interesting that positron production leads to an increase of the degree of emission and intensity of the γ radiation. The upper luminosity limit is determined only by the power of the source of heating. Annihilation of the positrons and electrons as a result of their high energy cannot lead to emission of a γ line with hν ∿ 0.511 MeV, and since the positron production rate is a process weaker by a factor of 137 than bremsstrahlung, the annihilation does not influence the γ intensity in the continuous spectrum. Since quasars and powerful radio sources undergo a strong cosmological evolution in analogy with the situation with the background in the radio band, it can be assumed that the main contribution to the background is made by sources emitting at a red shift z ∿ 2. In this case, the exponential cutoff occurs at hν ∿ 7 MeV. We note that the total energy density of the background radiation in the 1 - 6 MeV region amounts to only 3×10^{-5} eV/cm^3, which is smaller by three or four orders of magnitude than the energy density of the background radiation in the infrared band [10]. We see therefore that the consumption of a small fraction of the total infrared-radiation source power in the heating of the electrons to relativistic temperatures can fully account for the observed distortions of the γ background.

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ORIGIN OF THE X-RADIATION OF THE METAGALAXY

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There is no unified point of view at present concerning the origin of the metagalactic x-radiation. Felten and Morrison [1] considered the possibility that the sources of relativistic electrons responsible for the diffuse x-ray background are powerful radio galaxies with a spectral index $\alpha = 0.7 - 0.8$. Longair and Syunyaev [2] criticized this point of view, for within the framework of this model it is difficult to explain the observed form of the x-ray spectrum, and in particular the kink of the spectrum in the energy region 20 - 40 keV. This difficulty led Brecher and Morrison [3] to another hypothesis concerning the origin of the background x-rays. They showed that the form of the observed x-ray spectrum agrees well with the spectrum of the electrons of our galaxy. They therefore believe that the leakage electrons from normal galaxies produce the x-radiation by Compton scattering from the relict radiation. It is necessary in this case to choose a leakage time $\tau = 10^6$ years. Within the framework of this model, however, it is difficult to explain the experimental value of the flux of x-radiation, for this requires that the total energy of the relativistic electrons within the normal galaxy amount to 10^{58} erg, which is approximately four orders of magnitude larger than the customarily assumed energy of the electrons of our galaxy. This difficulty is encountered in fact also in the hypothesis of Longair and Syunyaev [2], where the sources of the x-radiation are taken to be powerful infrared objects (nuclei of N- and Seyfert galaxies, or quasars).

The advantage of radio galaxies lies in the fact that a large reserve of energy of relativistic electrons ($\sim 10^{58}$ erg) and a short leakage time (10^6 years) [1, 3] can explain the observed density of the metagalactic x-radiation. This raises the question of explaining the mechanism whereby the electron spectrum is produced, and in particular of explaining the kink of the electron spectrum in the 2 - 5 GeV region, corresponding to the observed kink of the x-ray spectrum in the 20 - 40 keV region. The difficulty lies in the fact that the small magnitude of the magnetic field inside the radio galaxies ($\sim 10^{-6}$) [1] and the ratio of the energy densities in the radio and x-ray bands [2] do not make it possible to attribute this kink to losses to synchrotron radiation and to the inverse Compton effect.

It is possible to retain the hypothesis that the background x-radiation is produced by leakage electrons from the radio galaxies. It suffices to assume, for this purpose, that the electrons are accelerated and scattered by inhomogeneities of the magnetic field of the moving plasma; this process was considered in an earlier paper by the authors [4]. It is assumed that the dimension of the electron-acceleration region is much smaller than the dimensions of the galaxy, and the magnetic field in the remainder of the galaxy is more homogeneous, so as to make the leakage time $\sim 10^6$ years [1, 3]. Since the processes of convective transport and synchrotron losses are insignificant for the radio objects in question, the equation for the density $n = n(r,\varepsilon)$ of electrons with energy ε at the point r is

$$\frac{\partial}{\partial\epsilon}\left[\frac{\overline{\Delta u^2}}{3c\,\Lambda(\epsilon)}\,\epsilon^4\,\frac{\partial}{\partial\epsilon}\left(\frac{n}{\epsilon^2}\right)\right]+\frac{c}{3}\,\Lambda(\epsilon)\nabla^2 n+S(r,\,\epsilon)=0\,. \tag{1}$$

Here $\Delta\mu$ is the fluctuation of the rate of radial spreading of the magnetic inhomogeneities, $\Lambda(\varepsilon)$ is the mean free path with respect to scattering, and $S(r,\varepsilon)$ is the source of the electrons involved in the acceleration process.

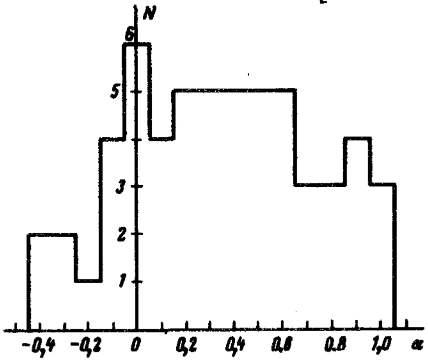
We obtained a solution of (1) for the case when $\Lambda(\varepsilon) = \Lambda_0\varepsilon^{-\beta_1}$ at $\varepsilon \leq \varepsilon_1$ and $\Lambda(\varepsilon) = \Lambda_1\varepsilon^{\beta_2}$ at $\varepsilon > \varepsilon_1$. The first dependenqe of the mean free path on the energy occurs when the Larmor radius of the electron is smaller than the characteristic dimension L_c of the magnetic inhomogeneities, and the second when the Larmor radius is larger than L_c. Thus, ε_1 is the energy at which the Larmor radius of the electron is of the order of the characteristic dimension of the magnetic inhomogeneities L_c. We present here only the asymptotic energy distribution of the electrons for the case of greatest interest, $\varepsilon >> \varepsilon_0$, where ε_0 is the characteristic energy of the initial electron distribution, which can be exponential or obey a power law with an exponent larger than 1.6. The solution of (1) for $\varepsilon >> \varepsilon_0$ yields

$$n(\epsilon)\sim\left(\frac{\epsilon_0}{\epsilon}\right)^{1+\beta_1}\quad \epsilon>>\epsilon_0\,,\qquad n(\epsilon)\sim\left(\frac{\epsilon_1}{\epsilon}\right)^{2\beta_2-1/2}\epsilon>>\epsilon_1\,. \tag{2}$$

This spectrum is in good agreement with the electron spectrum obtained from data on the background x-radiation [3, 4] at $\beta_1 = 0.4 - 0.6$ and $\beta_2 = 1.4 - 1.6$.

By specifying $\varepsilon_1 \simeq 3$ GeV [3], we obtain for the characteristic dimension of the magnetic inhomogeneities in the electron-acceleration region a value $L_c \simeq 10^{13}$ cm. The given asymptotic form (2) is valid under the following conditions:

$$\left[1+\frac{R^2\overline{\Delta u^2}}{c^2\Lambda^2(\epsilon_0)}\right]\left(\frac{\epsilon}{\epsilon_0}\right)^{\beta_1}_{\text{if } \epsilon\leqslant\epsilon_1} \gg 2;\quad \left(\frac{\epsilon}{\epsilon_1}\right)^{\beta_2} > \frac{R\sqrt{\overline{\Delta u^2}}}{c\Lambda(\epsilon_0)}\left(\frac{\epsilon_1}{\epsilon_0}\right)^{\beta_1}_{\text{if } \epsilon>\epsilon_1} \qquad (3)$$



Here R is the characteristic dimension of the electron-acceleration region. It must be emphasized that several recent papers [5, 6] report observation of a large number of radio sources in the region of high frequencies (>0.6 GHz) with a flat spectrum, α = 0.2 - 0.6, many of which are apparently metagalactic objects. It is important to note that at the given level of radio flux, their number is much larger than the number of radio sources with α = 0.7 - 0.8 (radio galaxies and normal galaxies, see the figure, which is taken from [6]). The value of the flux in the frequency region ∿1 GHz is larger by almost two orders of magnitude than the radio flux from our galaxy. The magnetic field inside these objects, as estimated in [5], may exceed 10^{-5} G. Therefore, if it is assumed that the dimension of these ojbects is $\sim 10^{22}$ cm, then the electron density inside them can exceed the electron density of our galaxy by two orders of magnitude. If these radio objects are regarded as sources of the relativistic electrons responsible for the x-ray background of the metagalaxy, then the leakage electrons lose a small fraction of their energy inside the objects under consideration, and lose the greater part of their energy in the metagalactic space, producing the x-radiation. Then the spectral index of the radiation α is connected with the index of the electron spectrum γ as follows: $\alpha = (\gamma-1)/2$ in the radio band and $\alpha = \gamma/2$ in the x-ray region of the spectrum [2, 4]. The value $\gamma = 1.4 - 1.6 = 1 + \beta_1$ obtained in [2] makes it possible to reconcile satisfactorily the spectrum of the radio objects with the spectrum of the x-radiation of the metagalaxy. Within the framework of this model, a kink should exist in the spectrum of the considered radio objects in the region of ∿10 GHz, if the magnetic field inside these objects is $\sim 10^{-5}$ G. At the present time, the number of experimental points is insufficient to draw a final conclusion, although such a kink has been observed for a number of objects [5].

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