Geminids 2012 – a spectacular show from Oman

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The Geminids are the most reliable prominent meteor shower currently visible. They can be observed from the whole northern hemisphere and even low southern latitudes as well. Nevertheless, as the weather is often unfavourable in Central Europe during December, a six-day-long visual observing campaign was carried out from Oman in 2012. There observing conditions were nearly perfect, especially in the Rub al-Khali desert in the western part of the country. As a consequence, we managed to record more than 1800 Geminids within almost 45 hours of effective observing time. An impression of the campaign together with a summary of the results is given.

1 Why observing the Geminids from Oman?

With a radiant declination of δ = +33°, the Geminid meteor shower is observable from the whole northern hemisphere and even low southern latitudes as well. Unfortunately, humid air often dominates mid-northern December nights, resulting in cloudy skies and high altitude fog respectively. To escape these inferior conditions one has to move south, preferably to the Tropic of Cancer, where dry weather prevails and radiant altitudes are comparable to mid-northern latitudes.

For 2012 the Geminid maximum was expected to fall on December 13th, 23^{h}30^{m} UT (McBeath, 2011), corresponding to night times in Europe, North Africa and Western Asia. Additionally, New Moon on the same day secured perfect astronomical circumstances. Therefore we, Thomas Weiland and Felix Bettonvil, decided in early 2012 to use the moonless spell in the month December for a six-day-long observing campaign from Oman.

Oman, covering the south-eastern tip of the Arabian Peninsula and stretching between 17° and 26° N, offers a 70 to 90 % chance of clear nights in December, with the highest values in its western part. Moreover, these areas, especially the Rub al-Khali desert, are blessed with nearly unspoiled, pristine skies. To add an extra bonus, Oman ranks as one of the safest and friendliest nations in the Arabian world.

2 The 2012 observing campaign

Our campaign started out on December 10th–11th and lasted until December 15th–16th. We concentrated on visual observing; additionally Felix Bettonvil operated one automatic Canon 350D DSLR camera equipped with a 8 mm / f 2.8 Nikkor fisheye lens in order to capture bright Geminids and fireballs.

On the whole, the weather stayed quite cooperative. During the maximum night (December 13th–14th) some cirrus clouds turned up, hampering our observations not much. Only the last observing session (December 15th–16th) fared ill, as fast moving cumulus clouds gave way to clear skies for less than one and a half hour.

Limiting magnitudes (averaged over each night) were ranging between 6.06 and 6.35 (Felix Bettonvil, BETFE; star counting method) and between 6.10 and 6.50 (Thomas Weiland, WEITH; direct view method, averted vision) respectively.

All in all we managed to record 1811 Geminids within 44.79 hours of effective observing time (see *Table 1*).

3 Results

Magnitude distribution / Population indices

From the total magnitude distribution (see *Table 1*) it can be deduced that 12 % (BETFE) and 15 % (WEITH) of all GEMs respectively reached at least magnitude 0, more or less comparable to other major annual streams.

Fireballs (≥ magnitude -3) were abundant during the maximum night (December 13th–14th; 10 (BETFE); 14 (WEITH)) and, to a much lesser extent, the night before and after. The brightest one of them reached magnitude -7 (December 13th, 22^{h}57^{m}25^{s} UT).

Interestingly, meteor numbers per magnitude class were slightly different for each observer, peaking at +3 (BETFE) and +4 (WEITH) respectively.

In a further step population indices were derived, using the magnitude difference between the meteors and the

Table 1: Observer statistics, magnitude distribution and meteor numbers.

Date	*UT*	T_{eff}	*lm*	*-6*	*-5*	*-4*	*-3*	*-2*	*-1*	*0*	*+1*	*+2*	*+3*	*+4*	*+5*	*+6*	*Σ*	*Observer*
10/11	20:55-00:00	3.17	6.06	0	0	0	0	0	0	0	2	4	8	2	3	0	19	BETFE
	20:30-23:30	2.90	6.10	0	0	0	0	0	0	1	2	4	7	4	1	0	19	WEITH
11/12	21:01-00:00	2.83	6.35	0	0	0	0	0	1	1	7	5	15	19	10	3	61	BETFE
	20:30-23:30	3.19	6.50	0	0	0	0	0	1	2	1	5	8	21	7	0	45	WEITH
12/13	20:55-01:10	3.33	6.25	0	0	0	1	2	0	4	13	14	38	46	21	3	142	BETFE
	21:00-01:00	3.98	6.45	0	0	0	1	2	1	7	22	23	34	91	27	0	208	WEITH
13/14	17:05-01:45	7.77	6.28	1	2	3	4	7	24	45	62	97	142	115	61	2	565	BETFE
	16:45-01:45	8.06	6.48	*3	3	2	6	15	42	51	49	93	117	184	39	0	604	WEITH
14/15	21:08-01:00	3.72	6.13	0	0	1	0	0	1	3	2	7	12	29	14	1	70	BETFE
	21:30-00:30	3.00	6.50	0	0	1	1	0	2	2	2	8	8	31	5	0	60	WEITH
15/16	22:35-23:52	1.87	6.10	0	0	0	0	0	0	1	1	0	3	1	5	0	11	BETFE
	22:15-23:15	0.97	6.35	0	0	0	0	0	0	0	1	0	0	3	3	0	7	WEITH
Σ		22.69		1	2	4	5	9	26	54	87	127	218	212	114	9	868	BETFE
Σ		22.10		*3	3	3	8	17	46	63	77	133	174	334	82	0	943	WEITH
Total		44.79		*4	5	7	13	26	72	117	164	260	392	546	196	9	1811	

* *The brightest GEM actually had magnitude -7.*

Figure 1 – Fisheye view, showing the Milky Way and nine bright Geminids. Composite of 15 pictures obtained on December 13th–14th (Canon 350D, Nikkor 8 mm / f 2.8, ISO 1600, 30sec exposures).

limiting stellar magnitudes, based on table 9.2, p. 178 in the HMO, 2nd ed. (Rendtel and Arlt, 2009).

For the time span of December 11th–12th to December 14th–15th this yielded values varying between r = 2,12 and 3.07 (BETFE; average 2.67) and 1.95 and 2.68 (WEITH; average 2.14). Due to the low GEM numbers, no population indices were derived for December 10th–11th and December 15th–16th respectively.

Despite the difference in population indices, which may be caused by the diverging methods of determining the limiting magnitude, the trend, however, is nearly the same: starting out with r-values around 2.7 on December 11th–12th and staying more or less constant during the following night, a distinctive minimum within the order of r = 2.0 was encountered on December 13th–14th. After that r-values were rising again to around 2.7.

Zenithal hourly rates

ZHR calculation followed the procedure given in the HMO, 2nd ed. (Rendtel and Arlt, 2009). Due to the fact that limiting magnitudes were close to, or even matching the standard sky of +6.5, using individual population indices would have a minor impact on ZHR calculation. Nevertheless, we took individual r-values of 2.00

(BETFE; in analogy to the IMO live ZHR profile[1]) and 2.14 (WEITH) respectively and averaged the results. The zenith exponent was assumed to be $\gamma = 1.0$. No perception coefficient was applied.

Maximum ZHRs started out with less than 10 on December 10th–11th and were rising more than twice during the following night. During the third session (December 12th–13th) much higher rates were encountered (within the order of 60). The maximum night (December 13th–14th) finally yielded ZHRs hovering around 105 for more than 8 hours. After this period they showed a steep decline, starting with about 35 at the beginning of the fifth run (December 14th–15th) and ending up within the order of 15. During the last session (December 15th–16th) ZHRs were comparable to those at the beginning of the campaign.

Concerning the time of maximum, there is no distinctive trend discernible. In order to smooth the profile and to get the peak out more clearly, ZHR values based on bins of 10 minutes obtained by WEITH were averaged using a sliding mean of 5 bins per step (A5). This puts the time of maximum to $22^h30^m \pm 10^m$ UT (ZHR 127 ± 28), about 1 hour earlier than predicted and quite in agreement with the corresponding IMO live ZHR profile[1].

General Appearance

Geminid meteors can be distinguished from those of other streams by their scarcity of trains. According to that, only 2 % of all GEMs logged by WEITH (n = 943; see *Table 1*) showed a prominent train (-7 to +3 magnitude class) and additional 9 % produced a short one (-6 to +4 magnitude class).

Color estimates by WEITH yielded mainly yellow and fewer white hues, with blue, orange and green tints to a much lesser extent.

Fireballs

The most prominent feature of the 2012 Geminids was a spectacular array of fireballs during the maximum night (December 13th–14th), occurring all within less than 5 hours ($19^h25^m15^s$ to $00^h08^m15^s$ UT). Magnitudes were ranging between -3 and -7 and fireballs ≥ magnitude -5 even showed a stronger concentration in time (3.3 hours; $20^h48^m50^s$ to $00^h08^m15^s$ UT), more or less centred on the time of maximum.

On December 12th–13th the brightest GEM reached magnitude -3 and on December 14th–15th magnitude -4.

Photographic results

Due to the fact that Geminid meteors are of medium speed and often bright, it was not too difficult to get them onto chip. With that in mind, Felix Bettonvil captured a few on the night of December 13th–14th (see *Figure 1*).

[1] http://www.imo.net

4 Conclusion

The 2012 observational results can be summarized as follows:

- Population indices were comparable to previous returns, showing a dip around the time of maximum (Rendtel, 2004; Rendtel et. al., 2009).
- ZHR values were definitely lower than in 2004, the last moonless return within the same time window (Miskotte et. al., 2011).
- The time of maximum was in line with the forecast, about 1 hour earlier than predicted (McBeath, 2011).
- An unusual concentration of fireballs was encountered on December 13th–14th within a relatively short time span (4.7 hours); bright fireballs (≥ magnitude -5) even showed a stronger concentration centred on the time of maximum (3.3 hours). Usually Geminids ≥ magnitude -1 reach their peak after the maximum; Uchiyama, 2010).
- There is probably no correlation between the occurrence of fireballs and the distance of (3200) Phaethon to Earth, with respect to December, 14th, 0^h UT (2012: 1.712 AE; near the maximum value; see Miskotte et. al., 2011).
- Concerning colors, yellow tints were dominating over blue hues; this may be an indication that not all meteoroids are Na-depleted to the same extent (see Jenniskens, 2006).

5 Future Work

In comparison with previous returns, the 2012 observational results may give rise to questions about the evolution of the stream:

- Have the Geminid maximum rates already peaked at the turn of the last century (see Miskotte et. al., 2011) or will they steadily increase until 2050 (Jones and Hawkes, 1986; cit. in Jenniskens, 2006)?
- Is the percentage of bright Geminids still on the rise and will they peak together with the highest rates (Jones and Hawkes, 1986; Williams and Wu, 1993; cit. in Jenniskens, 2006)?

The moonless returns of 2015, 2017 and 2020 offer excellent opportunities to prove this!

References

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