

The formats of the IAU MDC meteor data

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1 IAU MDC format - version 2013

The current version of the IAU MDC database provides 31 parameters, in maximum, about each meteor. The list of the parameters is given in Table 1.

Basically, a unique identification code is assigned to each meteor. In the *photographic* data, the identification code consists of 5 characters: 3-digit serial number of the meteor in a given partial catalogue and a 2-character code of this partial catalogue. In the *video* data, the identification code is introduced by a single character referring to the source of the data (e.g. "C" refers to the CAMS data), which is followed by the serial number of meteor (usually the same as the serial number in the original author catalog). This serial number can have up to 7 digits.

Each parameter is given in two lines of the datafile. In the first line, the code of the parameter (listed in the 2nd column of Table 1) and two binary values are written. If the first value is "1" and the second value is "0", then only the value of the parameter, without the determination error, is presented in the second line. If both values are "1", then the second line contains the value of the parameter together with the determination error. (The place for the parameter can be reserved with its code, binary values both equal to "0", and blank second line. Such a record is identical to the omission of the parameter.) The number of decimal digits of the value of any parameter and its determination error is arbitrary, usually depending on the precision of its determination. (We speak here about the number of *valid* decimal digits. Because of the automatic, computer writing, there can occur a lot of redundant 0s or 9s beyond the valid decimal digits. These should be ignored, of course.)

The record about a given meteor begins with the meteor identification code and is terminated with the line containing 3 spaces and character &. It is not necessary to list all 31 parameters in a particular record. Only the identification code is mandatory. The order of parameters within each record is optional, except for the code, which always begins the record.

The prevailing majority of parameters and their determination errors, if given, are double-precision (REAL*8) numerical values, which can be read into an array (or the errors into another, independent array). Unfortunately, the old photographic data contained some non-numerical marks, which implied an establishment of five exceptions:

(1) Meteor number/code given by the original author (ANo) sometimes contains a character, therefore this parameter is given as the text, 7-character variable.

(2) Quality of meteor data (Qm) was given as a single or two-character code. In the IAU MDC data, this parameter is given as 2-character variable. (Our reading subroutine returns only the first character and the second position is always a space.)

(3) Shower number is, sometimes, not a numerical, but a composite (numeral and character) variable. In the IAU MDC, this parameter is, therefore, given as the 2-character variable.

(4) A tiny fraction of photographic meteors was corrected in the IAU MDC and the character of this correction was given as a single-character variable. (A more detailed description of these corrections is given in the documentation to the photographic catalogs.)

(5) A small part of photographic meteors (video meteors have not been analyzed in this respect, yet) has an extremely hyperbolic (beyond the Gaussian tail) eccentricity. (This phenomenon was described in the paper by Lindblad B.A., Neslušan L., Porubčan V., Svoreň J.: 2003, *Earth, Moon, and Planets* 93, 249-260.) The mark indicating the extreme hyperbolicity is the single character "h" in the IAU MDC data.

Table 1: The list of parameters included in the new 2013 version of IAU MDC database. No.P. is the serial number of the parameter in the list and C.P. is the code of the parameter. The positional parameters are referred to the equinox 2000.0.

| No.P. | C.P. | explanation |
|-------|------|--|
| 1 | #IC: | IAU MDC identification code |
| 2 | ANo: | number/code assigned to the meteor by author |
| 3 | Yr : | year of the detection |
| 4 | Mn : | month of the detection |
| 5 | Day: | day and fraction of day of the detection (UT) |
| 6 | LS : | solar longitude corresponding to the date of the detection [deg] |
| 7 | mv : | magnitude of maximum photographic brightness of meteor |
| 8 | HB : | height of beginning of meteor trail [km] |
| 9 | HM : | height of maximum brightness [km] |
| 10 | HE : | height of end of meteor trail [km] |
| 11 | RA : | right ascension of geocentric radiant [deg] |
| 12 | DEC: | declination of geocentric radiant [deg] |
| 13 | Vi : | extra-atmospheric velocity [km s^{-1}] |
| 14 | Vg : | geocentric velocity [km s^{-1}] |
| 15 | Vh : | heliocentric velocity [km s^{-1}] |
| 16 | cZ : | cosine of the angular distance of geocentric radiant from the zenith |
| 17 | Qm : | quality code |
| 18 | q : | perihelion distance [AU] |
| 19 | e : | numerical eccentricity of orbit |
| 20 | 1/a: | reciprocal semi-major axis [AU^{-1}] |
| 21 | a : | semi-major axis [AU] |
| 22 | Q : | aphelion distance [AU] |
| 23 | i : | inclination of orbit to the ecliptic [deg] |
| 24 | arg: | argument of perihelion [deg] |
| 25 | nod: | longitude of ascending node [deg] |
| 26 | pi : | longitude of perihelion [deg] |
| 27 | Sh : | shower number |
| 28 | Mas: | pre-atmospheric photometric mass [g] |
| 29 | lgM: | decadic logarithm of the mass |
| 30 | cor: | correction mark (type of correction if any) |
| 31 | crh: | extreme-hyperbolicity mark |

2 Format of data files readable with OS-Windows word editors

Since there are the researchers preferring the environment of the OS Windows and corresponding word editors, the large set of the parameters in the IAU MDC catalogues is also provided in the form of the Excel sheet. The precision of each given parameter is unified for all partial catalogues and fixed. The sheet consists of 21 parameters arranged in order (for the codes see the 2nd column of Table 1):

#IC, Yr, Mn, Day, HB, HM, HE, mv, RA, DEC, Vi, Vg, Vh, q, e, 1/a, a, i, arg, nod, pi.

For 16 of these parameters, there are reserved the columns for their determination errors, specifically dHB, dHM, dHE, dRA, dDEC, dVi, dVg, dVh, dq, de, d1/a, da, di, darg, dnod, dpi. Therefore, the sheet consists of 37 columns. Number of lines is equal to the number of meteors in the given sheet/catalogue.

3 Reduced data: meteor in a single line

The single-line format provides the reduced and unified set of parameters on each meteor in a single line of the datafile. This format is provided to enable an easy visual reading of the data.

The *reduced set* consists of 11 parameters listed in Table 2.

Table 2: The reduced set of the parameters in the IAU MDC database. h.c. is the code of parameter in the headings of single-line file (table).

| | h.c | parameter | unit |
|-----------|-----|--|-----------------------|
| | IC | identification code | |
| yr mn day | | date of meteor fall in the form year-month-day; | |
| | | time of the fall is given as the fraction of day | [UT] |
| | q | perihelion distance | [AU] |
| | e | numerical eccentricity | [1] |
| | i | inclination to the ecliptic | [deg] |
| | arg | argument of perihelion | [deg] |
| | nod | longitude of ascending node | [deg] |
| | RA | right ascension of geocentric radiant | [deg] |
| | DEC | declination of geocentric radiant | [deg] |
| | Vg | geocentric velocity | [km s ⁻¹] |
| | Vh | heliocentric velocity | [km s ⁻¹] |

In the files with the 1-line data, the parameters are arranged in successive columns in the above-listed order. The IAU MDC attempts to achieve that all these parameters are provided for every meteor included into the center's data.

4 Old IAU MDC format – version 2003

Since the researchers may wish to utilize their old computer programs that read the data in the old format, the IAU MDC provides the photographic data also in the old format of the version 2003. The specific structure of these data is described in Table 3.

Table 3: Format for data in files "???.d03", i.e. the format of the 2003 version of photographic database (?? stand for the code of given photographic catalog). All the data are stored as 4 line records separated by blank line. C.P. is the code of the parameter (see Table 1). The individual values within one record are arranged in the following way:

| Position | C.P. | Variable | Format | Unit |
|-------------------|------|---|---------------|-----------------------|
| *** 1-st line *** | | | | |
| 1– 5 | #IC | Identif. code | aaaaa | |
| 10–14 | ANo | Meteor no. | aaaaa | |
| 17–18 | Qm | Quality | various codes | |
| 21 | cor | correction remark | code letter | |
| 22 | crh | extreme hyperbolicity | code letter | |
| 28–30 | | Stream no. - omitted in the new version | | |
| 33–34 | | Assoc. no. - omitted in the new version | | |
| 37–38 | Sh | Shower no. | aa | |
| *** 2-nd line *** | | | | |
| 2– 3 | Mn | month | xx | |
| 5–12 | Day | day | xx.xxxxx | |
| 14–17 | Yr | year | xxxx | |
| 19–23 | LS | longitude of the Sun | xxx.x | [deg] |
| 26–30 | RA | α_R | xxx.x | [deg] |
| 32–36 | DEC | δ_R | xxx.x | [deg] |
| 39–43 | | λ - omitted in the new version | | |
| 46–50 | Vg | V_g | xx.xx | [km s ⁻¹] |
| 52–56 | Vh | V_h | xx.xx | [km s ⁻¹] |
| 58–62 | Vi | V_∞ | xx.xx | [km s ⁻¹] |
| *** 3-rd line *** | | | | |
| 2– 6 | q | q | x.xxx | [AU] |
| 8–15 | a | a | xxxx.xxx | [AU] |
| 17–23 | Q | Q | xxxx.xx | [AU] |
| 25–29 | e | e | x.xxx | |
| 32–36 | i | i | xxx.x | [deg] |
| 38–42 | arg | ω | xxx.x | [deg] |
| 44–48 | nod | Ω | xxx.x | [deg] |
| 51–55 | pi | π ($\pi = \omega + \Omega$) | xxx.x | [deg] |
| *** 4-th line *** | | | | |
| 1– 5 | mv | M_{ph} | xxx.x | |
| 8–13 | cZ | $\cos(z_R)$ | xx.xxx | |
| 16–20 | HB | HB | xxx.x | [km] |
| 23–27 | HM | HMax | xxx.x | [km] |
| 30–34 | HE | HE | xxx.x | [km] |
| 38–43 | lgM | $\log_{10}(\text{mass [g]})$ | xx.xxx | |
| 46–54 | Mas | Mass | xxx.xxxxx | [g] |
| 60–64 | | K - omitted in the new version | | |
| 67–71 | | CW - omitted in the new version | | |

In the old data, the following parameters, which are not longer kept in the current databases, were given:

Stream no. – The stream no. refers to two computer stream searches by Lindblad (Lindblad, B.A.: 1971a, *Smithson. Contrib. Astrophys.*, No. 12, p. 1-13; 1971b, *Smithson. Contrib. Astrophys.*, No. 12, p. 14-24). A zero indicates that the search classified the meteor as sporadic. A blank indicates that the meteor orbit was not included in the search, or not available at the time of the search.

Assoc. no. – The association no. refers to a series of tentative groupings of orbits proposed by Whipple (Whipple, F.L.: 1954, *Astron. J.* 59., 201). Association nos. 30-88 are listed in Whipple (1954), and Jacchia and Whipple (Jacchia L.G., Whipple, F.L.: 1961, *Smithson. Contrib. Astrophys.* 4, 97); associations 1-16 in Babadzhanov and Kramer (Babadzhanov P.B., Kramer, E.N.: 1967, *Smithson. Contrib. Astrophys.* 11, p. 67-79). Stream searches by B. A. Lindblad within his work with the IAU MDC data confirmed many of these associations.

λ – elongation of meteor radiant (the angular distance between the meteor radiant and the apex of Earth's motion).

K – the comet-asteroid criterion. It is listed for all meteors.

CW – cosmic weight is only given for Harvard meteors. For definitions see (Whipple F.L.: 1954, *Astron. J.* 59., 201).

Parameters in the version 2003 in the appropriate Fortran-format command:

```
FORMAT(A5,4X,A5,2X,A2,2X,A1,A1,5X,A3,2X,A2,2X,A2,2X,A2)
FORMAT(I3,F9.5,I5,F6.1,F7.1,F6.1,F7.1,F7.2,F6.2,F6.2)
FORMAT(F6.3,F9.3,F8.2,F6.3,F7.1,F6.1,F6.1,F7.1)
FORMAT(F5.1,2X,F6.3,2X,F5.1,2X,F5.1,2X,F5.1,3X,F6.3,2X,F9.5,5X,F5.2,2X,F5.2)
FORMAT(A1)
```