Comparison of Centauro and usual γ's events

Brasil-Japan Collaboration on Emulsion Chamber (B-J Collaboration)
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B-J Collaboration experiments discovered a high transverse momenta in hadronic interaction, through cosmic ray events. Among then, mean transverse momenta $< P_{T_h} >$ of the order of 1 GeV/c events were found and such events were nicknamed Centauro events. As the high transverse momenta are of hadronic particles, naturally it is connected with the criteria of identification of secondaries. To have more confidence on the abnormal features of Centauro events, we used the Kolmogorov-Smirnov non parametric test, aiming to show the discrepancy with normal events.

1. Introduction

Since 1962, B-J Collaboration is doing experiments on high energy hadronic interactions (E > 10 TeV), by exposing detectors to the cosmic rays. These detectors, called emulsion chambers, are settled at Mt. Chacaltaya (5220m. above sea level, geographic coordinates $16^0$20'45" South, $68^0$07'31" West, corresponding to geomagnetic coordinates $4^0$50'40" South and $0^0$50'20" East). Details of emulsion chambers composed by photosensitive materials inserted between lead plates can be found, for instance in [1].

One of the features of Centauro events is the high mean transverse momenta, around 1 GeV/c, but this high value is a consequence of proper identification of particles (i.e. dependent on the criteria for hadronic and electromagnetic components identification). The main purpose of this paper is to show that some events observed by B-J Collaboration have small probability to be classified as an usual γ-event, despite of previous identification of particles.

2. Analysis

We concentrate our analysis only on 3 candidates for Centauro events. They have common features, such as small signal on the upper part of the detector and/or vertex determined through direct measurements. They were denominated Centauro I, V and VIII. Centauro I and V have estimations of the respective point of divergence, whereas Centauro I and VIII have greater signal (more particles) in lower part compared with upper one.

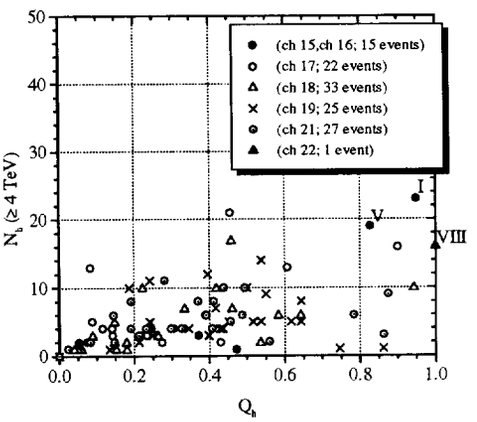

Figure 1. N_h - q_h correlation showing Centauro events concentrated on the right

Previous papers concerned on Centauro events, presented results for hadronic and electromagnetic components, separately. They show that Centauros are hadron-rich events, as in figure 1,

correlating N_h (number of hadrons) with $q_h = \frac{\Sigma E_h^{(\gamma)}}{\Sigma E_h^{(\gamma)} + \Sigma E_\gamma}$. In this figure the restriction of $N_h (\geq$ 4 TeV) is not valid for Centauro VIII, plotted with its total multiplicity. Also shows, in figure 2, that they have hadrons distributed isotropically as it are near to the analytical curve $R = \frac{\Sigma E \Sigma E \Theta^2}{[\frac{4}{\pi} \Sigma E \Theta]^2} \times \Theta$, calculated under a hypothesis of isotropic decay of secondary hadrons. Confirmation of quasi-isotropic behaviour was found in figure 3, correlating $mDW = \frac{1}{4\Sigma E}[\Sigma E + \Sigma E(\Gamma\Theta) + \Sigma E(\Gamma\Theta)^2 + \Sigma E(\Gamma\Theta)^3]$ with Θ, where the slope is $\approx$ 2, characterizing quasi-isotropic distribution of hadrons. In the case of Centauro I and V, transverse momenta distributions result in a mean value, $< P_{T_h}^{(\gamma)} >= 366 \pm 56$ MeV/c and 267 ± 43 MeV/c, respectively (figure 4), giving a $< P_{T_h} > \approx 1$ GeV/c if we use $k_\gamma = 0.3$. As all are dependent of proper discrimination between hadronic and electromagnetic components, we are trying to look for a feature characterizing Centauro as an unusual event.

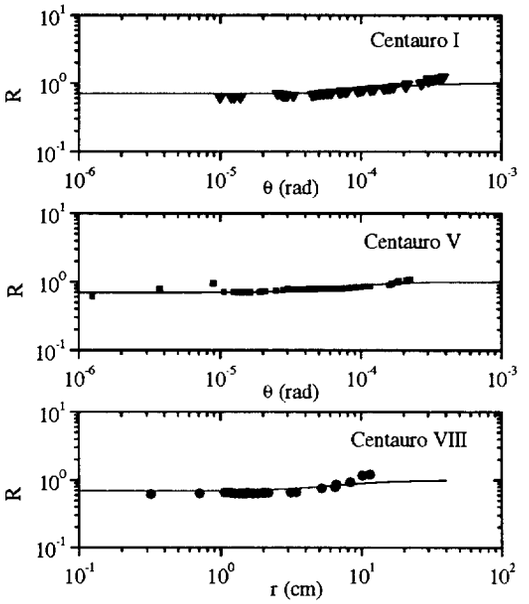

Figure 2. Plots showing a quasi-isotropic distribution of hadrons

For that purpose, distribution of fractional energy $f = \frac{E}{\Sigma E}$ (quantity similar to Feynman X parameter), of Centauro events were compared with the ones of usual γ-events with comparable multiplicity and observed total energy. Comparison of Centauro distribution shapes with joint distribution shape of 5 Guaçú events (all normalized to have the same f_{peak}, to allow comparison of shapes), shows that they are similar, but with small probability (figure 5). Figure 6 shows the same f distributions as before, but now without the f_{peak} normalization, and the probabilities are much smaller.

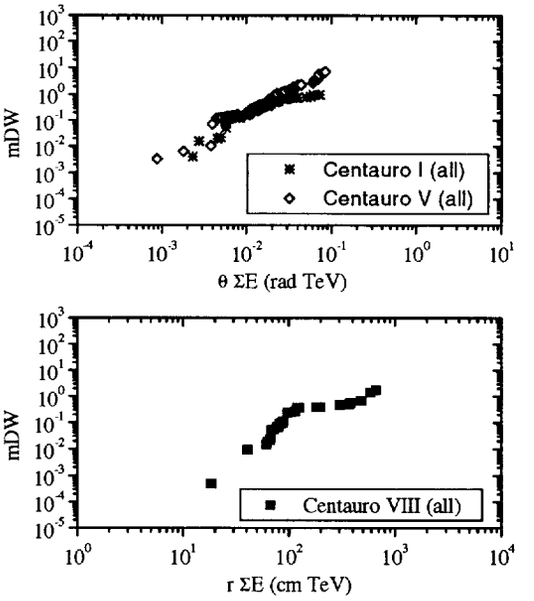

Figure 3. Distribution showing slope ≈ 2

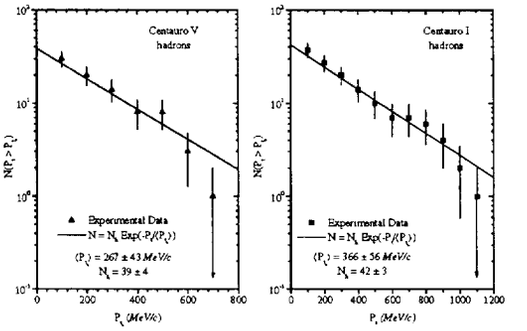

Figure 4. Distribution of $P_{T_h}^{(\gamma)}$

3. Conclusion

These analyses show comparison among Centauro and usual γ-events, having comparable multiplicity and total observed energy of particles. The analysis was made irrespectively from particles identification and shows small probabilities that Centauros and usual γ-events come from the same f distribution (Figure 6) and have rather similar shapes (figure 5).

REFERENCES

1. C.M.G.Lattes, Y.Fujimoto and S.Hasegawa, Phys.Rep.65, No.3(1980) 151.

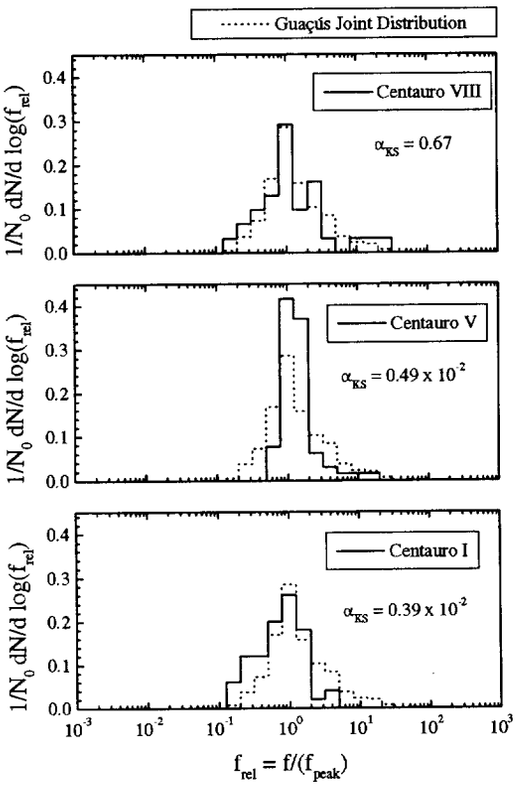

Figure 5. Comparison of Centauro and usual γ's events showing similitude of shapes

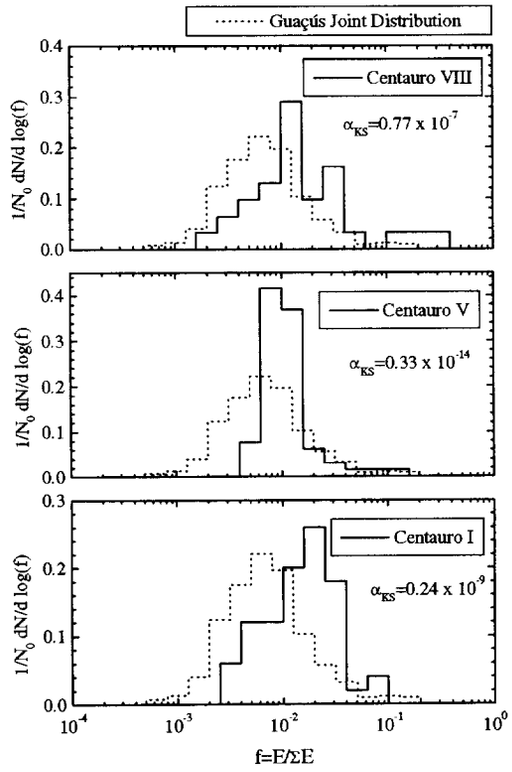

Figure 6. Comparison of Centauro and usual γ's events with very small Kolmogorov-Smirnov probability estimation

Acknowledgments

The authors are grateful to several scientific and educational agencies in Brasil (CAPES, CBPF, CNEN, CNPq, FAEP-UNICAMP, FAPESP, FINEP, UFF) and in Japan (AOYAMA GAKUIN UNIVERSITY, ICRC-UNIVERSITY OF TOKYO, WASEDA UNIVERSITY). One of us (EHS) acknowledges to the Organizing Committee of X^{th} ISVHECRI for the support to present this report at the Symposium.