The Sekiids

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Summary

A small group of DMS video meteors is identified as being associated with C/1961 T1 Seki and their relationship with the comet discussed, as is their near similarity to the b-Leonids.

Introduction

During an investigation of the DMS meteor databases' in which individual meteor orbits were tested against those of comets via the Drummond (1979) D' criterion (Greaves 1999), a group of three sporadic DMS video meteors were revealed as being probably associated with the comet C/1961 T1 Seki (= C/1961 VIII Seki). This was the only novel such association to arise from the analysis, yet had aspects that were beyond the remit of that paper.

This short paper examines the characteristics of these meteors, those characteristics as compared to the comet, and the fact that they bear both a strong resemblance to and a distinct character from the newly defined DMS meteor stream dubbed the b-Leonids.
The epithet "Sekiids" is merely a convenience with regards to the description of these meteors as their radiants lie on a piece of sky that has already had most of the appropriate bright stars utilised to name other streams. There is some small tradition of naming obscure streams after their parent comet, and alternatives like the "Denebolids" would a little trite, whilst the "November Leonids" would be a little silly. However, by extension to the precedent set by the naming of the b-Leonids, the "c-Leonids" could serve just as well, albeit being suggestive of a definite connection.

The Meteors

Table 1 lists the particulars of the b-Leonids, the Sekiids and C/1961 T1 respectively, with all meteor details coming from the DMS Video Meteors Orbit's Database accessible at www.dmsweb.org. It can be seen that the main differences between the two groups of meteors are primarily those of around ten degrees of right ascension and twenty to thirty degrees of argument of perihelion, *w*. The Sekiids are also slightly south compared to the b-Leonids and have perihelia that are 0.16 AU nearer to the sun on average.
Every one of the meteors in this sample was tested against every other meteor, and each were also tested against C/1961 T1, using Drummond's D' Criterion, the results are given in Table 2. As noted in Greaves (1999), the current usual practice is to adopt an upper threshold value of 0.105 for D', and Table 2 will be discussed in this context. Usually meteor orbits are compared against a mean value for a stream which itself changes as each new object is added, but here the number of objects is small enough in com-

Table 1: *Characteristics of the meteors (data from the DMS Video Orbits Database)*

Stream DMS	Date	RA Geo	DEC geo	Vgeo kms^{-1}	MV	q AU	e	i deg	ω deg	Ω deg
b-Leo V95613	20.124/11/1995	163.7	22.1	67.4	4	0.9145	0.7482	154.638	145.662	237.362
b-Leo V95652	21.220/11/1995	166.8	22.6	67.5	4	0.8965	0.8012	151.660	142.359	238.469
b-Leo V95723	22.152/11/1995	165.7	24.6	66.1	6	0.9333	0.6840	149.212	149.807	239.410
b-Leo V95736	22.169/11/1995	166.8	23.1	68.8	6	0.9218	0.8983	151.517	149.199	239.428
Sekiid V95649	21.217/11/1995	173.3	18.4	66.4	4	0.7333	0.8508	152.230	116.064	238.466
Sekiid V95730	22.165/11/1995	174.5	20.6	67.5	6	0.7799	0.9347	148.512	124.365	239.424
Sekiid V95746	22.177/11/1995	172.7	15.5	68.5	5	0.7519	0.9435	158.326	120.546	239.436
C/1961 T1 Seki	4/11/1961					0.6811	0.9982	155.711	126.575	247.355

Meteor/Comet		Meteor	D’
C/1961 T1	Sekiid	V95649	0.094
C/1961 T1	Sekiid	V95730	0.100
C/1961 T1	Sekiid	V95746	0.060
C/1961 T1	b-Leo	V95613	0.246
C/1961 T1	b-Leo	V95652	0.214
C/1961 T1	b-Leo	V95723	0.284
C/1961 T1	b-Leo	V95736	0.226
Sekiid V95649	Sekiid	V95730	0.072
Sekiid V95649	Sekiid	V95746	0.071
Sekiid V95730	Sekiid	V95746	0.075
b-Leo V95613	b-Leo	V95652	0.044
b-Leo V95613	b-Leo	V95723	0.057
b-Leo V95613	b-Leo	V95736	0.093
b-Leo V95652	b-Leo	V95723	0.087
b-Leo V95652	b-Leo	V95736	0.065
b-Leo V95723	b-Leo	V95736	0.136
Sekiid V95649	b-Leo	V95613	0.187
Sekiid V95649	b-Leo	V95652	0.160
Sekiid V95649	b-Leo	V95723	0.215
Sekiid V95649	b-Leo	V95736	0.196
Sekiid V95730	b-Leo	V95613	0.178
Sekiid V95730	b-Leo	V95652	0.139
Sekiid V95730	b-Leo	V95723	0.212
Sekiid V95730	b-Leo	V95736	0.154
Sekiid V95746	b-Leo	V95613	0.199
Sekiid V95746	b-Leo	V95652	0.169
Sekiid V95746	b-Leo	V95723	0.241
Sekiid V95746	b-Leo	V95736	0.185

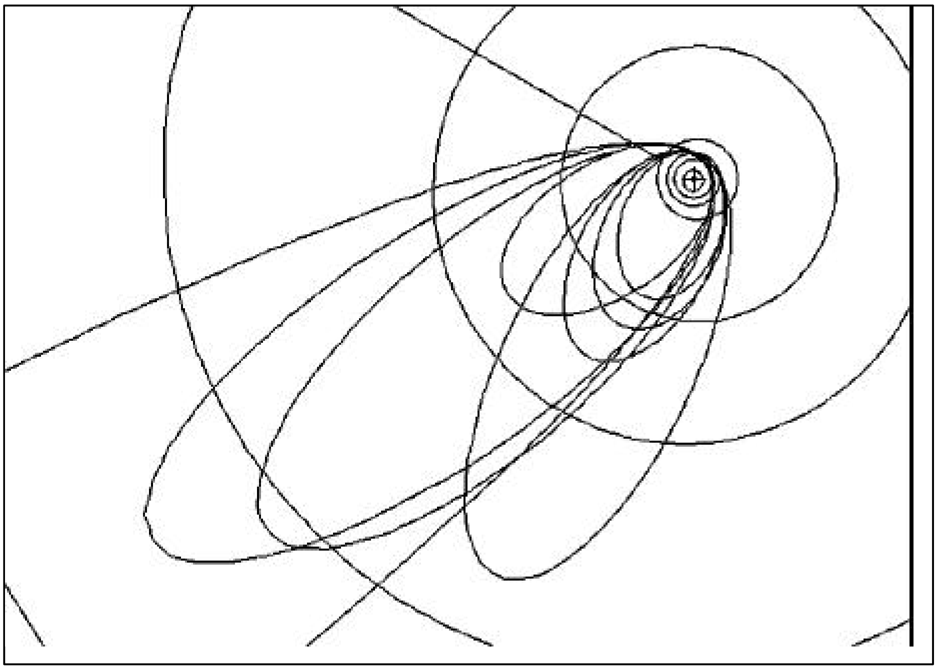

Figure 1*: The orbits of the proposed Sekiids with C/1961 T1 Seki and also the b-Leonids shown (see text for description).*

putational terms to allow the consideration of each object itself as a stream, such that any similarities between meteors can be more readily assessed.

Table 2 is split into five subsections. First the proposed Sekiids are compared to the suggested parent comet, and it can be seen that each meteor betters the 0.105 threshold value (though only just in one case!). Then the meteors listed as b-Leonids in the DMS Video Database are compared with C/1961 T1, and here the situation is quite different, with D’ falling between 0.2 and 0.3 for all four meteors. Note that “redundant” entries in Table 1 have not been repeated (ie V95649 versus V95730 is the same as V95730 versus V95649). To put these latter values into perspective it should be noted that objects with no evident relationship to each other can have D’ values of up to 1, though starting at about 0.5, whereas a good Geminid candidate will have D’ at about 0.01 to 0.02 when compared to 3200 Phaethon, whilst an average one would give a value of around 0.06, and, any orbit compared against itself usually gives D’ of around 10^{-11}. It should also be noted that this test is one of orbital *similarity*, and thus liable to fail objects whose orbits have evolved from that of the parent body (or vice versa, or both). In this context, values lying between 0.2 to 0.3 do show that b-Leonids and Sekiids are not the same class of objects, but they do not necessarily preclude any past connection.

In the next two subsections of Table 2 the Sekiids and then the b-Leonids are tested for internal consistency. All Sekiids have a D’ value of around 0.07 in comparison to each other. The b-Leonids have D’ values in relation to each other ranging from around 0.04 to 0.09, although as far as D’ is concerned V95723 and V95736 are not members of the same stream as their value is higher than the threshold limit (though admittedly not greatly so).

In the final subsection, the b-Leonids are compared with the Sekiids and here a mixed set of failed results can be found. Although some b-Leonids compare as badly with some Sekiids as they do with C/1961 T1 Seki itself, the Sekiid V95730 is as closely related to the b-Leonid V95652 as the (above mentioned) b-Leonid pair of V95723 and V95736 are to each other!

Figure 1 illustrates the orbits of both these streams as viewed from the North Ecliptic Pole. The three Sekiids are the ellipses lying within the near parabolic orbit that depicts C/1961 T1, whilst the b-Leonids are the four elliptical orbits lying slightly counter-clockwise to these (light grey lines lay below the Ecliptic, black ones above, the four inner circles surrounding the cross-like sun are the orbits of Mercury, Venus, Earth and Mars, with the orbits of Jupiter, Saturn and Uranus and even Neptune also being shown, although increasingly as partial arcs).

Figure 2 shows the radiant positions of the DMS b-Leonid meteors and the three DMS sporadic meteors suggested as being Sekiids in the present article (as can be seen from the plot, an alternate name for this stream could be the November beta-delta Leonids, a name which just manages not to conflict with any other stream name for radiants in this area)!

The Comet

C/1961 T1 Seki has a barely elliptical orbit (*see Table 1*) which equates to around 750 years in terms of period. Perihelion was on October 10th 1961, prior to it crossing the Ecliptic plane on the 4th of November, which itself was before a 0.10 AU Perigee on November 11th: the nodal point was apparently on the 29th November. Its orbital orientation and motion with respect to the Earth meant it spent most of that time performing a slow arc on the sky that lay just below β and θ Leonis, though this is not necessarily meaningful.
The comet itself may probably have reached apparent magnitude 4, as computed from its listed absolute magnitude, but showed little more than a diffuse, faint and even coma, with no evidence of any tail. It was in fact one of the "gassiest" comets ever known at the time, prompting several searches for and distributional mapping of exotic ion radicals in its spectrum (eg Dewey and Miller 1966). This latter fact seems in conflict with an object expected of being the source of meteoric dust.
On the other hand, the author notes the recent cases of C/1987XXX Levy and C/1988V Shoemaker-Holt, as well as that of C/1988V Liller and C/1996 Tabur Q1. In both these instances a comet was followed after a relatively short time period by another comet in virtually the same orbit. The consensus was that these secondary comets were originally part of the first comet, having split off at some time in the past. Also, at least in the case of C/1996 Q1, the second comet was a more diffuse and ephemeral affair, and indeed C/1996 Q1 actually fizzled to nothingness soon after approaching the sun (the author well remembers failing handsomely whilst trying to recover this "easy" comet following a waxing moon hiatus after an earlier successful viewing, it was only much later that he discovered what had happened)! For a full discussion of the situation concerning C/1996 Q1 Tabur see for instance Kronk's comet webpages at www.amsmeteors.org.

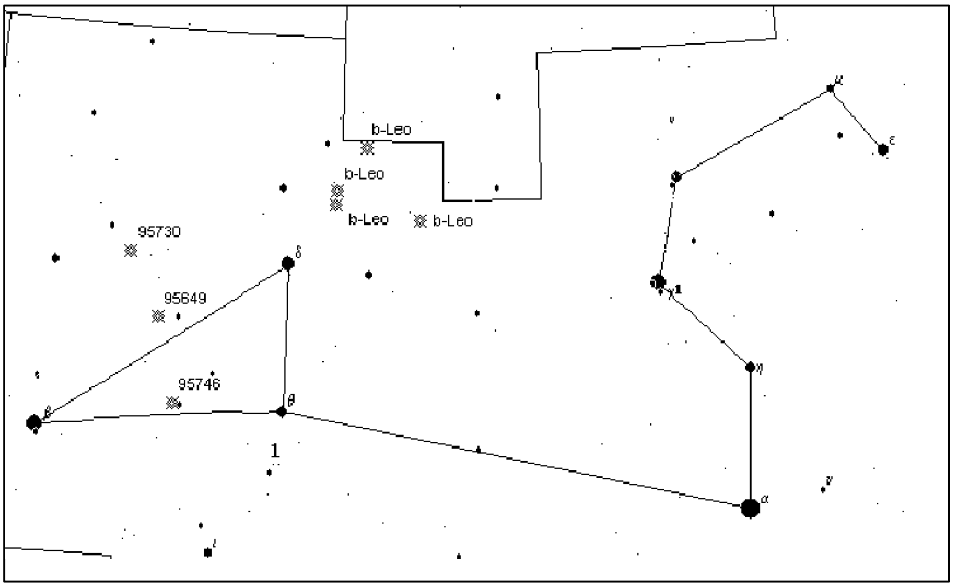

Figure 2: *A chart showing the radiant positions for the sporadic DMS video meteors suggested as being related to comet C/1961 T1 Seki, and also showing the radiants for the b-Leonids.*

In this light C/1961 T1 was tested via the D' criterion against every other comet orbit available*, with no real success, even the better values not starting until around 0.3. However, this was not entirely unexpected as a full cross check of the same comet database against the full DMS meteor orbit databases (Greaves 1999) had revealed no matching comet for the b-Leonids either: a "companion" comet to C/1961 T1 Seki that was *not* connected to the b-Leonids would have only served to further complicate matters!!!

Discussion

De Lignie (1998) makes a case for only accepting "new" streams as worthwhile candidates if they fulfil all of four criteria, with an emphasis on finding associations where productive future work can be envisioned, as opposed to the mere generation of ever longer lists. The b-Leonids themselves are one of four such new groups noted in that paper which were found via using these four criteria.
Coincidentally, the Sekiids automatically pass the two criteria based on temporal distribution and rates solely because the b-Leonids do, as a perusal of Table 1 will show. There it can be seen that of the seven meteors listed, four occurred within forty minutes of each other, this four consisting of two each of b-Leonids and Sekiids. The remaining Sekiid occurred within five minutes of one of the remaining b-Leonids, whereas the remaining b-Leonid is the temporal odd one out with respect to the other b-Leonids, let alone the Sekiids, so does not affect matters unduly. A third criterion of having at least three members to help avoid coincidences is also met by the Sekiids, if only just (in this respect it is noted that of the four suggested new DMS showers, two have four members, and one three).
The remaining criterion is one of statistical assessment, and de Lignie uses the original D criterion of Southworth and Hawkins (1963), suggesting that the currently popular value of 0.15 be used as the upper threshold limit. In this context the Sekiids fail the criteria, for although one Sekiid passes the D

threshold with respect to C/1961 T1 (despite a near ten degree difference in ascending node for the two), this same point emphasises the fact that *none* of the Sekiids pass this threshold with respect to each other!

In this paper the alternative Drummond (1979) D' criterion has been used. Here each proposed Sekiid passes that criterion's currently popular threshold level of 0.105 not only in comparison to the comet, but also in comparison to each other. The b-Leonids also more or less qualify as compatriots, for although one pairing just fails the test, each of these two is separately confirmed as being associated with its other fellows! However, the agreement is not quite as good under D' for the b-Leonids as it is for the Sekiids.

Small numbers can always lead to coincidences masquerading as meaningful reality, so it will also be noted here that in Greaves 1999 the entirety of the DMS meteor orbit databases were compared against a full list of comet orbits via the D' criterion, and that the case of the Sekiids was the only novel outcome to result from this analysis, in terms of both previously unknown meteor showers and previously unknown meteor-comet associations. The near coincidence with the b-Leonids was actually only noticed during the plotting of the Sekiids on a chart: a further perusal of their respective details revealed the similarity of dates, which in turn led to the idea of comparing the orbits. The consequent discovery of the near similarity of the latter led to a full investigation of the issue.

As far as the comet C/1961 T1 Seki is concerned, circumstantial evidence points towards the possibility that the Sekiids are a latter day group of meteors belonging to a schism comet, whilst the b-Leonids are a group of meteors associated with some unknown earlier comet that was parent to C/1961 T1. However, this would mean that the precession in the argument of perihelion for C/1961 T1 would have to be *retrograde* in comparison to the parent body, and the author is not certain whether this is actually physically possible, even allowing for the fact that the orbits for the meteors and comet are strongly retrograde and that non-gravitational forces often have a large influence in the dynamics of split(ting) comets.

A comparison with other similar distributions of showers in other constellations would at first sight be useful in this context. For example, there is a body of opinion that the Taurid complex is in fact an Encke complex, and that the showers emanating from Taurus in winter (as well as the daytime Taurid radio ones in Spring) are all consequent upon 2P/Encke and several possibly related Near Earth "Asteroids" that all may be the product of some larger ancient progenitor. On the other hand, few suggestions exist for a genetic relation between the mess of Summer showers that pepper the area of the Aquarius-Capricornus border.

In the end, the author feels that the law of parsimony should hold sway here, and that the apparent near similarity of the b-Leonids and putative Sekiids is merely a coincidence that has only been noticed for the first time due to increased observational effort by groups such as the DMS. After all, it should be noted that of the four new DMS showers listed in de Lignie (1998), three have meteors that were *all* discovered within one week of each other during mid November 1995 (as indeed were the Sekiids), and all of these meteors (just) had radiants lying within 90 degrees or so of γ Leonis: no doubt they were discoveries incidental to a concerted observing campaign aimed at the Leonids (the moon was new on 22nd of November that year, the night when most of the meteors were found). Similarly, the remaining new DMS shower has three members noted, all with radiants within 50 degrees of α Geminorum and all discovered on the relatively moon-free night of 13/14 December 1996.

No doubt more adjacent ecliptic streams will come to light in future years thanks to the efforts of groups like the DMS, thus reducing the apparent "significance" of such situations.

Conclusion and afterthought

An earlier analysis of DMS meteor orbits had suggested that a group of three video meteors not only constituted a group, but were also seen to be associated with comet C/1961 T1 Seki. Further analyses did nothing to disprove this association, and the stream was found to pass all the criteria considered significant in the identification of four new DMS streams, as long as the D criterion was replaced by the D' criterion. Even this modification could be considered conservative in nature, as in a separate work using the D' criterion only the case of the Sekiids had arisen as new as a consequence.

A striking similarity was noted between this group and the new DMS stream known as the b-Leonids. Despite no real evidence either way on the matter, a connection between the two groups of meteors would demand more special pleading than no connection would. It was also noted that in many ways the current dataset is (naturally) prone to observational selection effects (phase of moon, temporal proximity of major showers, etc), such that there is insufficient global data to put the issue of "special circumstance or coincidence" into a proper perspective. So coincidence was accepted as the most likely explanation as it was also the simplest explanation.

On a final note, it would be useful if professional scientists and/or others suitably qualified could provide significance tables for the various D criteria that could be put to general use.

As sample sizes get ever bigger, the probability increases of finding minor streams consisting of three, four or even ten "associated" meteors, which may in fact be just as likely to consist of meteors having only a coincidental connection (especially when data from different sources and years are intercompared). Given a large enough number of meteors plane random clumping would create such groupings. Meanwhile, multiple station video campaigns as run by the DMS, the Japanese MSSWG and others are bound to increase in output and number, thus increasing the *density* of observations.

Annual stream repeatability at first seems a fifth criterion, but where would the alpha Monocerotids be given that restriction?

As usually expressed at present, the D and D' criteria make no assessment as to what *number* of shower members is significant in comparison to sample size, with the values of 0.15 and 0.105 respectively being bandied about in the vast majority of works. Including this one!!!

* Sourced via Guide 7.0 DOS for PC planetarium from Project Pluto, USA (www.projectpluto.com)

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