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ANOMALOUS COMET TAILS AND THE 11-YEAR SOLAR ACTIVITY CYCLE

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The article analyzes the statistical aspects of the formation of anomalous comet tails. The state of solar activity during the formation of 97 anomalous tails was studied. It was found that in long-period comets such tails are observed during the period of decreasing activity (phase 0.75), and in short-period comets - immediately after the maximum (phase 0.55). This fact is important to take into account in the study of the physics and evolution of comets.

Keywords: comets, anomalous tails, solar activity, statistics

Introduction

The study of the dependence of specific cometary characteristics and parameters on the phase of the 11-year solar activity (SA) cycle has a long history. This paper analyzes the possible influence of solar activity on the formation of anomalous tails in some comets. These tails are directed toward the Sun and consist of larger particles. In this work, we aim to answer the question of during which phases of the solar activity anomalous comet tails most frequently appear. The authors believe that clarifying this issue will help to uncover the nature of this natural phenomenon.

Method and materials used

The task at hand is purely statistical in nature. The epochs (T) of the formation of anomalous comet tails are compared with the phases (F) of solar activity (SA) on the corresponding dates. The main part of the data concerning anomalous comet tails is taken from the dissertation by Safarov [1], which compiles information on 78 comets with such structures. An additional 19 cases, discovered during our review of astronomical literature, were added to this dataset. The data on SA phases were obtained from the website: https://solarscience.msfc.nasa.gov/greenwch/spot_num.txt (Cycles 1–25). Taking into account the asymmetry of the SA curve, the value of F is normalized so that the

intervals correspond to equal time periods, as was done in [2]. The distribution N(F) is shown in Figure 1. Calculations show that it is characterized by a mean and standard deviation of 7.64 and 1.41, respectively. Application of the Student's t-distribution [4] indicates that the obtained distribution is neither random nor uniform. It features a maximum (N = 9.93) in the interval 0.7–0.8. The confidence level for this maximum occurring in this interval is approximately 0.95. In the remaining intervals, the probabilities of deviations from the mean fall within statistical error margins. A more detailed analysis, involving changes in the boundaries of the F parameter intervals, shows that the most saturated interval is 0.69–0.80, with an N value of 11.26. This interval corresponds to the declining phase of solar activity.

$$F = \begin{cases} \frac{t - T_1}{2(T_{max} - T_1)}; & \text{if } t < T_{max} \\ \frac{t - T_{max}}{2(T_2 - T_{max})} + 0,5; & \text{if } t > T_{max} \end{cases}$$

Analysis results

The results of the conducted analysis are presented in Table 1 and Figure 1. It should be noted that our analysis includes comets observed up to the beginning of 2023.

Table 1

Distribution of occurrences of anomalous comet tails by solar activity phases

F	0.05	0.15	0.25	0.35	0.45	0.55	0.65	0.75	0.85	0.95
N (LPC)	7	6	8	10	5	11	9	15	13	13
N (PC)	2	2	2	2	2	5	6	3	3	5

In Table 1 (second row), the frequency of the appearance (N) of anomalous tails in 97 comets is shown as a function of the solar activity (SA) phase. For the comets under consideration, the most saturated interval is 0.69–0.80, where 17 comets are concentrated. Even taking into account the asymmetry of the SA curve, this number exceeds what would be expected under a uniform distribution. The distribution N(F) for periodic comets is presented in the third row of Table 1. It differs from the previous distribution by a shift in the maximum. For this set of comets, the maximum falls within the 0.47–0.58 interval (N = 7). Even without applying strict statistical criteria, it can be concluded that the difference between these two distributions is a significant fact.

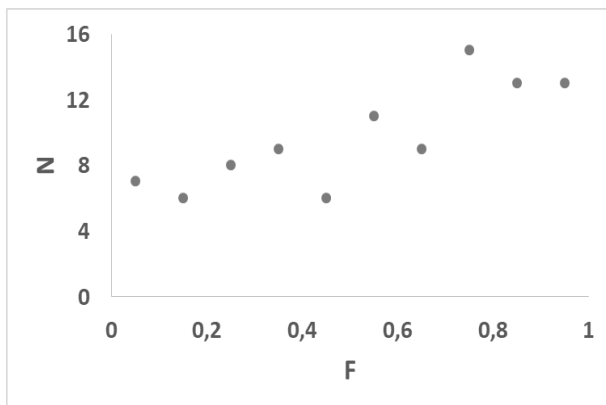


Fig 1. Frequency of the appearance of anomalous comet tails at different phases of solar activity (SA)

Conclusion

The frequency of anomalous tails, like many cometary parameters, correlates with the phases of the 11-year solar activity cycle. The highest occurrence of this phenomenon for all observed comets falls during the declining phase of the cycle. However, when dividing comets into long-period and periodic, anomalous tails appear more frequently in the post-maximum phase of solar activity for the latter. This feature could be used in the theory of comet physics and evolution. It is worth noting that similar results were obtained based on a more limited dataset [3].

REFERENCES

1. Сафаров А.Г. Исследование условия образования аномального хвоста комет. Диссертация на соиск. уч. ст. кан. физ. мат. наук. Душанбе. // 2018, 125 с.
2. Гулиев А.С. Гасымов Г.А. The Influence of Solar Activity on Discoveries of Comets from Different Classes// Kinematics and Physics of Celestial Bodies// 2020, 36, 1, 12-16
3. Гулиев А.С. Гасымов Г.А. Anomalous comet tails and 11 years cycle of solar activity// Двадцатая конференция "Физика плазмы в солнечной системе". Москва, 10-14 февраля 2025.
4. Гмурман В. Е. Теория вероятностей и математическая статистика: Учеб. пособие для вузов. М.: Высш. шк., 2003. 479 с.

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ANOMAL KOMET QUYRUQLARI VƏ 11-İLLİK GÜNƏŞ FƏALLIĞI**Ə.S.Quliyev, H.Ə.Qasimov**

Məqalədə anomal komet quyruqlarının formalaşması məsələsinin statistik aspektləri təhlil olunur. 97 anomal quyruğun əmələ gəlməsi zamanı günəş fəallığının durumu araşdırılmışdır. Aşkar olunmuşdur ki, uzunperiodlu kometlərdə belə quyruqlar fəallığın enmə dövründə (faza 0.75), qısaperiodlu kometlərdə isə maksimumdan dərhal sonra (faza 0.55) müşahidə olunur. Bu faktın kometlərin fizikası və təkamülünün öyrənilməsində nəzərə alınması vacibdir.

Açar sözlər: kometlər, anomal quyruqlar, günəş aktivliyi, statistika

АНОМАЛЬНЫЕ КОМЕТНЫЕ ХВОСТЫ И 11-ЛЕТНИЙ ЦИКЛ СОЛНЕЧНОЙ АКТИВНОСТИ**А.С.Гулиев, Г.А.Гасимов**

В статье анализируются статистические аспекты формирования аномальных кометных хвостов. Изучено состояние солнечной активности в период формирования 97 аномальных хвостов. Установлено, что у долгопериодических комет такие хвосты наблюдаются в период спада активности (фаза 0,75), а у короткопериодических комет — сразу после максимума (фаза 0,55). Этот факт важно учитывать при изучении физики и эволюции комет.

Ключевые слова: кометы, аномальные хвосты, солнечная активность, статистика