The Millman Fireball Archive: identification of possible meteorite streams

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The time of appearance data on 2373 fireball events documented within the Millman Fireball Archive (MFA - Beech, 2003) has been studied. The fireballs were observed from across Canada, during the time interval from early 1962 to late 1989.

By sorting the fireball appearance times according to solar longitude, distinct enhancements in fireball activity are found at the times of the α -Capricornid ($\lambda_{\odot} = 127^{o}$), Perseid ($\lambda_{\odot} = 141^{o}$), Taurid ($\lambda_{\odot} = 220$ to 235^{o}), Leonid ($\lambda_{\odot} = 235^{o}$), χ-Orionid ($\lambda_{\odot} = 250^{o}$) and Geminid ($\lambda_{\odot} = 262^{o}$) meteor showers. The cumulative number of fireballs, summed over 1-degree intervals of solar longitude, is shown in figure 1. The Geminds provide the most distinct peak of the annual meteor showers. Surprisingly the annual Perseid meteor shower is not particularly prominent within the data displayed. The Taurid meteor shower, consisting of both the northern and southern components, is likewise not particularly prominent in figure 1, but its variable outburst activity is discernable within the data restricted to just the months of October and November in each year (Beech, Hargrove and Brown, 2004). All of the annual meteor showers identified in figure 1 are known for their ability to deliver bright fireballs, and consequently their appearance indicates that the data set is sufficiently robust to allow periodic or outburst fireball showers to be identified.

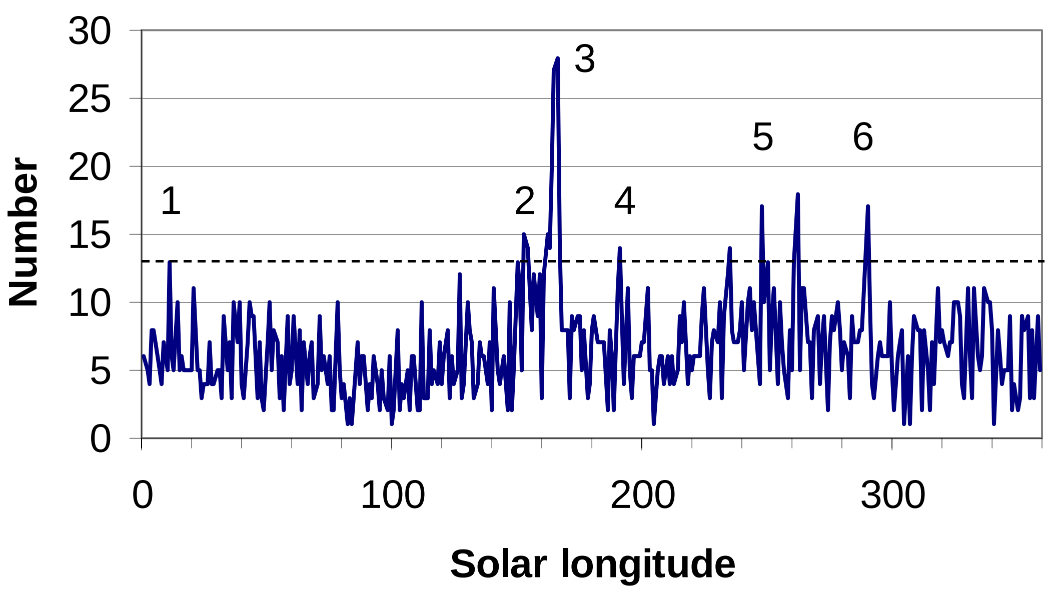

Figure 1. *The number of fireballs recorded in the Millman Fireball Archive arranged according to one degree intervals of solar longitude. Labeled peaks correspond to table 1 entries. The dashed horizontal line indicates the 'two sigma' level above the mean.*

In addition to the identification of six annual meteor showers, a further six distinct peaks are also discernable in figure 1. The times and characteristics of these 'other' peaks are summarized in table 1.

The most distinct peak listed in the table 1, and indeed the strongest peak in the entire activity profile falls at $\lambda_\odot = 165^o$ (September 7th) and we suggest that it may be related to the 'Group 3' meteorite stream identified by Halliday *et al.,* (1990). Likewise, the peak at $\lambda_\odot = 248^o$ (November 30th) is further identified as possible belonging to the 'Group 4' meteorite stream of Halliday *et al*. In addition we also tentatively associate the peak at $\lambda_\odot = 191^o$ (October 4th) with the HC34, H-chondrite meteorite stream identified by Wolf *et al.,* (1995; 1997). It has been suggested that the Peekskill meteorite (which fell on October 9th, 1992) is a member of this group.

The peak at $\lambda_\odot = 11.0$ (March 30th) accommodates the approximate fall times of the Peace River and Revelstoke meteorites. These two meteorites are clearly not related, however, since the Peace River meteorite is an L6 olivine Hypersthene ordinary chondrite, while Revelstoke is a CI carbonaceous chondrite. This being said, the peak at $\lambda_\odot = 11.0$ is reasonably distinct and may indicate that an intermittent fireball / meteorite producing shower is active on, or near to, March 31st.

The prominent peak at $\lambda_\odot = 290$ (January 10th) is also weakly evident in the study by Ahn (2003) who analyzed a set of historical Korean fireball records collected during the Koryo dynasty (AD 918 – 1392). The peak also falls within the possible time window allocated to the Group 4 meteorite stream of Halliday *et al*, 1990.

The peak at $\lambda_\odot = 154$ (August 26th) may correspond to the λ -Aqualid fireball stream, which according to Gavajdova (1995) is active from August 14th to 31st. This peak also falls, however, between the activity windows allowed for the Group 2 and Group 3 streams of Halliday *et al* (1990). Hasegawa (1993) finds within the historical record that a shower is intermittently active in the solar longitude interval from 150 to 153 degrees. This particular stream (Hasegawa's stream number 8) is identified according to a series of seven meteor shower outbursts recorded over the time interval from AD 464 to 1888. If the $\lambda_\odot = 154.0$ peak in figure 1 and Hasegawa's stream number 8 are related, then a truly ancient heritage is implied with activity, at various levels of intensity, being in evidence for perhaps the past 1500 years. This time is short, however, compared to the expected decoherence time (about 10^4 years) for a meteorite producing stream (Gladman and Pauls, 2004).

Label in Figure 5	Possible associations	$\lambda_\odot$ (deg.) of maximum	FWHM (deg.)	Number
1	Peace River / Revelstoke	11.0	± 0.5	13
2	λ -Aqualid stream	154.0	± 3.0	15
3	Group 3 meteorite shower	165.0	± 4.0	28
4	HC34 meteorite stream	191.0	± 2.0	14
5	Group 4 meteorite shower	248.0	± 3.0	17
6	Group 4 meteorite shower (extreme)	290.0	± 2.0	17

Table 1: *Prominent peaks identified in figure 1. Column 2 indicates possible stream and/or shower associations for each of the peaks. Columns 3, 4 and 5 provide the solar longitude of the peak, its full width half-maximum and the number of fireballs recorded at the peak solar longitude.*

References

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