N88-14548

RESULTS OF OBSERVATIONS OF THE ETA AQUARID AND ORIONID METEOR SHOWERS IN 1980-1984

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Abstract

The main characteristics of meteor showers associated with Comet Halley have been derived from the most recent radar observations carried out at the Ondrejov Astronomical Observatory during the periods of May 1-10 and October 15-30. The activity variations, the positions of activity maxima, the size distribution of particles, the particle flux variation within the stream and other characteristics have been determined and compared with other results.

1. Introduction

The International Halley Watch has included in its program the observations of meteor showers connected with Comet Halley. The main goals expected from these observations lay in the determination of the stream structure with high resolution, the dust production and the dynamical evolution of the dust particles as well as the determination of the physical properties and composition of the particles. It is supposed that most of the observations within the IHW program will be carried out during the comet return in 1985-1986. Some results of observations have been published earlier in a series of papers (HAJDUK 1970, 1973, 1981, BABADZHANOV et al., 1977, 1979, HAJDUK et al., 1983, 1984, HAJDUK and CEVOLANI, 1981, CEVOLANI and HAJDUK 1984, HAJDUK and BUHAGIAR 1982, and others) including simultaneous and long-term observations mainly from Ondrejov, Springhill, Hissar, Budrio and Perth observatories.

The data presented in this paper contain the results of the most recent observations, including preliminary results of observations of the Eta Aquarids in 1985 and show the structural features of the stream cross section immediately before the comet return. The data allows one to predict the most effective observational periods for the IHW observations during the next shower returns.

2. Observations and data

Figures 1 and 2 show the mean hourly rates of meteors during the Orionid and Eta Aquarid shower periods, respectively, in the years 1980-1984 and the preliminary data for the Eta Aquarids in 1985. Two categories of meteor echoes are presented: all echoes and echoes with duration $\tau \geq 1$ sec. The values (marked in the Figures by dots and circles) are deduced mainly from 5 hour intervals including the radiant transit of the meridian. The 1985 Eta Aquarid data are for 1 hour intervals only, corresponding to the radiant culmination.

It is obvious, as with previous results, that there is neither a significant, let alone an extraordinary increase in meteor activity, connected with the approach of the comet. Rather, some decrease in activity is observed in the last observations. This is in agreement with the shell model of the stream, suggested by MCINTOSH and HAJDUK (1983), according to which we observe, especially in the central parts

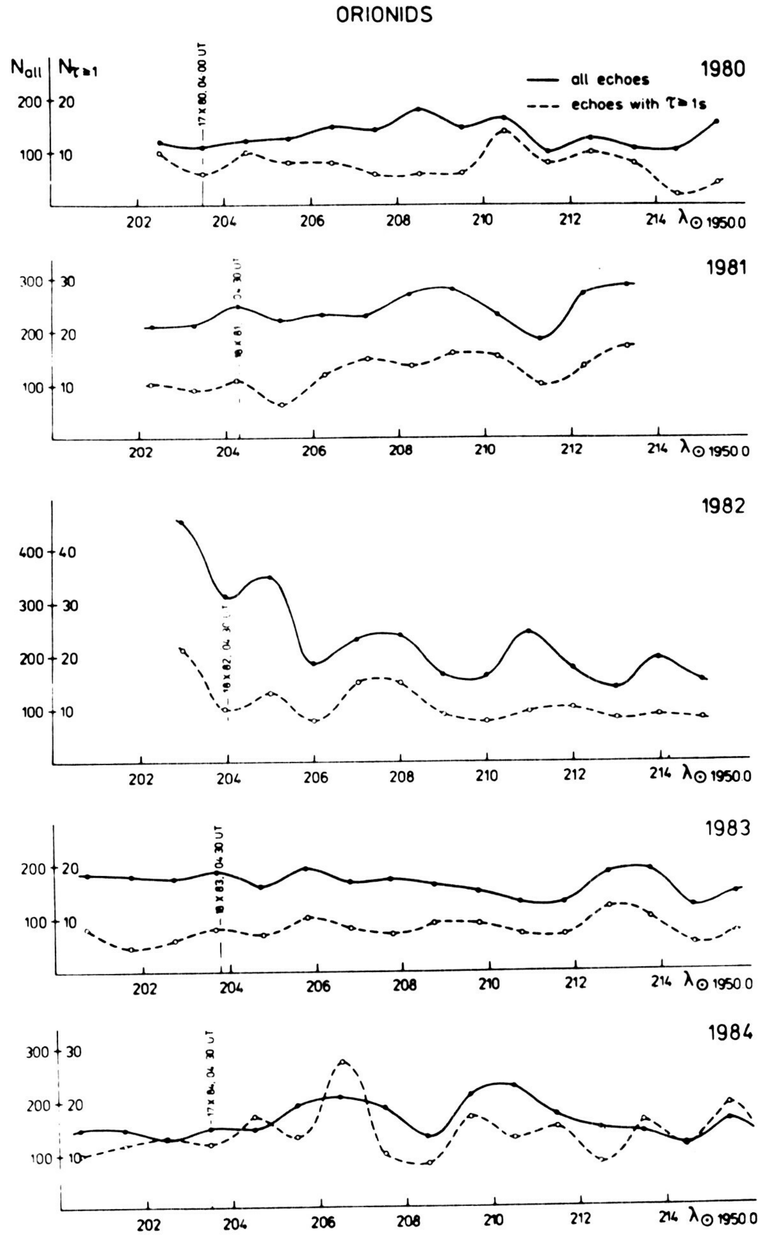

Fig. 1 Mean hourly rates of meteors during the Orionid shower period in 1981-1984.

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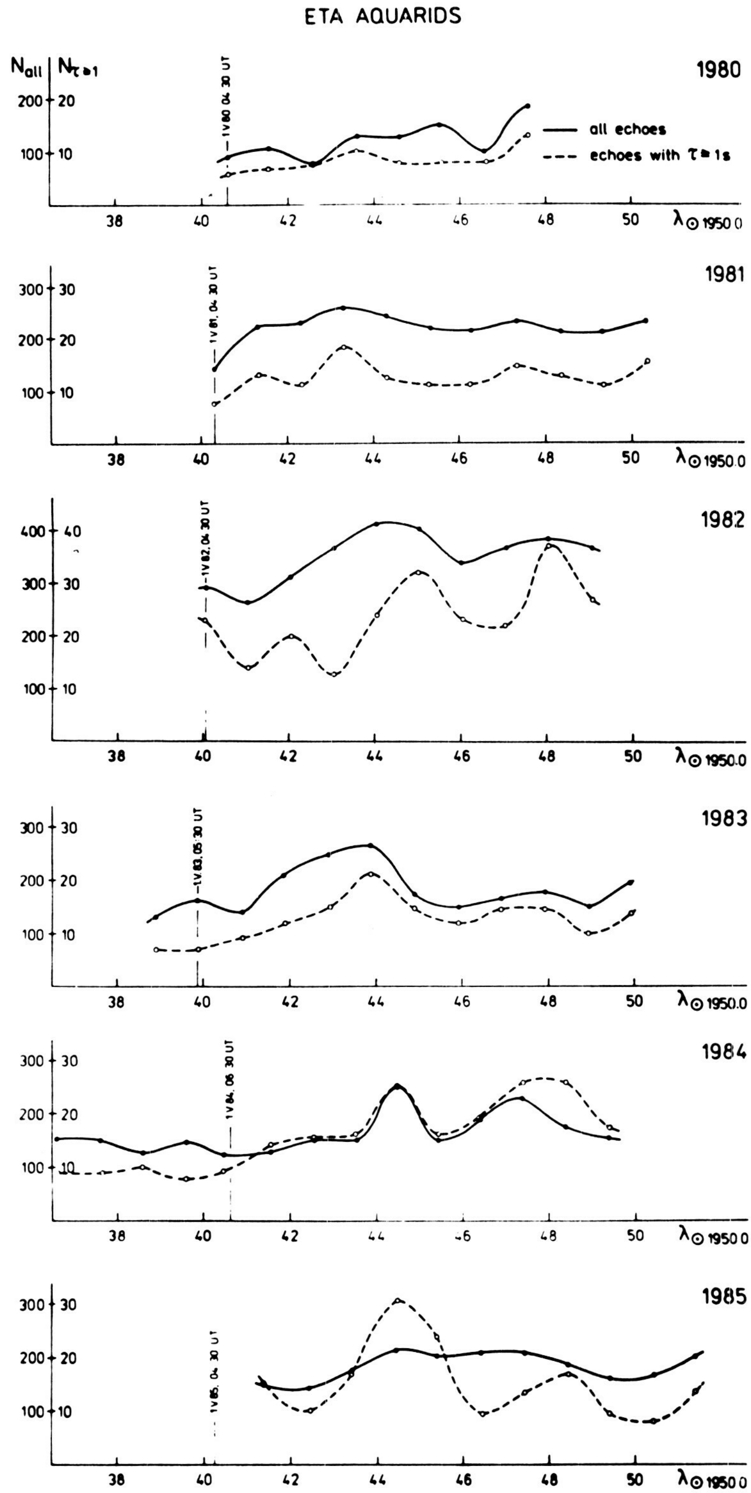

Fig. 2 Mean hourly rates of meteors during the Eta Aquarid shower period in 1980–1985.

of showers, particles ejected from the comet hundreds of revolutions ago. The quasi-diffusion of meteor particles is a very slow process and we cannot observe fresh ejecta of large particles in the mass range of observed meteoroids.

However, we may observe relatively young meteoroids, ejected from the comet during the last millenia and orbiting close to the previous orbits of the comet, crossing the Earth's orbit near the solar longitudes at about 38° and 203° (corresponding to April 28/28 and October 16/17). The orbit of P/Halley has crossed the Earth's orbit between 530 and 607 A.D. at its descending node in the case of the Eta Aquarids and between 836 and 763 B.C. at its ascending node in the case of the Orionids (YEOMANS and KIANG 1982, HAJDUK 1983). Of course, we cannot expect even at these solar longitudes very high meteor rates with the comet's return, but it is of great importance to observe the differences in the mass distribution of particles for the separate belts of particle orbits, as they represent the key to the determination of the evolution of the stream and through it to the evolution of the comet itself.

Planetary perturbations are the main source of the spread of orbital parameters of the comet and at the same time also of the ejected particles. As was shown by MCINTOSH and HAJDUK (1983), the spread in the position of the nodes and of the periods may produce a local and temporal mass concentration in the stream, resulting in the observed shifts of meteor shower maxima in solar longitude. It is difficult therefore to predict the exact time of the shower activity maximum for a particular year. However, the observed shifts are sometimes stable enough to recognize the tendency of such a shift for the next year. Figures 3 and 4 show the observed shower maxima during the last 27 years, based mainly on radar observations from Springhill, Ondrejov, Hissar and Budrio observatories. The positions of the maxima are given here in solar longitudes for the common equinox 1950.0. It can be deduced from these data that the highest activity of the 1985 Orionids may be expected on October 14, October 21 and October 27 and the highest activity of 1986 Eta Aquarids on April 30, May 5 and May 8, with an approximate error of 1 day. When some restrictions have to be made on the total period of observations the the dates mentioned above are recommended. This prediction of shower maxima dates differ in the case of the Orionids from that of Oct. 24.2 based on the basis of the closest approach of the Earth's and P/Halley's present orbit. In the case of the Eta Aquarids - the closest approach on May 8.5 coincides satisfactorily with one of our maxima.

The mass distribution function of the Eta Aquarids and Orionids has been deduced from the number distribution in different echo duration categories, and also from the amplitude distribution of the echoes. The background rate was assumed to be constant during the shower period in all years. With an adopted value of the mass distribution factors for the sporadic meteors of $s = 2.5$, we obtained values of the mass distribution factor for shower meteors in the range between $s = 2.2$ (Eta Aquarids 1981 and Orionids 1981) and $s = 1.8$ (Eta Aquarids 1984 and Orionids 1984). The mass function gradually decreased in the period from 1981 to 1984; however, the preliminary results for the 1985 Eta Aquarids give $s = 1.9$. Previous radar results yield $s = 2.08$ and $s = 1.95$ for the underdense and overdense Orionids respectively (HAJDUK

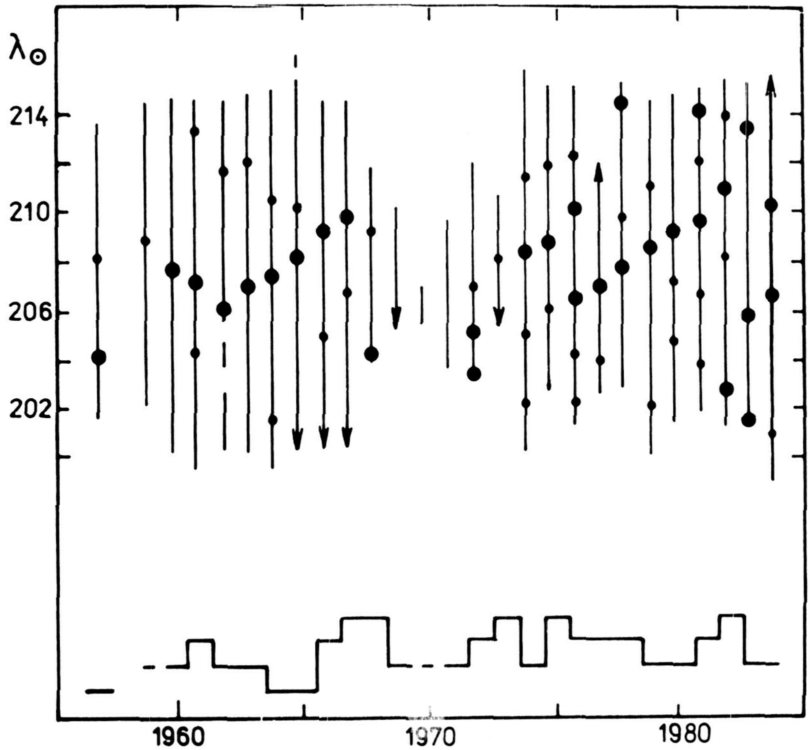

Fig. 3 The position of the Orionid shower activity maxima and secondary maxima (dots) in solar longitudes (1950.0) observed during last 27 years. The total shower activity in a particular year is given below in four levels.

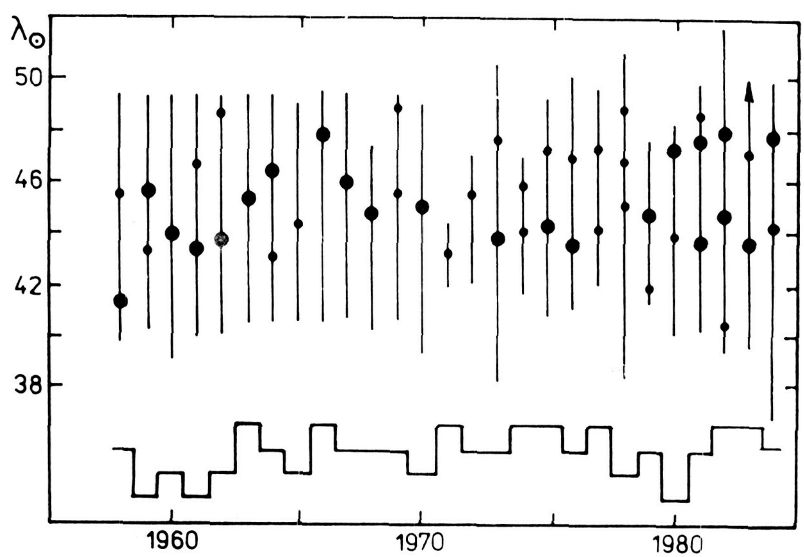

Fig. 4 The position of the Eta Aquarid shower activity maxima during the last 27 years. Other text as in Fig. 3.

1968), and previous visual observations give s = 1.95 for the Eta Aquarids and s = 2.15 for the Orionids (KRESAKOVA 1966).

Calculation of meteor flux ϕ yield values between the limits 10^{-11} $m^{-2}s^{-1} < \phi < 5.10^{-11}$ $m^{-2}s^{-1}$ in different years and shower periods for particles up to 7.25 magnitude, or 10^{-6} kg.

The study of the faint structure of the Halley stream during the IHW program should contribute substantially to our knowledge of the comet-meteor relationship. In addition, observations of the faintest meteors by means of optical and radar techniques may contribute significantly to the space missions sent to the comet. As was shown recently (HAJDUK 1985), the particle distribution in the vicinity of the comet yields at least one order higher risk for the space probes than that calculated before, and especially that the probability of the complete success of Giotto is considerably reduced. Telescopic or other optical and special radar observations of the particle size or mass distribution can improve the calculation of the risk to the space probes for given trajectories during the closest approach of the probes to the comet.

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