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Coma super-cluster an origin for the highest energy protons in observed Cosmic Rays flux.

PANTEA DAVOUDIFAR[1], SEYED JALILEDIN FATEMI[2], HAMID ARJOMAND KERMANI[1]
[1]*PhD Student in Astroparticle Physics / Kerman University*
[2]*Professor of Physics / Kerman University*
dfpantea@yahoo.com

Abstract: In the present work, after our work about the extragalactic gamma ray flux in direction of Coma super-cluster, with considering the Virgo proton flux and considering a constant gamma to proton ratio for the very high energy cosmic rays in first approximation, the extragalactic proton flux in Coma direction is calculated. We have considered the available theoretical models for gamma ray flux from Virgo supper-cluster and compared the result for Coma supper-cluster with KUO et al. model. [3]

We have studied that is it possible that the coma super-cluster be an origin for the highest energy protons in cosmic rays flux or not. a detailed analysis has made.

Introduction

The existence of the diffuse gamma ray background first denoted by Kraushaar et al. on the basis of data from OSO-3 satellite. More studies did by SAS-2 satellite (Fichtel and Thompson, 1982) and EGRET (Streekumar et al. 1998).
Most of the galactic gamma ray sources are in galactic plan, so the diffuse gamma ray flux in the galactic poles could be considered from extragalactic sources if they exist.
In our first work [1,2], by using EGRET data, first we have offered an exponential flux in direction of Coma super-cluster:

$$I(E) \propto E^{-\gamma}, \gamma = 1.8 \pm 0.4$$

$$I(E > 30MeV) \simeq 1.9 \times 10^{-6} cm^{-2} s^{-1}$$

We concluded that in this quarter $\sim 25.9\%$ observed total flux for $E > 30MeV$ originated from Coma super-cluster direction.
By assuming that a part of gamma rays in a cluster is produced by cosmic rays hadronic interactions (mainly protons) with thermal ions in inter cluster medium, by using the model (Dermer, 1986) for hadronic interactions and also by considering the Gamma rays production by Inverse Compton Scattering mechanism, in the work presented by KUO et al. [3] they have computed a diffuse gamma ray flux for a cluster.
In figure 1, we have shown our results which is presented in our first paper in this conference [1] in comparison with KUO et al.

Methods

As it could be seen in figure 1, the results of KUO et al. are in the favor of the A-model results for Virgo super-cluster although the agreement reduces by energy.
The difference between Coma excess and Virgo excess in this quarter is comparable with the results of KUO et al. and this latter is in good agreement with the observations.

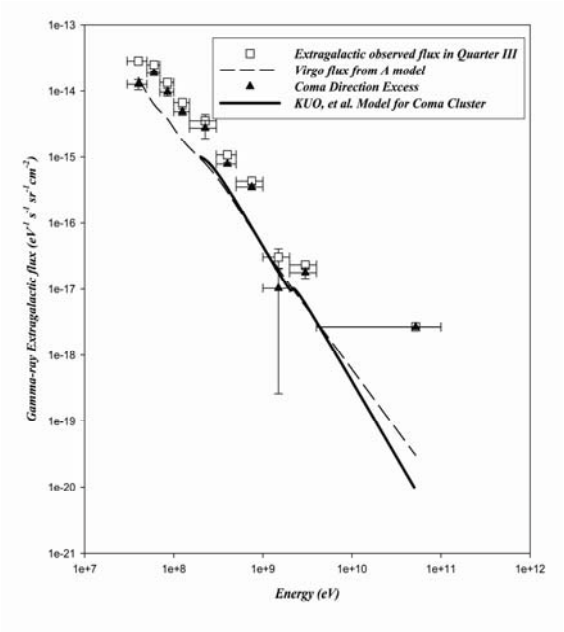

Figure 1: Observed Extragalactic Gamma ray excess in quarter III, computed Gamma ray excess in Virgo super-cluster direction from A-model, Extragalactic Gamma ray excess in Coma direction and the produced EGRB by hadronic interactions of cosmic ray protons and thermal gas of the cluster. [1]

Here we have tried to compute a proton flux in first approximation in direction of Coma super-cluster.
First we have accepted that the presented form for Virgo proton flux by Wolfendale et al. [6] is correct. By using this form, the experimental cosmic ray flux and the results of our first paper, we computed an extragalactic proton flux in Coma direction.
In first approximation we assumed that the gamma to proton ratio in this region is constant.
The computed amounts for gamma to proton ratio for $E > 10^{19} eV$ are between 0.1 and 1.2. So, first we have used 0.6. After normalizing all the ratios for experimental gamma flux to observed cosmic ray flux (mainly protons in this region) we have computed an optimized gamma to proton ratio.
By the results of our first work [1], the ratios for extragalactic gamma ray fluxes from Virgo direction, Coma direction and other clusters to the total extragalactic flux are respectively:

25.9%, 55.8%, 18.3%

After optimization process, the gamma to proton ration for $E > 10^{19} eV$ was:

0.34

Which is used to compute the proton flux in Coma direction.
By the optimized gamma to proton ration, and accepting the presented form by Wolfendale et al. for proton flux originate by Virgo cluster and other clusters [4,5,6]; we have computed the extragalactic proton flux in Coma direction.
Here in table 1 we have presented our results for some of the points.

Energy (eV)	Proton Flux ($eV^{-1}m^{-2}s^{-1}sr^{-1}$)	Energy (eV)	Proton Flux ($eV^{-1}m^{-2}s^{-1}sr^{-1}$)
2×10^{19}	0.4351×10^{-31}	4×10^{20}	0.1184×10^{-33}
3×10^{19}	0.4772×10^{-31}	5×10^{20}	0.6219×10^{-34}
4×10^{19}	0.3547×10^{-31}	6×10^{20}	0.3670×10^{-34}
5×10^{19}	0.1996×10^{-31}	7×10^{20}	0.2593×10^{-34}
6×10^{19}	0.1424×10^{-31}	8×10^{20}	0.1807×10^{-34}
7×10^{19}	0.1133×10^{-31}	9×10^{20}	0.1325×10^{-34}
8×10^{19}	0.7676×10^{-32}	1×10^{21}	0.9898×10^{-35}
2×10^{20}	0.7745×10^{-33}	2×10^{21}	0.1294×10^{-35}
3×10^{20}	0.2654×10^{-33}	3×10^{21}	0.4724×10^{-36}

Table 1: the results of computing proton flux in Coma direction

In figure 2, one can see our results for proton flux in highest energy range.

Discussion

By considering the mechanism presented by KUO et al. [3], as our results in paper 1 [1] is in good agreement, now we can talk with more confidence about proton flux in Coma direction.
In the figure 2, we can see that it is possible that we consider the origin of the cosmic ray protons in the highest energy range, Coma super-cluster.

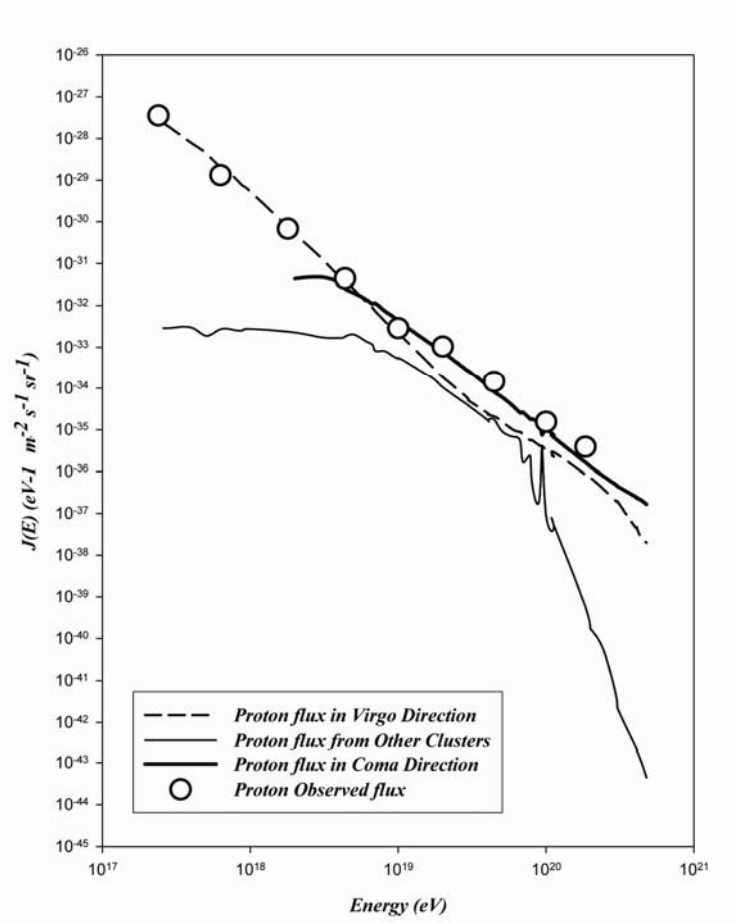

Figure 2: the computed proton flux in Coma direction in comparison with the observed proton flux, proton flux in Virgo direction and proton flux from other clusters and super clusters.

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