Orbits of the July Pegasid meteors observed during 2008 to 2011

Masayoshi Ueda[1]

During 2008 to 2011, we observed 63 TV meteors of the July Pegasids simultaneously with the SonotaCo Network in Japan. The activity period of the stream was determined as July 6–19. We derived the corrected radiant $\alpha_G = 349\overset{\circ}{.}6$, $\delta_G = +11\overset{\circ}{.}3$ at the solar longitude $\lambda_\odot = 110\overset{\circ}{.}9$ (equinox 2000.0), and geocentric velocity $V_G = 63.9$ km/s. In addition, the theoretical radiant and geocentric velocity from Comet Bradfield (1979 X = C/1979 Y1) are in accordance with these values, as Rendtel et al. (1995) and Jenniskens (2006) already suggested. From this fact, we are able to confirm that Comet Bradfield (1979 X) is the parent comet of the July Pegasids.

Received 2011 September 19

1 Introduction

The July Pegasids (JPE) have an activity period during July 7 to July 13. The zenithal hourly rate (ZHR) of JPE is about 3 (Rendtel et al., 1995). In addition, from the data of July during 1996 to 1999 in the Visual Meteor Databases of the International Meteor Organization (IMO), it is determined that the activity period is July 5–15, maximum $\lambda_\odot = 108\overset{\circ}{.}52 \pm 0\overset{\circ}{.}24$, and ZHR $= 3.11 \pm 0.13$ (Olech & Wiśniewski, 2002). Two positions of the JPE radiant have been reported: one from visual observations and another from photographic observations (Jenniskens, 2006). Triglav-Čekada & Arlt (2005) stated that the radiant point of the JPE could not be found from the data of July–August of 1993–2004 in the IMO video network database. But Molau & Rendtel (2009) derived the shower's radiant position and drift, and its velocity and drift, from analysis of 591 JPE meteors with the IMO Video Meteor Network. Furthermore, the JPE were active above the sporadic background from 2010 July 8 to 16 (Molau & Kac, 2010).

2 TV observations

TV meteor data of the JPE from 2008 to 2011 have been reported to the SonotaCo Network from the following observers: K. Adachi, H. Horigane, H. Inoue, T. Kamimura, T. Komai, T. Masuzawa, K. Maeda, K. Miyazaki, H. Muroishi, J. Nakai, S. Okamoto, N. Saito, the Sanbonmatsu High School, T. Sekiguchi, Y. Shiba, SonotaCo, the Toyama Astronomical Observatory, M. Ueda, S. Uehara, H. Yamakawa and J. Yokomichi.

The observation software used was UFOCaptureV2, and the TV meteors were analysed by the software UFOAnalyzerV2 and UFOOrbitV2 (`http://sonotaco.com/e_index.html`).

3 Data of the July Pegasid meteor stream

We found 34 simultaneous meteors belonging to the JPE in the meteor data of July 2011 (Figure 1 and Table 1). Furthermore, as a result of the investigated meteor data of 2008–2010, 29 meteors of the JPE were found (Table 1). Tables 2 and 3 show the radiants and orbital elements of 63 meteors belonging to the JPE. The explanation to Table 2 is as follows:

Table 1 – Number of simultaneous meteors observed by the SonotaCo Network in July, 2008–2011.

Month	No. of JPE	No. of other shower meteors	No. of sporadic meteors	Total
July 2008	1	220	288	509
July 2009	11	150	441	602
July 2010	17	266	828	1111
July 2011	34	224	794	1052
Total	63	860	2351	3274

- YYYYMMDD: year, month, day.
- hhmmss: hour, minute, second (UT).
- α_G, δ_G: the right ascension and declination of the geocentric radiant, corrected for zenith attraction and diurnal aberration (degrees, eq. 2000.0).
- V_∞: the initial velocity (km/s).
- V_G: the geocentric velocity of the meteoroid, corrected for the Earth's gravitational effects (pre-atmospheric geocentric velocity corrected as above) (km/s).
- V_H: the heliocentric velocity (km/s).
- Q: the angle between the great circles of the trails at the two stations.
- Abs.: maximum absolute magnitude of the meteor.
- H_b: the height at which the meteor was first observed (km).
- H_e: the height at which the meteor vanished (km).
- *: the beginning or the ending of meteor is out of camera field.

And the explanation to Table 3 is:

- Dur: duration of meteor.
- a: semi-major axis (AU).
- e: eccentricity.
- q: perihelion distance (AU).
- Ω: longitude of the ascending node (degrees, eq. 2000.0).
- i: inclination of the orbit (degrees).
- ω: argument of perihelion (degrees).
- P: period (years).
- $\lambda_\odot$: solar longitude (eq. 2000.0).
- Ent. ang.: entry angle of the meteoroid into the atmosphere (degrees; 90 degrees = zenith).
- Length: trajectory length (km).

[1]SonotaCo Network, 43-2 Habikino, Osaka, 583-0842, Japan. Email: `ueda@lily.sannet.ne.jp`

IMO bibcode WGN-402-ueda-jpe
NASA-ADS bibcode 2012JIMO...40...59U

Table 2 – The radiants, velocities and heights of July Pegasid meteors observed by TV (equinox 2000.0).

No.	Date	UT	Radiant		V_∞	V_G	V_H	Q	Abs.	H_b	H_e
	(YYYYMMDD)	(hhmmss)	α_G (°)	δ_G (°)	(km/s)	(km/s)	(km/s)	(°)	(mag.)	(km) *	(km) *
1	20080716	180028	352.7	+12.1	65.2	64.1	41.3	66.3	−2.8	114.4 *	86.0
2	20090706	164125	345.0	+9.8	64.5	63.3	40.1	62.8	−1.4	108.0	95.4
3	20090709	182410	347.4	+11.1	64.9	63.8	40.7	19.4	−0.1	111.1	95.2
4	20090712	154855	349.3	+11.0	65.1	63.9	40.9	37.4	−0.1	112.6	95.6
5	20090713	153332	350.8	+9.1	65.9	64.7	41.4	16.6	−0.7	106.6	96.3
6	20090713	174012	349.1	+10.9	63.5	62.4	40.0	36.6	−0.8	109.1	92.6
7	20090714	165052	351.0	+12.2	66.2	65.1	42.1	85.5	−2.0	115.9	90.1
8	20090714	173025	350.8	+10.5	62.4	61.2	38.5	77.0	1.0	106.0 *	101.4
9	20090715	180816	352.7	+10.8	63.8	62.8	39.6	42.5	0.2	106.4	96.1
10	20090715	181235	351.4	+12.1	64.7	63.7	41.0	55.8	0.5	105.2	95.4
11	20090715	183660	352.8	+12.3	65.1	64.1	40.8	27.1	−1.4	108.5	83.0
12	20090719	155758	351.4	+12.2	64.3	63.1	41.7	16.3	−3.4	112.2	90.9
13	20100707	160012	348.1	+8.8	66.7	65.5	41.2	77.1	0.7	110.7	102.0
14	20100707	163147	345.0	+11.1	66.5	65.4	42.3	18.2	−1.9	111.2	94.7
15	20100707	180630	345.7	+10.5	65.8	64.7	41.4	47.0	−2.0	107.4	93.7
16	20100709	142356	347.6	+12.4	64.4	63.1	39.8	78.2	−3.0	103.0	87.7
17	20100709	174248	345.0	+10.6	68.1	67.0	44.5	69.7	−0.1	108.2	96.1
18	20100712	140324	349.0	+11.1	63.8	62.5	39.6	49.9	−1.0	109.9	96.9
19	20100715	152142	350.8	+12.0	64.9	63.7	41.1	22.2	−4.4	114.9	83.2
20	20100715	181235	351.9	+11.6	67.0	66.0	42.9	18.0	0.1	104.0	96.1
21	20100716	165601	352.1	+11.5	64.1	63.0	40.3	16.6	−2.4	110.7	92.4
22	20100716	170250	351.1	+12.0	64.7	63.6	41.3	68.3	−2.2	111.3	89.8
23	20100716	181357	350.8	+11.9	63.5	62.4	40.3	23.8	−2.3	108.1	95.1
24	20100717	163612	353.5	+12.3	64.2	63.0	40.1	48.2	−2.4	106.1	93.8
25	20100718	150558	351.0	+10.0	63.4	62.1	40.6	14.9	−1.8	100.1 *	88.4
26	20100718	180257	352.4	+13.2	61.6	60.5	38.6	40.7	−2.1	109.3	97.2
27	20100718	182653	353.7	+13.2	65.2	64.2	41.5	31.0	−0.6	105.7	92.0
28	20100718	185526	353.0	+11.6	64.9	63.9	41.5	35.7	−3.1	108.8	83.0
29	20100719	180609	354.3	+12.8	66.7	65.7	43.0	50.0	0.2	105.1	97.4
30	20110709	130046	346.7	+10.4	66.0	64.6	41.5	15.8	−1.8	116.5	98.0
31	20110709	151912	346.5	+10.5	65.4	64.1	41.1	89.4	−2.5	111.7	92.3
32	20110709	163042	346.1	+10.3	65.5	64.3	41.4	88.0	−1.0	109.3	98.0
33	20110710	154304	347.0	+10.4	67.1	65.9	42.9	73.4	0.9	109.1	99.8
34	20110710	170112	347.5	+10.6	64.1	63.0	40.0	36.2	0.3	104.4	96.1
35	20110710	171022	347.1	+10.9	65.6	64.5	41.5	89.5	−1.8	107.0 *	96.2
36	20110710	173006	348.2	+10.9	66.2	65.1	41.8	37.9	−0.7	109.8	97.2
37	20110710	175351	347.2	+10.8	64.9	63.9	40.9	68.7	−0.5	112.2	95.6
38	20110710	175830	347.7	+11.2	65.2	64.2	41.0	86.7	−3.0	114.1	92.1
39	20110710	180507	347.1	+10.6	64.8	63.8	40.9	83.7	0.4	109.3	96.6
40	20110710	184521	346.6	+10.5	66.2	65.2	42.5	86.1	−0.4	101.1	92.0
41	20110711	154958	348.3	+11.2	65.2	64.0	40.9	63.2	−2.8	112.4	88.2
42	20110711	161646	349.3	+11.9	68.0	66.8	43.3	81.4	0.0	107.8	97.6
43	20110711	163601	347.9	+10.2	65.4	64.2	41.3	80.2	−2.3	108.7	94.6
44	20110711	190017	347.5	+11.0	66.4	65.4	42.7	87.8	−3.8	115.7	92.1
45	20110712	154238	348.5	+10.6	65.6	64.4	41.5	10.9	−1.5	113.1	100.3
46	20110712	163627	348.7	+11.1	64.8	63.6	40.8	81.9	−1.7	114.3 *	91.8
47	20110712	170315	347.8	+10.7	67.2	66.1	43.5	32.6	−3.5	116.6	86.2
48	20110712	185428	348.9	+10.7	64.9	64.0	41.1	31.1	−2.5	107.9	94.2
49	20110713	134444	348.6	+10.9	64.9	63.6	41.1	21.3	0.0	114.6	105.5
50	20110713	170909	350.0	+12.0	64.4	63.3	40.3	18.7	−3.6	118.6	81.7
51	20110713	184037	348.6	+11.9	64.1	63.1	40.7	75.5	−0.6	105.5	94.9
52	20110714	143521	351.6	+12.2	65.5	64.2	40.9	56.4	−1.2	106.3	97.5
53	20110714	160729	349.6	+11.4	64.4	63.2	40.7	72.2	−0.5	108.2	96.3
54	20110714	164740	349.8	+11.3	64.8	63.7	41.1	78.0	−1.3	109.1	91.2
55	20110714	171748	352.5	+13.1	64.8	63.7	40.1	52.8	−2.7	107.5	89.3
56	20110714	180000	349.9	+11.9	64.0	63.0	40.4	64.8	−1.5	109.2 *	89.5
57	20110714	180809	350.2	+11.7	66.1	65.2	42.3	42.5	−0.1	105.2	97.3
58	20110714	183111	351.0	+10.1	65.2	64.3	41.1	88.0	−1.4	102.8 *	90.1
59	20110714	183107	350.7	+12.0	62.9	61.8	39.0	35.5	−0.6	112.8 *	92.0
60	20110715	151103	349.4	+10.6	65.7	64.4	42.2	27.5	−4.0	105.0	89.7
61	20110717	171116	351.1	+13.4	63.6	62.5	40.5	85.7	−1.3	108.1 *	92.0
62	20110717	173613	352.3	+12.1	65.9	64.9	42.2	75.6	−0.1	110.2	93.0
63	20110717	183207	350.8	+13.3	62.1	61.1	39.4	24.1	−2.2	105.4	89.1
		Mean:			65.0			52.3	−1.4	109.2	93.4

Table 3 – The orbital elements of the July Pegasid meteors observed by TV (equinox 2000.0).

No.	Date (YYYYMMDD)	UT (hhmmss)	Dur (s)	a (AU)	e	q (AU)	Ω (°)	i (°)	ω (°)	P (yr)	$\lambda_\odot$ (°)	Ent. ang. (°)	Length (km)
1	20080716	180028	0.484	21.80	0.974	0.556	114.44	149.78	265.25	101.82	114.441	64	31.5
2	20090706	164125	0.250	6.46	0.909	0.586	104.61	148.28	263.64	16.44	104.609	50	16.4
3	20090709	182410	0.267	9.66	0.938	0.596	107.54	148.07	261.68	30.01	107.536	67	17.2
4	20090712	154855	0.400	12.22	0.954	0.567	110.29	149.15	264.66	42.72	110.293	40	26.2
5	20090713	153332	0.250	29.70	0.981	0.555	111.24	153.97	265.27	161.92	111.237	38	16.7
6	20090713	174012	0.284	5.96	0.914	0.513	111.32	147.79	272.11	14.54	111.321	62	18.6
7	20090714	165052	0.467	−37.07	1.016	0.595	112.24	148.89	259.77	—	112.242	56	31.3
8	20090714	173025	0.083	3.40	0.857	0.487	112.27	149.66	277.37	6.27	112.268	60	5.3
9	20090715	180816	0.184	5.00	0.893	0.533	113.25	151.83	270.46	11.20	113.247	62	11.6
10	20090715	181235	0.167	12.94	0.957	0.552	113.25	148.46	266.24	46.57	113.250	65	10.9
11	20090715	183660	0.417	11.43	0.949	0.584	113.27	150.08	262.70	38.68	113.266	68	27.6
12	20090719	155758	0.434	268.06	0.998	0.471	116.98	146.14	274.27	4390.63	116.978	49	28.3
13	20100707	160012	0.200	17.93	0.964	0.646	105.29	153.87	255.12	75.92	105.290	41	13.4
14	20100707	163147	0.317	−20.71	1.030	0.632	105.31	146.92	255.31	—	105.311	50	21.5
15	20100707	180630	0.234	27.52	0.977	0.621	105.37	148.26	257.78	144.46	105.373	63	15.4
16	20100709	142356	0.551	5.57	0.889	0.617	107.13	146.07	260.51	13.17	107.133	26	35.1
17	20100709	174248	0.200	−3.76	1.162	0.608	107.27	147.36	255.42	—	107.265	63	13.6
18	20100712	140324	0.484	5.02	0.892	0.544	109.98	148.10	269.26	11.25	109.981	26	29.9
19	20100715	152142	0.717	14.94	0.963	0.549	112.90	147.97	266.43	57.77	112.896	43	47.0
20	20100715	181235	0.133	−9.51	1.063	0.598	113.01	150.90	258.41	—	113.009	65	8.7
21	20100716	165601	0.334	7.19	0.927	0.524	113.91	149.68	270.40	19.28	113.912	58	21.7
22	20100716	170250	0.384	20.62	0.974	0.532	113.92	147.83	268.03	93.69	113.917	59	25.1
23	20100716	181357	0.234	7.28	0.931	0.504	113.96	147.04	272.67	19.66	113.964	65	14.4
24	20100717	163612	0.250	6.35	0.915	0.542	114.85	149.63	268.72	16.02	114.853	51	15.9
25	20100718	150558	0.317	9.00	0.952	0.431	115.75	149.32	280.44	26.99	115.748	35	20.3
26	20100718	180257	0.217	3.48	0.864	0.472	115.86	144.98	278.90	6.48	115.865	65	13.4
27	20100718	182653	0.234	36.40	0.985	0.561	115.88	148.56	264.44	219.71	115.881	64	15.4
28	20100718	185526	0.450	41.16	0.987	0.519	115.90	150.20	269.15	264.15	115.900	62	29.3
29	20100719	180609	0.133	−8.64	1.066	0.571	116.82	149.98	261.34	—	116.821	66	8.4
30	20110709	130046	1.585	35.05	0.983	0.601	106.84	148.82	259.90	207.56	106.838	11	103.7
31	20110709	151912	0.484	15.03	0.961	0.590	106.93	148.19	261.79	58.28	106.930	38	31.5
32	20110709	163042	0.234	28.30	0.979	0.582	106.98	148.21	262.20	150.57	106.977	50	14.9
33	20110710	154304	0.200	−9.73	1.062	0.604	107.90	149.26	257.75	—	107.899	43	13.6
34	20110710	170112	0.167	6.03	0.907	0.562	107.95	148.30	266.53	14.82	107.951	54	10.3
35	20110710	171022	0.200	46.02	0.987	0.591	107.96	148.04	260.93	312.35	107.957	55	13.1
36	20110710	173006	0.217	569.89	0.999	0.619	107.97	149.56	257.51	13604	107.970	59	14.7
37	20110710	175351	0.284	12.66	0.954	0.579	107.99	148.12	263.25	45.04	107.986	64	18.5
38	20110710	175830	0.384	14.56	0.959	0.599	107.99	148.21	260.80	55.56	107.989	62	25.0
39	20110710	180507	0.217	12.55	0.954	0.572	107.99	148.23	263.99	44.48	107.993	64	14.1
40	20110710	184521	0.150	−15.47	1.038	0.587	108.02	148.25	260.17	—	108.020	64	10.1
41	20110711	154958	0.517	12.51	0.953	0.586	108.86	148.26	262.44	44.28	108.857	46	33.8
42	20110711	161646	0.200	−6.96	1.095	0.659	108.87	149.62	250.87	—	108.875	49	13.4
43	20110711	163601	0.284	21.61	0.974	0.566	108.89	149.46	264.15	100.50	108.887	50	18.5
44	20110711	190017	0.350	−11.85	1.050	0.593	108.98	148.23	259.25	—	108.983	65	26.0
45	20110712	154238	0.284	44.49	0.987	0.567	109.81	149.34	263.65	296.84	109.805	44	18.5
46	20110712	163627	0.434	10.74	0.947	0.564	109.84	148.27	265.13	35.19	109.841	54	28.0
47	20110712	170315	0.551	−6.21	1.094	0.586	109.86	149.02	259.10	—	109.859	57	36.5
48	20110712	185428	0.234	14.89	0.962	0.564	109.93	149.29	264.67	57.45	109.932	66	15.1
49	20110713	134444	0.384	15.76	0.966	0.542	110.68	148.11	267.17	62.59	110.680	21	24.8
50	20110713	170909	0.651	7.38	0.922	0.574	110.82	147.90	264.66	20.06	110.816	60	42.5
51	20110713	184037	0.184	9.91	0.945	0.547	110.88	146.25	267.19	31.21	110.876	65	11.7
52	20110714	143521	0.284	12.03	0.950	0.599	111.67	149.46	260.94	41.72	111.667	28	18.6
53	20110714	160729	0.250	10.28	0.948	0.537	111.73	147.90	268.27	32.95	111.728	48	16.0
54	20110714	164740	0.334	15.82	0.965	0.547	111.75	148.44	266.58	62.93	111.755	55	21.8
55	20110714	171748	0.317	6.44	0.904	0.617	111.77	148.76	260.11	16.36	111.775	59	21.2
56	20110714	180000	0.334	7.88	0.931	0.545	111.80	147.26	267.81	22.13	111.803	65	21.7
57	20110714	180809	0.133	−19.52	1.030	0.583	111.81	149.03	260.78	—	111.808	65	8.8
58	20110714	183111	0.217	16.62	0.967	0.553	111.82	152.16	265.84	67.79	111.823	65	13.9
59	20110714	183107	0.350	3.98	0.866	0.534	111.82	147.57	271.34	7.93	111.823	67	22.6
60	20110715	151103	0.384	−22.91	1.023	0.524	112.64	148.96	267.56	—	112.644	38	24.9
61	20110717	171116	0.284	8.22	0.936	0.523	114.63	144.81	270.18	23.59	114.631	62	18.2
62	20110717	173613	0.284	−24.12	1.023	0.560	114.65	149.44	263.50	—	114.647	64	19.2
63	20110717	183207	0.284	4.52	0.891	0.491	114.68	143.70	275.56	9.62	114.684	69	17.5
	Mean:		0.329								110.897	54	21.5

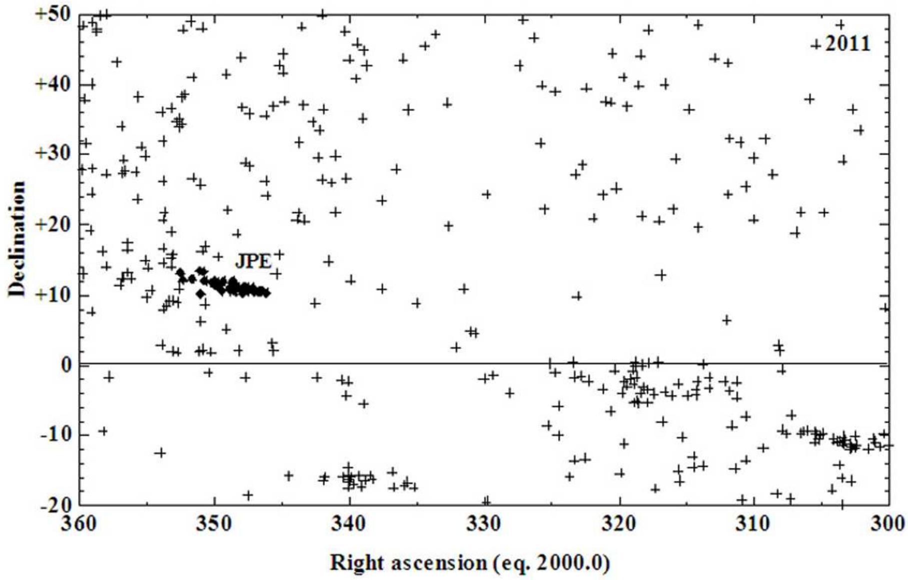

Figure 1 – Simultaneous meteor radiant mapping on celestial sphere in July, 2011
● Radiants of the July Pegasids in July, 2011
+ Radiants of the non-JPE meteors in July, 2011

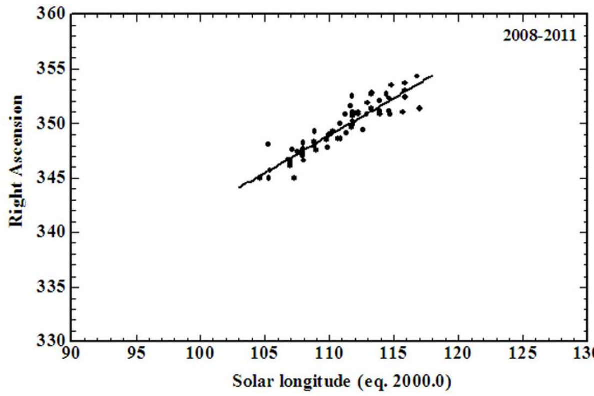

Figure 2 – The right ascensions of the July Pegasids (63 radiants) observed in 2008–2011.

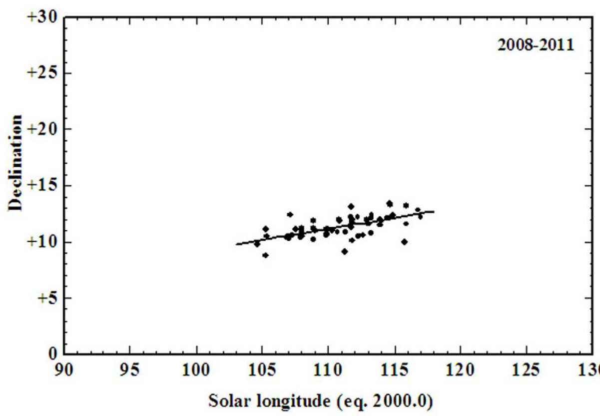

Figure 3 – The declinations of the July Pegasids (63 radiants) observed in 2008–2011.

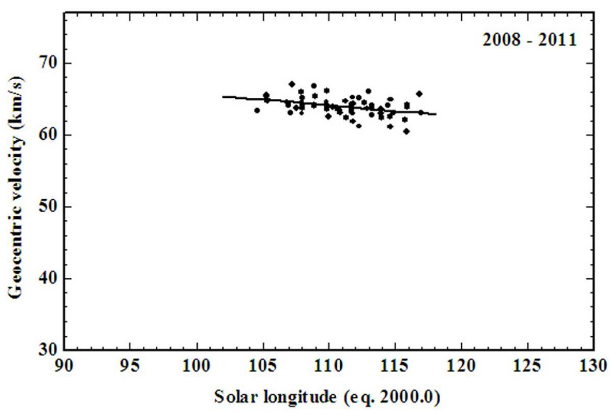

Figure 4 – The geocentric velocities of the July Pegasids (63 meteors) observed in 2008–2011.

From Tables 2 and 3, the activity period of JPE is $\lambda_\odot = 104\overset{\circ}{.}61$–$116\overset{\circ}{.}98$ (July 6–19). Figures 2, 3 and 4 show the daily motion of the JPE radiants and velocity. The corrected radiant is at $\alpha_G = 349\overset{\circ}{.}6 \pm 1\overset{\circ}{.}0$, $\delta_G = +11\overset{\circ}{.}3 \pm 0\overset{\circ}{.}9$ and the geocentric velocity is $V_G = 63.9$ km/s at $\lambda_\odot = 110\overset{\circ}{.}9$. The daily motions (per 1° in solar longitude) in right ascension, declination and the geocentric velocity of JPE are

$$\alpha_G = 349\overset{\circ}{.}55 + 0\overset{\circ}{.}707(\lambda_\odot - 110\overset{\circ}{.}9) \pm 1\overset{\circ}{.}0,$$

$$\delta_G = +11\overset{\circ}{.}27 + 0\overset{\circ}{.}170(\lambda_\odot - 110\overset{\circ}{.}9) \pm 0\overset{\circ}{.}9,$$

$$V_G = 63.87 - 0.149(\lambda_\odot - 110\overset{\circ}{.}9) \pm 1.2 \text{ km/s}.$$

The values of JPE radiant and velocity obtained from the above equations are shown in Table 4. In Table 5, we compare the radiant point, velocity and these drifts. Table 5 gives a value of the velocity drift that is quite similar. The magnitude distribution (absolute magnitude) of simultaneous JPE meteors in 2011 is shown in Table 6. There was a bright meteor of magnitude −4 among the meteors which belonged to the JPE.

4 Parent comet of July Pegasids

The parent comet of JPE is Comet C/1979 Y1 (Bradfield) (= 1979 X) (e.g., Rendtel et al., 1995). The theoretical radiant and geocentric velocity of JPE are shown

Table 4 – Mean radiant position and geocentric velocity of JPE observed during 2008–2011 (equinox 2000.0).

λ (°)	Date	α_G (°)	δ_G (°)	V_G (km/s)	a (AU)	e	q (AU)	Ω	i	ω	P (yr)
104.6	July 7	345.1	+10.2	64.8	34.63	0.982	0.622	104.°60	148.°40	257.°47	203.8
106	July 8	346.1	+10.4	64.6	25.48	0.976	0.609	105.°96	148.°57	259.°10	128.6
108	July 10	347.5	+10.8	64.3	19.73	0.970	0.590	108.°00	148.°55	261.°45	87.6
108.61	July 11	347.9	+10.9	64.2	18.41	0.968	0.584	108.°61	148.°55	262.°25	79.0
110	July 12	348.9	+11.1	64.0	15.86	0.964	0.570	110.°00	148.°71	263.°94	63.1
110.9	July 13	349.6	+11.3	63.9	14.78	0.962	0.564	110.°90	148.°77	264.°73	56.8
112	July 14	350.3	+11.5	63.7	13.40	0.959	0.552	112.°00	148.°70	266.°22	49.0
114	July 17	351.7	+11.8	63.4	11.65	0.954	0.531	114.°00	148.°84	268.°70	39.8
116	July 19	353.2	+12.1	63.1	10.01	0.949	0.512	116.°00	149.°11	271.°08	31.7
116.98	July 20	353.8	+12.3	63.0	10.24	0.951	0.503	116.°98	149.°00	272.°11	32.7

Table 5 – Comparison of JPE radiant (J2000.0), velocity and their drifts. The values α_G, δ_G, V_∞ and V_G are at the reference solar longitude $\lambda_\odot = 108°$, while $\Delta\alpha$, $\Delta\delta$, ΔV_∞ and ΔV_G are the values per 1° in $\lambda_\odot$.

Ref. $\lambda_\odot$(°)	Period $\lambda_\odot$(°)	Radiant position and drift (°) α_G	$\Delta\alpha$	δ_G	$\Delta\delta$	V_∞ (km/s)	ΔV_∞ (km/s)	V_G (km/s)	ΔV_G (km/s)	
108	105–126	347.2	+0.9	+11.1	+0.2	68.1	−0.16	—	—	Molau & Rendtel (2009)
108	105–117	347.5	+0.71	+10.8	+0.17	65.5	−0.17	64.3	−0.15	This work

Table 6 – Distribution in absolute magnitude of JPE and sporadics in July, 2011.

Mag.	−6	−5	−4	−3	−2	−1	0	1	2	3	Total
JPE			4	5	7	10	7	1			34
SPO	1	3	23	68	147	242	197	89	20	4	794

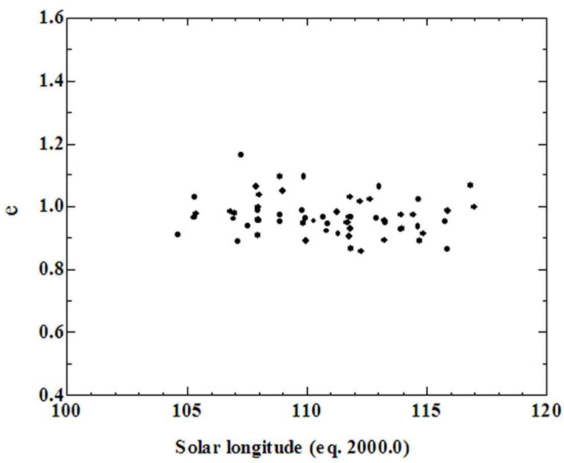

Figure 5 – Relation between heliocentric orbital element e and the solar longitude of 63 JPE meteors.

in Table 7. The theoretical position of the JPE radiant given by our analysis accords with our observations well. From this fact, we can say that the parent comet of JPE is Comet Bradfield (1979 X). The orbital elements of the JPE change with the solar longitude at the meteor apparition (see Figures 5, 6 and 7). This can be seen in Table 4.

5 Conclusion

In July of 2011, 34 TV simultaneous meteors of JPE have been observed by the SonotaCo Network. The numbers of simultaneous meteors in each year from 2008 to 2010 have been less than those in 2011 (Table 8). This is believed to have been affected by the bad weather

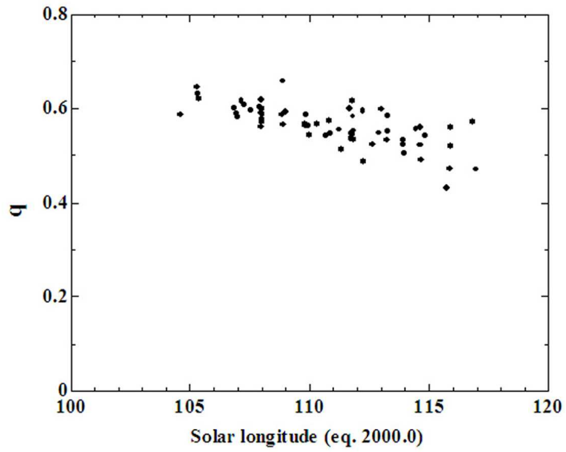

Figure 6 – Relation between the heliocentric orbital element q and the solar longitude of 63 JPE meteors. The q changes with progress of the solar longitude.

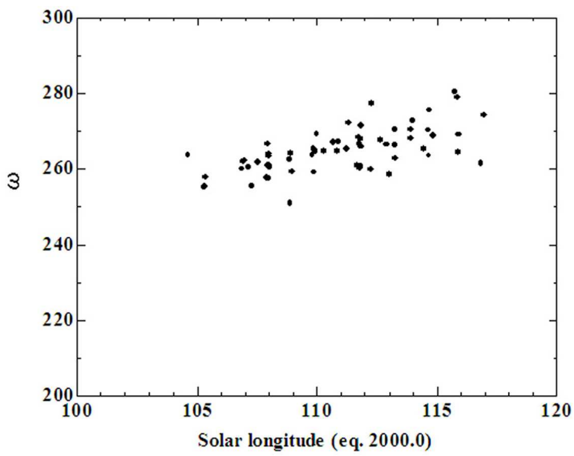

Figure 7 – Relation between the heliocentric orbital element ω and the solar longitude of 63 JPE meteors. The ω changes with progress of the solar longitude.

Table 7 – Comparison of theoretical radiant from parent comet C/1979 Y1 (Bradfield) and the JPE radiant determined by this study (equinox 2000.0).

	$\lambda_\odot$ (°)	α_G (°)	δ_G (°)	V_G (km/s)	a (AU)	e	q (AU)	Ω (°)	i (°)	ω (°)	P (yr)	Remarks
C/1979 Y1	108.61	346.5	+11.2	63.99	45.02	—	0.57	108.61	146.37	263.93	291	Jenniskens (2006)
July Pegasids	108.61	347.9	+10.9	64.2	18.41	0.97	0.58	108.61	148.55	262.25	79.0	This work
C/1979 Y1	110.6	348.5	+10.5	64.1	—	0.988	0.545	103.219	148.602	257.585	291	†
July Pegasids	110.6	349.3	+11.3	64.0	17.23	0.97	0.57	110.60	148.60	264.16	71.5	This work

†: Calculated by the method of Hasegawa (1990). The orbital elements are given in Marsden and Williams' Catalogue (1996).

Table 8 – Numbers of simultaneous TV meteors – JPE and sporadic meteors.

July Date	2008 JPE	2008 SPO	2009 JPE	2009 SPO	2010 JPE	2010 SPO	2011 JPE	2011 SPO
1		35		0		2		1
2		8		0		1		7
3		0		0		0		2
4		11		1		1		0
5		14		6		1		59
6		0	1	12		1		0
7		0		14	3	16		0
8		0		0		2		0
9		1	1	3	2	19	3	65
10		3		1		11	8	107
11		2		12		0	4	74
12		4	1	19	1	0	4	43
13		1	2	17		0	3	35
14		3	2	32		1	8	68
15		2	3	106	2	30	1	47
16	1	4		6	3	50		54
17		0		12	1	81	3	91
18		5		5	4	146		0
19		8	1	63	1	62		0
20		4		1		94		26
21		3		1		71		18
22		14		16		54		2
23		5		1		58		33
24		21		2		15		14
25		13		28		7		30
26		14		42		21		1
27		37		0		42		1
28		40		4		24		1
29		5		18		0		11
30		25		13		5		0
31		6		6		13		4
Total	1	288	11	441	17	828	34	794

in Japan. In this study, we have been able to determine the accurate radiant positions and geocentric velocities of the JPE meteors. This is why we think that the JPE should be added to the established 64 meteor showers of the International Astronomical Union (IAU). In addition, we are able to confirm that Comet Bradfield (1979 X = C/1979 Y1) is the parent comet of the JPE. Although the JPE is a weak shower, continued observations are encouraged in the future.

Acknowledgement

We thank Ichiro Hasegawa for his comments and suggestions.

References

Hasegawa I. (1990). "Predictions of the meteor radiant point associated with a comet". *Publ. Astron. Soc. Japan*, **42**, 175–186.

Jenniskens P. (2006). *Meteor Showers and Their Parent Comets*. Cambridge University Press. (page 715).

Marsden B. and Williams G. (1996). *Catalogue of Cometary Orbits*. Minor Planet Center, 11th edition. (page 34).

Molau S. and Kac J. (2010). "Results of the IMO Video Meteor Network – July 2010". *WGN, Journal of the IMO*, **38:5**, 167–170.

Molau S. and Rendtel J. (2009). "A comprehensive list of meteor showers obtained from 10 years of observations with the IMO Video Meteor Network". *WGN, Journal of the IMO*, **37:4**, 98–121.

Olech A. and Wiśniewski M. (2002). "An artificial meteor database as a test for the presence of weak showers". *Astron. Astrophys.*, **384**, 711–724.

Rendtel J., Arlt R., and McBeath A., editors (1995). *Handbook for Visual Meteor Observers*. IMO, Potsdam, Germany. (pages 169–170).

Triglav-Čekada M. and Arlt R. (2005). "The summer Pegasids from IMO video data". *WGN, Journal of the IMO*, **33:5**, 129–134.

Handling Editor: David Asher