THE THIRD SKY PROGRAMME.

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The study of the early universe goes in several directions. One of the most advanced at present is the statistical description of the power spectrum of primary temperature fluctuations of the CMB. These fluctuations are observed on the last scattering surface in the epoch of recombination of hydrogen at redshifts of about 1100. In addition, the global characteristics of the CMB spectrum carrying information on the global energy release in the epoch of $z < 10^5$ are investigated. However, with all the tremendous achievements of these works, there are still directions completely unexplored in the experiment.

The most obvious and promising is relatively high resolution spectroscopy combined with the study of individual fluctuations - the search and study of spectral-spatial fluctuations of the temperature of the CMB. In the field of the theory of such fluctuations, there is already a sufficiently large set of results on various aspects of physical processes and their quantitative calculation [1-3], as well as on the possible relationship with cosmological consequences of particle theory [4] associated with the mechanism of inflation. In particular, the picture of the spatial and spectral distribution inside a separate proto-object is described in sufficient details.

The distribution of brightness (intensity) along the radius of fluctuations for sufficiently small initial sizes of proto-objects is almost universal due to the fact that it is formed on at the last scattering stages of the epoch of hydrogen recombination. Before this moment, the radiation of the proto-object is locked near it due to large opacity for the Thomson scattering on electrons. The enlightenment increases rapidly only with a rapid decrease of the concentration of free electrons. Thus, all the observable geometrical parameters of fluctuations of size 10–20 'practically do not depend on the redshift of the proto-object. Only the amplitude will be different.

Another important feature of these fluctuations will be their summation along line of sight. In the case of the continuum Planck spectrum for each individual fluctuation, due to the same dependence of the photon frequency and temperature from z, the result of the summation can be averaged. In our case each fluctuation lying on the line of sight has its own spectral system of details, corresponding to the redshift z of this fluctuation. As a result, when summing, these details will not overlap each other. So we get a full three-dimensional picture for the distribution of proto-objects.

The details of spectral features of individual fluctuations are determined by the interaction of radiation with hydrogen and helium atoms in the Lyman series resonance lines and luminescence. The first mechanism gives effect in the Wien region of the CMB and has a form of characteristic leaps. The second mechanism gives distortions in the Raleigh-Jeans part of CMB spectrum. The spectral bands are determined by the size of the initial fluctuation and in our case will be of the order of several percents of the central frequency. The amplitude of the distortions is determined by the initial intensity of the fluctuations and by the quantum efficiency of the redistribution of the spectrum. In our case, in the Wien region (400 μm), the brightest spots will have a relative intensity of about 10^{-7}.

This estimation of the effect is based on the actually observed amplitudes of continual fluctuations corresponding to the standard theory of the origin and evolution of density fluctuations of matter. The amplitude can be substantially larger if there were non-standard objects or their clusters on the early Universe. In this case, it can be a sparse population not detectable by statistical methods. They may also have a substantially non-Planck spectrum. However, even for them, calculations of the quantum efficiency of spectrum processing due to resonant transitions in hydrogen and helium will be valid.

The observational program of this project requires

- a satellite on near-Earth orbit (500-1000 km altitude or around L2 Sun-Earth point) with 1.5 m telescope
- spatial resolution 4-5 arc min. per pixel matrix
- a receiving matrix in the range of 500-1200 GHz.
- the matrix receiver must have a spectral resolution of 5-10 GHz.
- sensitivity - the maximum possible.

References

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