UNUSUAL DISPLAY OF THE LYRID METEOR SHOWER IN 1982

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ABSTRACT. Radar observations of the 1982 Lyrid meteor shower carried out by the meteor radars at Ondřejov and Budrio, are analysed. The observations indicate a very low overall activity of the shower in this return. The shower is resolvable from the sporadic background only for echoes of longer durations. A sudden outburst in the echo rates consisting mainly of short duration echoes appeared on April 22, at 05:30-07:20 UT, with a duration of 40 minutes between the half-maximum points and 90 minutes between the quarter-maximum points. The peak appeared at 06:38 UT, at solar longitude 31.369° (1950.0).

НЕОБЫКНОВЕННАЯ АКТИВНОСТЬ МЕТЕОРНОГО ПОТОКА ЛИРИД В 1982 Г. В стати приводится анализ радиолокационных наблюдений метеорного потока Лирид полученных в Онджееве (Чехословакия) и в Будрио (при г. Болоня, Италия). Наблюдения показывают очень слабую общую активность потока в этом возвращении. Поток было возможно отличить от спорадического фона только для длительных радиоэхо. 22 апреля между 05:30-07:20 часов мирового времени наблюдалось резкое повышение численностей особенно короткодлительных радиоэхо. Этот взрыв активности Лирид продолжался в течение 40 минут между пунктами с 1/2 и 90 минут с 1/4 численности максимума. Максимум активности наступил в 06:38 часов мирового времени, при долготе Солнца 31,369° (1950,0).

NEOBVYKLÁ AKTIVITA METEORICKÉHO ROJA LYRÍD V ROKU 1982. V práci sa analyzujú radarové pozorovania meteorického roja Lyríd v roku 1982, uskutočnené meteorickými radarmi v Ondřejove a Budrio (Bologna). Pozorovania poukazujú na veľmi nízku celkovú aktivitu Lyríd pri tomto návrate. Roj bolo možné odlíšiť od sporadického pozadia len pre ozveny dlhších trvaní. 22. apríla medzi 05:30 -07:20 hod. SČ sa pozorovalo náhle zvýšenie počtu hlavne krátkotrvajúcich meteorických ozvien. Výbuch v aktivite Lyríd trval 40 minút medzi bodmi s polovičnou frekvenciou maxima a 90 minút medzi bodmi so štvrtinovou frekvenciou maxima. Maximum nastalo o 06:38 hod. SČ, pri dĺžke Slnka 31,369° (1950,0).

The April Lyrid meteor shower is known as a shower of comparatively low activity extending over a few days only. In the past, however, the shower exhibited several strong displays. The last observed sudden increase in the activity with a peak rate of about hundred meteors per hour was recorded in 1922, though, by only one observer, H.N. Russell in Greece. From this viewpoint better documented was the event of 1803, well seen in the eastern part of the United States (Olivier, 1925), which was probably the last great shower of the Lyrids. After a long time, an exceptional return of the Lyrids was observed again in 1982. Adams (1982) summarized the observations submitted to him from over 30 visual observers in Northern America, United Kingdom and Australia. On April 22, between 06-08 UT the observers could watch a sudden outburst in the Lyrid activity, with a peak zenithal hourly rate of about 250 meteors at 06:50 UT (solar longitude of 31.381°, equinox 1950). The duration of the shower between the half-maximum points was about 15 minutes only. Between the quarter-maximum points the storm lasted about 48 minutes and consisted primarily of faint meteors, with a mean observed magnitude of 3.62.

Radar observations of the Lyrid shower in 1982, carried out with the meteor radars at Ondřejov and Budrio, are described in the present paper. The observations demonstrate a sudden enhancement of the meteor echoes consistent with the visual observations.

Regular observations of the Lyrid meteor shower at the Ondřejov Observatory /14.8°E, 49.9°N) have become a part of the observing program since 1980, and at the Budrio Meteor Station near Bologna (11.6°E, 44.5°N) since 1982. The Ondřejov meteor radar operates at a frequency of 37.5 MHz, with a pulse length of 10 μs, a repetition frequency of 500 Hz and with a peak power of 25 kW. The radar utilizes a directive antenna, common for both transmitting and receiving, fixed in elevation at 45°, but steerable in azimuth. The Budrio radar operates at a frequency of 42.7 MHz, with a pulse length of 10 μs, a repetition frequency of 140 Hz, and a peak power of up to 200 kW. The transmitting antenna consists of five arrays directed eastwards and is fixed at an elevation of 45°. The receiving antenna is an interferometric system made up of seven directive antennas. Detailed descriptions of both radars, operation and data procession can be found elsewhere (Plavcová and Šimek, 1960; Verniani et al., 1974).

During the Lyrid observation, the Ondřejov radar was operated on six successive nights, April 18-24, at 21-06 UT, with the antenna pursuing the motion of the Lyrid radiant in azimuth at a distance of 180°. The usual way to find the shower rates is to substract the sporadic background rates from the total counts of echoes. The 1982 Lyrid observations were terminated when the shower was still active, therefore, for the background the first nights of observation could only be considered. Due to a malfunction of the equipment the observations on the first night had to be terminated one hour earlier. The averaged corresponding hourly rates on the first two nights were taken for the sporadics.

Table 1

The mean hourly rates of echoes of different duration classes (21-06 UT)

Day 1982, April	λ_{sun}	$N_{\tau\geqslant0.2}$	$N_{\tau\geqslant0.5}$	$N_{\tau\geqslant1}$	$N_{\tau\geqslant8}$	$N_{\tau\geqslant1}/N_{\tau\geqslant0.2}$
18/19	28.21	140.6	27.0	9.7	0.1	0.07
19/20	29.20	157.0	27.9	9.7	0.8	0.06
20/21	30.18	138.0	28.9	12.7	1.0	0.09
21/22	31.16	139.5	36.8	20.8	3.9	0.15
22/23	32.14	168.1	39.9	20.0	4.4	0.12
23/24	33.11	128.6	28.9	11.7	2.2	0.09

Table 1 lists the mean hourly echo rates of four different echo duration classes on individual nights, together with the solar longitudes for the mid-points of observation (equinox 1950). From the standard range-time records the echoes of duration less than 0.2 s were omitted, the echoes of $\tau\geqslant0.2$ s being referred to as all echoes. Table 1 shows that the total activity of the 1982 Lyrids was very low, and, even on the date of expected maximum, the rates of all echoes were comparable with the background activity. The Lyrids are resolvable only at longer durations, especially at $\tau\geqslant8$ s. The ratios of echoes of $\tau\geqslant1$ s to all echoes are listed in the last column of Table 1 from which a definite overabundance of echoes of $\tau\geqslant1$ s can be inferred.

The Lyrid radiant culminates at 04:10 LT, which for Ondřejov corresponds closely to CET (CET=UT+1). As the antenna of the meteor radar is steerable in azimuth only, an optimum orientation of the antenna for detection of the shower meteors cannot be kept throughout the whole observation. The optimum conditions are fulfilled at about ±4 hours from the meridian transit of the Lyrid radiant when it crosses the 45° almucantarat. For Ondřejov, the radiant attains the highest elevation of 74°. Table 2 lists the relative activity of the shower with respect to the sporadic background in a period of 6 hours, symetrical with respect to the transit of the Lyrid radiant (0-6 hr, UT), for three echo duration classes ($\tau\geqslant0.5$, $\tau\geqslant1$ and $\tau\geqslant8$ seconds). A low proportion of shower meteors of shorter durations (smaller masses) in this return of the shower is apparent. While on April 22 the ratio for echoes of $\tau\geqslant0.5$ s is only 0.4, for echoes of $\tau\geqslant8$ s it rises up to 6.6.

Table 2

The ratios of shower to sporadic background rates for different echo duration classes, at 0-6 hr (UT)

Day	$N_{shower}/N_{sporadic}$		
	$\tau \geq 0.5$ s	$\tau \geq 1$ s	$\tau \geq 8$ s
21	0.1	0.3	1.0
22	0.4	1.4	6.6
23	0.4	1.0	5.7
24	0.1	0.1	2.7

Without including all the correction factors entering the radar observations, it is not possible to determine absolute echo rates in successive one-hour intervals, and only relative echo rates in corresponding day-to-day periods can be derived. The mean hourly rates of the Lyrids per night (21-06 UT), for echoes of $\tau \geq 1$ and $\tau \geq 8$ seconds vs. solar longitude for equinox 1950, are plotted in Figure 1a.

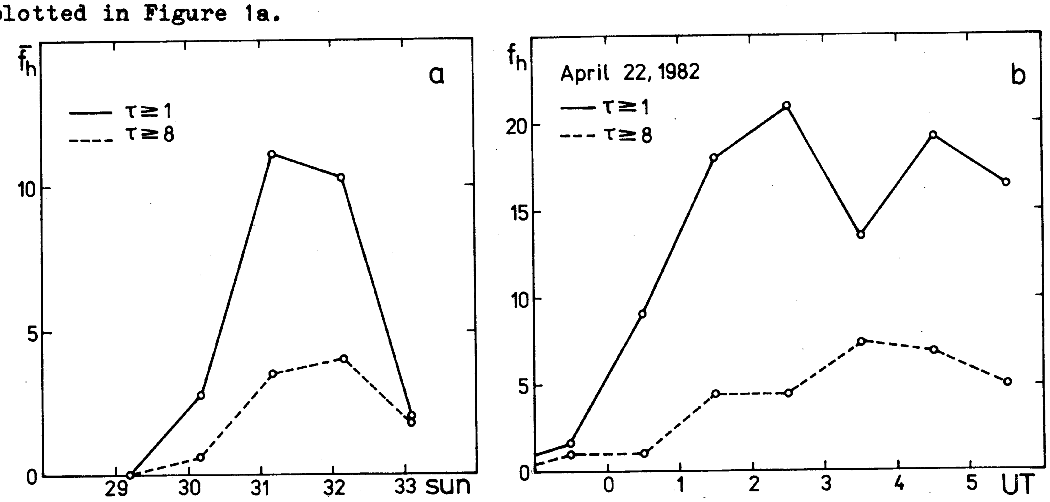

Fig. 1 Hourly rates of the shower echoes for two echo duration classes observed at Ondřejov. (a) Mean hourly rates per night (21-06 UT) plotted against solar longitude (equinox 1950). (b) Variation of the hourly rates on April 22.

The plots indicate a relative displacement of the maxima of echoes of $\tau \geq 1$ s and $\tau \geq 8$ s, respectively. The result is not consistent with Table 2, according to which, both maxima should appear on the same day (April 22), but the displacement is due to an enhancement of long duration echoes on the period of 21-00 UT on the night of April 22/23, the period not included in Table 2.

The operation of the Budrio radar is mainly aimed at providing wind measurements in the meteor zone, and no record of echo duration is available. Moreover, the equipment is automatically blocked when an echo is recorded, and information about any other echo appearing during that time is missing. Consequently, accurate echo rates cannot be obtained, unless the duration of each echo registration is known. An approximate information about the total blocked time can be found considering the upper limit for the blockation, which is 0.2 s.

Observations of the 1982 Lyrids by the Budrio meteor radar were carried out on April 17-25, in a series almost without interruption, 24 hours per day. In the morning hours on April 22, an exceptionally high number of echoes was recorded, with a peak of 232 echoes between 07-08 CET (06-07 UT). The observed numbers of echoes in one-hour intervals on April 22, 0-14 UT, are plotted in Figure 2a (solid histogram).

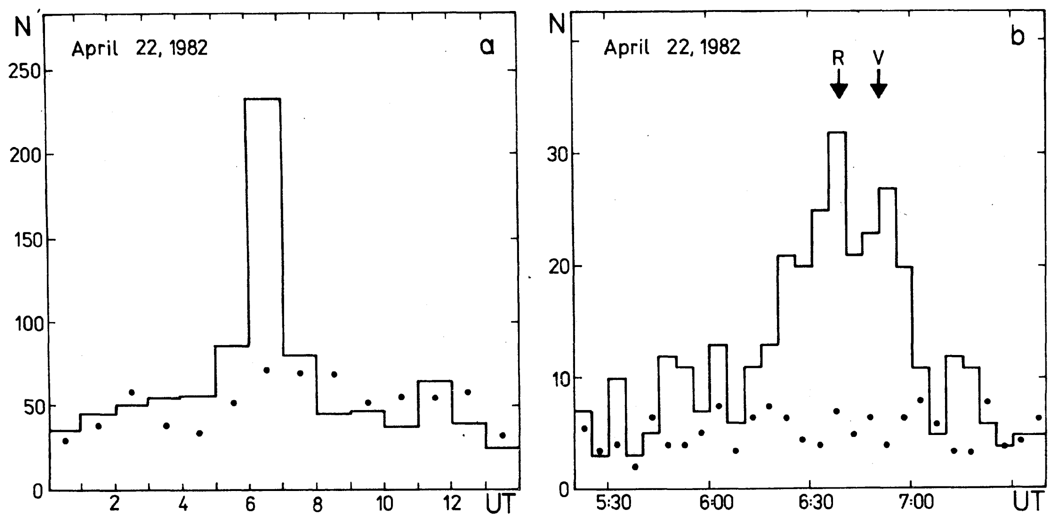

Fig. 2 Meteor echoes observed at Budrio on April 22. Solid histograms represent the counts of echoes in (a) one-hour, (b) 5-minutes intervals. Sporadic background rates are indicated by dots. By arrows are marked the positions of the peak activity observed by radar (R) and visual observers (V), respectively.

It can be seen that the increased activity, with a very strong peak, lasted for almost three hours. The peak corresponds to the observed outburst in the activity of the Lyrid meteors reported by the visual observers (Adams, 1982). Unfortunately, the Ondřejov observations were terminated at 06 UT every day and, hence, no reliable data on the distribution of echo durations during the outburst of the Lyrids, are available. Nevertheless, the Budrio observations provide at least information on the exact position of the maximum, and quantitative data concerning this spectacular event.

To resolve the peak itself, the observed echoes in 5-minutes intervals around the maximum are plotted in Figure 2b (solid histogram). The highest number of echoes was recorded within 06:35-06:40 UT and the peak, with 10 echoes in one minute, appeared at 06:38 UT, i.e. at the solar longitude of 31.369° (equinox 1950). The increased activity between the points of one-half of the maximum lasted for about 40 minutes, and the period between one-quarter of the maximum points about 1.5 hour. Sporadic background rates in corresponding intervals are indicated in Figure 2 by dots. As the background rates the averaged values from April 18 and 19, were considered like in the Ondřejov data. The distribution of the slant ranges of echoes at 06-07 UT (April 22) is marked in Figure 3 by a thick line, together with the corresponding distribution in the sporadic background period (thin line). The plots clearly demonstrate the contribution of the Lyrids in this one-hour interval of echo counts.

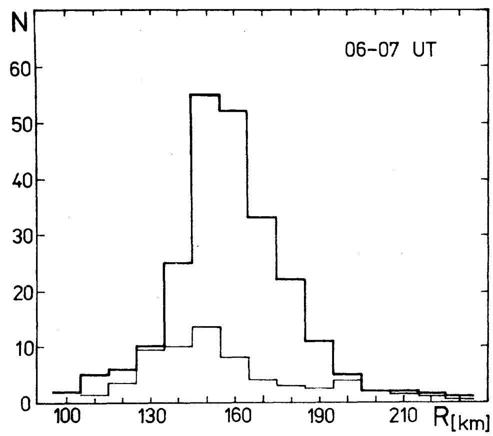

Fig. 3 Distributions of slant ranges of echoes observed at Budrio on April 22, 06-07 UT (thick line) and in the corresponding sporadic background period (thin line).

According to the Budrio observations (Fig. 2a), there is an apparent increase of the shower activity even in the interval preceding the peak hour, the interval covered by the observations at Ondřejov, too (05-06 UT). Figure 1b shows the activity of the Lyrids on April 22 as observed at Ondřejov, for two echo duration classes ($\tau \geq 1$ and $\tau \geq 8$ seconds). The observed increase in echo counts is more steady for echoes of $\tau \geq 8$ s which are not so sensitive to the antenna orientation with respect to the shower radiant position. But, the increase in echo counts between 05-06 UT evident in the Budrio data is missing in Ondřejov observation for echoes starting with $\tau \geq 1$ s. This suggest that the increase observed at Budrio had to be caused chiefly by echoes of very short durations. To a certain extent, this inference is supported by the above visual observations (Adams, 1982), according to which the outburst in the Lyrids activity consisted primarily of faint meteors.

The radar observations of the 1982 Lyrid meteor shower presented in this contribution have shown an unusual structure of this return of the shower. The overall activity was very low; the shower could be resolved from the sporadic background only for echoes of durations $\tau \geq 1$ s. A sudden outburst in the echo rates consisting above all of short duration echoes appeared on April 22 between 05:30-07:20 UT (Fig. 2b). The observed width of the storm was twice as large as that reported by visual observers; 40 minutes between the half-maximum points, and 90 minutes between the quarter-maximum points. The peak observed by the visual observers, at 06:50 UT (solar longitude 31.381°), is very close to that resulting from radar observations, which appeares at 06:38 UT, at the solar longitude 31.369°.

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