Discovery of the February epsilon Virginids (FEV, IAU #506)

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Combining first week of February CAMS and SonotaCo data resulted in the detection of at least one previously unreported shower. The February epsilon Virginids radiate from R.A. = 201.°7 and Dec = +10.°4, with a mean geocentric velocity of 63.0 km/s at solar longitude 315.°3. The mean orbital elements of these meteoroids are $q = 0.488 \pm 0.021$ AU, $1/a = 0.085 \pm 0.095$ 1/AU, $e = 0.958 \pm 0.046$, $i = 138.°1 \pm 1.°3$, $\omega = 271.°2 \pm 3.°7$, and $\Omega = 315.°3 \pm 0.°9$. The shower may originate from comet C/1808 F1 (Pons), if that comet is a Halley-type comet.

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1 Introduction

February has been regarded colloquially as an uneventful month in terms of meteor shower activity, so one can imagine our surprise at the amount of activity found when examining the February data from our Cameras for All-sky Meteor Surveillance (CAMS) system. CAMS consists of three separate stations that use video surveillance cameras to automatically monitor the night sky for meteor activity. We compare data across multiple stations to produce trajectories and orbits of incoming meteors of at least +4 magnitudes (Jenniskens et al., 2011).

2 Results and discussion

Figure 1 shows the combined CAMS 2011 and 2012 data (1118 meteors) for the first week of February. Fast apex-source meteors are the cloud on the left, the slower antihelion source meteors are on the right. Each show a lot of structure, indicative of meteoroid streams. Our goal is to add new showers to the IAU Meteor Shower Working List and confirm those that are already listed.

The previously reported February Eta Draconids (FED) stand out well as a compact cluster (Jenniskens & Gural, 2011). This long-period comet shower had an outburst in 2011. In 2012, CAMS detected two additional FED orbits.

One stream not previously reported was a cluster of nine meteors in the 2012 CAMS data (marked "FEV" in Figure 1) with a geocentric radiant near the star ε Virginis.

We examined CAMS data from the year before, and the SonotaCo data (2007–2009; 773 meteors), for evidence of prior activity (SonotaCo, 2009). From these data sets, we were able to obtain 15 additional candidates.

Extending the period examined from 2012 data through February 9th also added 4. This brought the total number of meteor orbits potentially associated with this shower to 28.

Next, D-criteria calculations (Jenniskens, 2008) were performed on each of these 28 orbits. The D-criterion

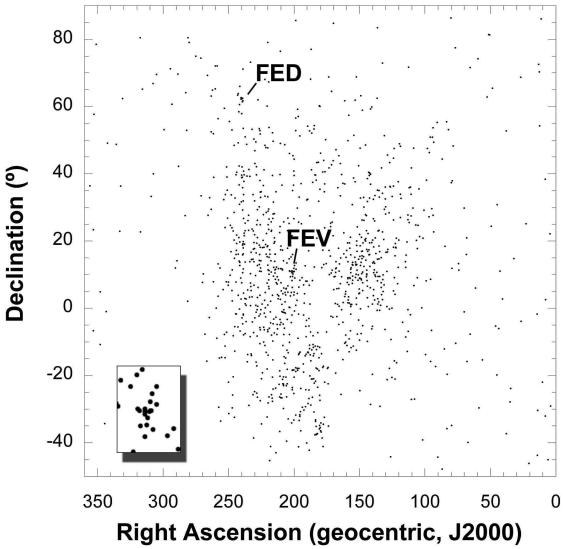

Figure 1 – CAMS meteors in the first week of February. Inset shows the FEV cluster.

indicates how closely two orbits are related. By calculating the D-criterion for each individual orbit as compared to the median of the orbits (Table 1), we were able to eliminate outliers from the data set. We determined that 22 of the 28 orbits had D-criterion values of less than 0.15.

The shower was reported to the IAU, assigned number 506 and named the February epsilon Virginids (FEV). It is active between 312.°9 − 320.°3, with peak activity around solar longitude 315°. On February 5, the shower radiates from R.A. = 202°, Decl. = 11°, with geocentric velocity $V_g = 63$ km/s.

The semimajor axis of $a \approx 11.8$ AU corresponds to an orbital period of $P = 40.4$ years. At face value, this implies a Halley-type parent body, although an intermediate long-period comet cannot be ruled out (Jenniskens, 2006). If this is a Halley-type stream, then there would be good prospects of future outbursts from this shower, when dust gets trapped in mean motion resonances (Jenniskens, 2006).

A search of orbital parameters of known Near Earth Objects from the Jet Propulsion Laboratory (JPL) Small Body Database produced a candidate parent body (Table 1): C/1808 F1 (Pons).

Comet Pons provides a theoretical radiant match (Table 1), if the line of apsides is rotated by precession (method "W" by Neslusan et al., 1998). The comet has

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evolved well beyond the point of passing Earth's orbit at the descending node, now having a daytime-shower node at Earth on August 20th, something expected for Halley-type comets, but perhaps not from long-period comets. With only 10 observations over 8 days, the comet orbit is not well enough determined to tell the difference.

Other potential parents exist. C/1978 T3 (Bradfield) has similar longitude of perihelion and inclination, but does not provide a matching theoretical radiant position when rotating the line of apsides (Table 1), or the nodal line.

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References

Jenniskens P. (2006). *Meteor Showers and their parent comets*. Cambridge Univ. Press, 790 pages.

Jenniskens P. (2008). "Meteoroid streams that trace to candidate dormant comets". *Icarus*, **194**, 19–22.

Jenniskens P. and Gural P. S. (2011). "Discovery of the February Eta Draconids (FED, IAU#427): the dust trail of a potentially hazardous long-period comet". *WGN, Journal of the IMO*, **39**, 93–97.

Jenniskens P., Gural P. S., Dynneson L., Grigsby B., Newman K. E., Bordon M., Koop M., and Holman D. (2011). "CAMS: Cameras for Allsky Meteor Surveillance to validate minor meteor showers". *Icarus*, **216**, 40–61.

Neslusan L., Svoren J., and Porubcan V. (1998). "A computer program for calculation of a theoretical meteor-stream radiant". *Astronomy and Astrophysics*, **331**, 411–413.

SonotaCo (2009). "A meteor shower catalog based on video observations in 2007–2008". *WGN, Journal of the IMO*, **37**, 55–62.

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Table 1 – Orbital elements of 22 February Epsilon Virginids.

$\lambda_\odot$ (°)	Date (m/d/y)	Time (UT)	Source	R.A. (°)	Decl. (°)	V_g (km/s)	$1/a$ (1/AU)	q (AU)	e	i (°)	ω (°)	Ω (°)	ϖ (°)
312.86	02/01/09	$17^h06^m09^s$	SonotaCo	199.61	+11.93	61.73	0.188	0.469	0.912	136.28	275.73	312.86	228.59
313.23	02/02/11	$14^h08^m05^s$	CAMS	199.91	+10.95	64.74	−0.042	0.515	1.022	139.83	266.83	313.22	220.05
313.74	02/03/12	$08^h32^m49^s$	CAMS	201.57	+11.19	62.57	0.160	0.507	0.919	137.57	270.79	313.74	224.53
313.86	02/03/12	$11^h13^m58^s$	CAMS	201.72	+10.82	63.50	0.092	0.523	0.952	138.77	267.87	313.85	221.73
313.95	02/03/12	$13^h21^m13^s$	CAMS	198.53	+11.64	60.99	0.194	0.414	0.920	135.65	282.12	313.94	236.07
314.08	02/03/11	$10^h14^m37^s$	CAMS	200.33	+11.93	61.27	0.203	0.456	0.908	135.05	277.46	314.07	231.53
314.18	02/03/11	$12^h47^m07^s$	CAMS	199.65	+12.78	60.09	0.250	0.425	0.894	132.36	281.83	314.18	236.01
314.20	02/03/11	$13^h08^m27^s$	CAMS	200.97	+10.2	64.27	0.018	0.510	0.991	140.32	268.23	314.20	222.43
314.80	02/04/12	$09^h30^m46^s$	CAMS	200.35	+10.93	63.26	0.043	0.474	0.980	137.96	272.85	314.80	227.65
314.96	02/04/12	$13^h22^m54^s$	CAMS	201.61	+10.6	63.24	0.082	0.496	0.959	138.39	270.87	314.96	225.84
315.23	02/04/11	$13^h28^m31^s$	CAMS	201.69	+8.24	64.10	0.078	0.497	0.961	143.48	270.67	315.22	225.90
315.30	02/04/08	$20^h40^m10^s$	SonotaCo	201.64	+8.81	63.95	0.070	0.494	0.966	142.19	270.87	315.30	226.17
315.84	02/05/12	$10^h09^m27^s$	CAMS	202.85	+9.33	61.88	0.238	0.477	0.887	139.42	275.70	315.84	231.54
315.93	02/04/09	$17^h50^m30^s$	SonotaCo	204.50	+10.59	64.92	−0.028	0.569	1.016	138.45	260.70	315.93	216.63
315.98	02/05/12	$13^h25^m14^s$	CAMS	201.14	+9.53	60.08	0.330	0.405	0.867	137.84	285.66	315.97	241.63
316.93	02/06/12	$11^h49^m26^s$	CAMS	203.58	+11.2	63.52	0.019	0.513	0.990	135.94	267.92	316.92	224.84
319.16	02/08/11	$10^h39^m26^s$	CAMS	204.69	+9.05	62.36	0.140	0.467	0.934	137.93	275.19	319.16	234.35
319.22	02/08/11	$11^h55^m23^s$	CAMS	203.75	+8.72	61.60	0.189	0.431	0.919	138.13	280.19	319.21	239.41
319.87	02/09/12	$09^h38^m54^s$	CAMS	205.93	+10.11	64.94	−0.113	0.530	1.060	136.87	264.17	319.87	224.04
319.92	02/09/12	$10^h50^m19^s$	CAMS	205.51	+8.72	63.05	0.088	0.483	0.958	138.49	272.54	319.92	232.46
320.09	02/08/09	$20^h16^m54^s$	SonotaCo	206.14	+9.97	62.75	0.082	0.495	0.960	135.65	270.95	320.09	231.04
320.32	02/09/11	$14^h05^m54^s$	CAMS	204.81	+8.26	62.98	0.075	0.457	0.966	139.15	275.36	320.32	235.67
	Median value:			201.67	+10.40	63.02	0.085	0.489	0.959	138.05	271.75	315.26	228.12
	Standard error of median value:			±0.48	±0.28	±0.31	±0.023	±0.009	±0.010	±0.5	±1.3	±0.54	±1.4
	Dispersion of values (σ)			2.2	1.3	1.4	0.11	0.040	0.047	2.4	6.1	2.5	6.5
	C/1808 F1 (Pons)			206.38	+8.29	62.03	0.0	0.390	1.0	134.30	253.74	325.64	219.38
	C/1978 T3 (Bradfield)			237.63	−2.56	62.82	0.0	0.432	1.0	138.26	240.45	358.42	238.87