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III-3-8. Interaction of Nuclei and Photons of High Energies with a Thermal Radiation in the Universe*

N. M. GERASIMOVA, A. I. NIKISHOV
and I. L. ROSENTHAL
USSR

Due to the Doppler effect photons emitted by stars (average energy $\varepsilon_0 \sim 1$ ev) can be so energetic as to cause disintegrations of the cosmic ray nuclei of high energies (with the Lorentz factor $\gamma \sim 10^7$). If one assumes that heavy nuclei have the greatest energy in cosmic radiation then the photoeffect can change a high energy part of the cosmic radiation spectrum.

We shall assume that the energy spectrum of cosmic radiation of the power type is produced in the source. Then the nucleus spectrum of a given element isotope coming to the Earth (with taking into account the photoeffect) will be as follows:

$$N(E)dE \approx \frac{RE^{-\beta}dE}{1+T_n/T_p},$$

where T_n and T_p are nuclear and photonuclear life times respectively,

$$1/T_p = C\int_{\varepsilon_{0\min}}^{\infty} \sigma_p(\varepsilon)n(\varepsilon_0)d\varepsilon_0$$

$\sigma_p(\varepsilon)$, the cross section of the nucleus photodisintegration;

ε, the photon energy in the nucleus system;

$n(\varepsilon_0)d\varepsilon_0$, the spectrum of stellar photons.

In contrast to the spectrum in the source the obtained spectrum has a "gap" at the energies of 10^{17}-10^{19} ev for the nuclei of the iron type. A maximum value T_n/T_p for the iron nuclei formed in the Galaxy is reached at $E=6\cdot10^{17}$ ev and is equal to 0.8 at the average photo density $\bar{n}_g=0.3$ photon/cm^3.

The effect is small for nuclei of the Galactic origin since it is necessary for the total nucleus crushing that at least several reactions (γ, n) or (γ, p) take place, *i.e.* it must be $T_n/T_p \gg 1$. This condition may be fulfilled for the nuclei coming from the metagalactic space. Density of matter in the metagalactic space is three order of magnitude less than in the Galaxy, and, according to the available data, density of radiation is only few times as less. Taking into account the life time of the Galaxy, we shall obtain for iron nuclei $T_n/T_p \approx 10$ at $E=10^{18}$ ev. That's why it becomes possible to make a conclusion that the metagalactic component of heavy nuclei does not make a contribution to the corresponding part of the primary spectrum.

Now we shall consider a possible absorption of quanta with the energy $\sim10^{12}$ ev at a collision with thermal photons in the Universe. A cross section of the process $\gamma+\gamma \rightarrow e^+ + e^-$ is equal to 10^{-25} cm^2 at the energy $E=10^{12}$ ev, which is of interest for us. If density of photons with the energy 0.5-3 ev in the Universe is $n_u=0.3$—0.1 photon/cm^3, then at the distance $R=10^{26}$ cm probability of the photon absorption is of the order of unity.

A threshold of the considered reaction corresponds to $E=10^{11}$ ev and the effect reaches the maximum value at $E=10^{12} \sim 10^{13}$ ev. The effect slightly depends on the shape of the spectrum of thermal photons in the energy range of 0.5-3 ev. Owing to the above-said one can expect that a flux of γ-quanta coming from the distant source will be weakened in the energy region of $\sim10^{12}$ ev.

* No manuscript has been received and the preprint is reprinted. This paper was read by L. I. Sarytcheva.