2006 Orionid Meteor Shower Surprise!

By Wes Stone

On the morning of October 17, 1993, I saw a rather spectacular Orionid display from Silcox Hut on Mt. Hood during the Cosmos '93 symposium. This was my first dark sky star party with big telescopes, and the weather had been rather poor until this night. While I had recently become interested in formal meteor observing, I was seduced by the views of the Veil Nebula, Horsehead Nebula and other exotic deep-sky targets that the light buckets hauled in. It seemed like every time I looked up from the eyepiece, one or more meteors streaked across the sky. I knew this activity was unusual, but I didn't know just how *unusual. My estimate was somewhere around 40 Orionids per hour. It was only later that I learned that what I saw was probably the prelude to an Orionid outburst reported by several observers on October 17/18.*

I was lucky enough to have four mostly clear mornings around the peak of the 2006 Orionid meteor shower. As a bonus, I was housesitting at a rural site with good horizons. I've watched several Orionid returns in the past, with variable results. The shower's long duration and broad peak mean that timing is less critical than with some showers (i.e., the Quadrantids). On the other hand, the Orionids are usually a second-tier shower with peak rates around 20 meteors per hour. Often, my observed rates have been even lower. The shower is often described as having several submaxima around the "traditional" maximum date of October 20/21. It could also be described as having spurts and lulls of activity around the maximum. Sometimes, a lull even occurs during the predicted maximum. Prior to this year, my best hour of formal counting featured 27 Orionids. That observation took place from White River Canyon near Mt. Hood on October 20/21, 1998. This year, the Orionids had a true surprise in store.

My Observations

On Friday morning, October 20, 2006, I arose expecting to see normal rates of 10-20 Orionids per hour. To my surprise, I saw high rates averaging around 40 Orionids per hour. The Orionids are typically rich in faint meteors, but this morning featured many bright meteors. Skies were decent, but not spectacular due to high humidity. Near the end of the watch, I had to take a 10-minute break due to passing fog. In all, I observed for 2.75 hours between 1000 and 1300 UT (3am – 6am PDT) and saw a total of 154 meteors. Of these, 111 were Orionids. Despite slightly worsening conditions, my final hour was most active with 46 Orionids.

Eighteen of the 111 Orionids were magnitude -1 or brighter, and seven were fireballs of -3 or brighter (see Figure 1 for an explanation of magnitude estimation). The mean Orionid magnitude was 1.6, very bright for this shower. My past years with decent numbers of Orionids showed fainter mean magnitudes: 2.8 in 1998 and 2001 and 2.6 in 1999. The brightest Orionid this morning was estimated at -8, one of the ten brightest meteors I've seen in 13 years of observing. I described its terminal burst as a flashbulb low in the east. Imagine if it had been high in the sky and near the center of my visual field! I noted wakes or trains following 42 Orionids (38%), these are characteristic of fast, bright meteors seen under decent sky conditions. In contrast, only 5 sporadic meteors (15%) left wakes or trains. I only noted color (green) in one Orionid during this session.

The zenithal hourly rate or ZHR is an estimate of the number of shower meteors that would be seen by an observer in one hour under a clear, unobstructed sky with the shower's radiant at the zenith (overhead or 90° elevation) and a naked eye limiting magnitude of 6.5. Corrections are applied based on radiant elevation, obstructions and actual limiting magnitude to derive a ZHR. Sometimes additional corrections based on perception indices for individual observers are also considered. The Orionid radiant doesn't reach the zenith from my latitude of 42.5 degrees north, but its elevation of 60° at mid watch made this correction small. And since my limiting magnitude was better than 6.5 for most of my observing periods the correction for limiting magnitude actually reduced my ZHR result. My total ZHR for my observation was 38±4. For the final hour, it was 47±7. I assumed an r-value (population index related to the brightness profile of the shower and used in the limiting magnitude correction) of 2.0, as is typical for a first estimate and probably appropriate given the brightness of the observed Orionids. For more information on the ZHR and its limitations, see my article "What the Heck is a ZHR?" at http://skytour.homestead.com/zhr.html.

Since the Orionids generally produce a peak ZHR of 20-25, and indeed the International Meteor Organization's 2006 shower calendar at http://www.imo.net/calendar/2006/fall suggested these were the rates to expect in 2006, the high activity was a surprise. Was the activity of October 19/20 just an unusually strong, short-lived spurt, or would the next morning bring a surprise as well?

Figure 1: My summary report for the morning of October 20, 2006

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Observer: Wesley Stone (STOWE)
Location: Oregon Shores, OR (42d 33m 00s N, 121d 55m 11s W)
Method: Counting: Watch/Tape recorder
Date: 2006 October 19/20
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Interval	Teff	Lm	NTA	STA	ORI	EGE	Spo
1000-1015	0.25	6.8	-	-	6	-	3
1015-1031	0.25	6.8	-	-	9	-	4
1031-1046	0.25	6.9	1	-	12	1	3
1046-1102	0.25	6.9	-	-	8	-	3
1102-1117	0.25	6.8	-	2	10	1	2
1117-1133	0.25	6.8	-	-	10	1	7
1133-1148	0.25	6.7	-	-	10	-	1
1148-1204	0.25	6.7	-	-	8	-	2
1204-1219	0.25	6.7	-	-	11	-	3
1219-1235	0.25	6.7	-	1	17	1	2
1245-1300	0.25	6.5	-	-	10	1	4
1000-1300	**2.75**	**6.8**	**1**	**3**	**111**	**5**	**34**

Magnitude Distributions

Magnitude:	-8	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	Tot	Mean
NTA	0	0	0	0	0	0	0	0	0	0	1	0	0	1	4.0
STA	0	0	0	0	0	0	0	1	0	2	0	0	0	3	2.3
ORI	1	2	1	3	5	6	13	8	29	24	14	4	1	111	1.6
EGE	0	0	0	0	0	0	2	1	2	0	0	0	0	5	1.0
Spo	0	0	0	0	1	2	3	4	6	13	4	1	0	34	2.1

Key/notes: At the top of the report is my name, observing code, and observing location. When a meteor appeared, I spoke the data into my tape recorder and briefly glanced at my illuminated watch for the time to the nearest minute. With high activity and some simultaneous meteors, it wasn't necessary to look at my watch after every meteor. Still, looking away from the sky caused dead time of about two seconds every time I did. Someday, I'll get a talking clock so that I can keep my eyes on the sky 100% of the time.

I broke my observation into intervals of 15 minutes effective observing time (Teff, allowing for the dead time). Intervals of one hour or more would be typical if there wasn't any unusual activity. Note the 10-minute break from 1235-1245 when I wasn't able to observe due to fog. LM=Limiting magnitude, an estimate of the faintest star visible to the naked eye. In practice, this is determined by counting the number of stars visible in triangular or trapezoidal areas and then consulting tables after the observation. Showers are given three-letter abbreviations, and there were several minor showers active as well as the Orionids. NTA=Northern Taurids, STA=Southern Taurids, ORI=Orionids, and EGE=Epsilon Geminids. Spo refers to sporadic meteors, apparently random and not associated with any known shower. For each interval, the number of meteors from each shower is listed. Totals are in bold at the bottom.

Magnitude distributions give the number of meteors in each magnitude (brightness) class for each shower. Magnitude is estimated by comparing the peak brightness of each meteor with stars of a known magnitude. Lower magnitudes are brighter; meteors of magnitude -3 or brighter are considered "fireballs" and are rather rare and spectacularly bright. The brightest comparison object visible in the sky during the observation was the star Sirius at magnitude -1.5, so accurate magnitude estimation of fireballs was difficult. There are more faint meteors than bright ones, but the fainter ones are progressively less likely to be seen, so the magnitude distribution follows a characteristic curve. In the rightmost column is the mean magnitude for each of the showers. Had I been observing from a light-polluted site or under poorer conditions, I would have seen fewer faint meteors and the mean magnitude and magnitude distribution would have been shifted toward fewer, brighter meteors. The limiting magnitude is thus very important in comparing observations and determining the brightness profile of a shower.

I had to work a full day on Saturday, October 21. With darkness lingering late in the last days of Daylight Saving Time, I figured I could get up an hour earlier than usual, do a quick meteor observing session and then get ready for work. My night's sleep was a bit fitful, and I got up for a drink of water around 2am. Possible auroral activity was predicted, so I made a quick check of the northern sky. No auroras were evident, but in less than a minute I saw three bright Orionids through the window, including one I estimated at magnitude -2. Although this was likely a sign of continued high activity, I didn't want to be a danger during my commute or a zombie during my workday, so I squeezed in a couple of hours of sleep.

It was 4:54am (11:54 UT) when I began my formal meteor watch. I was rested and refreshed, and I felt like my visual perception was at its peak. The sky was beautiful, with the previous morning's lingering moisture having exited the scene. My limiting magnitude was constant at 7.1 throughout my hour of observing. Surprisingly, the Orionids were even stronger and brighter than on the previous morning. In one hour of observing, I counted 74 of them with a mean magnitude of 1.5. I also observed 24 other meteors (21 of the sporadics) for a bountiful hourly total of 98. Half of the Orionids left wakes or trains, as opposed to 19% of the sporadic meteors. The brightest meteor, a -5 Orionid, left a train visible for ~45 seconds. The Zenithal Hourly Rate for this observing session was 54±6. Orionid activity was still very high, and probably slightly higher than 24 hours earlier, but the better sky conditions accounted for some of the increase in observed rates. Careful computation of the r-value from multiple observations on this date might make the increased rates more evident in the ZHR. If the brightness profile of the Orionid stream had been constant, an 0.3-magnitude improvement in limiting magnitude should have resulted in an 0.3-magnitude increase in mean magnitude. Instead, the mean magnitude was actually slightly brighter than on the previous morning. This suggests that an r-value of 2.0 applies too severe a correction to the ZHR for October 20/21.

Figure 2: My summary report for the morning of October 21, 2006

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Observer: Wesley Stone (STOWE)
Location: Oregon Shores, OR (42d 33m 00s N, 121d 55m 11s W)
Method: Counting: Watch/Tape recorder
Date: 2006 October 20/21
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Interval	**Teff**	**Lm**	**NTA**	**STA**	**ORI**	**EGE**	**Spo**
1154-1209	0.25	7.1	0	0	22	0	6
1209-1225	0.25	7.1	0	0	21	0	3
1225-1240	0.25	7.1	0	1	13	1	9
1240-1256	0.25	7.1	0	0	18	1	3
1154-1256	**1.00**	**7.1**	**0**	**1**	**74**	**2**	**21**

Magnitude Distributions

Magnitude:	**-5**	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**Tot**	**Mean**
STA	-	-	-	-	-	-	-	-	1	-	-	1	4.0
ORI	1	1	2	7	13	7	18	15	7	2	1	74	1.5
EGE	-	-	-	-	-	1	-	1	-	-	-	2	2.0
Spo	-	-	-	-	1	4	4	7	5	-	-	21	2.5

Key/notes: See Figure 1 for an explanation of terms and reporting conventions.

On Sunday morning, October 22, I split my time between meteor observing and telescopic viewing. My time at the telescope was eerily similar to 1993 at Silcox Hut; often, I would look up from the telescope and see two or three nearly simultaneous Orionids streak across the sky.

I began a formal meteor observing session at 3:30am (10:30 UT). Skies were excellent, with the average limiting magnitude again 7.1. Observed Orionid rates fell somewhere between those of October 20 and October 21. In meteor observing, we often notice small-scale clustering of meteors, and this is generally attributed to random chance. On Saturday morning, this clustering seemed to occur against a steady background. On Sunday, it felt like there were more dead periods between bursts of meteors (although the longest Orionid-free interval was only six minutes). In 1.5 hours of effective observing time, I counted a total of 132 meteors. Of these, 101 were Orionids for a raw hourly rate of over 67! Clearly the show had not diminished much. The mean Orionid magnitude was fainter at 2.2 (still fairly bright considering the limiting magnitude). The brightest meteors were three Orionids of magnitude -3. One of these left a train visible for 12 seconds. Thirty-three Orionids (33%) left wakes or trains, compared to 3 (12%) of the sporadics. The ZHR for the session was 51±5 assuming an r-value of 2.0, although the fainter mean magnitude probably dictates a larger r-value and smaller ZHR, at least relative to that of my October 20 and October 21 observations.

I stopped my session a bit early in order to catch the 9th-magnitude comet P/2006 T1 (Levy) in Sextans. Orionids continued to fall during my telescopic session. Figure 3 summarizes my Sunday morning data.

Figure 3: My summary report for the morning of October 22, 2006

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Observer: Wesley Stone (STOWE)
Location: Oregon Shores, OR (42d 33m 00s N, 121d 55m 11s W)
Method: Counting: Watch/Tape recorder
Date: 2006 October 21/22
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Interval	**Teff**	**Lm**	**NTA**	**STA**	**ORI**	**EGE**	**Spo**
1030-1045	0.25	7.1	-	1	13	-	6
1045-1101	0.25	7.1	1	-	18	1	3
1101-1116	0.25	7.0	1	1	14	-	2
1116-1132	0.25	7.0	1	-	21	-	4
1132-1147	0.25	7.1	1	-	22	-	6
1147-1203	0.25	7.1	-	-	13	-	3
1030-1203	**1.50**	**7.1**	**4**	**2**	**101**	**1**	**24**

Magnitude Distributions

Magnitude:	**-3**	**-1**	**0**	**1**	**2**	**3**	**4**	**5**	**Tot**	**Mean**
NTA	-	-	-	1	1	1	1	-	4	2.5
STA	-	-	-	-	2	-	-	-	2	2.0
ORI	3	4	6	10	27	34	13	4	101	2.2
EGE	-	-	-	-	-	1	-	-	1	3.0
Spo	-	-	-	3	2	13	4	2	24	3.0

Key/notes: See Figure 1 for an explanation of terms and reporting conventions.

Monday morning, October 23, looked like it would be the last chance for favorable weather. Again, I did some telescopic observations before and after my meteor session. I didn't see any Orionids through my 10" Dob, but I did see two telescopic meteors while observing a galaxy in Eridanus. Naked-eye Orionid activity was still impressive, even at a casual glance.

At 3:00am (10:00 UT) I settled into my sleeping bag for two hours of meteor observing. Orionid activity was still higher than in any of my counts from previous years, but it appeared to have slacked off a bit. There were still impressive bursts of activity (including five Orionids in a single minute), but there were longer dead periods as well. One Orionid-free period stretched to 13 minutes. Still, raw Orionid rates for the first and second hours were 55 and 49, respectively! These 104 Orionids were joined by 35 other meteors for a two-hour total of 139. A bit of high cirrus in the second hour dropped the limiting magnitude from 7.1 to a still-decent 6.8. Mean Orionid magnitude was 2.1, similar to the previous morning. This morning's only fireball was a beauty, a -5 Orionid that peaked near the center of my observing field in Taurus and showed a color combination of orange and violet. This fireball left a persistent train visible for 30 seconds. Thirty-one Orionids (30%) left wakes or trains, compared to 12% of sporadics. The ZHR for this morning's observation was 43±4, again assuming an r-value of 2.0.

Figure 4: My summary report for the morning of October 23, 2006

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Observer: Wesley Stone (STOWE)
Location: Oregon Shores, OR (42d 33m 00s N, 121d 55m 11s W)
Method: Counting: Watch/Tape recorder
Date: 2006 October 22/23
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Interval	Teff	Lm	NTA	STA	ORI	EGE	Spo
1000-1015	0.25	7.1	-	1	10	1	3
1015-1031	0.25	7.1	-	-	11	-	5
1031-1046	0.25	7.1	1	-	16	1	4
1046-1102	0.25	7.1	-	-	18	1	3
1102-1117	0.25	6.8	-	-	6	-	2
1117-1133	0.25	6.8	-	2	13	-	3
1133-1148	0.25	6.8	-	-	14	-	4
1148-1204	0.25	6.8	2	1	16	-	1
1000-1204	**2.00**	**7.0**	**3**	**4**	**104**	**3**	**25**

Magnitude Distributions

Magnitude :	-5	-2	-1	0	1	2	3	4	5	6	Tot	Mean
NTA	-	-	-	-	-	1	1	-	1	-	3	3.33
STA	-	-	-	-	-	1	2	1	-	-	4	3.00
ORI	1	1	8	14	7	20	29	18	5	1	104	2.13
EGE	-	-	-	-	-	2	-	1	-	-	3	2.67
Spo	-	-	1	3	3	2	11	4	0	1	25	2.44

Key/notes: See Figure 1 for an explanation of terms and reporting conventions.

Monday evening and Tuesday morning were partly cloudy with lots of cirrus. Another problem was smoke from prescribed burns in the forests nearby. I started a meteor watch under fair conditions at 5:00am (1200 UT), but this smoke soon encroached on my field of view. After 20 minutes, the sky got markedly worse and observing became rather pointless. One hour of effective observing time is generally considered necessary to obtain useful data, so my abbreviated session only indicates continued strong Orionid activity. In 0.33 hours of observing time, I saw 10 Orionids and six other meteors (see Figure 5 for details).

Figure 5: My summary report for the morning of October 24, 2006

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Observer: Wesley Stone (STOWE)
Location: Oregon Shores, OR (42d 33m 00s N, 121d 55m 11s W)
Method: Counting: Watch/Tape recorder
Date: 2006 October 23/24
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Interval	Teff	F	Lm	NTA	STA	ORI	EGE	Spo
1200-1220	0.33	1.05	6.7	1	1	10	0	4

Magnitude Distributions

Magnitude :	-1	0	1	2	3	5	Tot	Mean
NTA	-	-	-	1	-	-	1	2.0
STA	-	-	-	-	1	-	1	3.0
ORI	1	2	2	2	2	1	10	1.6
Spo	-	-	-	1	3	-	4	2.8

Key/notes: See Figure 1 for an explanation of terms and reporting conventions. A new correction factor "F" is introduced in Figure 5. F is used in the ZHR equation to account for the obstruction of a portion of the visual field.

The Big Picture

Obviously and fortunately, I was not alone. Other observers around the world were also reporting high Orionid activity. Many reports were posted to the 'meteorobs' mailing list (see http://www.meteorobs.org/). I wasn't able to observe on the morning of October 19, but Wayne Hally was out in New Jersey and reported roughly normal Orionid rates under mediocre conditions. His report (archived at http://lists.meteorobs.org/pipermail/meteorobs/2006-October/004958.html) does show a bright mean magnitude for the Orionids, although the sample size is small. Likewise, other observers were able to observe on mornings after the peak. Their observations generally indicate a gradual drop in Orionid rates. On October 25, the International Meteor Organization issued a circular (http://lists.meteorobs.org/pipermail/meteorobs/2006-October/004937.html) that profiled the unusual Orionid activity. The accumulation of data gives a clear picture of a very broad peak without a sharp maximum. It's as though the Orionids were not only better than usual, but also better-behaved.

I'm not an expert on the modeling meteor streams, but I found Gary Kronk's concise history of the Orionids (http://comets.amsmeteors.org/meteors/showers/orionidhistory.html) quite illuminating. The "filamentary" structure that is considered responsible for the Orionid spurts and lulls has also been implicated in the unpredictable background activity of the Leonids. In some years, activity profiles have been more erratic than others. While there has been some suggestion of periodicity in strong Orionid returns (see the IMO Meteor Shower Calendar at http://www.imo.net/calendar/2006/fall), often simple intervals of years do not adequately describe the variable activity of meteor showers. The Orionids are related to comet 1P/Halley, but well-separated from the comet's current orbit. Kronk's history points to belts of debris as the key to year-to-year variation in Orionid strength. Debris trail modeling has been very valuable in the prediction of major outbursts from the Leonids and Giacobinids, and has had some success predicting lesser outbursts from these and other showers. With the stream's age and special circumstances surrounding the Orionids, it is not immediately clear whether the same techniques could help predict variations in Orionid activity. In any case, the 2006 Orionid return serves notice that this is a potentially exciting and unpredictable shower. High rates in 2006 likely say nothing about what will happen in 2007, but Orionid observations will be valuable in any case.