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ON THE NATURE OF X-RAY EMISSION OF RADIOGALAXIES

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ABSTRACT

The possible mechanisms of X-ray emission of radiogalaxies Cygnus A and Virgo - A are analyzed. Investigated with this in view are the physical conditions in "optical" condensations of Cygnus A, where, incidently, the mass of gas present is $\sim (1-3) \cdot 10^8 M_\odot$. The thermal (bremmstrahlung) emission in the central part of that source may be the possible cause of X-ray emission of Cygnus A. The extension of this radiation in the optical frequency band is constituted by the continuous spectrum of the central part of Cygnus A. The mass of the hot plasma ($T_e \sim 5 \cdot 10^7$) must be $> 10^{11} M_\odot$. The comparatively dense cold condensations in this plasma are responsible for the optical emission. By their nature these condensations are analogous to the "stationary condensations" in Cassiopea A.

Another possible cause of X-ray emission of Cygnus A may be the continuing activity of its nucleus, of which the dimensions must be quite small. An analogous situation may also arise in the case of the source in Virgo - A, though the possibility of X-ray emission of this object being a high-frequency extension of ejection's synchrotron radiation apparently appears to be more probable. If the X-ray sources of radiogalaxies are linked with the continuing activity of their nuclei, the variability of this radiation flux can be expected.

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It was recently revealed that radiogalaxies Cygnus A and Virgo - A are sources of X-ray emission [1]. The power of this emission in the band 1 – 10 A is $L_x \sim 3 \cdot 10^{46}$ erg/sec for Cygnus A, and $L_x \sim 3 \cdot 10^{43}$ erg/sec for Virgo - A, which is by nearly 2 orders greater than the power of their synchrotron radio-emission. Note that in Cygnus A the power of optical radiation is several times

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* O PRIRODE RENTGENOVSKOGO IZLUCHENIYA RADIOGALAKTIK

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less than that of radioemission; consequently, for this object $\sim$98 percent of total emission corresponds to the X-ray region.

The discovery of X-ray emission from radiogalaxies was not unexpected. While analyzing the optical spectrum of Cygnus A, we already reached the conclusion in 1964 that the ionization of the gas found there (responsible for the emission lines) is explained most naturally of all, by the powerful ($> 10^{46}$ erg/sec) X-ray emission of that radiogalaxy. In 1965, we reached the conclusion that the nucleus of the radiogalaxy Perseus A (NGC 1275), (and also that of radiogalaxies), must be powerful ($L_x > 10^{43}$ erg/sec) source of X-ray emission, that ionizes the interstellar gas present there [2].

From general reasonings, Japanese researchers have recently derived the conclusion that radiogalaxies must be sources of X-ray emission [3].

The above-said obviously does not belittle the fundamental importance of the discovery of metagalactic sources of X-ray radiation. This discovery sets before the astronomy new and quite serious problems. We shall now pause at some of them. Two basic questions arise first of all:

1) what is the distribution of X-ray sources within the bounds of radiogalaxies ?
2) of what kind is the mechanism of X-ray emission ?

Evidently, these two questions are not independent. It is nonetheless deemed appropriate to consider these questions separately during the first stage of discussion.

In the case of radiogalaxy Virgo-A, conceivable are the following possibilities of localization of the X-ray source: a) the source is located in the nucleus NGC 4486; in this case its angular dimensions are $< 1''$; b) the source is linked with the well known "ejection" observed in this galaxy; in this case its angular dimensions are $\sim 20''$; c) the source is more or less uniformly distributed over the entire galaxy or its central part; in this case its angular dimensions are of 1 to 5', and its shape is more or less "rounded".

The following possibilities are conceivable in the case of Cygnus A:
a) the source coincides more or less with two radioemitting "clouds" and appears to be binary with, at the same time, the angular dimensions of each of the components being $\sim 30''$ and the distance between them $\sim 100''$. b) The source of X-ray radiation coincides with optically observed object situated between the radioemitting clouds; c) the source has insignificantly small angular dimensions; in this case it may be connected with the yet unobserved center of activity of Cygnus A of which the existence may be assumed by analogy with the nuclei of quasars and "seyfert" galaxies (no equivalent is found in the available glossaries).

It is possible that the "center of activity" is located between two optical condensations.

At contemporary level of X-ray astronomy technology, when the resolution is, at best, $\sim 10'$, it is difficult to make a choice between the above-formulated various possibilities by way of direct observations. (In principle, this problem may be resolved by installing an X-ray telescope on the surface of the Moon, or, which is less reliable, on an artificial satellite of the Moon. The estimate of angular dimensions may be obtained from observations of settings and risings of X-ray sources beyond the lunar horizon).

At the same time, without an answer to these questions the nature of metagalactic sources cannot be understood. The only thing that can be done in this situation is to attempt to exclude from the above-enumerated possibilities if only a few by way of theoretical analysis. Here are referred to : a) the thermal, bremmstrahlung emission of an optically thin layer of hot plasma, b) the Planck emission of very hot objects, c) the synchrotron radiation, being the extension of the synchrotron spectrum of the source at lower frequencies, d) the inverse Compton effect.

As to the latter mechanism, it is easy to show that it does not pass on well known photon sources (for example, on optical photons of the ejection in NGC 4486).* However, the possibility is not excluded that quite compact ($\leq 10^{17}$) sources of the microwave and submicrowave emissions of great power, analogous to the recently detected source in NGC 1275, are encountered in the nuclei of radiogalaxies. In such a situation one ought to expect a sufficiently powerful X-ray emission conditioned by the inverse Compton effect (see [2]).

Other possible X-ray emission mechanisms will be discussed below, suitably to the concrete conditions in the given radiogalaxy, to the consideration of which we shall now pass.

CYGNUS A.

Although the optical object identified with this source of radioemission has been known for already 15 years, even but a rough quantitative analysis of its spectrum has not been fulfilled to-date. Meanwhile, such an analysis is entirely prerequisite at discussion of X-ray emission of this source. Now we shall attempt to perform this on the basis of available data [4] and [5] . First of all, it follows from the Schmidt's spectrograms [5] that the intensity of the emission line H_β is about equal to one percent of the intensity of all emission lines (the error of our estimate is of about several tens of percent). On the other hand, according to [4] the emission in lines constitutes more than 50 percent of the total optical emission of that source. Assuming the optical luminance of Cygnus A to be $L_O \sim 10^{44}$ erg/s we find that the luminance in the line H_β is $L_{H_\beta} \sim 5 \cdot 10^{41}$ erg/sec. Further, we have:

$$L_{H_\beta} = 1.22 \cdot 10^{-25} \int N_e N_i \, dv \qquad (1)$$

the dependence of L_{H_β} on the electron temperature T_e being at the same time small (we assumed $T_e = 10^{4\circ}$). Substituting the value of H_β in (1), we shall find the volumetric measure of emission:

$$\int N_e N_i \, dv \sim 4 \cdot 10^{66} \text{ cm}^{-3}.$$

* see infrapaginal note next page.

The mean angular diameter of each of the two radiating emission lines of condensation is $\sim 2''$ (see the photographs brought out in [4]). Assuming the distance to Cygnus A being $\sim$ 165 mps (which corresponds to the Habble constant $H = 100$ km/sec pulse), we shall find that the effective volume of condensations is $1.3 \cdot 10^{65}$ cm^3 and hence $\overline{N_e N_i} \sim 30$ cm^{-6} . Since hydrogen must be basically ionized, $N_e \sim N_i$, and hence $\overline{N}_e \sim 5$ cm^{-3}, and the mean density of the gas is $\rho_{gas} \sim 10^{-23}$g/cm^3 . (Indeed, lines OIII, NeIII, NeV are observed in the Cygnus A spectrum, which points to the high degree of ionization). The total mass of gas in condensations is 10^{42} g, or $5 \cdot 10^8 M_\odot$. The accounting of the inescapable inhomogeneity in the distribution of gas must diminish its total mass by several factors, which most likely is $\sim(1-3) \cdot 10^8 M_\odot$. Hence it may be seen outright that the emission in the lines cannot be sustained at the expense of the kinetic energy of gas' clouds. From the line width of Cygnus A spectrum follows the fact that the velocity of inner motions of the emitting gases is comparatively small: $\sim 3 \cdot 10^7$ cm/sec. Consequently, the kinetic energy of the gas is $\sim 10^{56}$ ergs. This is why there will be enough of that energy for only several tens of thousand of years in order to sustain the observed radiation in the lines. Note that the characteristic recombination time will be still less. It is thus necessary to derive the conclusion that in order to sustain the emission in the lines and the observed ionization of gas clouds in Cygnus A, a certain lateral" or "alien" mechanism will be required. The same mechanism must also explain the observed peculiarity of the ionization in this object: the concentration of elements at various stages of ionization (for example, 0I, 0II, 0III) are comparable. Such a mechanism is precisely the X-ray radiation, as was shown by us in 1964. It should be stressed that the state of the gas in Cygnus A (as also in Virgo A) constitutes a good indicator of characteristics of X-ray sources in that object.

Let us consider at first the possibility of explaining the X-ray emission of Cygnus A by a thermal mechanism (hot plasma bremmstrahlung). The emission power of the unit of volume of hot plasma in a unitary frequency interval is :

$$\varepsilon_\nu = 6.9 \cdot 10^{-38} e^{-h\nu/kT_e} T_e^{-1/2} gI \cdot N_e N_i \qquad (2)$$

The emission of a certain volume of gas in the frequency range from $\nu_1 = 3 \cdot 10^{17}$ sec^{-1} to $\nu_2 = 3 \cdot 10^{18}$ sec^{-1} will be :

$$L_x = 1.43 \cdot 10^{-27} \cdot T_e^{1/2} \left\{ e^{-h\nu_1/kT_e} - e^{-h\nu_2/kT_e} \right\} \int N_e N_i \, dv \qquad (3)$$

According to [1], $T_e \sim 5 \cdot 10^7$. This is why the term in braces is near the unity, just as is the factor gI. According to [1], the emission power of Cygnus A is $L_x \sim 3 \cdot 10^{46}$ erg/sec. If this emission is thermal, the volumetric measure of the emission $\int N_e N_i \, dv \sim 3 \cdot 10^{69}$ is a sufficiently great quantity. It is ~ 1000 times greater than the volumetric measure of emission of a comparatively cold plasma, responsible for the emission of optical lines in the central region of Cygnus A. However, serious difficulties in regard to the localization of the hypothetical hot plasma within the bounds of the source arise at once.

* (From the preceding page). Note , incidently, that because of inverse Compton effect, we may expect γ-quantum emission in the ejection NGC 4486, with energies $\sim 10^8 - 10^9$ ev. It may be shown that the power of this emission is $\sim 10^{42}$ erg/sec.

If it is located in extended radioemitting clouds (their effective volume is $\sim 3 \cdot 10^{68} cm^3$), $\overline{N}_e \sim 3$ cm , ρ_{gas} $5 \cdot 10^{-24}$ g/cm^3 and the mass of the hot plasma is also obtained greater, $\sim 10^{12} M_o$. Assuming a great inhomogeneity in the distribution of the hot plasma, it is possible to decrease its mass by several factors, the latter remaining at any rate rate great. The difficulty here is not even in the absolute value of the hot plasma mass, but in the fact that it is one thousand times greater than that of the "cold" plasma located inside the source. We are indeed compelled to estimate that the hot plasma has been ejected by some explosive type process from the central region of Cygnus-A. But then, at such a relationship between the hot and the cold plasma, the very existence of the latter in the central part of Cygnus-A is incomprehensible.*

It is possible to bring forth still several more arguments against the possibility of localization of such a large mass of hot plasma in radioemitting clouds of Cygnus-A. First of all, one should have been anticipating a strong depolarization of synchrotron radioemission owing to Faraday rotation. The rotation angle of the polarization plane is given by the formula:

$$\Psi = \frac{2.4 \cdot 10^4 N_e \cdot H \cdot \cos \alpha \cdot l}{\nu^2} \tag{4}$$

assuming $\nu = 10^{10} \sec^{-1}$, $N_e \sim 3 cm^{-3}$, $H \sim 2 \cdot 10^{-4}$, $l \sim 10^{23}$ cm, $\cos \alpha = 1/2$ we shall find that $\Psi = 7 \cdot 10^3$ is an enormous quantity. None of the reasonable assumptions about the inhomogeneity in the spatial distribution of hot plasma clouds can overcome this difficulty, for in centimeter waves there is observed a polarization of Cygnus-A.

It seems to us that the above-enumerated deductions make the assumption of the thermal nature of Cygnus-A X-ray emission quite little probable, the hot plasma being, at the same time, confined in a large volume of that source's radioemitting clouds. Attention should, however, be drawn to an important case. Besides the bright (in optical rays) region of dimension $\sim 5''$ at the center of Cygnus-A, responsible for the emission of spectral lines, there is a large region with dimensions $30'' \times 18''$ overlapping it (see photographs in [4]). This region knowingly does not emit spectral lines [5]. Note in this connection that traces of Fraunhofer absorption lines are absent in the optical spectrum of Cygnus-A [5]. So far, the nature of this optical emission with continuous spectrum is still obscure.

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* It is noteworthy that the spectrogram of Cygnus-A, obtained at crossover of both condensations by the spectrograph's slot, does not reveal any relative shift of radial velocities of these condensations, exceeding ~ 100 km/sec. Estimating that these condensations are confined in the gravitational field of masses inside them (possibly including the invisible nucleus of radiogalaxy Cygnus-A), we shall find the upper limit of the mass of the central region of Cygnus-A:

$$M \lesssim \frac{V \cdot R}{G}, \text{ where } V_l \sim 5 \cdot 10^6 \text{ cm/sec is}$$

the upper limit of the velocity of each condensation relative to system's center of

(.. continued next page)

It is possible that this is the thermal bremmstrahlung emission of the hot plasma. In such a case the high-frequency extension of this emission's spectrum may constitute the cause of the observed X-ray emission of Cygnus-A. We shall consider this interesting possibility at further length.

Since the dimensions and the shape of the emitting region are well known from optical observations (ellipse $\sim 30'' \times 18''$ with a rather strong brightness concentration toward the center), the effective volume is $\sim 10^{68}$ cm . Hence it follows that at volumetric measure of the emission

$$\int N_e \, Ni \, dv \sim 3 \cdot 10^{69}$$

(obtained in the assumption that the X-ray emission of Cygnus-A is the thermal emission of the hot plasma),

$$\overline{N}_e \sim 5 \, cm^{-3},$$

that is, about the same as for the "cold"plasma occupying a comparatively small volume. In central regions N_e must be somewhat higher (by several factors). The total mass of hot plasma will be $\sim 10^{45}$ g or $5 \cdot 10^{11} M_\odot$ (the accounting of the inhomogeneity will permit to lower this estimate by several times).

In the frequency interval of the optical spectrum $(3600 < \lambda < 6300)$ the power of hot plasma's bremmstrahlung emission is

$$L_{0,H} \sim 2 \cdot 10^{43} \text{ erg/sec},$$

which is in perfect agreement with the power of optical emission with continuous spectrum of Cygnus-A. Such a coincidence is quite symptomatic, especially on account of clearly nonstellar nature of that emission (see above).

At such an interpretation it is necessary to admit that in the central part of Cygnus-A the "hot" and the "cold" plasma coexist side by side. How can this be understood? The assumption of the fact that the hot and cold plasmas were ejected at time of nucleus' explosion is beset with great difficulties. This is why it should be assumed that the enormous amount of gas ($>10^{11} M_\odot$) already existed in that region prior to the explosion. As pointed out by Ginzburg [6], the relativistic particles, ejected at time of explosion owing to the beam instability, may transmit to this gas the essential part of their energy and strongly heat the gas. After the relativistic particles have passed through the gas, it will cool off rather slowly (in our case during a time $\sim 10^{14}$ sec). Because of inhomogeneities present prior to the explosion, the gas heating process by cosmic rays will take place irregularly. Owing to pressure of the magnetic field, of relativistic particles and of hotter plasma, separate densifications in the unperturbed gas will begin to densify further. Apparently an analogous pattern is observed in Cassiopea-A. As is well known, "stationary condensations" are observed there, which have low motion velocities and a rather high density [4]. S. B. Pikel'ner explained these condensations by

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*).. . continuation)
gravity. Assuming $R \sim 1.5$ kps, we find that $M < 10^9 M_\odot$. If we estimate that the hot plasma was ejected from the central part of Cygnus A, its mass can hardly exceed significanlty the total mass of the central region. Our estimate of the latter's mass will be underrated if both condensations move nearly exactly in the pictorial plane, case which is little probable.

the "squeezing" of interstellar medium's inhomogeneities by the pressure of the magnetic field and of relativistic particles occurring after explosion [7]. In this connection the recent discovery of X-ray emission from Cassiopea-A, which is almost certainly thermal [8], is of particular significance. But this means that in Cassiopea-A very hot plasma ($T_e \sim 10^8$) and cold, comparatively dense stationary condensations, "disseminated" in it, coexist simultaneously. An analogous situation may take place on Cygnus-A, only the scales being here different.

If the just described pattern corresponds to reality, the "cold" plasma in Cygnus-A must necessarily have a very nonuniform structure. It must consist of separate, comparatively small and dense formations analogous to stationary condensations of Cassiopea-A, immersed in the hot plasma with low density. Depending upon its density, these condensations may have different kinetic temperatures and states of ionization. The latter, as stressed above, must be determined by the X-ray emission of the surrounding hot plasma.

The most attractive aspect of this hypothesis is the fact that it naturally explains the relatively low radial velocities of the two observed "large" condensations of Cygnus-A and the comparative narrowness of their spectral lines (note that the width of these lines is nearly the same as in stationary condensations of Cassiopea-A). The very presence of the enormous gas cloud, in which the explosion took place, raises anew the question of the nature of Cygnus-A and of its parent objects.

It is well known, for example, that a weak optical nebula of irregular shape is observed around the quasar 3C-48. It is possible that the nature of this emission is the bremmstrahlung of a very hot plasma, of which the mass would be $\sim 10^{11} M_\odot$. In such a case one may expect an X-ray emission from that object, of which the flux would be approximately by one order less than for Cygnus-A.

If the X-ray emission of Cygnus-A is a thermal emission from a plasma with $T_e \sim 5 \cdot 10^7$, one may expect to find in its spectrum the emission lines Fe XXVI with wavelength near 2 A. The detection of these lines, whose intensity may be rather substantial, would serve as the decisive argument in favor of the "thermal" hypothesis.

Let us consider now other possibilities of interpretation of the X-ray emission from Cygnus-A. First of all, it appears to be obvious that the latter cannot possibly be the extension of the observed synchrotron spectrum of this source., for in the region of high frequencies it is rather steeply "fallen-off".

It appears to be, however, quite possible that there is at the center of Cygnus-A (possibly between two gas condensations) the nucleus of this source, powerfully emitting in the microwave and submicrowave bands. An analogous situation has been recently revealed in NGC 1275. The interpretation of this phenomenon (see [3]) leads to the conclusion that the dimensions of such a nucleus are $\sim 10^{17}$cm. Because of the inverse Compton effect in the field of such an emission with fairly high energy density, the n ucleus may be a powerful source of X-ray emission. The attempts to detect the emission from Cygnus-A in micro and submicrowave bands, and also from other radiogalaxies, and quasars, must be regarded as quite an important and timely problem of astrophysics.

Possible also is another X-ray emission mechanism by the assumed nucleus of Cygnus-A. The question evolves about the accretion of interstellar gas by a massive compact body with radius much greater than the Schwartzshild's r_g. Applied to neutron stars, this problem was considered in [9]. The total energy liberation, computed per unit of mass of gas, incident upon such an object, will be

$$\bar{\varepsilon} = \frac{c^2 r_g}{2R} \qquad (5)$$

where R is the radius of the object. If, for example, / ...? ...... ? /** $1.5 \cdot 10^{20}$ erg/g. This energy will be liberated mostly in the form of X-ray quanta. (Refer to [9]). The power liberated at accretion will be :

$$L_X = \bar{\varepsilon}\frac{dM_1}{dt} \sim 10^{15}\bar{\varepsilon}\left(\frac{M}{M_\odot}\right)^2 \cdot \frac{\rho_0}{10^{-24}} \cdot \left(\frac{a_0}{1\ \mathrm{km/sec}}\right)^{-3} \qquad (6)$$

where $\frac{dM_1}{dt}$ is the quantity of gas incident per unit of time upon a nucleus of mass M, ρ_0 being its density at infinity, a_0 is the velocity of atoms. In order to have $L_X \sim 10^{46}$ erg/sec at $\rho_0 \sim 10^{-23}$g/cm^3 and $a_0 \sim 100$ km/sec, it is necessary that $M \sim 10^8 M_\odot$ be quite an acceptable value. At the same time the radius of the nucleus will be $\sim 10^{14}$cm*. In this case, the X-ray emission will be thermal by its nature; it is, however, occurring in a very specific fashion. Note further that $10^6 M_o$ will fall in $\sim 10^{13}$ sec, which is a comparatively small quantity.

Thus, we reach the conclusion that the most probable cause of X-ray emission of Cygnus-A is either the bremmstrahlung radiation of hot plasma with mass greater than $10^{11} M_o$, or the continuing activity of this source's nucleus. In the first case the angular dimensions of the source must be 20'' — 30'', and in the second case there should be less than 1''. The most observation, allowing the final choice between the possible hypotheses on the nature of X-ray emission of Cygnus-A (and of parent objects) would be the revelation of flux' variability in such an emission. If its source is in the minor nucleus, it should be variable at any of the above-described mechanisms, similarly to the optical, centimeter and microwave radiation of quasars. Note in this connection that a variability has been recently detected in the high-frequency radioemission from the nucleus of radiogalaxy NGC 1275 [10].

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* Note that the recently discovered variability of the X-ray source Sud xR - 2 [1] may be explained by accretion to a neutron star, moving through a cloud of interstellar gas with a fairly rapidly varying density and relative velocity of atoms a_0. If $\rho_0 \sim 10^{-22}$ g/cm^3, $a_0 \sim 1$ km/sec, these quantities varying considerably at the same time over distances $\sim 10^{13} - 10^{14}$ cm, the observed emission power and the characteristic variability time ($\sim 3 \cdot 10^7$ sec) can be explained.

** sentence incomplete in the original text

It is not excluded that the source of X-ray radiation linked with Cygnus-A was not detected during the 1964 observations not only because of the high value of the flux from the galactic source, Sud x R - 2, but also because its own flux was then lesser. The investigation of the possible variability of the metagalactic sources of X-ray emission is one of the most important problems of rocket astronomy. (Note that the detection of X-ray emission flux' variability of the Crab nebula (with a period of several months) would also be a direct corroboration of its synchrotron nature).

V I R G O — A.

Now we shall analyze the possible nature of the X-ray source in the radiogalaxy NGC 4486. The hypothesis on the thermal nature of this source appears to us as being of scarce probability. Contrary to Cygnus-A, there are no observation-based foundations in favor of that assumption. Thus we have to consider other possible mechanisms of X-ray emission by radiogalaxy NGC 4486. It is most natural of all to assume that this emission is of high-frequency type, constituting the extension of the synchrotron radiation of the ejection.

As is well known, there is observed in the central part of NGC 4486 a binary source of small angular dimensions, which gives at 31 cm 50 percent of the flux from the entire Galaxy, and at 21 cm — 60 percent [11] . At higher frequencies the share of this small source is still greater [12] . On the other hand, in meter waves the contribution of the small source does not exceed 10 percent of the total flux [13], [13]. This means that the spectrum of the minor source (most likely of all linked with the ejection), is more slanting. Analysis of the existing data on flux from Virgo-A in all frequencies allows to derive the conclusion that for $\nu < 700 - 800$ mc/s the spectrum is either flat, or rises with frequency, while for $\nu > 1000$ mc/s, the spectral index $\alpha \sim 0.6$. At an extended source, $\alpha \sim 1$. It essential to note that the optical synchrotron spectrum of the ejection is the continuation of its radioemission. The mean spectral index between $\lambda = 21$ cm and $\lambda = 0.5$ m is $\alpha_{r,o} \sim 0.65$, while the average spectral index between the optical and the X-ray region is also close to 0.65 (see Fig. 1). The representation of the X-ray emission of the ejection NGC 4486 as being the extension of its synchrotron spectrum seems to be in contradiction with the observations by Bless [14] , who found a very high value of the spectral index of the ejection between $\lambda = 4300$ A and $\lambda = 6300$ A: $\alpha = 2.6 \pm 0.3$ [14]. However, one should be particularly prudent when referring to this result. If the spectral index is very great, this means that on account of synchrotron losses there takes place a rapid deexcitation of "optical" relativistic electrons. At the same time, one should be anticipating a rapid rise of α along the ejection, something that according to [14] does not exist. Note further that the stellar magnitude of the ejection, found in [14], agrees poorly with the observations by V. I. Moroz [15] . An objection of theoretical character may also be brought forth against the possibility of ejection of syncrotron emission in the X-ray band. The time of energy losses of the respective ultrahigh energy electrons is found to be very short by comparison with the minimum lifetime of the ejection, which is $\sim$ 3000 years. However, it should be noted that in relativistic electrons, responsible for the synchrotron radiation of the ejection, the lifetime also is much rather less than the lifetime of the ejection*. An analogous situation takes place also in the Crab Nebula, as is well known. Only the assumption about a continuous injection of relativistic particles in the ejection region can remove this difficulty. Therefore, the possibility of X-ray emission of NGC 4486 being the extension of the synchrotron radiation of the ejection emerges as quite probable.

Another possible X-ray emission mechanism in NGC 4486 is the radiation of a certain peculiarity confined in its nucleus. Certain mechanisms of such a radiation were already discussed in reference to the source in Cygnus-A.

If the source of X-ray emission is located in the nucleus of NGC 4486 and has very small dimensions, it is surrounded from all parts by a "cold" plasma, which it ionizes and excites to glow. Since the power of optical emission in the lines in this plasma is $\sim$1000 times lower than that of X-ray emission, only a very small fraction of it is absorbed. This situation can only be explained by the assumption of great inhomogeneity in the distribution of the plasma (for example, $\sim$1% of a sphere of radius $\sim$30 ps is shielded by clouds confined inside it).

Just as is the case for Cygnus-A, the decisive experiment would be the detection of emission flux' variability from Virgo-A. It would be also very important to attempt in revealing the micro and submicro emission from this object, and to determine anew the spectral index of ejection's optical synchrotron emission.

**** THE END ****

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NOTE BY TRANSLATOR.

The original text being a typewritten manuscript with formulas inserted in long hand required certain corrections, such as mistypes, omitted words etc.. Only one sentence, page 8 of the translation, was incomplete in the original, and remains therefore incomprehensible.

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* Starting from the fact that at $\nu_0 \sim$ 700 - 800 mc the spectral index from the synchrotron radiation of the ejection varies by $\sim$0.5, by using a method analogous to that developed in [16] (taking into account of the fact that the magnetic energy of the ejection is not less than the total energy of its synchrotron emission during lifetime), it may be found that $H \sim 10^{-2}$ and the deexcitation time of "optical" relativistic electrons is $\sim$1 year. At the same time their energy density is substantially less than the magnetic energy density [17].

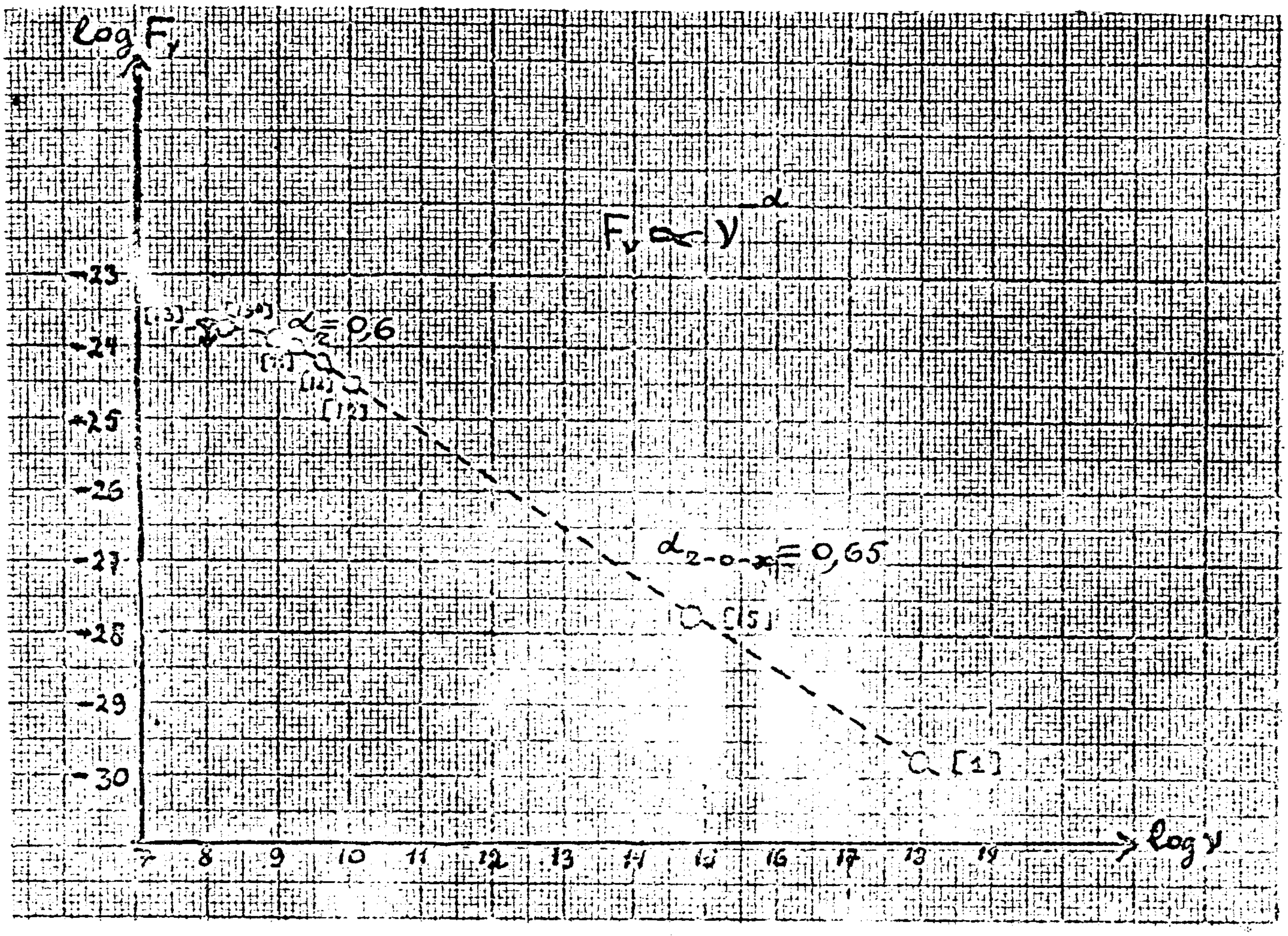

Fig. 1

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100	CLARK, TOWNSEND
110	STROUD
400	BOURDEAU
610	MEREDITH
611	MC DONALD
	KNIFFEN
	GUSS
	FICHTEL
	BOLDT, VKB
	SERLEMITSOS
612	HEPPNER
	NESS
613	KUPPERIAN
	BOGGESS III
	MILLIGAN
	STECHER
	DONN
	HALLAM •
614	WHITE
	BEHRING
615	BAUER
	GOLDBERG, HERMAN
	MAIER, STONE
640	HESS
641	CAMERON
	BURLEY
	JONES
630	GI for SS (3)
252	LIBRARY
256	FREAS

N A S A HQS.

SS	NEWELL, NAUGLE
SG	MITCHELL
	ROMAN
	SMITH
	SCHARDT
	DUBIN
SC	LIDDEL
SL	BRUNK
	FELLOWS
	HIPSHER
	HOROWITZ
SM	FOSTER
	GILL
RR	KURZWEG
RTR	NEILL
USS	
WX	SWEET

OTHER CENTERS

AMES
SONETT
LIBRARY

LANGLEY
160 ADAMSON
185 WEATHERWAX

J P L
128 MEGHREBLIAN
185-133
328 NEUGEBAUER
183-401
251 SNYDER
180-500
VIS - WYCKOFF
LAB
LIBRARY
111-113

U. IOWA
VAN ALLEN

U. C. at BERKELEY
WILCOX

UCLA
COLEMAN

SWCAS
JOHNSON

N. R. L.
FRIEDMAN *
