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The Tunguska cosmic body could be short-period comet

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Abstract

The Tunguska phenomenon has been investigating during 100 years but discussions about a nature of this object are continuing. Here we show that the Tunguska cosmic body could be only comet and, more probably short-periodical comet. According to estimations, ~10^{11} kg of water had been carried in the Earth' atmosphere during the Tunguska event. Therefore, an initial size of the Tunguska object could be ~1 km. The trajectory and radiant of the Tunguska cosmic body was determined from results of investigations of the epicenter of the Tunguska disaster and evidences of eyewitnesses. The azimuth of the trajectory was determined as A=300^o and the angle of inclination was calculated as 20^o. The radiant of the Tunguska cosmic body is situated not far from the ecliptic plane. Therefore, this object could be short-period comet. The Tunguska cosmic body moved from the Sun, therefore its initial speed was >30 km/s.

1. Introduction

An influence of the Tunguska event on the Earth' atmosphere was unexampled. At midnight an airglow was so intensive, that one could read a small print of newspaper. Almost hundred articles contained information about light nights, beautiful sunsets and solar halos, had been published only in 1908. All these phenomena could be explained by a huge field of noctilucent clouds [1, 2].

2. Water in the atmosphere

After the Tunguska disaster a field of noctilucent cloud had exceeded 10 million km^2. According to calculations [2, 3], it is necessary to bring ~10^{11} kg of water in the atmosphere for formation of cloudy field with this size. It is obvious that so mach water in the Earth' atmosphere has been added by a body with a comet nature only. On the assumption of low density of the comet (0.1÷0.3 g/cm^3) we found an initial radius of the Tunguska cosmic body as 400÷600 m. Therefore, this object could be an average size comet.

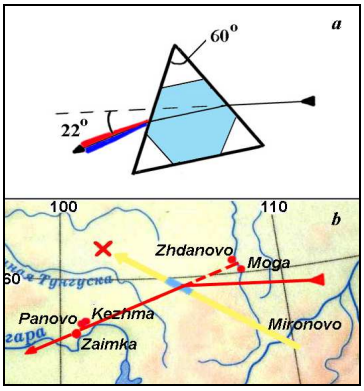

Figure 1: A formation of a halo with a radius of 22^o. (a) Refraction of light by an ice crystal (hexahedral prism). (b) Refraction of sunlight by ice crystals of noctilucent clouds. Yellow arrow – the trajectory of the Tunguska cosmic body. Blue area – altitudes on this trajectory where noctilucen clouds formed

3. The rainbow trail

A track, which has remained on the sky after a flight of this cosmic body, confirms comet nature of this object. Two groups of settlements, where the track was observed similar to a rainbow, are showed in Fig. 1. These are: (i) Kezhma (6 reports of eyewitnesses), Zaimka (3 reports) and Panovo and (ii) Moga, and Zhdanovo. It is possible, that this iridescent colour track was a fragment of a halo around the sun with a radius of 22^o, inasmuch as a line, which united these two groups of settlements (Fig. 1b) makes up a corner ~22^o with solar rays. During the disaster the Sun located practically to the east of the epicenter. It is well known, that a colour halo with a radius of 22^o is a result of refraction of sunlight on hexahedral prismatic crystals of ice clouds (Fig. 1a). In any case, formation of the

rainbow track is impossible without ice crystals or water drops, therefore water evolved from the object during its flight immediately.

4. A short-period comet

The final part of the trajectory of the cosmic body can be determined by traces of the disaster. Every year since 1959, dozens of people have investigated the epicentre of the Tunguska disaster. As a result, a map of windfall [4] and the area of burn affections to trees [5] was determined and created. Symmetrical lines of obtained territories were interpreted as the moving direction of the Tunguska cosmic body on the final part of its trajectory (Fig. 2). Probably the trajectory with an azimuth A=300° corresponds more to the Tunguska cosmic body. Firstly, this trajectory coincides with a mean trajectory of a flight of a cosmic object over Preobrazhenka village (Fig. 2), calculated by Konenkin [6]. Secondly, this trajectory is situated close to one, which was calculated by Zolotov [7] (Fig. 2), who took into account the influence of ballistic waves on the direction of fallen trees. Thirdly, this trajectory intersects a zone, where Doroshin [8] found substances with a maximal concentration of mineral dispersed particles. Doroshin investigated peat bogs along a circle with a radius of 80 km around the epicentre and discovered this zone with a width of 30 km (Fig. 2). Quite possibly, these mineral particles were dropped by the cosmic body during its flight.

The angle of trajectory inclination was calculated as α=20° via crossing the sun by the trajectory that was observed in Kezhma [9]. Based on A=300°, α=20° we calculated a radiant of the Tunguska cosmic body (in equatorial coordinates: straight ascendancy $\alpha=5^h10^m$ and declination $\delta=4^o$). Due to the fact that this radiant is situated not far from the ecliptic plane, we can conclude that the Tunguska cosmic body could be short-period comet. This object was coming from the opposite direction of the Earth, therefore its initial speed was >30 km/s.

Confirmation of the accuracy of calculations A and α could be the following. This trajectory crosses a zone, where noctilucent clouds formed (the altitudes of 74–92 km) at a distance of 168–212 km from the epicentre (Fig. 1). This zone is located just over a line, which connects settlements where the rainbow trail was observed. This line has a corner of ~22° with a direction of sunrays at the moment of the Tunguska disaster. Therefore, we can conclude, that eyewitnesses from Kezhma, Panovo and Zaimka observed iridescent columns of halo 22° but inhabitants of Moga and Zhdanovo observed a reflection of refracted rays.

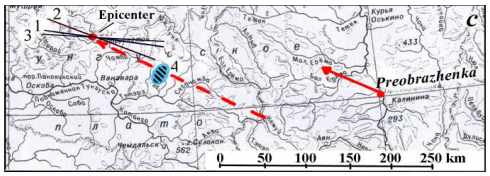

Fig. 2. The trajectory of the cosmic body. Sign: 1 – an axis of symmetry of windfall [4]; 2 – an axis of symmetry windfall, taking into account ballistic waves (Zolotov [7]); 3 – a line of symmetry of burn affections of trees [5]; 4 – a part of the zone, where the body's substance was dispersed (Doroshin [8]); an arrow – a trajectory of the body's flight over Preobrazhenka [6]; a dashed line – the trajectory of the Tunguska cosmic body.

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