Short paper

# Eta Aquarids 2013 – Dual-station meteor videography

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NEMETODE, a network of low-light video cameras in Cheshire and West Yorkshire operated by members of the BAA Meteor Section, monitors the activity of meteor showers, enabling the precision measurement of radiant positions and, from the best quality data, the altitudes and geocentric velocities of meteors and their solar system orbits. The results from dual-station observations of the 2013 eta Aquarid shower are presented and discussed.

## Equipment and methods

NEMETODE members William Stewart (WS) and Alex Pratt (ARP) employed the same equipment and methods as described in their paper on the 2012 Geminids[1] and on the NEMETODE website.[2]

## The eta Aquarid meteor stream

The eta Aquarids (MDC reference 031 ETA) are active from mid-April to late May with a ZHR of ~55 at maximum. Their parent body is comet 1P/Halley, which also produces the Orionids (008 ORI) during October and early November.[3] As viewed from mid-northern latitudes the low declination radiant of the eta Aquarids rises shortly before dawn, making observations in the morning twilight difficult. The resulting 'Earth-grazers' do however produce characteristic long-pathed trails.

## Results

The first probable eta Aquarid candidate was recorded on 2013 April 15/16 (Ravensmoor N) and the last on 2013 May 25/26 (Ravensmoor SE). The magnitude distribution of 51 eta Aquarids captured during this period (measured by *UFO Analyser*) is given in Table 1.

## Dual-station eta Aquarids

*UFO Orbit* supports three built-in quality assurance criteria:

Q1 – minimum criteria for radiant computation
Q2 – standard criteria for radiant and velocity computation
Q3 – criteria for high precision computation

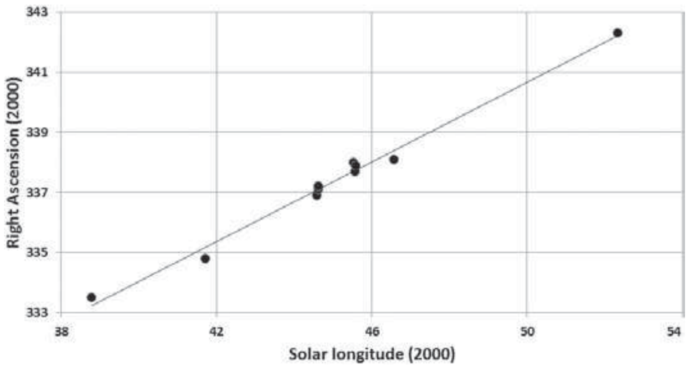


**Figure 1.** eta Aquarid radiant drift in right ascension.

(When analysing captures, Q1 includes level Q2 and Q3 data, Q2 includes level Q3 data.)

Between 2013 April 28/29 and May 12/13 a total of 10 Q1-level dual-station eta Aquarids was recorded.

## Radiant drift

*UFO Orbit* was used to derive the radiant point for each dual-station eta Aquarid, corrected for zenith attraction. These were used to estimate the daily drift of the radiant in right ascension and declination.

The method of least squares gives the linear fits:

$$RA = 0.663 * \lambda_{solar} + 307.54 \qquad r = 0.995$$

$$Dec = 0.234 * \lambda_{solar} - 11.564 \qquad r = 0.807$$

where $\lambda_{solar}$ = solar longitude (°) and r is the correlation coefficient.

If we assume that eta Aquarid maximum occurred at solar longitude 45°,[4] the estimated values of RA and Dec, and daily motion in RA (dRA°) and Dec (dDec°) are presented in Table 2 for comparison with other sources.

**Table 1. Magnitude distribution of the 2013 eta Aquarid meteors**

| *Absolute Mag:* | –3 | –2 | –1 | 0 | 1 | 2 | 3 | 4 | Sum | Mean |
|---|---|---|---|---|---|---|---|---|---|---|
| Leeds | 0 | 1 | 4 | 4 | 5 | 2 | 0 | 0 | 16 | 0.2 |
| Ravensmoor North | 0 | 0 | 0 | 4 | 2 | 1 | 1 | 0 | 8 | 0.9 |
| Ravensmoor NE | 1 | 0 | 0 | 0 | 1 | 3 | 6 | 0 | 11 | 2.0 |
| Ravensmoor SE | 0 | 1 | 1 | 4 | 6 | 1 | 2 | 1 | 16 | 0.9 |

## Detection and extinction altitudes

*UFO Orbit* computed the detection and extinction altitudes of 8 Q2 eta Aquarid meteors and their absolute magnitudes, captured between 2013 April 28/29 and May 6/7 (see Figure 3). (Note: Absolute magnitude is the magnitude the meteor would have if it was in the zenith, 100km above the observer.)

**Table 2. The position of the eta Aquarid radiant at maximum and its daily motion**

| | $\lambda_{solar}$(°) | RA(°) | RA | dRA(°) | Dec(°) | dDec(°) |
|---|---|---|---|---|---|---|
| NEMETODE | 45 | 337.4 | 22h 30m | 0.66 | −1.0 | 0.23 |
| HBAA[4] | 45 | 335 | 22h 20m | 0.9 | −1 | 0.4 |
| IAU MDC[5] | 46.9 | 339.0 | 22h 36m | 0.73 | −1.4 | 0.31 |
| IMO[6] | 47 | 339.1 | 22h 36m | 0.64 | −0.5 | 0.33 |
| SonotaCo[7] | 46.3 | 338.3 | 22h 33m | 0.62 | −0.8 | 0.29 |

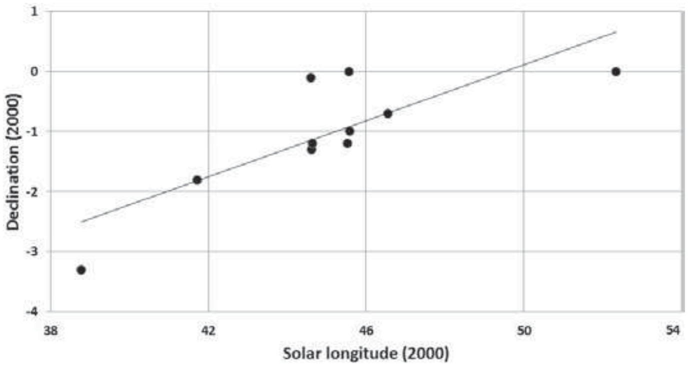


**Figure 2.** eta Aquarid radiant drift in declination.

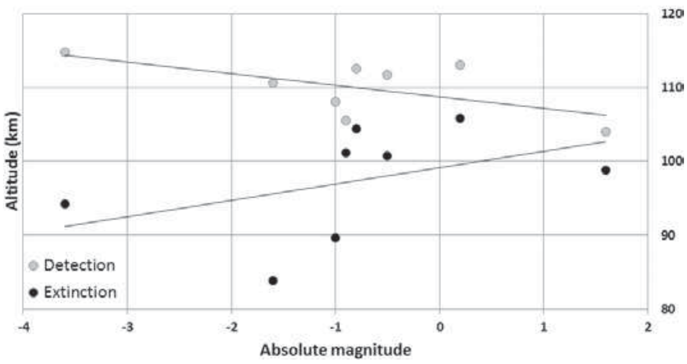


**Figure 3.** Detection and extinction altitudes of 8 Q2 eta Aquarid meteors.

The small difference between some of the detection and extinction altitudes is a consequence of the low-elevation radiant leading to meteor trails that are almost parallel to the Earth's surface.

## Geocentric velocities

*UFO Orbit* computed the geocentric velocities (Vg) of the 8 Q2 eta Aquarid meteors, which gave the following:

Mean 66.0 km/s
Standard deviation 0.7 km/s

These are compared with other sources in Table 3.

**Table 3. Geocentric velocities of 8 Q2 eta Aquarid meteors**

| | Vg (km/s) |
|---|---|
| NEMETODE | 66.0 |
| IAU MDC[5] | 65.0 |
| IMO[6] | 67.4 |
| SonotaCo[7] | 65.4 |

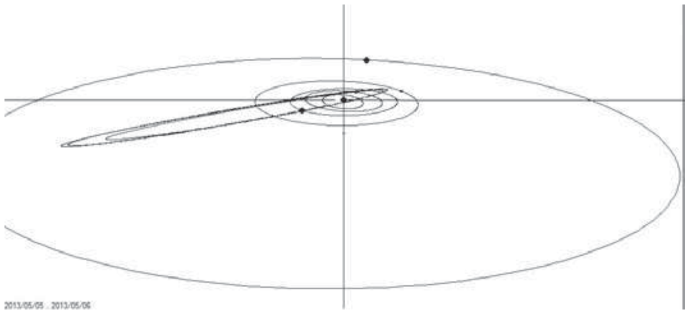


**Figure 4.** View of the 3 Q3 unified eta Aquarid orbits.

## Orbits

*UFO Orbit* computed the orbital elements of 3 Q3 eta Aquarids, captured on 2013 May 4/5 and 5/6. For each pair of observations it calculated two orbits and a unified orbit; the latter are given in Table 4. A view of the 3 unified orbits is displayed in Figure 4.

## Conclusions

From the UK the eta Aquarids radiant rises at about 02:00 UTC, giving a narrow observing window in twilight, before sunrise two hours later. NEMETODE cameras were fortunate to obtain 51 detections of 37 individual eta Aquarid meteors due to the unexpectedly enhanced rates in 2013.[6]

The small grazing angle resulted in long meteor trails, which helped to improve the astrometric and orbital measures.

The authors do not recommend any changes to the eta Aquarid data in the BAA *Handbook*.

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## References

1 Pratt A. R. & Stewart W., 'Geminids 2012 – Dual-station meteor videography', *J. Brit. Astron. Assoc.*, **123**(6), 325–327 (2013)
2 **http://www.nemetode.org/**
3 **http://imo.net/calendar/2013#eta**
4 BAA *Handbook* 2013, 98 (from NASA SP-319, pp. 185–186, 1973)
5 **http://tinyurl.com/qyotgas**
6 Molau S.*et al*, 'Results of the IMO Video Meteor Network – May 2013', *WGN*, **41**:4, 134 (2013)
7 SonotaCo, 'A meteor shower catalog based on video observations in 2007–2008', *WGN*, **37**:2, 59 (2009)
8 **http://ssd.jpl.nasa.gov/sbdb.cgi?ID=c00001_0**

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**Table 4. Orbital elements of 3 Q3 eta Aquarid meteors, IAU MDC shower data & parent body comet 1P/Halley**

| | Solar long. | Abs mag | Vg | a (au) | q (au) | e | p | Peri | Node | Incl |
|---|---|---|---|---|---|---|---|---|---|---|
| | 44.624317 | −1.6 | 65.8 | 14.439 | 0.577 | 0.960 | 54.889 | 97.217 | 44.625 | 163.695 |
| | 45.522839 | −0.9 | 64.9 | 6.569 | 0.559 | 0.915 | 16.842 | 93.814 | 45.523 | 164.023 |
| | 45.579281 | −3.6 | 65.7 | 11.951 | 0.578 | 0.952 | 41.332 | 97.173 | 45.579 | 163.816 |
| Mean | 45.2 | | 65.5 | 10.986 | 0.571 | 0.942 | 37.688 | 96.068 | 45.242 | 163.845 |
| Std. dev. | | | 0.5 | 4.023 | 0.011 | 0.024 | 19.284 | 1.952 | 0.536 | 0.166 |
| IAU MDC[5] | 46.9 | | 65.0 | 11.60 | 0.545 | | | 91.9 | 45.6 | 165.1 |
| 1P/Halley[8] | | | | 17.834 | 0.586 | 0.967 | 75.32 | 111.332 | 58.420 | 162.263 |