

MODEL OF BRIGHTNESS OF LIGHT POLLUTION OF ATMOSPHERE

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Ternopil State Technical University and
Astronomical Observatory of National University
of Lviv conducted a joint study and research
the problem of light pollution atmospheric lighting
devices.

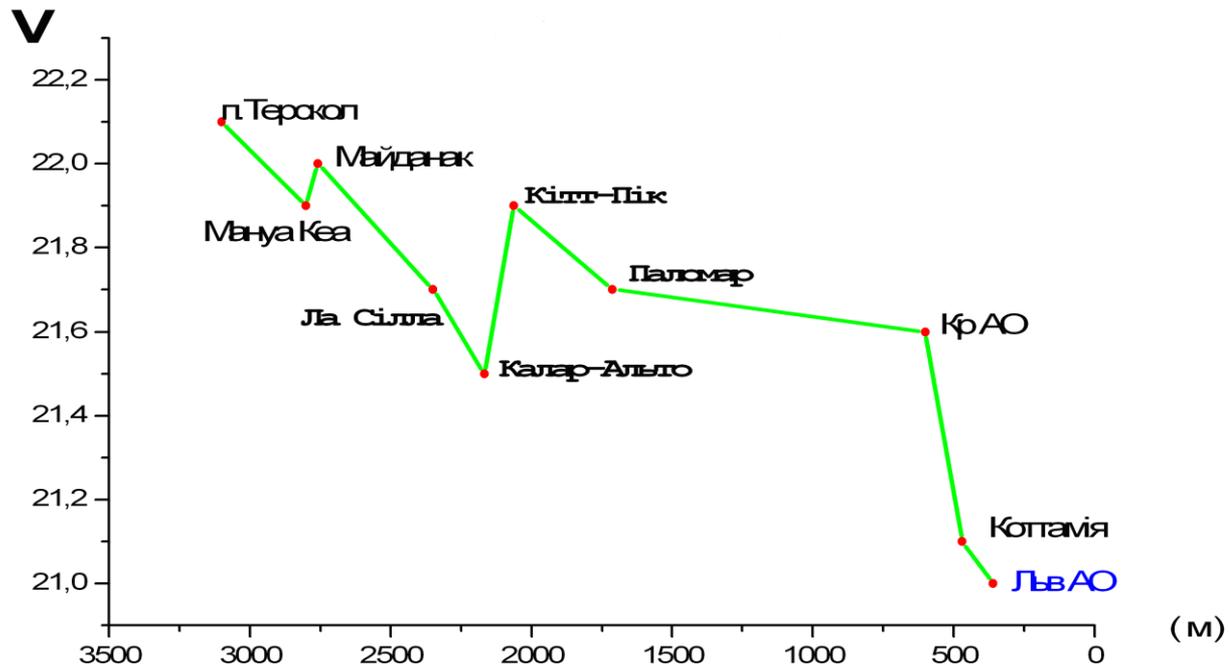
Practical problems whose solution aimed at project:

1. Measurement background sky and indicators
in the U, B, V, R – filters.
2. Comparison of measurement data for other cities.
3. Mathematical modeling of light pollution.

The most important parameter of the astroclimate is the background of the night sky. In places where there is no artificial lighting, the brightness of the sky at the zenith in the absence of stars is brighter than 10m, with minimal solar activity, low albedo and no aurora borealis is equal to $V = 22.0$, $B = 23.0$ m /sec². The main task of building mathematical models of light pollution is the study of factors of anthropogenic origin

Meteorological characteristics that affect light pollution	Changes in the city compared to the countryside
Repeated fogs (smog) in winter and summer,	> 100% , > 30%
Cloudiness	> 5-10%
Dust content	> в 5-20 раз
Precipitation	> 5-10%
average temperature	> 0.5-1⁰C 1-2⁰C

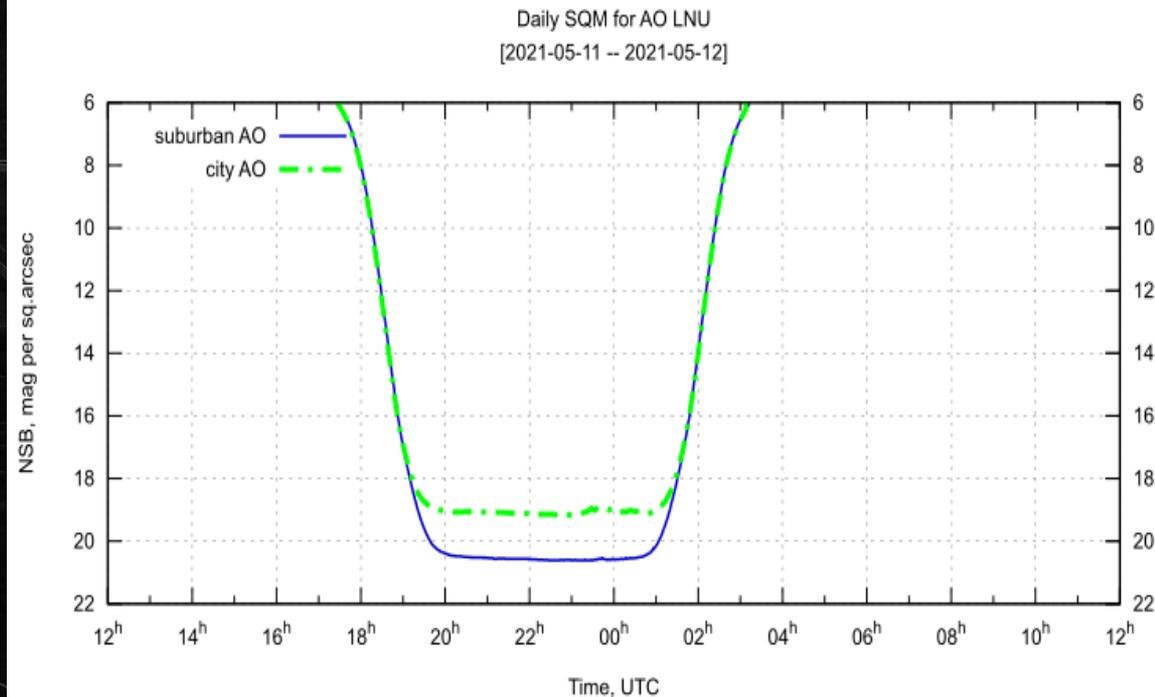
Comparison of the brightness of the night sky V (mag) in the zenith of the celestial sphere for different observatories of the world depending on the height above sea level (meters).



Observation of light pollution in astronomical observatory Ivan Franko National University of Lviv (AO LNU)

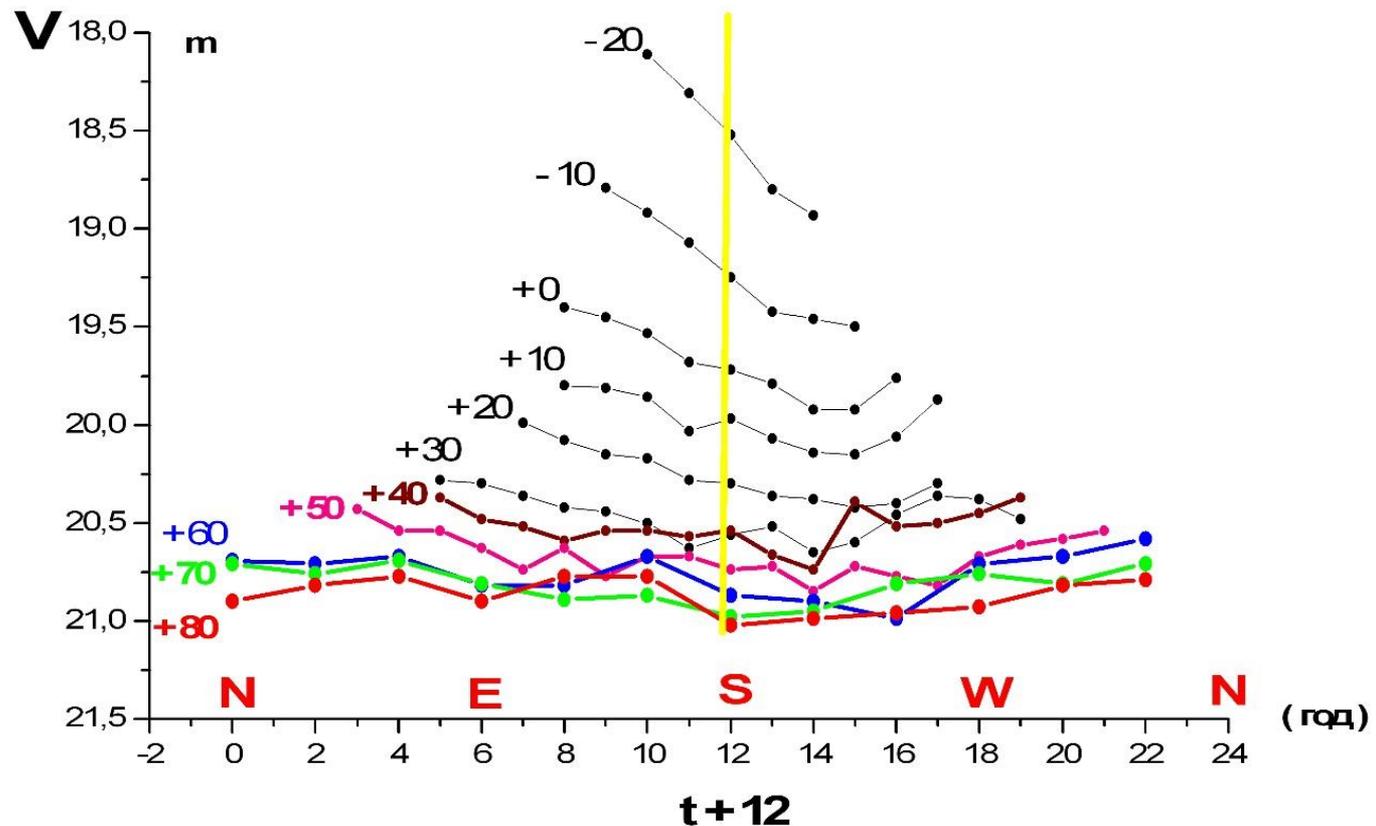
New data = 2021.

for Lviv received 18.94 mpsas, and for a
suburban station in the village of Bryukhovychi 10
km from the city received 20.13 mpsas

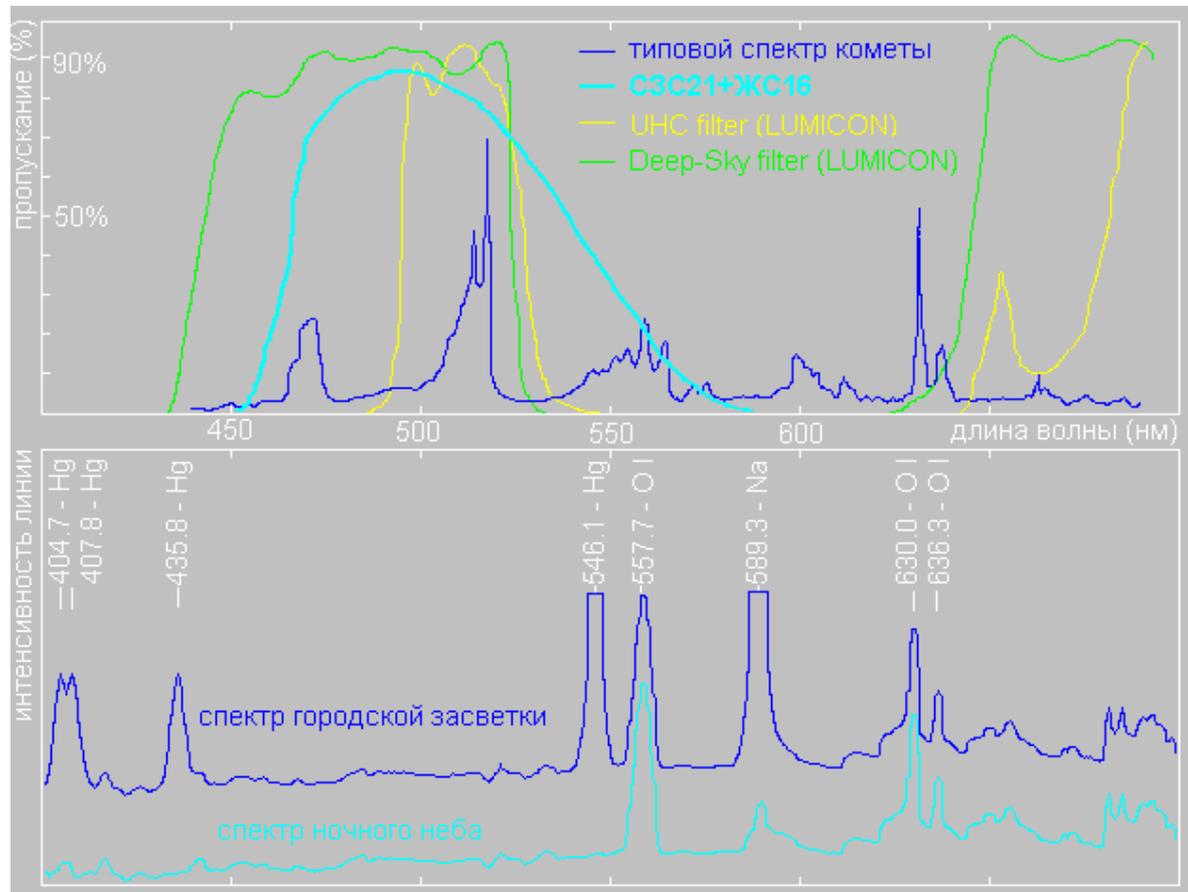


The brightness of the night sky V (mag) from the change of the spherical coordinate of inclination δ (from +80 to -20 degrees) and the time angle t (hours)

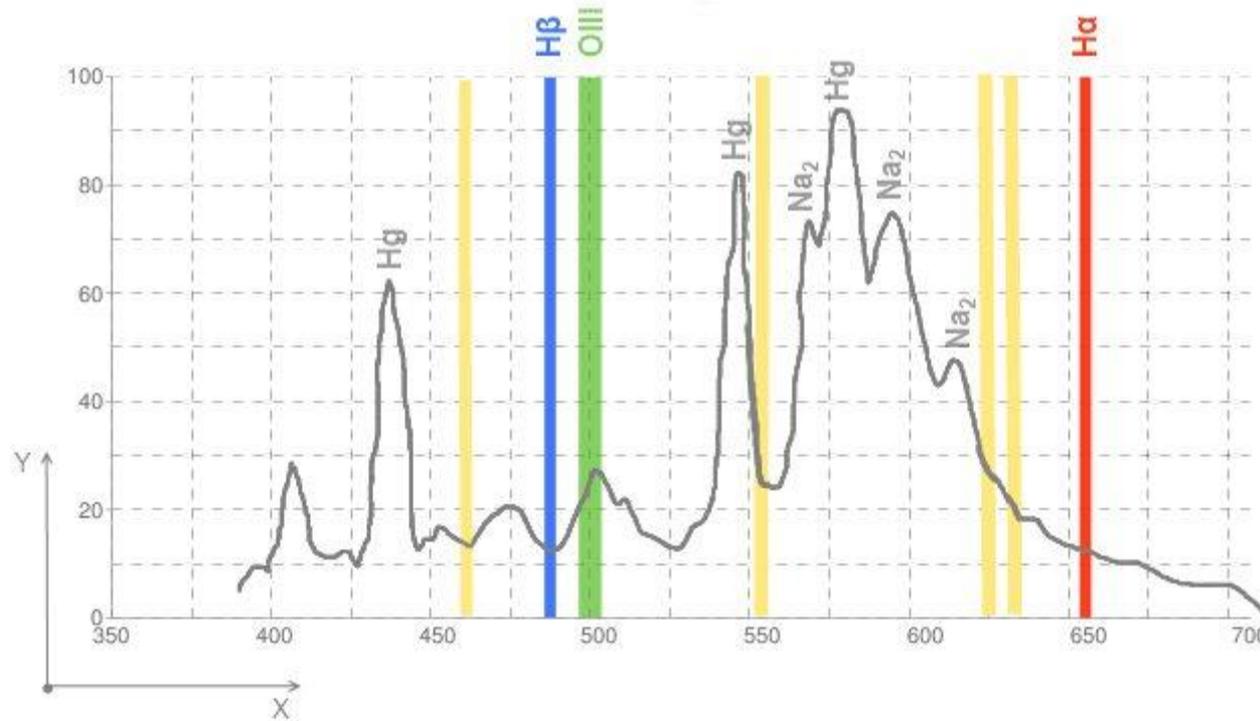
Historical data. 2009-10.



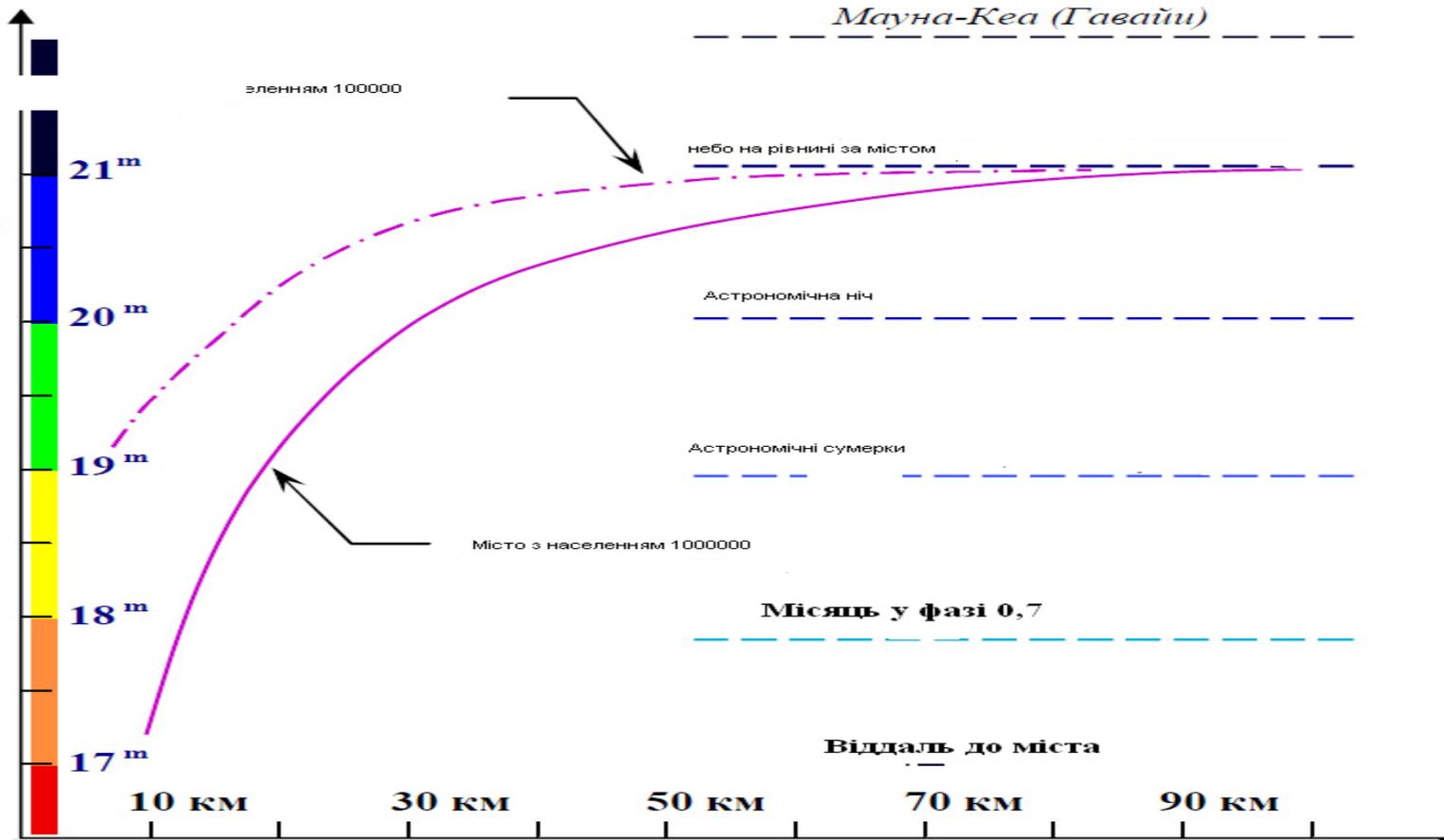
Typical spectra of night sky radiation in the wavelength range 400 ... 700 nm in the absence of illumination by city lights (lower curve) and in urban illumination (upper curve).



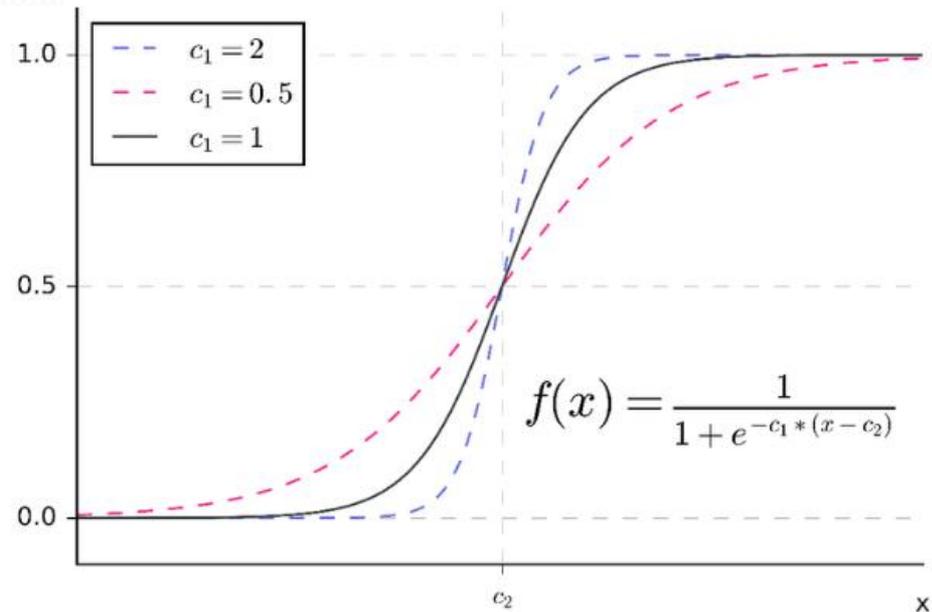
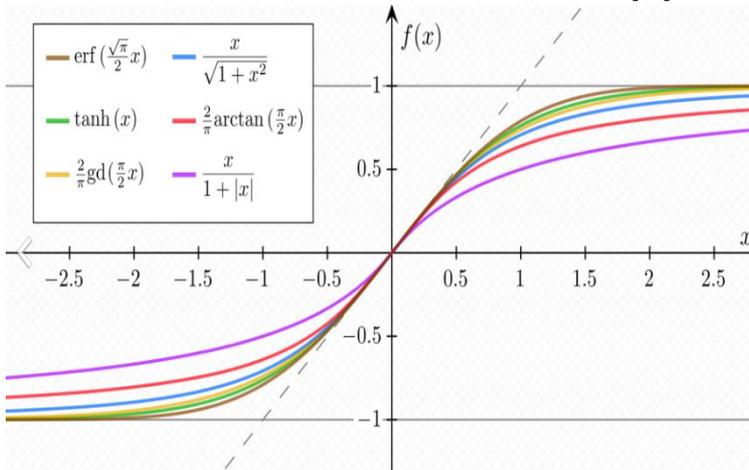
The main sources of light pollution of the atmosphere of the line of intense radiation of nebulae



The brightness of the sky at a distance from the city

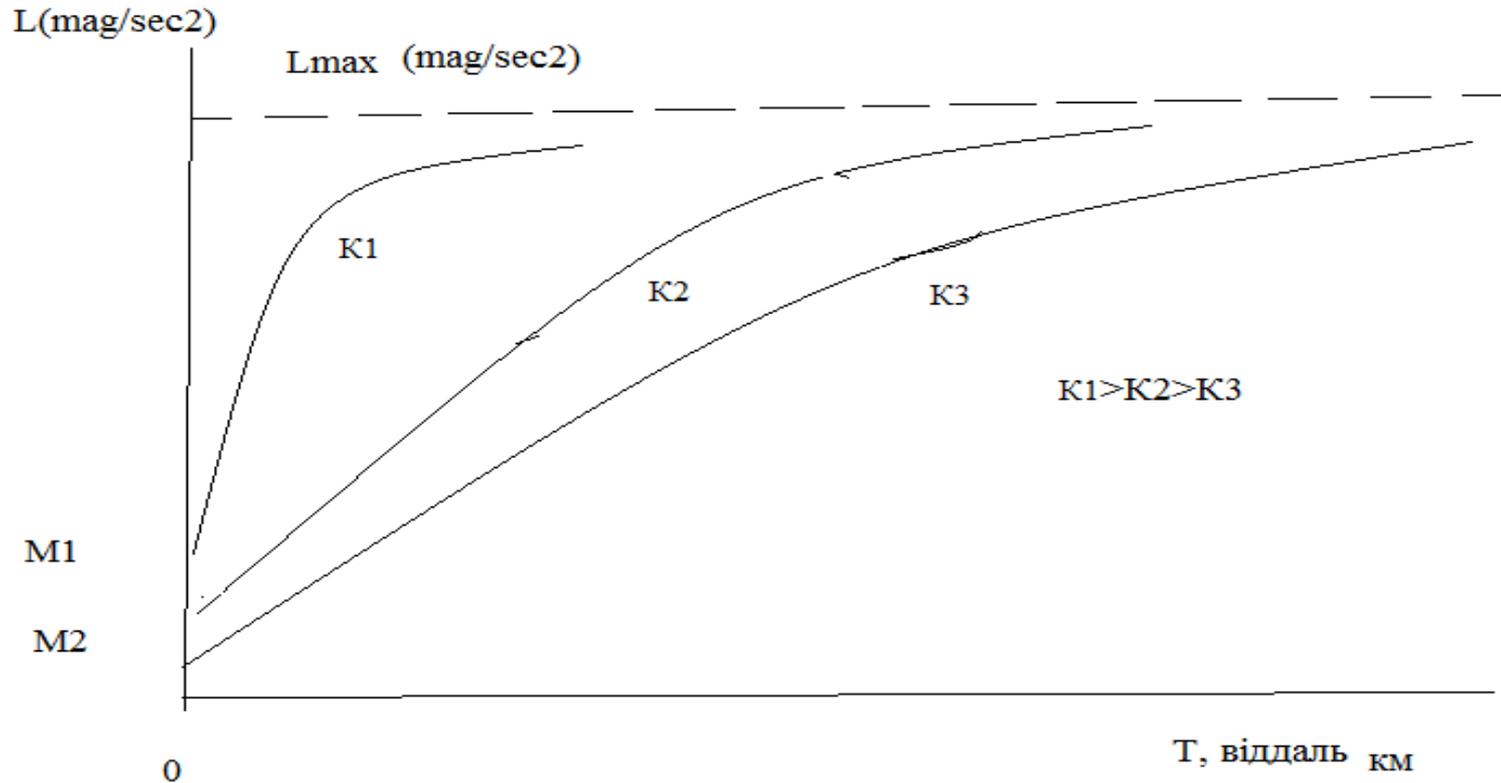


Functions of the sigmoid class for approximation:



Differential equation of the dependence of light pollution on distance:

$$\frac{dL}{dt} = k(L_{\max} - M)$$
$$L(t) = (L_{\max} - M) \exp(-kt)$$



Sky brightness model

The brightness of the sky $L(d)$ (mag /sec²), created by artificial light sources at a distance of d (km) from the city is approximated by:

$$L(d) = 22.0 - (22.0 - m) \cdot \exp(-k \cdot d);$$
$$k = 0.0758 + (0.001952/N);$$

where N is the number of inhabitants in million people;
 m - brightness of the sky background in the city, mag / sec².

Attenuation of brightness of stars Δm (mag) taking into account light pollution of the atmosphere:

$$\Delta m = \delta m \cdot ((P/T_0) / (P/T)) \approx (2.5 \lg p) \cdot \Delta M(z) \approx 1 \approx 2.5 \cdot \lg (L_{pr}/L(z));$$

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Rayleigh model: $\delta m = 0.17$ mag, background model of the aerosol $\delta m = 0.26$ mag,
the average model $\delta m = 0.34$ mag.

P - atmospheric pressure, (mbar);

T -atmospheric temperature, (K);

$P_0 = 1013$ mbar;

$T_0 = 273.15$ K.

L_{pr} - natural brightness of the sky,; mag /sec²;

$L(z)$ - the brightness of the sky from artificial lighting,; mag /sec²;

P - coefficient. atmospheric transparency;

$M(z)$ - is the mass of the atmosphere

Thank you for attention