THE FORMS OF IONIZATION CURVES PRODUCING BRIGHT METEORS

M.Narziev. Institute of Astrophysics of Academy of sciences of Tajikistan, *Bukhoro str. 22, Dushanbe 734042, Tajikistan.* E-mail: mirhusseyn_narzi@mail.ru

Introduction: The ionization curves of meteors, which are products of interaction of meteoroids with Earth's atmosphere, contain very important information not only about the processes of destruction of meteoroids, but also about physical and dynamic characteristics as meteoroids and Earth's atmosphere. Consequently, the study of the experimental ionization curves of meteors presents large scientific and practical interest for meteor physics, geophysicists and area of distribution of radio waves.

Earlier variation of ionization along a meteor trails with a magnitudes + 5^m ÷ + 13^m, investigated as by a statistical method [1,2], so on results of the multiple stations observations of individual meteors [3.4]. However, in the statistical method all the anomalies in the forms of the ionization curve are smoothed, that it lead to neglect of the peculiarities of the mechanism destruction of the individual meteors [3.4]. In the works [3,4] form of ionization curves of the individual meteors was identified as form a parabola.

Study of ionization curves of relatively bright individual meteors were begun in Tajikistan [5]. For processing only meteors with radar echo duration less than 1 sec were used. However, for the calculation of the value of electron line density, was not taken into account fact of the recombination electrons with the neutral particles. This leads to a decrease in the value of the electron linear density. The ionization curves of bright meteors (especially with radar echo duration more than 1 sec), in general, was not investigated.

Apparatus. For experimental research of the ionization curves of meteors brighter than $+5^m$, we used the results of the radar observations of meteors in 1976-1980. The observations were carried by the radar complex located in Gissar astronomical observatory of the Astrophysical Institute of the Tajik Academy of Sciences with the following characteristics [6]: radio wavelength λ = 8 m, power in impulse 60 kW, repetition frequency of 500 per second, pulse length 6.5 microseconds, and receivers sensitivity $8\cdot10^{-14}$ watts. The reception of the reflected signals from meteor trails was carried out in the five stations. The location of the receiving stations and their distance from the central R are given in table 1. Here A_i are the azimuth of the i-th point. The distance between two of the most remote stations is 15 km, wich allowed to registrate a sketch of the ionization curve with the length to 3.75 km on the height. The following parameters of radar echo were registrated in the film: the number registration of meteor, the date and time of appearance, distance to the meteor trail from the main central station with accuracy of ± 0.1 km, difference of the distance between i and central station with accuracy of 0.025 km, the amplitude of reflected signals for central and outlines stations, the duration of radio echo with accuracy of 0.002 s. and phase pictures for determination of the wind velocity.

Table 1. Location of receiving stations (II÷V) relatively central (I).

Stations	II	III	IV	V
Azimuths A_i	315°	93°	202°	135°
R (км)	4.1	3.8	3.9	10.9

Results and discussions: 1000 meteor with radio echo duration in the interval of 0.1÷10 sec were processed. For each meteor we determined the following parameters: The velocity (km/s) by two methods: by the diffraction and the bearing-time, the horizontal coordinates of point secular reflections and radiants, the height H_1 for the central point of trail and excess of the height H_i- point relatively the central. Further, by the measuring values of the radio echo duration the values of electron line density q_i were calculated for the 4 or 5 points of meteor trail. Knowing q_i and their heights H_i, we built a sketch of the ionization curve for each meteor. We took the sketches of ionization curves having region of the maximum ionization with rising and descending parts for further analysis'. Such were 690. Extrapolating the rising and descending parts of sketch of the ionization curve on zero level, we deduced the form of the ionization curve of the meteor.

The observations of the ionization curves have a variety of forms. We revealed the five groups of the ionization curves of the meteors with a similar form of the electron line density distribution. The average velocity V_∞, the mean of the height of maximum ionization H_m, the mean of the vertical trail length (difference between height of the beginning H_b and end H_e) Δh, quantity meteors for different types of the ionization curves are presented in table 2. According to the results presented in the table, the mean values of velocity V_∞ and height of maximum ionization H_m for various forms of ionization curves are close to each other. Samples of the ionization curves are given in Figure 1. In the first group entered the ionization curves with a slow increase of linear electron density and a more rapid decline (Figure 1 A). This group included 31.2% of ionization curves. The form of ionization curves of this group is similar to the classic. However, the length of the meteor trails (difference of heights of beginning and end $\Delta h = h_b - h_e$) is somewhat shorter and make up in average 7.93 km on the height.

Table 2. Some characteristics of ionization curves

Groups	V∞ (km/c)	H_m (km)	Δ h (км)	N
A	41.4	96.0	7.93	215
B	40.2	95.7	7.41	175
C	40.3	94.6	6.96	182
D	41.5	95.9	5.94	77
F	41.0	95.5	5.16	41

The second group included the ionization curves with the symmetrical form distribution electron line density (figure. 1. B). Here included 26.4% ionization curves of meteors. The average lengths Δ h of the meteors of this group make up 7.41 km.

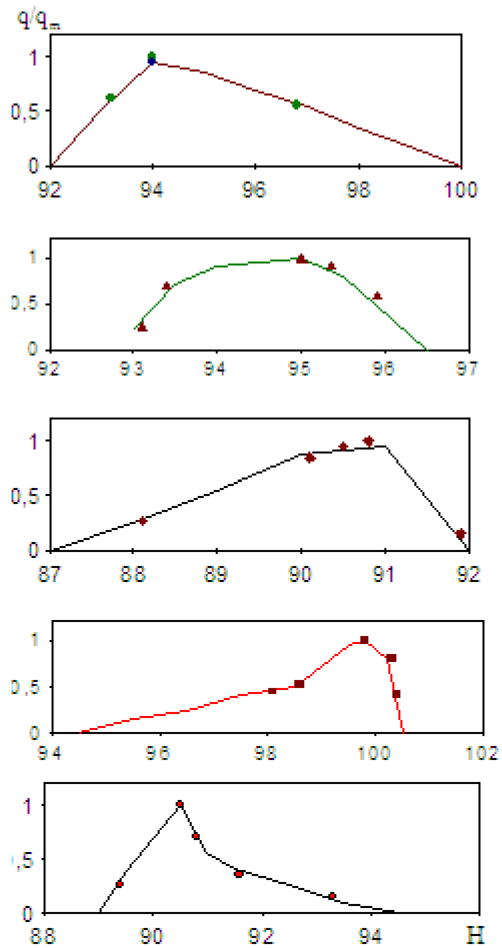

Figure 1: A form of ionization curves of meteors.

The ionization curves with a sharp increase in a electron line density and the slow decline are entered on the third group (fig. 1 C). The average values of Δh compose 7 km and mean values of the velocities' of meteors is close to the first two groups of ionization curves. In the latter two classes of ionization curves were entered of the meteors with flares (curves with sharp peaks). The percentage of ionization curves with outbreaks at the start (Figure 1 d) is 11.2%. Unlike curves type B, reducing the electron line density at descending branch of the ionization curves occurs approximately exponentially. The length of the outbreaks (the interval from the sharp increase in the values of the electron line density before slow decrease) both in group G and group D compose 0.72 km. The value of the line electron density at the point of maximum ionization 1.5-3 times more than curves with smooth variation of ionization along meteor trails. The average Δh of this ionization curves group is 5.9 km.

These results show, that the flashes are characteristic not only of bright photographic meteors, but are also among the radar meteors brighter than + 5^m. However, their share is smaller than in the case of striking photographic meteors. Thus, the ionization curves of meteors brighter than 5 magnitudes, as light curves of the bright photographic meteors, have different forms.

Conclusions:

1. From the results of the radar observations of meteors from 4-5 stations in GissAO (Tajikistan) in 1976-1980, we received a sketch of the ionization curves of about 1000 meteors.
2. Analysis of the observed ionization curves of meteors shows that they have a variety of forms. About 64% of them belong to the region of maximum ionization along with the ascending and descending parts of the ionization curves meteors.
3. We classified the meteors' ionization curves and identified 5 groups that vary in the form of electron line density distribution along a meteor trails.

References:

[1] Greenhow J.S., Neufeld E.L.(1957) Montly. Not. Roy. Astron. Sos. 117, 4, 359-369. [2]. Delov I.A., Kacheev B.L. (1971) Astron. Vest.3, 190-195. [3] Verniani F., Hawkins G.S. (1965) Harvard Coll. Obs. Res. Rep. 12, 1-35. [4] Verniani F. J. (1973) Geoph. res. 78, 35, 8429-8462.[5]. Gartman N.A., Chebotarev R.P. .(1982) Comet and Meteors, 32, 23-36. [6]. Chebotarev R.P. et al. (1970) Biyll. Inst. Astrophus. AN.Tj.CCR, 55, 25-28.