COMA CLUSTER: CR ACCELERATION AND GAMMA-RAY PRODUCTION

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The Coma cluster is situated near to the North Pole and its galactic coordinates are: $l\sim 50^0$ and $b\sim 87^0$. The distance to the cluster is about 138 Mpc. Observations in soft X-rays (see e.g. Briel, 1992) discovered there the thermal emission from the diffuse hot intracluster gas whose density and temperature are: $n\sim 3\cdot 10^{-3}$ cm^{-3} and $T\sim 10^8$K. Measurements of hard X-ray flux from Coma showed controversial detection in different experiments (see Bazzano et al. 1990 and Rephaeli et al. 1994).

Radio investigations of Coma show an extended halo (see e.g. Schlickeiser et al. 1987, Kim et al. 1990, Giovannini et al. 1993). Radiosize of the halo is 40'. The radio flux is generated by relativistic electrons through their synchrotron losses.The origin of these electrons in the halo is unclear. They cannot be ejected by one of radio galaxies in the cluster since the luminosity of the likeliest candidate of the electrons is by a factor 10 less than that is needed to supply the Coma halo. Therefore two models of for the electron origin are usually discussed: a) in-situ acceleration and b) production of secondary electrons in the halo (see Schliekeiser et al. 1987).

Parameters of charge particle propagation in the halo are determined by the structure of magnetic fields there.

As it follows from the observations of Faraday depolarization there are two magnetic field components in the Coma halo: the tangled magnetic field has a strength of about 8.5 ± 1.5 μG, while the uniform component is much weaker, about 0.2 ± 0.1 μG. The scale of magnetic fluctuations is less than 1 kpc (Feretti et al. 1995). On the other hand, Kim et al. (1990) obtained that the magnetic field reversal occurs on a scale size of 14 –40 kpc and its strength is 2μG.

Particle propagation in these tangled magnetic fields is described as

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diffusion with coefficient (see Dogiel et al. 1987)

$$D = c^2 \int_{-\infty}^{\infty} \int_{-\infty}^{t} \left(\mathbf{h}(\mathbf{r},t)\delta(\mathbf{r}' - \rho(\mathbf{r},\tau,t))\mathbf{h}(\mathbf{r}',t') \right) d^3r\,dt'$$

where ρ is the trajectory of magnetized particles, $\tau = t - t'$ and $\mathbf{h} = \mathbf{H}(\mathbf{r},t)/\mid \mathbf{H}(\mathbf{r},t) \mid$. For the spectra of magnetic field fluctuations in Coma the diffusion coefficient can be approximated by $D_{xx} \geq (\pi c L_{cor})/6 \sim 10^{31} cm^2/s$, where L is the correlation length of magnetic field fluctuations.

Assuming in-situ acceleration we immediately obtain the parameter of Fermi II acceleration if the characteristic velocity of magnetic fluctuations is of the order of the thermal velocity u: $D_{pp} \sim u^2/D_{xx} \leq 10^{-15}s$

The accelerated electrons generate in the halo radio and gamma-ray fluxes. From the observed radio flux we could estimate the Coma gamma-ray emission. Its value strongly depends on the strength of magnetic fields there.

If the field strength is about of 10^{-5}G then the inverse Compton gamma-ray flux near the earth at 100 keV is $\sim 10^{-8} ph/cm^2s$ and bremsstrahlung radiation: $\sim 10^{-6} ph/cm^2s$. In both cases this flux cannot be detected by the OSSE telescope.

If the magnetic field strength is $\sim 10^{-6}$G the inverse Compton flux is $10^{-5} ph/cm^2s$ (still not seen by OSSE). The bremsstrahlung flux, however, is large enough ($\sim 2 \cdot 10^{-4} ph/cm^2s$) to be detected by this telescope.

In the case of secondary electron production we could estimate the gamma-ray flux from π^0-decay. It equals $10^{-9} \div 10^{-8} ph/cm^2s$ for both cases that is less than the EGRET telescope sensitivity.

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