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Annihilation of Photons in the Upper Layers of the Atmosphere and the Blue Color of the Sky Before the Sunrise

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Abstract

In the process of interaction of solar radiation with gas atoms in the upper layers of the earth's atmosphere, axions take part along with photons. The resonant absorption of hard ultraviolet photons by oxygen atoms, as well as the annihilation of hard ultraviolet photons, the energy of which is not equal to the energy of electronic transitions in oxygen atoms, ensures the safe blue color of the morning sky. Indeed, during the annihilation of a pair of photons in the field of an atomic nucleus and the subsequent decay of an axion, of the two newly appeared photons, the atom, as a rule, absorbs the harder photon. As solar radiation moves towards the earth's surface, multiple cascade annihilation reduces the hardness of ultraviolet radiation. The issues of coloring the sky in the morning, afternoon and evening are considered.

Keywords: Photon, Axion, Blue Sky, Ultraviolet Radiation.

Introduction

In work delivered task get answer to the question "Why is the sky blue?" The answer to this question is generally accepted to be the following statement: "When light from the Sun falls on the Earth, He passes By interplanetary space, which is a vacuum, enters the atmosphere and interacts with the inhomogeneities of the air, which contains atoms of different elements: oxygen, nitrogen. Elastic scattering of light occurs on these inhomogeneities of the air. For an observer on the ground, the sky is blue because What, When solar light, (containing different colors) passes through the atmosphere - blue color is scattered with a greater probability than red. That is, the blue color of the sky is scattered in the atmosphere photons of sunlight." This interpretation Not gives answer on questions: for check Why does the atmosphere warm up in the morning hours? How does elastic scattering of light occur? broadcast energy atmosphere, If in elastic Rayleigh scattering the wavelength of the radiation does not change?

Annihilation Photons

Physical Model for Interpretation of the Color of the Sky

Subject work is analysis optical processes in the Earth's atmosphere. We believe that the change the color of the sky during daylight hours from blue to light blue, in the morning before sunrise, to red, In the evening on sunset, connected With annihilation of solar radiation photons in the electromagnetic field of the nuclei of oxygen atoms, the presence of which is due to the decay of oxygen and ozone molecules under the influence of solar radiation. Our goal is to show that in the process of such interaction, the atmosphere is heated, and it is not solar photons that reach the Earth's surface, but newly born photons that appear as a result interactions photons solar radiation with atoms of atmospheric gases.

The process of such interaction involves the annihilation of photons in the electromagnetic field of the atomic nucleus, leading to birth short-lived axions [1–4]. Because birth axion is expected in the presence of a strong electromagnetic field, for example, the field of an atomic nucleus, then neither elastic scattering of radiation on solid particles, which are not present in the upper layers of the atmosphere, nor Mandelstam-Brillouin scattering as a result interactions radiation With natural elastic vibrations of the medium will not be considered by us. In the morning hours, until the atmosphere has warmed up and water vapor has filled the lower layer atmospheres Also Not we will consider scattering Sveta on fluctuations density Wednesday (small local deviations density from her average value), which are believed to be associated with the process of scattering of solar radiation. These inhomogeneities cause the scattering of light, which was first considered by Rayleigh. Recall that Rayleigh scattering-

Rayleigh scattering - coherent scattering of light without change of wavelength (also called elastic scattering) by particles, heterogeneities or others objects.

This process Not gives answer on questions: for check Why does the atmosphere warm up in the morning hours? What way is happening broadcast energy gases in atmosphere, If at elastic Rayleigh When light is scattered, the wavelength does not change?

Annihilation Photons
V Field Atomic Nuclei of Atoms
Traditional, according to Boru And Einstein, scheme interactions radiation And substances includes the following processes: 1) resonant absorption of radiation, 2) spontaneous emission, 3) resonant stimulated emission. In the absence of resonance between frequency radiation pumping And frequencies electronic transitions V atoms And molecules atmospheric oxygen And nitrogen follows assume that the process of interaction between radiation and atoms is carried out due to another (non-resonant) interaction.

Let us dwell on the work of the American physicist Primakov's theory (HENRY PRIMAKOFF), according to which, the annihilation of two quanta (photons) V field atomic nuclei Maybe bring To the birth of an axion – A 0 :

$$\text{what} + \text{hv} = A^0 = \text{wh} + \text{white}, \quad (1)$$

And his disintegration (direct And back Primakov effects), where hv is the energy of quanta (photons) of the light source acting on Wednesday; v - frequency this radiation; hv 0 j – the energy spent on the transfer of electrons located at the ground level – 0 to one of the higher excited levels j ; hv ij - energy photons at the exit of the medium, produced as a result of axion decay, (is determined by the difference between the energy of the virtual level – i and the energy of the excited atomic level – j , to which the electron is transferred. The number of levels j in the spectrum of oxygen and nitrogen atoms is large, so we have many new components of the radiation spectrum at the exit of the studied dispersed medium (in our case, the near-Earth atmosphere). The energy of newly produced photons is hv ij less energy of photons of the light source [5].

What determines the energy of the virtual level? ня – i ? The energy of the virtual level – i is determined by the sum of the energies of two photons of solar radiation .

Photons, the frequency of which in (1) is designated the value of v i j , in general, are scattered into the corner 4 π
steradians.

Considered process annihilation steam photo- nov together With processes 1) resonant absorption of radiation, 2) spontaneous emission, 3) resonance forced radiation complements when viewed from a quantum perspective, the picture of the interaction of radiation and matter.

When analyzing the spectrum of radiation of the sky, reaching surfaces lands V current daylight hours, we will take into account all four processes.

Change Colors Sky During Daylight Hours
Can highlight 4 regime coloring earthly sky during daylight hours:
1) morning sky, Sun more Not appeared over horizon
2) firmament from sunrise sun to moment, related With appearance tough ultraviolet on surface of the earth
3) midday hard ultraviolet
4) afternoon sky, sunset red sun

Morning firmament, Sun has not yet appeared above the horizon on a cloudless morning before sunrise, the blue sky illuminates the earth's surface. The photons that an observer on the earth's surface registers cannot possibly be the photons emitted the sun (the sun is still below the horizon). After leaving the sun, photons head towards the earth, Not interacting with each other With friend (laminar movement). Moving rectilinearly because of horizon, photons in the upper layers of the atmosphere meet atoms oxygen. Source atoms oxygen is stratospheric ozone, formed in result impact UV radiation Suns on molecular oxygen (O2). IN spectrum atom oxygen We we have set transitions V UV areas spectrum. Photons, energy which equal the energies of interlevel transitions of oxygen atoms, according to the Einstein-Bohr scheme, are absorbed in the upper layers of the atmosphere (resonant absorption) radiation), at this electrons atoms oxygen and nitrogen move from the ground level to excited levels, rising successively from lower levels to higher ones. The same thing happens with electrons in the case when the energy of photons differs from the energy of interlevel transitions . IN this case electrons are crossing over on excited levels due to the annihilation of solar pairs photons (according to ratio)

(1) With education short-lived axions. Photons that appeared V result axion decay lead myself differently: How rule, V first queue, atoms absorb ultraviolet (hard) photons, energy (frequency) which more how energy of photons of the parent pair.

That's why V morning watch to sunrise sun Hard ultraviolet photons do not reach the earth's surface.

The other part of the photons that appeared in the atmosphere during the decay of axions, the frequency of which in
(1) is designated size v i j , dissipates V corner 4π steradian. Blue radiation firmament, coming-reaching the surface of the earth before sunrise is due to these photons.

Particular attention should be paid to the case when energy photons radiation pumping, more than energy interlevel transition. For these photons according to dispersion theory refractive index less units And That's why They or are reflected in the opposite direction, or annihilate in pairs. During annihilation, electrons move to excited levels, as in the case considered above.

Firmament from sunrise sun to moment associated with the appearance of hard ultraviolet radiation on the earth's surface.

After sunrise in the morning hours there is no photons tough ultraviolet V coming on earthly surface radiation conditioned by oblique propagation of solar radiation to the earth's surface. Due to the oblique incidence solar rays photons tough ultraviolet surfaces lands Not reach. How And before sunrise they are absorbed by oxygen atoms - continues process transition electrons

of oxygen and nitrogen atoms to higher levels. Note that What How And early in the morning are absorbed not only resonant photons, But And photons, appeared in the process of annihilation. In the morning hours the sky saves blue-blue color. All a greater number of atoms in the path of solar radiation radiation turns out V condition, When population electrons on basically And excited levels of atoms are aligned.

Midday Hard Ultraviolet

To moment, When Sun located V zenith, an equilibrium is reached between the number of electrons at the ground and excited levels. The equilibrium is ensured: on the one hand, by the absorption of solar photons, and, on the other hand, by the process non-radiative relaxation And processes

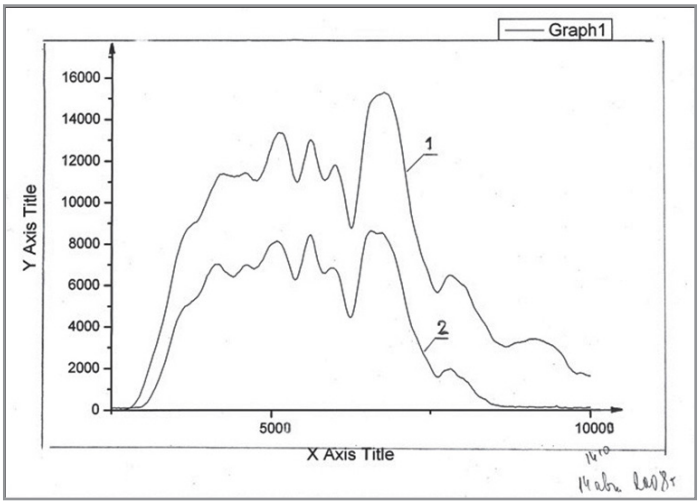

Figure 1: Distribution of energy in the sky radiation spectrum – spectrum No. 1 Distribution energy V spectrum radiation firmament, passed through cloud - No. 2 On the abscissa axis is the wavelength in angstroms, on the ordinate axis is intensity V relative units stimulated and spontaneous emission. With equality of populations at the ground and excited levels of oxygen and nitrogen atoms, the refractive index air Wednesday strives To unit regardless from lengths waves falling on earth radiation [6]. Therefore, and also because by midday, the layer of atmosphere above the observer for solar rays becomes thinner, part of the solar photons from tough ultraviolet region of the spectrum (1000–3000 A°) reaches the earth's surface. The observer is advised to find shelter.

By this time, the heating of the atmosphere reaches its maximum value. Under the influence of solar radiation, the earth and water vapor warm up fill atmosphere, What leads To additional scattering solar radiation V at- mosphere. Higher mentioned O Rayleigh scattering Sveta on fluctuations density Wednesday (small local deviations of density from its average value). On drawing 1 presented spectra radiation of the sky recorded in the afternoon time (14 hours, Moscow). One from them (No. 1) received from cloudless plot sky, the second (No. 2) from the cloud screening the spectrograph from firmament. Process Rayleigh scattering in cloud weakens intensity radiation, arriving at the earth. The similarity of the spectra indicates that when the atmosphere is saturated with water vapor, we actually have coherent Rayleigh scattering .

Afternoon Sky, Sunset Red Sun

In the afternoon, the blue color of the sky fades. In the afternoon, the path length traveled by solar radiation begins to increase. Electrons thrown into excited levels begin to return to the ground level. In this case, along with spontaneous emission and the process of nonradiative relaxation the role of stimulated emission increases. In our case external source photons is solar radiation. This radiation is capable of causing forced transitions in atoms located V excited condition. In atoms oxygen deserve attention electronic transitions associated with radiation in the red region spectrum With lengths waves: 6563 Ah, 6726.3 A°. B red areas spectrum, coinciding With indicated lines, we see an increase in intensity (in Fig. 1 spectrum No. 1). Height intensity is due to the fact that circumstance, What on transitions, With which are associated with lines with wavelengths: 6563 A°, 6726.3 A°, the process of resonant stimulated emission occurs. In the evening, as the sun approaches the horizon, the processes of electron return from excited on basic level. Process resonant stimulated emission is manifested in a change coloring solar disk. In the evening For the observer, the solar disk is colored red. The round shape of the solar disk near the line horizon Maybe be distorted V dependencies from the height of the sun's rise above the horizon. Above the sea surface, before the sun sets behind the horizon, the disk is deformed and becomes a trapezoid. The reason transformations round disk V The trapezoid is the density of water vapor, which depends on the altitude. At the surface of the water, the vapor density is maximum, which increases the angle of deflection of light radiation – the base of the trapezoid.

Conclusion

We have considered the process of changing the color of the sky during daylight hours. In the process of interaction solar radiation With atoms gases in top layers terrestrial atmosphere along With photo- by us accept participation axions. Resonant absorption atoms oxygen, nitrogen photons hard ultraviolet, A Also annihilation photons of hard ultraviolet, the energy of which is not equal to the energy of electron transitions in atoms, provide on surfaces lands safe blue-light blue color morning firmament. Using the photon annihilation model to interpret the observed changes in sky color between morning and evening allowed us to explain the change colors, mechanism heating air masses above the earth's surface. If in the upper layers of the atmosphere the processes of scattering of solar radiation with the participation of axions play a decisive role, then in the lower layers of the at-

mosphere near the earth's surface in second half days noticeable becomes contribution to the Rayleigh scattering process. Figure 1 shows two spectra of scattered solar radiation. The spectrum of scattered radiation cloud, repeats spectrum radiation sky. We see that in the spectrum regions from 3000 A^{o} to 7500 A^{o} scattering Sveta on fluctuations density medium (Rayleigh scattering), does not depend on the length waves dispersed Wednesday radiation. We we don't see significant differences V scattering blue And red flowers. For both flowers the signal attenuation is the same. Therefore, as mentioned in the introduction statement, What blue color V The atmosphere is more likely to dissipate than the red one, which needs to be checked.

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