TOTAL CONTENT OF ATMOSPHERIC OZONE MEASUREMENT APPARATUSES, CREATED IN THE SPACE RESEARCH INSTITUTE AT THE BULGARIAN ACADEMY OF SCIENCES

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Abstract. In the Space Research Institute at the Bulgarian Academy of Sciences a Satellite Impulse Photometric equipment Therma has been developed, launched on the Orbital Station Mir in 1986, a laboratory Multichannel Scanning Spectrophotometer has been developed with dispersive diffraction lattice. At present an Spectrophotometer is under development permitting the measurement of the general atmospheric ozone content in the bands of Hartley and Huigens

Key words: atmospheric ozone, spectrophotometer

The anthropogenic contamination of the earth surface and the breach of the biosphere ecological balance are of the most important problems for the present day. It follows the particularly importance of the problem for the environment monitoring and tendency toward the changing of the atmosphere ecological important components control. Among them especially place take the atmospheric ozone, the little gases particles and the industrial air contaminators. For the problem solution it’s necessary to be done the synchronous space and land explorations of these components implement. It’s important is also the increasing of the devices and systems information and accuracy as well as the new devices development.

The Space Research Institute (SRI) at the Bulgarian Academy of Sciences has a 20 years experience in spectro-photometric devices creation. The Space Research Institute (SRI) at the Bulgarian Academy of Sciences (BAS) has a about 20 years experience in spectro-photometric devices creation (Getsov, Mardirossian et al., 2003).

A swift-operating pulse photometer “Therma” (Getsov, 1998) has been designed (Fig.1), launched on the MIR Orbital Station in 1986.

In SRI – BAS is developed also a lab ultraviolet spectrophotometer (Fig. 2) with
dispersing diffracting grating (Jekov, Mardirossian et al., 1998. The input optical system makes a scanning on 45° to the zenith, it’s elaborated 12 discrete wavelength, the signal is translated for processing and recording in computer, to the computer output is received the result in digital and graphic view.

It’s also developed absorbing filter spectro-photometer AOM-5 (Hristov, Jekov et al., 1999), of photo-electronic amplifier 9 interferenting filters with. Is shown on Fig. 3 the AOM-5.

Fig. 3

In this paper it examines for the terrestrial-subsatellite explorations spectro-photometer of the total ozone concentration. It’s shown on fig. 4 the whole suggested scheme. It’s made up of a reflecting mirror 1, an input objective 2, an input swift 3, a collimator objective 4, a diffraction lattice 5, an output swift 6 and electroengine pitch 8. After the output swift it’s fitted a lens 7 which turns the beaming on photoelectric amplifier 9 with supplying panel 10. To the photoelectric amplifier output is plugged a moulding amplifier 11 in, the output signal of which feeds to computer system 12.

Fig. 4
The spectro-photometer works as follows:

The luminous flux form the Sun, in the presence of clouds from the zenith, falls the plane reflecting mirror 3 on and directs to the quartz objective 2, passes the input swift 3 and through the collimator objective 4 falls the diffraction lattice 5 on which diffracts it in the optical spectrum ultraviolet part. The electroengine pitch 8 provides such the lattice dispersing that in exact moment a fixed spectral line (with a fixed wave length $\Delta \lambda$) falls the output swift on, passes and through the receiving lens 7 is focused over the photocathode sensitive area of the photoelectric amplifier 9. The darkled current is measured closed output swift at. During the optical signal registration the photoelectronic amplifier is in the photons accounting regime. The amplifier output signal amplifiers from a moulding amplifier 11 and receives for according and processing in the computer system 12.

During the spectro-photometer optical-electronical tract projecting, the level proportion rational choice is an important problem. In (Petit, 2002) are shown analytical equations of the characteristics at the fluctuation signals, which give possibility to make a valuation of the necessity value of the ratio signal/noise and signal/level, at given probability for the right detection $P$ and admitting probability for wrong signal $P'$.

In the paper is made an assessment for characteristics influence in the fluctuation optical signals registration into the Gauss noises background with giving an account for the instability of the level device level work. In the signal optimum linear filtration conditions, known to the amplitude accuracy, the probabilities for the right found signal $P$ and for the wrong signal $P'$ can be calculated over the equations (Гушкин, 1998; Kalhor, Nevrether, 2001):

$$P = \int \int P(U/A)P(A)P(U_0)dUdAdU_0$$

$$P' = \int \int P(U / 0)P(U_0)dUdU_0$$

where: $P(U/A)$ – relative density probability of the $U$ realisation ($U$ is the tension of the filter output moment value);

$P(A)$ – a function of the electrical signals amplitude distribution;

$P(U_0)$ – a function of the binary quantator level work distribution;

$U^*, A^*, U_0^*$ – changing area of $U, A, U_0$ values respectively.

For this problem solution it’s reported the follow conditions:

1. The function of distribution $P(U_0)$ can be depicted with uniform or normal distribution;

2. The mathematical expectances and the disperses of the upper distributions are equal;

3. The function of distribution $P(A)$ can be depicted with normal distribution with parameters- signal amplitude $A$ and its disperse $\sigma_A$.

The signal amplitude $A$ is a positive value and for calculation truth it’s necessary to be done the condition:

$$\frac{\sigma_A}{A} \leq 0,4 \ .$$

Applying the Gauss noises statistics (Дунаев, 1999) and according to the values $U$ and $A$ changing range, after double integration we have:
\[
P = \frac{1}{2} + \frac{1}{2} \int_{L_0} P(l) dl
\]

(3)

\[
P' = \frac{1}{2} - \frac{1}{2} \int_{L_0} P(l) dl ,
\]

(4)

where: \( \mu = \frac{A}{\sigma_A} \) – signal amplitude mathematical expectance;

\( l = \frac{U_0}{\sigma_A} \) – signal/noise correlation;

\( \sigma = \frac{\sigma_A}{A} \) – a coefficient characterizing the amplitude disperse;

\( P(l) \) – the correlation level/noise function of distribution;

\( L_{o} \) – changing area of \( l \) value.

In the given function \( P(U_0) \) it’s not difficult to be found the function \( P(l) \) using the standard methods for casual constants transformation.

In \( U_0 \) uniform statistics:

\[
P = \frac{1}{2} \left[ 1 + Z_1 \left( Z_2 - Z_3 + \frac{1}{\sqrt{n}} \left( e^{-Z_2^2} - e^{-Z_3^2} \right) \right) \right]
\]

(5)

and in case of Gauss noises background

\[
P = \frac{1}{2} \left( 1 + Z_4 \right) ,
\]

(6)

where:

\[
Z_1 = \frac{\sqrt{2(1 + \mu^2\delta^2)}}{2\sqrt{3}\rho l} ; \quad Z_2 = \frac{\mu - \bar{l} + \sqrt{3}\rho l}{\sqrt{2(1 + \mu^2\delta^2)}} ;
\]

\[
Z_3 = \frac{\mu - \bar{l} - \sqrt{3}\rho l}{\sqrt{2(1 + \mu^2\delta^2)}} ; \quad Z_4 = \frac{\mu - \bar{l}}{\sqrt{2(1 + \mu^2\delta^2 + \rho^2\bar{l}^2)}} ;
\]

\( \rho = \frac{\sigma_{U_0}}{U_0} \) – a coefficient characterizing the quantator level work disperse.

Analogous to this equation, for \( P' \):

\[
P' = \frac{1}{2} \left[ 1 + Z'_1 \left( Z'_2 - Z'_3 + \frac{1}{\sqrt{n}} \left( e^{-Z'_2^2} - e^{-Z'_3^2} \right) \right) \right] .
\]

(7)
In the case of Gauss noises background:

\[
P' = \frac{1}{2} \left(1 - Z_4'\right)
\]

where:

\[
Z_1' = \frac{1}{\sqrt{6} \rho l}
\]
\[
Z_2' = \frac{i(3\rho - 1)}{\sqrt{2}}
\]
\[
Z_3' = \frac{i(3\rho + 1)}{\sqrt{2}}
\]
\[
Z_4' = \frac{i}{\sqrt{2(1 + \rho^2 f^2)}}
\]

After using of (Серг, Семенъяев, 1992) is received a function subjection \(P = f(\rho)\) for \(l = 4\) and different values for \(\mu\) and \(\delta\) (Fig. 4). The uninterrupted curves correspond to the uniform statistics of \(U_0\), and the interrupted – to the Gauss statistics.

Of the presented graphics are observed that when the parameter \(\rho\) increases, the probability for wrong signal increases. In passing of non-fluctuating signal (\(\delta = 0\)) or fluctuating (\(\delta = 0.3\)), along with the level correlation total change for the worse, the dispersing of feed level influence (the parameter \(\rho\)) on the wrong signal probability increases. Besides, along to parameter \(\rho\) increasing on the system, differences in the statistics features of \(U_0\) begin to make an influence, after that in the passing from uniform to Gauss distribution the probability considerably decreases.
As conclusions it can be remarked:

1. The presented graphical results indicate if $\rho \geq 0.3$ the system with feed level uniform statistics dispersing has considerable high noise-protection according to cases when $U_o$ is under Gauss distribution subjection.

2. The received results are useful in optical-digital project of spectro-photometer tract for rational choose of the level correlation and system noise-protection assessment.

REFERENCES:


