

Forecast of enhanced activity of eta-Aquariids in 2013

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Abstract. We tried to simulate distributions for Eta-Aquariids (ETA) of dust trails from 1P/Halley, we found out that some dust trails formed by meteoroids ejected in –1197 and –910 would approach the Earth in 2013. It means that the enhancement of eta-Aquariids would be expected. Actually, the enhanced activity of eta-Aquariids was observed in 2013. Its peak time corresponded with the time when the dust trails approached the Earth based on our simulation. Therefore, it was sure that the enhancement was caused by these dust trails.

Keywords: meteoroid stream, meteor showers, comet, orbits, evolution, radiant

1. Introduction

Eta-Aquariids (ETA) is one of the established meteor showers. The regular activity is middle level for meteor showers, its ZHR is about 50. The parent body is 1P/Halley which is the same as Orionids. The enhancement activities of Orionids were observed between 2006 and 2010, we explained that it was caused by the dust trail formed by meteoroids ejected in about 3000 years ago (Sato and Watanabe 2007).

We tried to simulate distributions for eta-Aquariids of dust trails from 1P/Halley by using the same method as Orionids. As a result, we found out that some trails would approach the Earth in 2013. Therefore, it was expected that eta-Aquariids would be enhanced in 2013.

2. Dust trail model

We applied the simplest approach of the dust trail model. Each trail was assumed to be formed by meteoroids ejected during the perihelion passage of the parent comet. The trail was calculated by test meteoroids ejected parallel to the comet motion, both ahead of and behind the comet. In some models the meteoroids ejection is assumed to the sunward (Ex. Ma, et al. 2002). However, we only considered the ejection along the path because the effect of the divergence of the orbits compared with the parent comet is larger than other assumption, which covers the case of sunward ejection. It is also noted that the ejected meteoroids perpendicular to the path move a heliocentric orbit that is indistinguishable from that of the comet. To calculate the perturbations, we included the three largest main-belt asteroids in addition to the eight planets, Pluto and the moon. We did not take the effect of radiation pressure on the meteoroids into account in our calculation. The orbital

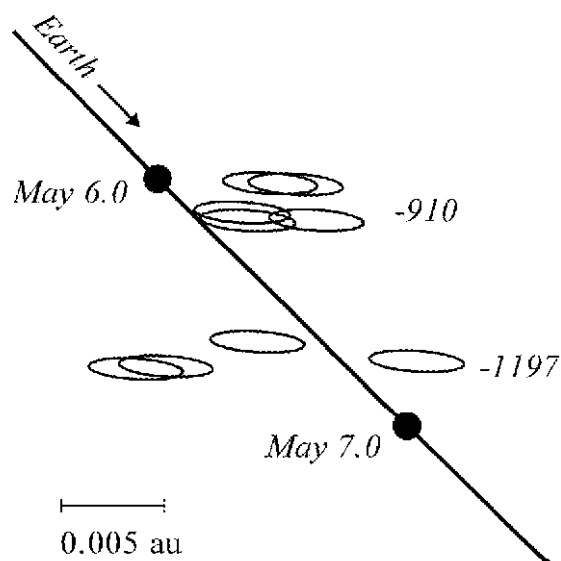


Figure 1. Distributions of dust trails in 2013. Two kinds of dust trails formed by meteoroids ejected in -1197 and -910 would approach the Earth in 2013.

elements of parent comet were those calculated by Yeomans and Kiang (1981). The calculated trails were those generated from -1403 (1404 BC).

3. Forecast from simulation

Figure 1 shows the distributions of dust trails of eta-Aquariids in 2013. Two kinds of trails (-1197 and -910 trails) would be expected to approach the Earth's orbit. These dust trails were complicated because of the perturbations. Table 1 shows the situation of the dust trails. It gives that the enhancement peak would be expected to occur between 5:00 and 22:00 on May 6. We announced this forecast based on our simulation to meteorobs mailing list (by IMO) and NMS mailing list (by Nippon Meteor Society in Japan).

4. Observation results

An enhanced activity of eta-Aquariids was actually observed in 2013. Figure 1 shows the results of visual observations by IMO (IMO 2013) and NMS (Uchiyama 2013). According to the summary by IMO, the peak was observed between about 2:00 and 18:00 on May 6, the ZHR reached about 130. The similar result was obtained by NMS, its peak time was recorded about 18:00 on May 6, the ZHR reached about 110.

Table 1. Data of main dust trails in 2013. The date is the time when the Earth passed the ascending node of the given trail particles. ΔR is the difference in heliocentric distance between the Earth and each trail in the ecliptic plane. The value of fM means the approximate degree of extension about dust trails.

Ejection Year	Expected Date [UT]	peak time [UT]	LS (2000)	ΔR [au]	Ejection Velocity [m/s]	fM	Radiant α [deg.]	δ [deg.]	Vg [km/s]	Orbital Period [yrs]
-910	2013 May 06.24	05:44	45.681	-0.0037	-2.36	0.038	337.78	-0.88	66.08	72.0
-910	2013 May 06.24	05:45	45.682	-0.0018	-2.12	0.095	337.77	-0.89	66.04	71.9
-910	2013 May 06.26	06:16	45.703	-0.0017	-2.05	0.038	337.78	-0.88	66.04	71.8
-910	2013 May 06.27	06:27	45.710	-0.0017	-2.11	0.017	337.79	-0.88	66.04	71.9
-910	2013 May 06.29	07:02	45.734	-0.0046	-2.50	0.11	337.82	-0.86	66.10	72.0
-910	2013 May 06.40	09:42	45.841	-0.0041	-2.29	0.035	337.88	-0.83	66.10	71.9
-1197	2013 May 06.53	12:37	45.959	+0.0021	+3.44	0.013	337.89	-0.80	65.99	71.7
-1197	2013 May 06.89	21:19	46.310	-0.0026	+3.43	0.012	338.14	-0.67	66.12	71.7

Molau (2013) reported that this year the peak of IMO Video Meteor Network is by a factor of two to three higher than in the previous years. Its peak of flux density observed about May 6.

Each peak time was consistent with the expected time based on our simulation. It was sure that such enhancement of eta-Aquariids was caused by approach of dust trails obtained by our simulation.

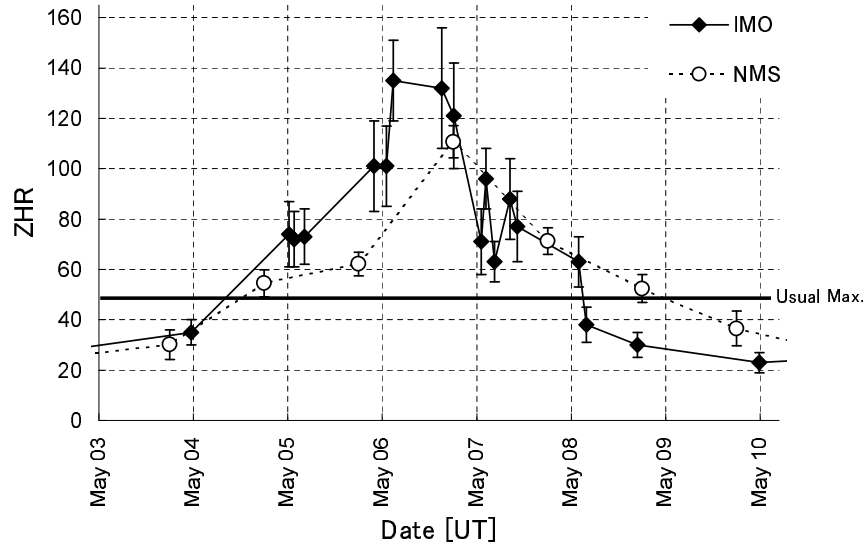


Figure 2. Results of visual observations. Black square with a solid line means data by IMO (IMO 2013) and white circle with a dotted line means data by NMS (Uchiyama 2013).

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