

The study of methods on the Geminids Meteor Shower's (2020) height  
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Abstract

Photograph from two location were used to measure the hight of Geminids Meteor shower. The meteor's heights were found to be around 30 to 180 kilometers above the sea level, where meteor should start to burn up. In this research, pictures were captured by DSLR camera on the 13<sup>th</sup> December 2020. Apparently, after analyzed by trigonometric and parallax method, both methods have approximately same accuracy. Both of methods are similar and could be used as the same, the decision is up to information from pictures and number of observation points.

Introduction

Meteor shower is a made up of ion, dust, and debris that light up while falling down through earth's atmosphere in many numbers. The Geminids meteor shower is special, it came from debris of an asteroid / rocky comet called 3200 Phaethon instead of comet like other meteor showers.

Methods

1. Set camera to same setting and capture pictures in areas that are at least 15 kilometers apart (for accuracy).
2. Separate the calculation into two parts, parallax and trigonometric method

Parallax method : First, overlaid two pictures from both observations and find the angular distance. Second, calculate angular distance by comparing to the distance between Pollux and Castor from the picture. Finally, use TAN's function to calculate the meteor's height and plus the result then divide by two to find the average height.

Trigonometric method : Match stars in meteor's picture with reference stars in the 'Stellarium' program, draw lines using angle from azimuth and altitude of meteor and find the intersections. Measure the distance and use TAN's function in excel to find the height of the meteor and make them on average.

3. Analyze and compare the results that we got from both methods, find the error and discuss for conclusion.

Result and Discussion

Meteor number 6's height was found reaches over 250 kilometers in parallax method and reaches over 300 kilometers in trigonometric method. The result from parallax method show in table 1 and table 2 . And the result from trigonometric method show in table 3 and table 4.

The reason predicted is the chosen picture was taken around 2 AM of 14<sup>th</sup> December 2020, has Geminids constellation around the zenith, and has altitude point higher if compared to other meteor head to tail distances. Also, they might be an error from sky obstacles and other light disturbance.

Table 1 the height of meteors' tails (parallax)

Meteor number	Distance between meteor's tails (Pixel)	Meteor's tails angular distance (Degree)	The height of meteor's tails (Kilometer)
1	469.07	4.20	178.50
2	544.68	4.87	153.62
3	628.59	8.17	91.21
4	507.28	6.54	114.31
5	1001.01	8.98	82.93
6	225.58	2.93	256.23

Table 2 the height of meteors' heads (parallax)

Meteor number	Distance between meteor's heads (Pixel)	Meteor's heads angular distance (Degree)	The height of meteor's heads (Kilometer)
1	529.88	4.74	157.93
2	551.38	4.93	151.75
3	696.32	9.05	82.21
4	584.20	7.53	99.12
5	1100.89	9.87	75.28
6	250.50	3.25	230.69

Table 3 the height of meteors' tails (trigonometric)

Meteor number	Distance of meteor tails from observation point (Kilometer)		Meteor tails' altitude (Degree)		The height of the meteor (Kilometer)		
	Point 1	Point 2	Point 1	Point 2	Point 1	Point 2	Average number
1	630.31	552.08	31.63	31.70	115.40	101.36	108.38
2	800.18	773.47	48.46	39.98	268.47	192.79	230.63
3	27.50	108.91	76.56	67.87	34.20	79.60	56.90
4	57.03	160.82	75.94	60.52	67.69	84.56	76.12
5	129.65	86.00	71.09	70.51	112.50	72.23	92.36
6	681.03	626.87	66.6	70.25	467.80	518.98	493.39

Table 4 the height of meteors' heads (trigonometric)

Meteor number	Distance of meteor heads from observation point (Kilometer)		Meteor heads' altitude (Degree)		The height of the meteor (Kilometer)		
	Point 1	Point 2	Point 1	Point 2	Point 1	Point 2	Average number
1	623.51	542.35	30.12	30.62	107.53	95.42	101.47
2	379.11	340.78	37.53	40.47	86.57	86.42	86.50
3	24.04	108.76	74.48	67.28	25.73	77.21	51.47
4	37.01	141.22	76.08	59.16	44.38	70.31	57.35
5	129.32	70.60	68.59	69.82	98.04	57.10	77.57
6	595.15	534.42	64.74	69.02	374.93	414.26	394.60

Conclusion

The meteor's heights were found at the same range around 30 to 180 kilometers above the sea level, where meteor should start to burn up. Conclude that both methods have approximately the same accuracy. An accuracy from both methods are almost the same but, the trigonometric method's information can be used to find incident angle that improves the credibility of the result.

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Reference: Richard Dibon-Smith. (2016). Gemini Transit Date of principal star. Retrieved January 13, 2021 from [http://www.dibonsmith.com/gem\\_con.htm](http://www.dibonsmith.com/gem_con.htm)