

# ON A TRIANGULATION OF AN ALLEGED “HESSDALEN LIGHT”

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**Abstract:** An analysis of August 15, 2002 triangulation data and August 6-7, 2002 video and sighting data supports the hypothesis that the “recurring light” sighted in Hessdalen in Summer 2002 was a pair of vehicle headlights. The triangulation carried out by Adams (2007) was helpful to identify the possible location of the country road covered by the vehicle.

On August 6, 7 and 15, 2002, an unidentified light was sighted in the Hessdalen valley (central Norway) by a group of astrophysicists, engineers and technicians, during an optical and ground survey named “EMBLA Project”. Because of the repetitive behavior of the light (as regards azimuth, altitude, duration, time of the day, etc.), the whole set of sightings likely concern the very same “recurring” source of light (Adams, 2007, p. 107-108).

As regards the August 6-7 sightings, astrophysicist Massimo Teodorani repeatedly stressed in his reports that the photometric and spectroscopic data he had collected during the survey proved that it was a genuinely anomalous light (Teodorani, 2004, 2006). This author countered, via his telescopic observation, and a set of topographic, photometric and spectroscopic evidence that the data pointed toward a car headlights solution (Leone, 2006a, 2006b). Recently, Marsha Adams, of the “International Earthlight Alliance”, a group devoted to the study of anomalous lights around the world, added further video evidence on the August 7 sighting, and carried out an analysis of a triangulation on the August 15 sighting (Adams, 2007). Adams concluded that both car headlights and an anomalous light were present during the August 7 sighting, and that the August 15 triangulation demonstrates that the source of light was closer to the witnesses (8.3 km) than expected by this author because of the position of a candidate road (10.2 – 11.9 km) on a specific Hessdalen valley hill.

While the attempt to triangulate the luminous phenomenon, with the goal of obtaining its distance from the observers, deserves to be very much praised, reasons suggesting that this triangulation adds further weight to the vehicle headlights hypothesis will be here presented.

## 1. The August 15, 2002 triangulation

As above discussed, a triangulation of an alleged recurring anomalous light, was carried out by Adams (2007, p. 114). That triangulation led to a 8.3 km estimate of distance between the EMBLA Project observers and the visual stimulus. A geometrical analysis of that triangulation will follow.

Let A (Lat. 62.80137° North, Long. 11.17522° East) and B (62.83861° N, 11.18674° E) be the two observers in the Hessdalen valley attempting to triangulate the position of a luminous stimulus C. The actual positions are given by Adams (2007, p. 115).

As a first step, let's calculate the A-B distance ( $d_{AB}$ ) out of the haversine formula (Sinnott, 1984), which is more accurate for small distances than the traditional spherical law of cosines. According to the haversine formula:

$$d_{AB} = r \cdot 2 \arcsin \left\{ \sqrt{\sin^2 \left( \frac{\phi_B - \phi_A}{2} \right) + \cos \phi_A \cos \phi_B \sin^2 \left( \frac{\Delta \lambda}{2} \right)} \right\} \quad [1]$$

where  $\phi_A, \lambda_A$ ;  $\phi_B, \lambda_B$  are the latitude and longitude of the points A and B,  $\Delta \lambda$  is the longitude difference and  $r$  is the average great-circle radius of the earth (6372.8 km). By inserting the above values into the equation, the haversine formula yields  $d_{AB} = 4.2$  km.

In order to estimate the distance between observer B (where the EMBLA project carried out its optical survey) and the stimulus C, via the triangulation data, a first plane geometry approximation will be here attempted. This first approximation is deemed legitimate given the short distances involved. By simple trigonometrical relationships follows that the distance between the observer B and the stimulus C ( $d_{BC}$ ) is:

$$d_{BC} = \frac{d_{AB} [\sin(\gamma - \beta)]}{\text{tg}(\beta - \alpha)} + d_{AB} [\cos(\gamma - \beta)] \quad [2]$$

where  $\beta$  is the bearing from B to light minus  $180^\circ$ ,  $\alpha$  is the bearing from A to light minus  $180^\circ$ , and  $\gamma$  is the bearing of AB with respect to the vertical grid lines. The  $\gamma$  parameter is derived by a measurement on the relevant 1:50,000 Hessdalen map of the Norwegian Mapping Authority (Haltdalen, 1995) and it is found to be equal to  $6.1^\circ$ .

In the available Hessdalen map, it is convenient to use grid bearings as opposed to true bearings. If grid bearings are used, the magnetic bearings reported by Adams ( $181.2^\circ$  from observer A and  $184.7^\circ$  from B) have to be corrected by the grid magnetic (G-M) angle. According to the Hessdalen map, in the Hessdalen valley the true north is  $1^\circ 45'$  west of the grid north. Thanks to the National Geophysical Data Center data (NGDC, 2007), we know that the magnetic declination on August 15, 2002 was, in that corner of Norway,  $0^\circ 52'$  east. Therefore, it follows that the G-M angle is  $0.9^\circ$ . As pointed out by the Hessdalen maps, to convert magnetic north to grid north, we have to subtract G-M angle. Thus, the grid bearings from the observers are:  $180.3^\circ$  (A) and  $183.8^\circ$  (B). By inserting the above parameters, equation [2] yields  $d_{BC} = 7.0$  km. An analogous result is obtained if the true bearings reported by Adams (2007, p. 115) are used. The reasons of the slight discrepancy between this author's and Adams' estimate are unclear.

Apart from this discrepancy, several sources of error are present. One error is mostly the outcome of the negligible  $\beta - \alpha$  angle ( $3.5^\circ$ ), which was a consequence of the questionable choice of putting observer "A" almost right on the expected observing line from the "B" viewpoint. By supposing a  $0.2^\circ$  error in the bearing estimates, the distance might be affected by an error up to 0.7 km. Furthermore, if the bearing readings were not exactly simultaneous, discrepancies of the order of a few decimals of degrees (i.e. of several hundreds of meters) might easily arise. From Adams' paper is unclear what methodology was adopted to guarantee an exact synchronization between the observers' readings (it is reported only that observer B determined the bearing after taking photographs of the spectrum (Adams, 2007, p. 114)) and to avoid the possibility that two different headlights on two different roads were actually involved.

If the magnetic bearings collected on the sites are deemed reliable, the intersection point appears to be on the Skarvan peak, i.e. in front of the Lobergsvollen hill. The  $184.7^\circ$  magnetic bearing from observer B (corresponding to a  $183.8^\circ$  grid bearing and to a  $185.6^\circ$  true bearing) almost exactly cross the northern end of a country road on a slightly northward continuation of the Lobergsvollen road (standard reference 32VPQ108610), which actually is on the Skarvan peak, near Nyheim (N62.76493 E11.16960). This corner of the road is not hidden by the Heggsethogda hill in the foreground and therefore it is likely visible from the B viewpoint. Nyheim is at 8.4 km from observer B, in agreement with Adams triangulation, and it is at a mere 400 m from the intersection point derived by Adams (2007, p. 115). The  $181.2^\circ$  magnetic bearing from observer A

(corresponding to a  $180.3^\circ$  grid bearing and to a  $182.1^\circ$  true bearing) also crosses the above country road near Nyheim. At present, this one appears to be most likely road covered by the vehicle responsible for the recurring light. However, given the above reported uncertainties associated with this triangulation, the Nyheim country road should be considered only a *candidate* road until further evidence surfaces.

As regards the optical power issue, the light sighted on Aug. 15 was deemed by Adams to be “smaller and dimmer” than her prior Aug. 7 Aspaskjolen observations (Adams, 2007, p. 114). Should Adams’ estimates of distance be even remotely correct, then the expected optical power output on Aug. 15 would be  $(8.3/3.9)^2$  times higher than before. This corresponds to a luminous power 4.5 times greater. Even by considering the logarithmic Weber-Fechner law, concerning the human perception of visual stimuli of different intensities (Copelli, Roque, Oliveira, & Kinouchi, 2002) the light sighted on August 15 had to appear 1.5 times brighter than from Aspaskjolen. This effect might be an outcome of the fact that, as all the vehicle headlights beams, the luminous source was not a isotropic radiator. Furthermore if the triangulation estimate is correct, the luminous intensity ( $2.1 \cdot 10^5$  cd) is much more consistent than before with the expected luminous emission by vehicle headlights (Leone, 2006a, p. 49, eq. 4).

Finally, as for the relationship between triangulation data and visual evidence, most vehicles have headlights situated at a width of 1.1 m or 1.3 m (Castro, Martinez, Tornay, Fernández, & Martos, 2005, p. 41). For headlights width of 1,2 m at a distance of 8.3 km (Adams, 2007), the expected angular width would be about 0.5 minutes of arc at naked eye and about 14.8 minutes of arc through a telescope at 30x magnification, i.e. far above the – 1 minute of arc – resolving power of the eye.<sup>1</sup> Thus, car headlights beaming toward the observer, at the distance estimated via the triangulation data, would be easily resolved through the portable telescope used by this author.

Summing up, the case for the car headlights behind the recurring light sightings is strengthened by Adams’ important work. The triangulation shows indeed that the source of light was behind the Heggsethogda hill, in agreement with the conjecture put forward by this author (Leone, 2006a,b), and in sharp disagreement with Teodorani’s contention that the light was hovering tens of meters above that hill (Teodorani, 2004, p. 240), and with Adams’ expectation that “the light would appear overhead” (Adams, 2007, p. 114); furthermore, the triangulation confirmed that the source of light was close to a country road in the southern Hessdalen valley, albeit different from the one formerly put forward by this author when poorer bearing data were available (Leone, 2006a,b).

## 2. The August 6-7, 2002 sightings

Video evidence on the Hessdalen recurring light was obtained by Adams on August 7, 2002. Out of the contents of this video-recording, which she has kindly submitted to CIPH, Adams has put forward the following scenario: (1) Car headlights (likely on the Borren road) appeared soon after an exchange between Adams and Erling Strand by a 2-way radio. (2) This author correctly identified these headlights through telescopic observation. (3) The recurring light appears. (4) The EMBLA team takes photographs and spectrum of the recurring light.

Although portions of this scenario are not new (see for example Teodorani, 2006), many clues point toward the fact that the whole set of witnesses (Adams, Teodorani, and the other members of EMBLA survey) sighted the very same luminous stimulus witnessed by this author by means of a portable telescope – namely, a couple of vehicle headlights – right when the EMBLA project members had jumped up excitedly pointing at the usual, southerly placed, recurring light. A number of these clues will be here discussed.

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<sup>1</sup> This expected angular width is 50% off this author’s visual perception of the vehicle headlights size (one full moon diameter, i.e. 30 minutes of arc). Such a discrepancy is hardly surprising given the perceptual process involved, namely the estimate of the angular size of two lights seen through a telescope by the comparison with the angular size of a stimulus seen by naked eye. A further inferential process affecting the visual estimate might be the effect of object familiarity on the perception of size and distance (Gogel, 1969).

## 2.1 Apparent position of Adams' car headlights

By comparing the car headlights apparent position – as it might be deduced out of Adams video recording – with the background landscape and with the recurring light apparent position, its magnetic azimuth should be close to  $181^\circ$  (i.e. 3 to 4 degrees eastward with respect to the recurring light) and its angular elevation is lower than the recurring light's one (this estimate is uncertain, however -  $0.5^\circ$  is a reasonable figure). Thus, it is very unlikely that car headlights were on the Borren road (magnetic azimuth  $183.7^\circ$ , angular elevation  $0^\circ$ ). Furthermore, while the car headlights had a sensible leftward apparent motion, i.e. the car had to be on a north-easterly course, the Borren road points due north. It is much more likely that the car was on the FV576 road, either near the church (5.5 km from Vista point) or near Kjerringsvollen (8.5 km away).

## 2.2 Apparent position of the recurring light

Adams (2007, p. 111) contains two revealing figures – “Figure 1” and “Figure 2” – excerpted out of the video he recorded on August 7. While “Figure 2” shows “vehicle headlights” toward the left side of Nyvollogda mountain, “figure 1” shows the “typical position of the recurring light”, i.e. closer, by perspective, to the right side Hessjohogda mountain in the background. Contrary to what assumed by Adams, no confusion of optical stimuli was likely. Since the arrival of the EMBLA team in the Hessdalen valley, its leader reported indeed that he was eagerly awaiting for the recurring “saddle's light” (Italian: “luce della sella”), where by saddle he meant the valley-like feature of the horizon outline close to  $185^\circ$  magnetic azimuth, where the Heggsethogda hill in the foreground almost coincide by perspective with an apparent valley in the background. The recurring light actually showed itself very close to this “saddle”, i.e. very close to the horizon outline. Thus, in order to have a closer look to this specific light, on Aug. 7, this author kept the telescope pointed toward this “saddle” awaiting for a new appearance of the light. When the recurring light appeared, the telescope was ready for observing this specific light without having to move it in a sensible way.

Moreover this author, right after the former August 6 sighting of the recurring light, sketched the landscape where the light had appeared (see Figure 1). As it is evident this sketch might be almost superimposed to the actual photographs of the recurring light. By considering the “saddle” area where the Heggsethogda appear to be closest to the background, a  $1^\circ$  error upon the recurring light magnetic bearing ( $185^\circ$ ) is a generous estimate. Therefore, the actual magnetic bearing of the car headlights captured by Adams ( $181^\circ$ ) is significantly different of the azimuth of the light this author observed through the telescope, given the sketch of the landscape outline evidence. This sketch shows that this author was actually looking at the light near the saddle on August 6, and heavily suggests that the same occurred the following day.



Figure 1 - Sketch of the recurring light this author drew soon after the Aug. 6 sighting (left). Photograph of the recurring light shot in August 2002 (right). The angular position of the light is the same as in the frames published in the Embla 2002 report (© CIPH, Hessdalen 2002).

### 2.3 Apparent motions

According to Adams' video recording, the car headlights at 181° sensibly moved leftward, while the recurring light was apparently stationary. As this author was not compelled to follow the light with the telescope (at a 30x magnification, the field of view was just slightly larger than the full moon diameter, namely 0.5°), this is much more consistent with the apparent behaviour of the recurring light.

### 2.4 Horizon outline

The car headlights at the beginning of Adams' video appeared very far in azimuth from the "interesting" place (3 to 4°) and, most importantly, very far from the horizon outline (likely 1.5°). This video actually shows that the car headlights at 181° were apparently under the top of the mountain in the background just before their disappearance. No confusion is possible with a recurring light near the horizon outline, right under a valley in the background (see Figure 1).

### Conclusions

Both August 15 triangulation and August 6-7 video and sighting data support the hypothesis, formerly put forward by this author, that the "recurring light" sighted in Hessdalen in 2002 was a pair of vehicle headlights. The triangulation carried out by Adams was helpful to identify the possible location of the country road covered by the vehicle.

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