 GeV kinetic energy there is an approximate plateau. From 2 GeV on a marked decrease in the flux of protons is observed, which reaches 50% of the maximum at 5 GeV, and falls to 10% of the maximum at 10 GeV, decreasing to much smaller fractions beyond such energy[3]. According to our model in ref [1] , protons accelerated beyond 2.7 GeV kinetic energy (which comes from the difference between 3.7 GeV and the proton rest mass of about 1 GeV, i.e., the "energy advantage") should become unstable since they lose the energy advantage acquired by settling in the lower energy vortex state. A related effect breaks Cooper pairs in superconductors if their kinetic energy gets greater than the pairing interaction provided by phonon-intermediated coupling.

Figure 2 shows a plot of the estimated (from collected data) *energy* distribution for the interstellar flux of protons [3], which peaks exactly at 2.7 GeV.

2. Conclusion

This short note analyzes data collected for the flow of protons in cosmic rays in the light of a recently proposed model in which protons are modelled as vortices in an energy state 2.7 GeV below a parent state from which they would have condensed[1]. We have found evidence for a critical kinetic energy of 2.7 GeV in both the number distribution of protons and in their energy distribution. Although It is clear that 2.7 GeV represents a critical value for the energies of protons in cosmic rays, further work is clearly needed to explain why protons would still be found at very high enegies, far beyond the proposed 3.7 GeV parent state limit.

3. 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.

Figure 1: Reproduction of the upper left part of the double-log plots in Figure 1.1 of ref.[3] (linearized scales are adopted here). The *number* flux of protons in 10^3 m^{-2} $(sr.\ s)^{-1}$ units is plotted against the protons kinetic energy in GeV. The vertical 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.

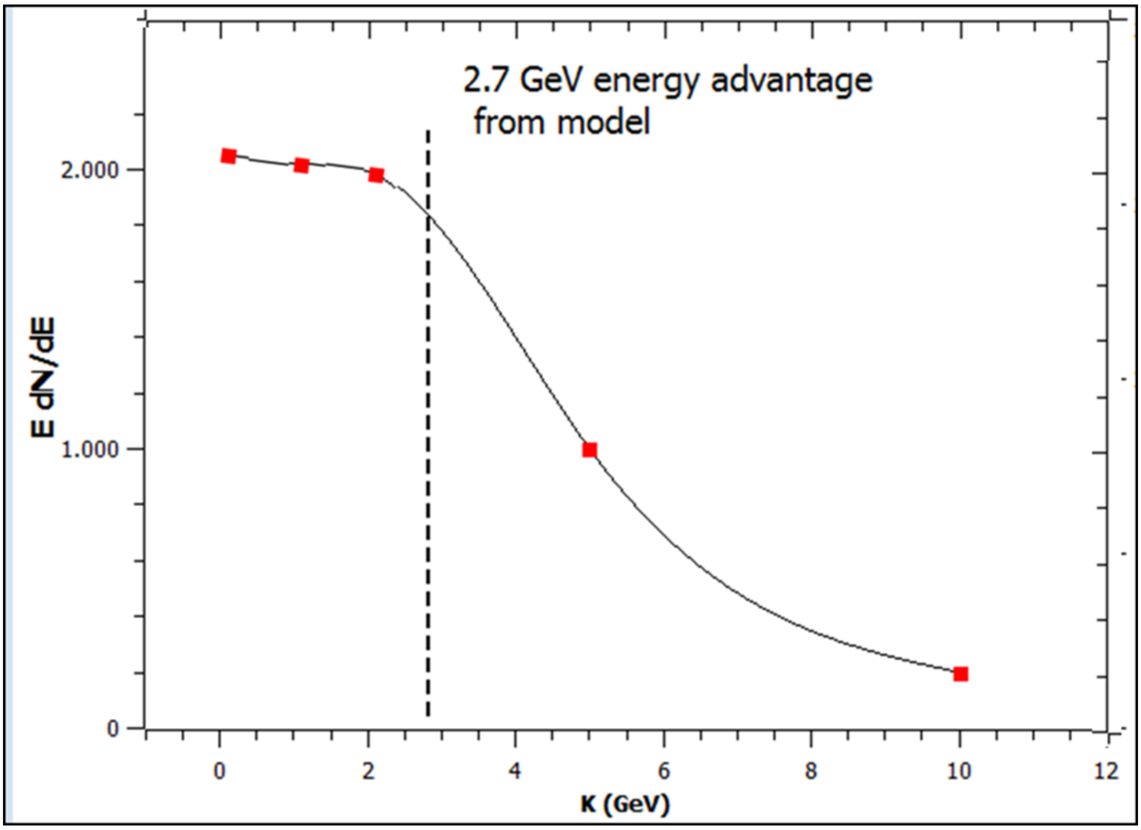

Figure 2: Estimated *energy* flux distribution of interstellar protons in cosmic rays, which peaks at exactly K= 2.7 GeV[3].