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Analysis of the structure of Lyrids meteor shower

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Abstract

Lyrids' structural parameters (luminosity function parameter of r meteors distribution magnitudes, the S parameter distribution of meteoroids in the mass flow, zenithal hour number (ZHR)) are determined by visual observations made in the 1900–2007 interval. The minimal value of S is equal to 1,54 ± 0,02 and corresponds to the Sun longitude 32,19º ± 0,04º. Lyrids' activity profiles as ZHR depending on the L Sun longitude were constructed for studying the flow activity. ZHR averaging for the individual values was held according the observation in 1900–1963, 1900–2000, 2001–2007 and 1900–2007. The peak position for all groups is the same within the error and equal to 32,326º±0,107. It Two periods of lyrids activity were revealed: a period which is close to 60 years; and s period of about 10–12 years.

1. Introduction

The Thatcher 1861 I comet, with an orbital period of 415 years, is the parental comet of Lyrids. Lyrids are observed from 16 to 25 April, and have a low annual activity. However, in some years, the flow activity increases, and it is not associated with the comet's approach to the Sun. Four bursts of the flow activity have been reported and described in the literature in 1803, 1922, 1946 and 1982.

These reports discuss the 12-year cycle of the flow activity and its possible causes, primarily related to Jupiter's influence on the meteoroids' motion in the shower. Thus, as a rule, the main research method is the simulation of possible scenarios of Lyrids' meteoroid swarm formation and its further evolution. The study of the shower structure by visual observations, obtained over a long time interval, allows us to clarify the period of the periodic activity of the Lyrids.

Lyrids' structural parameters (luminosity function parameter of r meteors distribution magnitudes, the S parameter distribution of meteoroids in the mass flow, zenithal hour number ZHR) are determined by visual observations of lyrids, made in 1987–2007, under the aegis of the International Meteor Organization (IMO), as well as earlier observations, which were published in various sources.

2. Method and results

S parameter distribution of meteoroids in the mass is defined in the following form:

$$S = 1+2.5.\lg r \qquad (1)$$

when the value of function of r luminosity in visual observations is found by the distribution of meteors' magnitudes obtained by an observer for each night of observation.

The method of r and S parameters definition by visual observations is described in detail in [1]-[2].

According to the most statistically secured observations made in 1987–2007, and published on the International Meteor Society (IMS) website for each year of the observations, S individual values calculated by formula (1) were averaged over intervals of the Sun's longitude, taking into account the balance.

At the first stage, S values were averaged separately for each year and in the observation groups in 1987–1999 and in 2000–20007. The comparison of S values in each group showed that the results agree with each other within the errors. Thus, the average S curve as a function of the Sun's longitude was derived by averaging all the 1987–2007 observations. It's considered averaged values of the parameter S Lyrids, by visual observation in 1987–1999, 2000–2007 and 1987–2007. In contrast to the start period and the end of the air flow, the interval of the Sun's longitude 31º-33º is well provided by observations, so S parameter is held by the dotted line for these areas. The minimum value of S is equal to 1,54±0,02 and corresponds to the Sun's longitude 32,19º±0.04º. Descending and ascending branches performed by the least-squares method are described by the equations.

The values of the S parameter, which were obtained by other authors on the visual and radar observations of the Lyrids, are in the range of 1.54–1.93, which agree with derived values.

Based on the 12-year period of Lyrids' activity, we can analyses the value of S parameter in 1922, 1994 and 2006, compared to the average curve, which was obtained according the observations of 1987–2007. It's showed S values for adjacent 1923, 1993, 1995 and 2005. As can be seen, only S values which were obtained by visual observations in 1922–1923 and

radio-observations in 1982 are above the average line. For other years, S ranges are within average values. Thus, the study of the S parameter on the long interval observations showed that it is impossible to reveal any periodic variations of S parameter, associated with a 12-year period of the increasing stream activity. The analysis of the Lyrids' observation shows that the increase of the flow activity can be registered by radio-location method only. There was not a single significant increase in the activity of the Lyrids' stream in the last sixty years according to the visual observations. It is possible that in some years the number of flow increases owing to the small mass of meteoroids which can be recorded by radio only.

Profiles of the Lyrids' activity as ZHR, depending on the Sun's L longitude for each year separately, were constructed for studying the shower activity. ZHR averaging of ZHR individual values was conducted by 1900–1963, 1990–2000, 2001–2007 and 1900-2007 observations for the intervals of the Sun longitude 0.5º–1º. Position of the maximum, which was determined by the intersection of the ascending and descending branches conducted by least squares, is the same for all groups within a mistake and equal to 32.326º ±0.107.

ln (ZHR max) the maximum value found for each year of observation in the 1901–2007.

As can be showed, peaks of shower activity are viewed with the period which equals 10-12 years ZHRmax values for these years, are higher than average value of the activity. The Malycev period of 27 years, which is concerned with Saturn, is not confirmed, since the activity was too low in 1952. The highest values of activity in 1922, 1923 and 1982 give a period which is close to sixty years.

4. Summary and Conclusions

Thus, there are two periods of the stream activity which can be assumed. Most probably, the impact of resonances 1:5 (59.4-year period), and 1:1 (11.7-year period) from Jupiter is the cause of the periodic activity of the Lyrids [3]. There is the highest activity of the Lyrids when these periods coincide.

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References

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