Geminids 2012 – Dual-station meteor videography

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A network of low-light video cameras in Cheshire and West Yorkshire monitors the activity of meteor showers, enabling precision measurement of radiant positions and, from the best quality data, the altitudes and geocentric velocities of meteors and their solar system orbits. The results from dual-station observations of the 2012 Geminid meteor shower are presented and discussed.

Equipment and methods

Alex R. Pratt (ARP) and William Stewart (WS) employed the same equipment and methods as described in their paper on the 2012 Perseids,[1] on their website,[2] and in the current *Journal*.[8]

Results

The first likely Geminid candidate was recorded on 2012 Nov 18 at 01:26:22 UT (Ravensmoor North) and the last on 2013 January 9 at 05:58:34 UT (Leeds). The magnitude distribution during this period (measured by *UFO Analyser*) is given in Table 1.

The activity profile of the Geminids is presented in Figure 1. Bad weather restricted our coverage of the shower, including its brief maximum. The histogram indicates that rates were low until activity picked up around 2012 Dec 09/10. High rates were recorded on Dec 12/13; unfortunately the night of maximum (Dec 13/14) was clouded out. Rates had declined by Dec 14/15 and skies were cloudy for the following week.

Table 1. Magnitude distribution of the 2012 Geminid meteors

	Magnitude								
	−3	−2	−1	0	1	2	3	Sum	Mean
Leeds	0	4	13	43	7	0	0	67	−0.2
Ravensmoor East	0	12	24	55	32	1	0	124	−0.1
Ravensmoor North	2	1	3	17	38	55	9	125	1.3

Table 2. The position of the Geminid radiant at maximum and its daily motion

	Solar long.(°)	RA (°)	RA	dRA (°)	Dec (°)	dDec (°)
ARP/WS	262.0	113.6	7h 34m	1.04	32.3	−0.23
HBAA[3]	262.0	113	7h 32m	1.1	33	−0.07
IAU MDC[4]	262.1	113.2	7h 33m	1.02	32.5	−0.15
IMO[5]	262.2	112	7h 28m	1	33	−0.07
SonotaCo[6]	261.4	112.8	7h 31m	0.90	32.3	−0.19

Dual-station Geminids

UFO Orbit supports three built-in quality assurance criteria:

Q1 – minimum criteria for radiant computation
Q2 – standard criteria for radiant and velocity computation
Q3 – criteria for high precision computation

(When analysing captures, Q1 includes level Q2 and Q3 data, Q2 includes level Q3 data). Between 2012 Dec 5 and Dec 15 a total of 31 Q1-level dual-station Geminids was recorded.

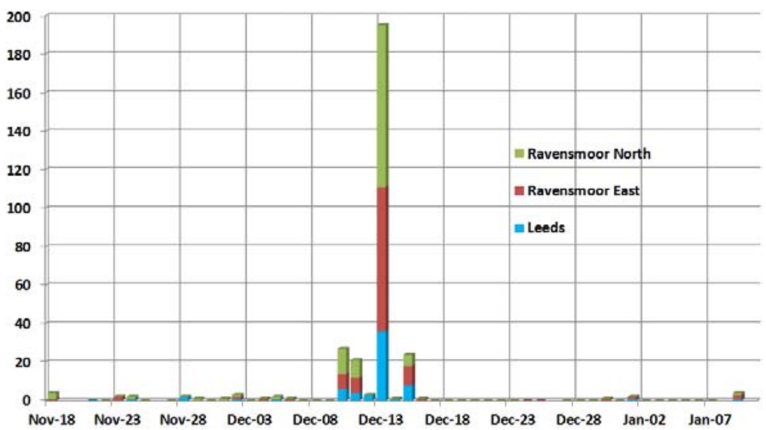

Figure 1. Daily Geminid video captures (All dates are 0h UT).

Radiant drift

UFO Orbit was used to derive the radiant point for each dual-station Geminid, corrected for zenith attraction. These were used to estimate the daily drift of the radiant in right ascension and declination.

Drift in RA

The method of least squares gives the linear fit:

RA = [1.038 * (Solar longitude)] – 158.37
r = 0.879

Drift in Dec

There is more scatter in the data, showing weaker correlation. The method of least squares gives the linear fit:

Dec = [–0.232 * (Solar longitude)] + 93.05
r = 0.629

If we assume that Geminid maximum occurred at solar longitude 262°.0,[3] its estimated RA is 113°.6 (7h 34m) and Dec 32°.3. The estimated daily motion in RA (dRA) is 1°.04 and in declination

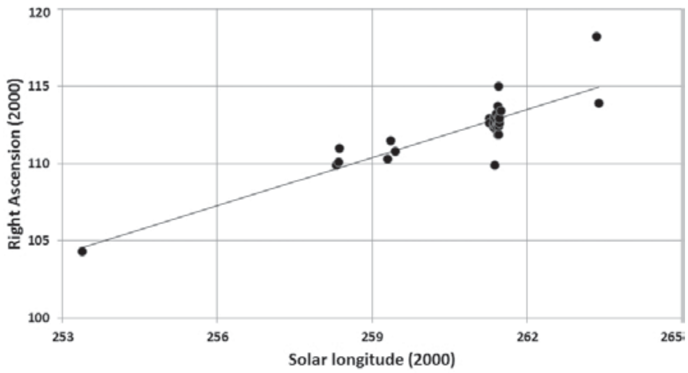

Figure 2. Geminid radiant drift in right ascension.

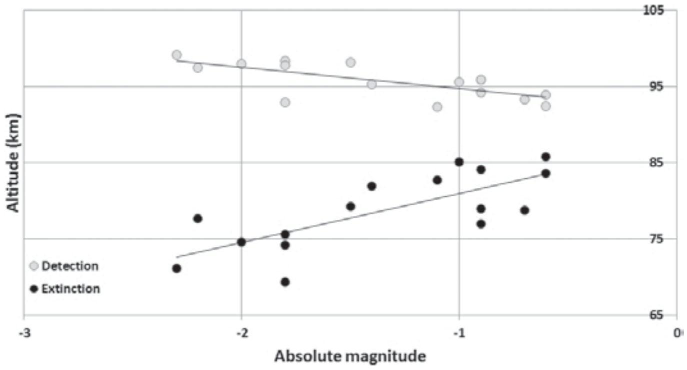

Figure 4. Detection and extinction heights of 16 Q2 Geminid meteors.

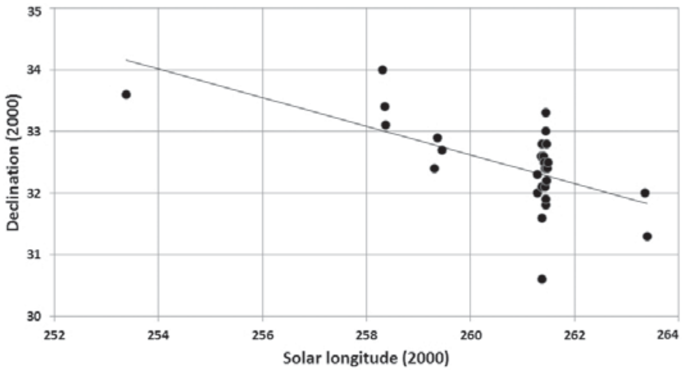

Figure 3. Geminid radiant drift in declination.

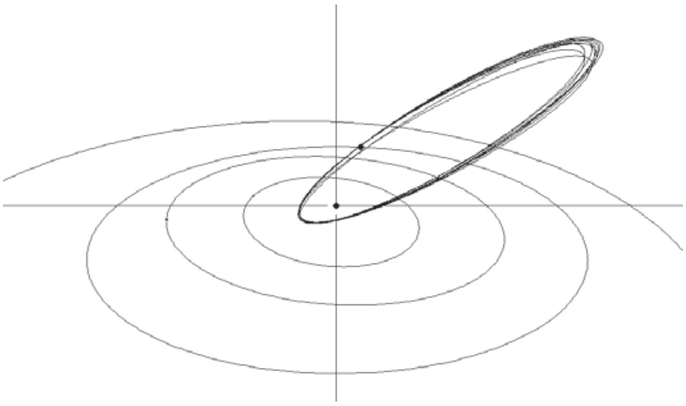

Figure 5. A view of the nine unified Geminid orbits.

Table 3. Geocentric velocities of Geminid meteors

	Vg (km/s)
ARP/WS	33.5
IAU MDC[4]	34.58
IMO[5]	35
SonotaCo[6]	33.5

(dDec) is –0°.23. These figures are presented in Table 2 for comparison with other sources.

Detection and extinction altitudes

UFO Orbit computed the start and end heights of 16 Q2 Geminid meteors and their absolute magnitudes, captured between Dec 10 and 13 (see Figure 4). (*Note:* Absolute magnitude is the magnitude the meteor would have if it was in the zenith, 100km above the observer.)

The method of least squares gives the linear fits:

Detection altitude (km) = [–2.35 * (Absolute magnitude)] + 91.9
r = 0.667

Extinction altitude (km) = [5.65 * (Absolute magnitude)] + 87.9
r = 0.749

Our results from negative magnitude Geminids suggest that for every one magnitude increase in brightness they are detected 2km higher in altitude and reach about 5km lower in the atmosphere before burning up.

Geocentric velocities

UFO Orbit computed the geocentric velocities (V_g) of the 16 Q2 Geminid meteors, which gave the following:

Mean 33.5 km/s
Standard deviation 0.6 km/s

These are compared with other sources in Table 3.

Table 4. Orbital elements of nine Geminid meteors, IAU MDC shower data and parent body (3200) Phaethon (J2000)

Solar long.	*a (AU)*	*q (AU)*	*e*	*p*	*Peri*	*Node*	*Incl*
258.314880	1.257	0.153	0.878	1.411	323.729	258.315	24.684
258.358795	1.180	0.156	0.867	1.282	324.194	258.359	22.509
261.367035	1.355	0.145	0.893	1.578	323.884	261.367	22.337
261.401520	1.275	0.146	0.886	1.440	324.478	261.401	23.200
261.414612	1.355	0.147	0.891	1.578	323.551	261.414	23.030
261.427826	1.332	0.147	0.890	1.538	323.801	261.427	22.786
261.447418	1.318	0.148	0.888	1.513	323.762	261.447	22.429
261.453705	1.312	0.148	0.888	1.503	323.902	261.453	23.570
261.458069	1.335	0.147	0.890	1.542	323.738	261.458	22.114
Mean	1.302	0.149	0.886	1.487	323.893	260.738	22.962
Std. dev.	0.057	0.004	0.008	0.096	0.280	1.362	0.793
IAU MDC[4]	1.372	0.141			324.42	261.49	24.02
(3200) Phaethon[7]	1.271	0.140	0.890	1.433	322.148	265.267	22.241

Orbits

UFO Orbit computed the orbital elements of nine Q3 Geminids, captured between Dec 10 and 13. For each pair of observations it calculated two orbits and a unified orbit; the latter are given in Table 4.

The nine unified orbits are displayed in Figure 5.

Conclusions

The poor weather during late 2012 prevented the authors from obtaining good coverage of the Geminid meteor shower. However, the results are in accordance with the shower data published by the BAA, IAU MDC, IMO and *SonotaCo*.

The altitudes at which Geminids were detected and extinguished were generally 15km lower into the atmosphere than Perseid meteors.[1] The Geminids' relatively low values of V_g allowed good orbital data to be obtained. It is interesting to note the close agreement between the orbital elements of the captured Geminid meteors and those of their parent body (3200) Phaethon.

The authors have insufficient data to recommend any changes to the Geminid data in the Meteor Diary in the *BAA Handbook*.

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References

1 A. R. Pratt, W. Stewart & L. Entwisle, 'Perseids 2012 – Multi-station meteor videography', *J. Brit. Astron. Assoc.,* **123**(3), 157 (2013)
2 **http://www.nemetode.org/**
3 *Hbk. Brit. Astron. Assoc.,* 2012, 98
4 **http://www.astro.amu.edu.pl/~jopek/MDC2007/Roje/pojedynczy_obiekt.php?kodstrumienia=00004&colecimy=1**
5 **http://imo.net/calendar/2012#gem**
6 *SonotaCo*, 'A meteor shower catalog based on video observations in 2007–2008', *WGN*, **37**(2), 59 (2009)
7 **http://ssd.jpl.nasa.gov/sbdb.cgi?sstr=3200**
8 W. Stewart & A. R. Pratt, 'A modern video meteor detection system and network – Overview and typical costs', *J. Brit. Astron. Assoc.,* **123**(6), 321 (2013)

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