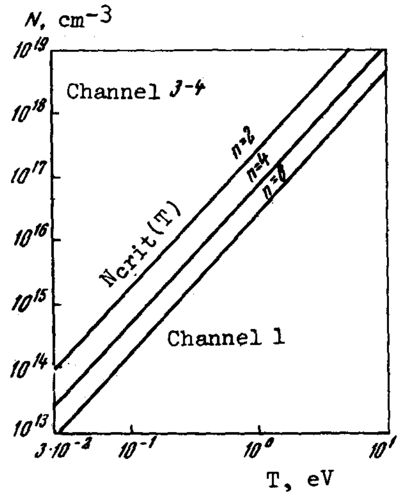

Fig. 2. Regions of predominant decay at the level n of a hydrogenlike ion (Z = 2) through different channels (see Fig. 1).

lowest auto-ionization level to the level n - 1 varies approximately like n^{-1}. Thus, the relative role of the auto-ionization increases with increasing principal quantum number. However, for very high levels it can be greatly weakened by the resonant capture of an electron by an ion in the state n - 1.

The indicated effect must be taken into account in considering the kinetics of the ion level population under conditions of rapid cooling of the electrons. Such conditions are of interest for certain applications of quantum radiophysics [4].

The authors are grateful to L. I, Gudzenko and V. A. Abramov for useful discussions and valuable hints.

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ESTIMATE OF THE ENERGY DENSITY OF SUBCOSMIC RAYS FROM MEASUREMENT OF THE ULTRAVIOLET BACKGROUND

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Submitted 8 December 1967
ZhETF Pis'ma 7, No. 6, 215-218 (20 March 1968)

Charge exchange of protons of subcosmic rays on interstellar hydrogen with capture of an electron in the 2p state should lead to emission of L_α quanta of a wavelength that is shifted as a result of the Doppler effect. Measurements of the radiation flux from the Milky Way in the wavelength range λ = 1225 - 1340 Å ($F = 3 \times 10^{-7}$ erg/cm^2-sec-sr), performed with the "Venera" research satellites [1], made it possible to obtain the upper limit of the energy density of the subcosmic rays with energy 25 - 100 keV ($w_1 < 5 \times 10^{-3}$ eV/cm^3) and to estimate it up to energies on the order of 1 MeV.

If N_H is the density of the interstellar hydrogen, n(E) the density of the subcosmic particles of given energy, and σ the cross section of the process as a result of which a Doppler-shifted quantum is produced, then the luminosity per unit volume is

$$j = N_H \int_E n(E)\, V(E)\, \sigma(E)\, dE.$$

It is also necessary to take into account the dependence of the wavelength of the quantum on the angle between the wave vector of the photon and the direction of motion of the radiating atom

$$\frac{\Delta\lambda}{\lambda} = \frac{V\cos\theta}{c}$$

and

$$j(\lambda_1 \div \lambda_2) = \frac{1}{2} N_H \int_{E_1}^{E_2} n(E) V(E) \sigma(E) \int_{-1}^{-\frac{\Delta\lambda_1 c}{\lambda V}} d(\cos\theta)\, dE,$$

where

$$E_1 = 2\left(\frac{\Delta\lambda_1}{\lambda}\right)^2 mc^2 \text{ and } E_2 = \left(\frac{\Delta\lambda_2}{\lambda}\right)^2 mc^2,$$

and the signs of the integration limits are chosen such that the shift is in the red direction, i.e., the particle should move away from the observer. The assumed flux is in this case

$$F = \frac{1}{4\pi} j(\lambda_1 \div \lambda_2) l = \frac{1}{8\pi} N_H l \int_{E_1}^{E_2} n(E) V(E)\, \sigma(E) \left(1 - \frac{\Delta\lambda_1 c}{\lambda V(E)}\right) dE,$$

where the effective distance ℓ = 300 parsec was determined from the condition that the optical absorption thickness of the interstellar dust is equal to unity [1].

At energies E < 50 kV, the particle beam moving in the hydrogen consists essentially of neutral atoms, and the fraction of the protons decreases rapidly at high energies, owing to the decrease in the cross section of the resonance charge exchange. For the estimates we used the data given in [2] on the composition of the beam as a function of the energy. The cross section of the process

$$H(1S) + H(1S) \rightarrow H(2P) + H(\Sigma), \tag{1}$$

where $H(\Sigma)$ corresponds to any final state (including ionization) of the particle at rest, was calculated in [3]. For our purpose the approximation of [3] (which is valid when E > 30 keV) is perfectly acceptable

$$\sigma_1(E) = \frac{1{,}85 \cdot 10^{-15}}{E,\ \text{keV}}\ \text{cm}^2.$$

The cross section of the process

$$P + H(1S) \rightarrow H(2P) + P \qquad (2)$$

was measured up to E = 30 keV; $\sigma(E < 30 \text{ keV}) > 2 \times 10^{-17}$ cm^2 [4], and its asymptotic value is calculated in [5]. When E > 50 - 100 keV, the cross section of the process (2) decreases rapidly, and the fraction of the hydrogen atoms in the beam decreases analogously as a result of which the role of the process (1) also decreases when E > 100 keV. Consequently the dominant appreciable contribution to the radiation of the shifted quanta is made by particles of energy 25 - 100 keV, in spite of the fact that radiation of particles with E >> 100 keV also falls in the wavelength region under consideration.

Assuming that n(E) is constant, which is perfectly justified when considering the narrow energy region 25 - 100 keV (since the ionization losses are maximal here and depend little on the energy compared with the cross sections and the angle factor) [6], and using the measured value of the flux as an upper limit, we get

$$n(E) < \frac{10^{-9}}{N_H} \quad (\text{cm}^{-3}\text{keV})^{-1}$$

Putting $N_H = 1$, we obtain an upper bound $n(E) < 10^{-9}$ $(\text{cm}^{-3}\text{keV})^{-1}$, i.e., the upper limit of the energy density of subcosmic particles with 25 < E < 100 keV. Knowing the type of energy dependence of the ionization loss $(dE/dt) \sim E^{-1/2}$ at E > 100 keV, we can reconstruct, neglecting injection completely, the maximum possible spectrum n(E) that increases towards larger energies, and obtain an upper limit of the density of subcosmic rays with E ~ 1 MeV.* Indeed, in the stationary case we have

$$n(E)\frac{dE}{dt} = \text{const} \quad \text{i.e.,} \; n(E) \sim E^{1/2},$$

whence

$$w_2 = \int_{E_2}^{E_3} n(E)\,E\,dE < 1 \text{ eV/cm}^3$$

for 100 kV < E < 1 MeV. It is obvious that the foregoing estimates can be greatly lowered (a) by narrowing the spectral interval, since 100 keV corresponds to a maximum shift of 17 Å; in the measurements of [1] the spectral interval exceeds the required value by 15 times, and (b) by separating the contribution of the stars, which undoubtedly determines the entire effect observed in [1]. This is easiest to do in observations perpendicular to the plane of the galaxy with a small field of view. It is also interesting to carry out observations for $\lambda < 1216$ Å, where the radiation from the stars should be much weaker. A decrease of the limit of n(E) makes it possible to determine the energy at which $n_{max}(E)$ is reached and in the region of which the main energy of the cosmic rays is concentrated.

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* We neglect here the possible acceleration of the particles by plasma waves in the interstellar medium, and assume that in the energy band under consideration they are all the result of ionization losses.

ERRATA

Article by P. I. Fomin, Vol. 6, No. 11, p. 373.

Detailed calculations (performed with V. I. Truten') have shown that the inequalities (5) and (9), which are based on preliminary estimates, are incorrect, and they should be replaced by the equalities $B = 3\pi/2$ and $Z_3 = 0$. Equation (4) has thus a unique solution.

In spite of the vanishing of Z_3, it is possible to obtain a finite renormalized charge in the theory under consideration, unlike in [3], by letting the bare charge to to infinity.

Article by R. V. Ambartsumyan et al., Vol. 7, No. 3, p. 66.

Figures 2 and 3 of this article should be interchanges, but the captions should be left in place.

Article by N. E. Alekseevskii et al., Vol. 6, No. 8, p. 249.

The azimuthal orientation of the sample is incorrectly indicted in the text and in Fig. 1. $\vec{H} \perp [0001]$ must be replaced throughout by $\vec{H} \parallel [0001]$.

Article by Yu. V. Gulyaev, Vol. 7, No. 5, p. 132.

Equation (1) should read:

$$\Delta V = -\frac{LE_0 E_{\sim}^2}{\sigma(E_0^2)}\left\{\frac{d\sigma(E_0^2)}{dE_0^2} + \frac{2\left(\frac{d\sigma(E_0^2)}{dE_0^2} + \frac{d^2\sigma(E_0^2)}{d(E_0^2)^2}E_0^2\right)\cos^2\gamma}{1 + \omega^2\tau_e^2\left(1 + \frac{d\ln\sigma(E_0^2)}{d\ln E_0^2}\right)^2}\right\}$$