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Questioning Answers on the Hessdalen Phenomenon

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Abstract—According to a recent paper on a long-term scientific survey (code-named EMBLA Project), an anomalous atmospheric luminous phenomenon of well-defined physical characteristics (optical radiant power up to 19 kW, three well-distinguished peaks about 50 nm wide, dimensions ranging from decimetres up to 30 m, etc.) is reportedly occurring on a daily basis in the Hessdalen valley in Norway. Although photographic and eyewitness evidence supporting the actual existence of so far unexplained low atmospheric phenomena in the Hessdalen valley does exist, the phenomenological picture obtained by the EMBLA scientists is shown to be largely questionable and explainable as unrecognised vehicle headlamps.

Keywords: Hessdalen lights—Italian Committee for Project Hessdalen—EMBLA—eyewitness evidence—photometry—spectroscopy—headlamps—film sensitivity—UAP—UFO—unidentified flying objects

Discoveries, advances
By[e] by[e].
Questions are made
Answers are made.
Questioning? Answering?
—A dadaist poet

Introduction

According to astronomer B. Haisch (2002), "Advances are made by answering questions. Discoveries are made by questioning answers." Philosophers and historians of science have been debating for years about what is at the heart of the scientific enterprise. There are some students that put the focus on the first part of the slogan, i.e. on answers, advances and commitment to a paradigmatic worldview. This school of thought dates back to T. Kuhn's influential *Structure of Scientific Revolutions*. Another tradition of thought, brilliantly exposed in K. Popper's *Logic of Scientific Discovery*, looks at the second part of the slogan and characterizes the entire scientific enterprise through questions, discoveries and criticism. If the emphasis is on answering the questions, the "transition from criticism to commitment marks the point where progress begins". On the contrary, if questioning the answers is felt crucial, "commitment is [...] an outright crime" (Lakatos, 1970: 92–93). A last approach worth mentioning here pays great attention to the understanding of the scientific *practice*, as opposed to slogans generalizing a certain view of the scientific *method* (Feyerabend, 1988).

Whatever the heart of the scientific enterprise, it is interesting to see Haisch's tool against the background of a specific subject, namely the research of the anomalous luminous phenomena sighted in the Hessdalen valley in Norway for some years.

Does the Hessdalen Research Suffer More from a Shortage of Answers or Questions?

Since 1981, unidentified lights have been sighted by Hessdalen inhabitants and researchers. Many scientific attempts at discovering the nature of these lights have been carried out. Visual and instrumental data have been amassed, mostly by Norwegian and Italian researchers, like M. Teodorani, who recently answered many questions concerning this subject (Teodorani, 2004). In Teodorani's contribution, he has stressed the importance of more advances in the Hessdalen research through more sophisticated instrumentation, and has expressly labelled this subject as the "Hessdalen phenomenon". Teodorani (2004) got some favourable reviews. According to a well-informed collector of anomalies, the Hessdalen research "certainly represents the most thorough, science-based study of what are generally called 'nocturnal lights'" and "the Hessdalen phenomenon [...] is supported by what seems to be a mountain of solid scientific work" (Corliss, 2004). The web site of the laudable civil private organization called the National Aviation Reporting Center on Anomalous Phenomena (NARCAP) labels Teodorani (2004) as "probably [...] the most thorough instrument-based examination of any suspected UAP [Unidentified Aerial Phenomena]" (NARCAP, 2004).

In this paper, a different viewpoint will be presented. What if the Hessdalen phenomena (as opposed to a "Hessdalen phenomenon") are worthy of study *notwithstanding* the evidence discussed by Teodorani (2004)? Do we really need at present to make advances on the Hessdalen lights research? Or, rather, do we need to question the hasty answers given so far?

The Hessdalen Lights

The Hessdalen valley is in central Norway, southeast of Trondheim and near the Swedish border (Dalsbygda, 1992; Haltdalen, 1995). From November 1981 onward, a series of unidentified lights has been reported by the residents of the valley.[i] According to the sighting reports, the lights were seen hovering or moving around at various speeds. They were reported to be just above the roofs of the houses, just above the ground, or high up in the air. The lights appeared to have different specific forms. The colours were mostly white, or yellow-white.

They occurred several times a day, but mostly during the evening or nighttime, and especially in wintertime (Strand, 1985).

The *Project Hessdalen*

In June 1983, a small group with five participants set up a "Project Hessdalen", under the directorship of Leif Havik, Odd-Gunnar Røed, Erling Strand, Håken Ekstrand and Jan Fjellander. This group secured technical assistance from the Norwegian Defense Research Establishment, the Universities of Oslo and the University of Bergen. The project involved three stations with observers and their cameras (some fitted with gratings); a spectrum analyser; an infrared viewer; a seismograph; a Geiger counter; a magnetograph; and a laser. Field operations at Hessdalen started on January 21 and ended on February 26, 1984 (Strand, 1985).

Project Hessdalen carried on further field work in the area during the winters of 1985 (Hynek, 1985) and 1986. The series of sightings allegedly ended in 1986. While photographic, spectrographic and radar data had been collected, Project Hessdalen did not find a definite answer, and investigators disagreed on the nature of the phenomenon. According to Røed, though the lights "seemed intelligent in their movements", they probably had some "complex" natural cause. On the contrary, Strand remarked that "if the lights were natural, it's strange that they existed for a five-year period and that they were recorded in Hessdalen and nowhere else" (Clark, 1998: 486). Further studies and field works by other private researchers were carried on. As a result of these efforts, several sightings were explained as misperceptions of astronomical bodies and planes (Henke, 1987). Others turned out to be due to temperature variations in air levels causing the refractions of distant light sources (Devereux, 1989; Krogh, 1985). Notwithstanding this, a "residue" of reports of "unidentifiable" lights was left (Devereux, 1989). While no longer reaching the "peaks" of activity that occurred between 1982 and 1984, sightings of unidentified lights have been reported in the following years to some extent. Allegedly, the rate of observations is now about 20 reports per year (Sturrock, 1999; Sturrock et al., 1998).

To face this scientific "anomaly", in August 1998, two assistant professors at Østfold College (Sarpsborg, Norway)—Erling Strand (former co-founder of Project Hessdalen), School of Computer Science, and Bjørn Gitle Hauge, Department of Engineering and Natural Sciences—set up at Hessdalen a permanent Automatic Measurement Station (AMS) aimed at constantly monitoring the west side of the valley by means of automatic videocameras (Strand, 2002).

The Italian Committee for Project Hessdalen

In August 2000 and 2001 a team of Italian physicists, astronomers, engineers and technicians, jointly with the Østfold College researchers, carried out a set of measurements at Hessdalen both in the radio and in the optical wavelengths; this study was code-named EMBLA Project (Hauge, 2001; Teodorani et al., 2000, 2001). Although some members of the Italian team work at the Italian National Research Council, Institute of Radioastronomy (CNR-IRA), Bologna, Italy, they were not officially charged by the CNR with this task. Thus, the missions required a different source of financial support. This issue was solved through an ad-hoc civilian fund-raising committee established in July 2000. This committee, called the Italian Committee for Project Hessdalen (CIPH), is a volunteers' association, headed by Renzo Cabassi, whose aim is the promotion of the scientific study of Hessdalen-like phenomena (CIPH, 2002). Both the 2000 and 2001 EMBLA missions were funded by CIPH and headed by Teodorani.

The EMBLA Missions

The first EMBLA mission was carried out in August 2000. As a result of this first radio-optical survey, Teodorani et al. (2000) wrote that "without any sort of doubt unstructured and plasma-like lights often co-exist with 'structured objects'". During the mission a peculiar "blinking light", classed as "Type 1", was frequently seen (Teodorani et al., 2000: 9–10).

This same peculiar light showed itself the following year as well. In August 2001, during the EMBLA 2001 mission, "the very most part of the targets was due to very intense 'blinking lights', which were mostly seen from Aspåskjolen towards the South direction. These light-phenomena lasted from 5 up to 60 seconds. The blink was always irregular" (Teodorani et al., 2001: 16). According to Teodorani et al. (2001): "1) the luminous phenomenon is a thermal plasma; 2) the light-balls are not single objects but are constituted of many small components which are casually vibrating around a common barycentre; 3) the light-balls are able to eject smaller light-balls; 4) the light-balls change shape all the time; 5) the luminosity increase of the light balls is due to the increase of the radiating area" (p. 1). During a workshop at Hessdalen, Teodorani (2002) openly stated that "the approximately globular shape of the plasmoids is due to a sort of 'central force' which simulates gravity and which gives the plasmoids the shape of a 'mini-star'. [...] There is no doubt from the recorded data, that the phenomenon shows characteristics of self-regulation from an energetic point of view, and so far it is not possible to identify a mechanism of natural origin which is able to act spontaneously with such a surprising efficiency".

In the period August 5–18, 2002, a third optical EMBLA mission to Hessdalen was carried out. As in former years, the mission was headed by Teodorani. However, unlike the former missions, EMBLA 2002 was only partly funded by CIPH due to disagreements on the issue of the methodology of data collection and analysis accomplished during the previous years.

In August 2002 the author of this paper was charged by CIPH to collect sighting reports by the residents in the valley and to evaluate the methodologies of data collection carried out at Hessdalen by the Italian-Norwegian team of researchers during the EMBLA 2002 survey. CIPH field investigations at Hessdalen got under way on August 1 and ended on August 8, 2002.

Eyewitness Evidence

During the week-long stay at Hessdalen, this author had two chances to see an almost motionless and point-like light-phenomenon jointly with the whole EMBLA 2002 team. The first sighting happened at about 2150Z, August 6; the second one at 2105Z, August 7 (Leone, 2003a,b).

While the EMBLA team observed the light with the naked eye or through the objective lens of a reflex camera, this author observed it with the naked eye and (on one occasion) through a portable refractor telescope (Stein Optik, 60 mm diameter, 30–90× magnification).

At the observation point, the EMBLA team's expectations—arising from previous years' observations—were that the light had to appear low on the horizon toward a southerly placed "saddle", apparently between two high peaks. Each time this specific light showed itself, the EMBLA team jumped up excitedly, calling the observers' attention toward the bright, stationary, point-like luminous phenomenon. No confusion of optical stimuli was possible since this specific light was the only relevant source of light at that particular azimuth and angular elevation. After the first sighting reported by Leone (2150Z, August 6), this author pointed the refractor telescope at the expected angular coordinates. When the light appeared the second time (2105Z, August 7), the EMBLA team shot photographs and collected a spectrum (Teodorani, 2004: 226). At the same time, this author looked at this light through the refractor telescope and easily identified it as *a pair of car headlamps.*

The CIPH field investigation ended the morning following this identification and therefore no time was left for any attempts at photographing the light.

The EMBLA 2002 Report

On October 9, 2002, Teodorani published a paper titled "EMBLA 2002—An Optical and Ground Survey in Hessdalen" (Teodorani & Nobili, 2002).

According to Teodorani, "*only the pictures of a blinking light seen towards south from the Aspåskjolen spot, were confirmed to be due to the ''Hessdalen Phenomenon'' and therefore were considered for analysis*" (Teodorani & Nobili, 2002, pp. 2–3). This light was the very same blinking light sighted by this author, jointly with the EMBLA team, on August 6 and 7.[ii]

Though this author had duly informed Teodorani that the blinking light was positively identified as a couple of vehicle headlamps, the EMBLA 2002 report fails to address this identification. On the contrary, according to the report, upon the basis of photometric and spectroscopic evidence, the luminous phenomenon observed and photographed in August 2002 emitted "a power of the order of 100 kW"; its increase in luminosity was caused "by many lights-spheroids surrounding an initial 'light-seed'"; it hovered "tens of meters over the top of the hills" (Teodorani & Nobili, 2002: 17).

In summing up for the *Journal of Scientific Exploration* the results of the 2000–2002 surveys, Teodorani somewhat lowered his estimates and remarked that "the phenomenon's radiant power varies, reaching values up to 19 kW". These changes would be allegedly caused by "sudden surface variations of the illuminated area owing to the appearance of clusters of light balls that behave in a thermally self-regulated way" (Teodorani, 2004: 217). Teodorani concluded that some of the observations can be explained by an electrochemical model for the ball-lightning phenomenon (Turner 1998, 2003).

As the results reported by Teodorani & Nobili (2002) and by Teodorani (2004) are in glaring contradiction with the visual sightings experienced by this author, a discussion of the evidence collected during the EMBLA 2002 optical survey is in order.

Linear and Angular Image Measurements

Most of the optical evidence discussed by Teodorani (2004) concerns data collected during the August 2002 survey. As reported above, the survey concluded that *only the pictures of a blinking light seen towards the south from the Aspåskjolen spot* were due to the "Hessdalen Phenomenon" (Teodorani & Nobili, 2002: 2). For a photograph of this light, see Figure 1.

The "Aspåskjolen" observation point was a grass field (Long.: 11°10′53″ East; Lat.: 62°50′16″ North; altitude: 690 m) in the northern Hessdalen valley, on the right side of a country road connecting Hessdalskjølen (along the main road FV576) to Åsbardet (Haltdalen, 1995; Hessdalskjølen, 1995). See the observation point in Figure 2.

Neither Teodorani (2004) nor Teodorani & Nobili (2002) give any detail on the apparent position of the "blinking light".

As from the CIPH field investigation, the "blinking light" appeared, by perspective, between two high peaks in the southern landscape: Hessjøhøgda (Long.: 11°08′21″ East; Lat.: 62°41′47″ North; altitude: 1057 m) and Nyvollhøgda (Long.: 11°10′32″ East; Lat.: 62°40′29″ North; altitude: 1044 m) (Dalsbygda, 1992).

Through a set of linear and angular measurements of a positive color print of a southern landscape photograph and through the linear measurements of the light's image on the enlarged frames published in the EMBLA 2002 paper (Teodorani & Nobili, 2002: 4), it was possible to estimate the horizontal and vertical angles of the luminous phenomenon with respect to the top of the mountains. Through these measurements, the following estimates were obtained: azimuth $= 185.1° \pm 0.4°$; angular elevation $= +0.3° \pm 0.4°$.[iii]

Important data on the distance of the source of light can be inferred through a geometrical analysis of the whole set of frames reported by Teodorani & Nobili (2002: 4). Each frame shows that the light is *always apparently placed*

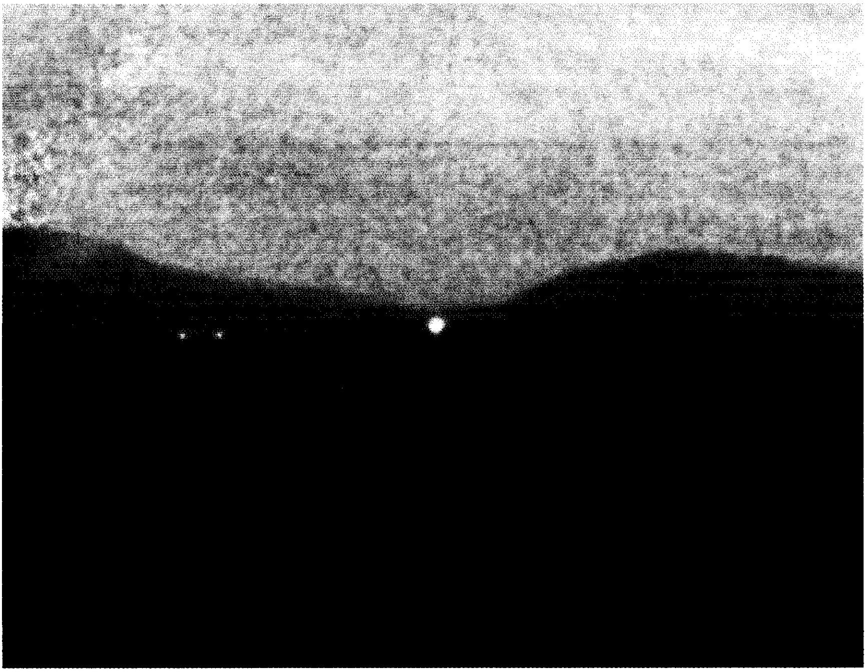


Fig. 1. An example of "correct light phenomenon" according to the EMBLA team. This photograph was shot from the Aspåskjolen spot in August 2002. The angular position of the light is the same as in the frames published in the EMBLA 2002 report (© CIPH, Hessdalen 2002).

slightly over the Heggsethødga hill in the foreground. As shown by Leone (2003b), the apparent light's angular elevation is constant independently of its apparently variable azimuth. Furthermore, it appears that the apparent position of the light does not change the expected ratio with respect to other features of the landscape visible in the frames. According to Teodorani the light was hovering over the (Heggsethødga hill) trees in the foreground (Teodorani & Nobili, 2002: 3). However, should the light be placed over the Heggsethødga hill, a "real" displacement of the light on the ridge would lead to an equal "apparent" displacement with respect to the background mountains.

The measurements of the frames demonstrate that this is not what happened. Thus, the light was likely placed behind the Heggsethødga ridge, i.e. on the *Løbergsvollen-Heggsetvollen* hill.

Site Visit Results and Analysis of the Topographical Charts

Although the ground is mainly covered by forests and seldom cultivated areas, and there are no inhabited houses along the line of sight, the analysis of the topographical charts shows that at least a country road crosses the

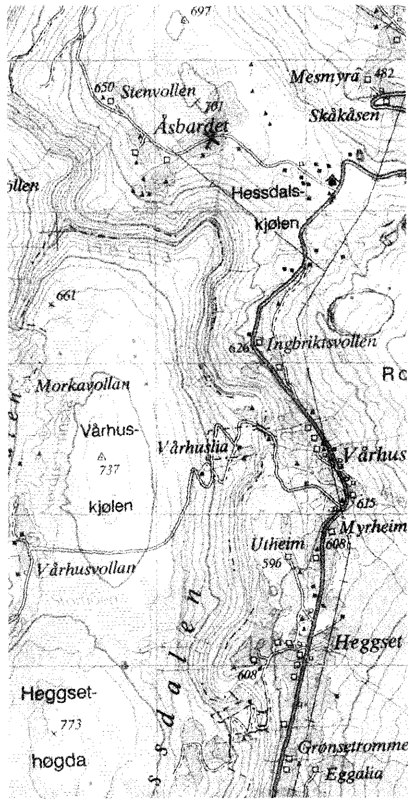
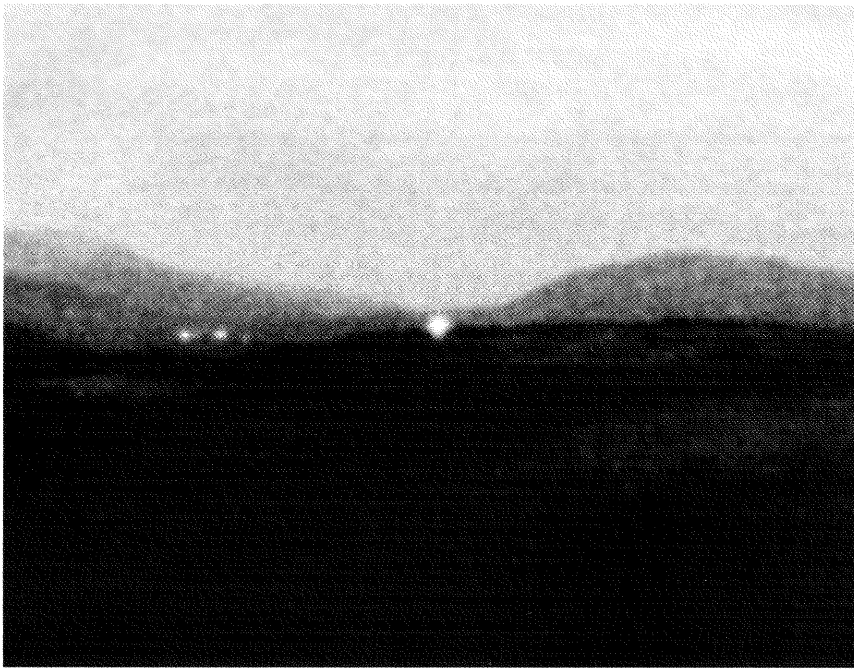


Fig. 2. Northern Hessdalen valley. The cross marks the observation point (Haltdalen, 1995).

Løbergsvollen-Heggsetvollen hill (in this corner of Norway there are many low-traffic private toll-roads which are open to transit upon the paying of a toll to meet road maintenance expenses by the owners of the lands). It is a private road joining the Hessjøen lake (720 m in altitude) to the FV576 country road (which crosses, in a south-north orientation, the whole Hessdalen valley) close to Fjellheim. To locate this country road in the 1:50 000 Hessdalen valley charts (Dalsbygda, 1995), the standard reference is: 32VPQ103579 (see Figure 3). This road (760 m in altitude) is about 11 500 m south of Aspåskjolen and enjoys an unobstructed view from the observation point. Furthermore, it points toward the observation point, according to a roughly south-north fashion. Its angular coordinates from the Aspåskjolen viewpoint are as follows: azimuth = 185.2° ± 0.3°; angular elevation = 0.3° ± 0.1° (the error on the azimuth is mainly due to the actual position of the observation point, while the error on the angular elevation is given by the length of the road). This road's position shows an excellent agreement, within the measurement error, with the "blinking light" position reported above.[iv]



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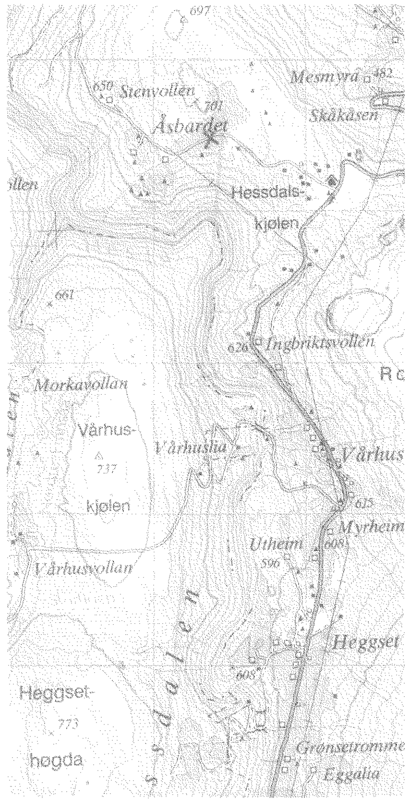

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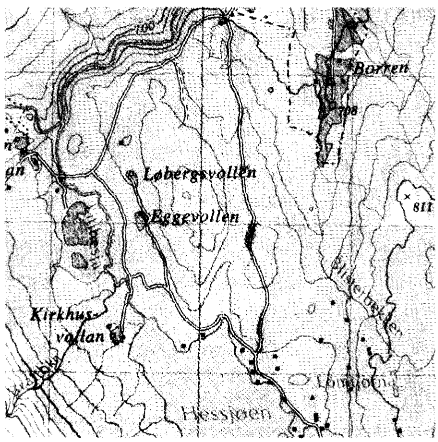

Fig. 3. The Løbergsvollen-Heggsetvollen hill in the southern Hessdalen valley. On the right side of the hill, the private road joining the Hessjøen lake to the FV576 country road on a roughly south-north course is clearly visible (Dalsbygda, 1992).

Photometric Evidence

Teodorani (2004: 249–250) obtained an absolute power of the light phenomenon of 18.8 kW, as opposed to the former 100 kW figure (Teodorani & Nobili, 2002). This value was derived out of a photometric equation suggested by Maccabee (1979, 1999):

$$P = 4\pi d^2 \frac{E}{\tau \frac{\pi}{4}\left(\frac{F}{f}\right)^2 T} e^{\frac{3.9d}{V}} \tag{1}$$

In order to arrive at this absolute radiant power estimate Teodorani analysed a slide that he took in Hessdalen (Teodorani, 2004: 228). Such a slide was passed to a scanner, and the image of interest was resized (image interpolation) and then transformed into a black and white frame (using Adobe Photoshop version 5.5 software). Using Iris software, the counts and the 2-D intensity distribution of any single component of the light cluster were measured. After determining the saturation level and ascertaining that there was no substantial over-exposure, the counts were scaled with the exposure parameter deduced from the Density–Log (Exposure) characteristic curve for the specific Kodak film (Teodorani, 2004: 250). Quantities, symbols and estimates reported by Teodorani are listed in Table 1.

According to Teodorani, this 18.8 kW absolute power estimate would lead to a figure 60 times higher than the luminous power emitted by a "known streetlight" of known distance which was present in the same slide (Teodorani, 2004: 250). Although the photometric Equation 1 used by Teodorani is correct in itself, his methodology is flawed by an unlikely assumption. Apart from a minor

TABLE 1
Parameters of the Photometrical Equation (Equation 1)

Absolute radiant power	P	18.8 kW
Distance[a]	d	$9{\cdot}10^3$ *m*
Total energy received by the film[b]	E	$3.4{\cdot}10^{-5}$ *lm s*
Exposure time[c]	τ	5 s
Focal length	F	0.27 *m*
f-number	f	2.8
Lens transmission factor	T	0.9
Visibility	V	$1.5{\cdot}10^4$ *m*

[a] This distance value was obtained through an alleged triangulation carried out in August 2002. Since no details on this topic are reported by Teodorani (2004: 234), it is not possible to cross-check the accomplished methodology and the reliability of the figure.

[b] The total energy received by the film was obtained by multiplying the average film exposure level (8.8 $lm{\cdot}s/m^2$) and the image area ($3.9{\cdot}10^{-6}m^2$).

[c] It is fair to remember that Teodorani did not time the duration of the phenomenon. On the unreliability of this estimate, see Leone (2003b: 18).

calculation mistake (the value quoted by Teodorani and reported in Table 1 led to $P = 16.3$ kW), Teodorani assumed in fact that the stationary light was an isotropic radiator (4π). No evidence allows such a conjecture. The EMBLA video and photographs do not support the isotropic radiator assumption since they are shot from one single point of view and their resolution is much too low to resolve the nature of the source of light. In spite of the above-quoted flaw, Teodorani's treatment deserves to be praised since he carefully lists the values of each parameter included in the photometrical equation. This healthy procedure allows us to check the employed methodology as well as to suggest—should it be necessary—alternative interpretations of the physical data. In particular, it is interesting to see what happens if we let the 4π assumption drop.

By writing Equation 1 as $P = 4\pi I$, where I is the luminous intensity ($lm/sr =$ cd), and by letting:

- $A = (\pi/4){\cdot}(F/f)^2$, where A is the area of the lens aperture (m^2), F is the focal length (m) and f is the f-number,
- $E = H{\cdot}A_i$, where E is the photometric energy deposited within the boundary of the image ($lm{\cdot}s$), H is the average film exposure level ($lm{\cdot}s/m^2$) and A_i is the image area (m^2),
- $b = 3.9/V$, where b is the atmospheric extinction (m^{-1}) and V is the visibility (m), one gets the following formula:

$$I = \frac{H{\cdot}A_i{\cdot}d^2{\cdot}e^{bd}}{\tau{\cdot}A{\cdot}T} \tag{2}$$

i.e. the very same equation used by Leone in his previous analysis of the EMBLA survey (2003b: 19, equation 5). As was written by Maccabee (1987: 265), this formula "can be found by inverting standard photometric equations which give the image exposure in terms of source intensity". By introducing in

Equation 2 the parameter values reported by Teodorani himself, it is possible to get an estimate of *luminous intensity*. While following from Equation 1, Equation 2 does not require the groundless 4π assumption.

The visibility V—or visual range—quantity in Equations 1 and 2 follows from Equation 3 when the standard value of 0.02 for the threshold of brightness contrast ε is used:

$$V = \frac{1}{b}\ln\left(\frac{1}{\varepsilon}\right) = \frac{3.912}{b} \tag{3}$$

However, in the derivation of the visual range, it was assumed that a black object was viewed against a uniformly illuminated horizon sky (Johnson, 1954: 80). This condition is hardly applicable in the case of the photograph shot by the EMBLA team, where a bright point-like source of light was photographed at night.

The source of the visibility value reported by Teodorani (15 km), is unclear; however, granted that this value is reliable, *the visual range at night for light is not independent of the luminous intensity* and therefore has to be extrapolated from the available experimental data. In 1935, M.G. Bennett carried out a set of empirical studies to establish the relationship between the visual range at night as estimated from lights of varying candlepower and the visual range during the day (Bennett, 1935, as cited in Johnson, 1954: 98).

If a luminous intensity of 10^5 cd (order of magnitude) is considered, it turns out that the visual range at night should be 1.5 to 2.5 times higher than the corresponding daytime visibility (extrapolated from Bennett, 1935). Letting $V =$ 15 km, the visual range at night D to be inserted in Equation 2 will be taken as a factor of 2 greater, i.e. the average 30 km figure. By inserting the parameter values into Equation 2, the equation yields:

$$I = \frac{3.4 \cdot 10^{-5} lm \cdot s \cdot (1.15 \cdot 10^4 m)^2 e^{\frac{3.9 \cdot 1.15 \cdot 10^4 m}{3 \cdot 10^4 m}}}{5s \cdot 7.3 \cdot 10^{-3} m^2 \cdot 0.9} = 6.1 \cdot 10^5 \text{ cd} \tag{4}$$

This value of luminous intensity is a necessary consequence of both Teodorani's equation (Equation 1) and Teodorani's parameters (the only exception is the estimated distance as, in order to be consistent with the road hypothesis, the value of d in the above equation is set equal to 11 500 m, rather than 9000 m). However, this value of luminous intensity is affected by a large uncertainty. The value of visual range, V, is very uncertain; it could be larger than 30 km. The exact exposure level, HA_i is also uncertain; it could be less than $3.4 \cdot 10^{-5}$ $lm \cdot s$. The exposure time, τ, is perhaps the most uncertain quantity as no time measurements were carried out by Teodorani. Thus, the calculated intensity could be in error by 50% or more. As an example, even by letting a conservative 25% error upon HA_i and V, by letting a reasonable 50% error upon τ (i.e. $5 \pm 2.5\ s$), by neglecting the uncertainties of the other quantities, and by estimating the propagation of errors:

$$\sigma_I = \sqrt{\left(\frac{\partial I}{\partial V}\right)^2 \sigma_V^2 + \left(\frac{\partial I}{\partial HA_i}\right)^2 \sigma_{HAi}^2 + \left(\frac{\partial I}{\partial \tau}\right)^2 \sigma_\tau^2},$$

one gets that the luminous intensity could be in error of $4.1 \cdot 10^5$ cd, i.e. the luminous intensity should be estimated as:

$$I = (6.1 \pm 4.1) \cdot 10^5 \text{ cd}$$

What remains to be ascertained is whether this value is consistent with the vehicle headlamps hypothesis suggested by the eyewitness experience of this author and by the topographical data.

Motor vehicle headlamp illumination is regulated in Europe by rigid international regulations issued by the United Nations Economic Commission for Europe. These regulations fix the maximum luminous intensity I_M for vehicle headlamps (ECE Regulation, 2002: 18), as follows:

$$I_M = 2.25 \cdot 10^5 \text{ cd}$$

Comparing the maximum luminous intensity with the estimated value obtained out of the formula used by Teodorani, using the very same parameter figures (with the cautions as above), results in a strong corroboration of the headlamps hypothesis. The discrepancy between the expected maximum luminous intensity and the experimental figure is within the error associated with this measurement, as calculated above. Thus, if the gratuitous isotropic radiator assumption is discarded, a self-consistent hypothesis, involving unrecognised vehicle headlamps, emerges.

Spectroscopic Evidence

A spectrum of a "Hessdalen light phenomenon" obtained with an ROS grating (lent by the CIPH committee) connected to a Praktika BX-20 reflex camera equipped with a 270 mm lens, using Kodak Ektachrome 100 ASA film, is published by Teodorani (2004: 226). According to his 2002 report, "the spectrum [. . .] appears as a continuum spectrum with no resolved lines, and shows to be constituted by two big peaks at 5750 and 6600 Å [editor's note: i.e. 575 nm and 660 nm] and one much smaller double peak at 4500 Å [editor's note: i.e. 450 nm]" (Teodorani & Nobili, 2002: 10–11). The shape of the spectrum collected by Teodorani is shown in Figure 4.

Teodorani (2004: 227) put forward the hypothesis that "the lights are actually uniformly illuminated solid objects". Thus, "the observed narrow peaks (typically $\Delta\lambda = 400$–500 Å [editor's note: i.e. 40–50 nm]) mostly coincide with those produced by three kinds of light-emitting diode (LED) illuminations systems. [. . .] The peak at 4400 K resembles that of a red LED light of the types

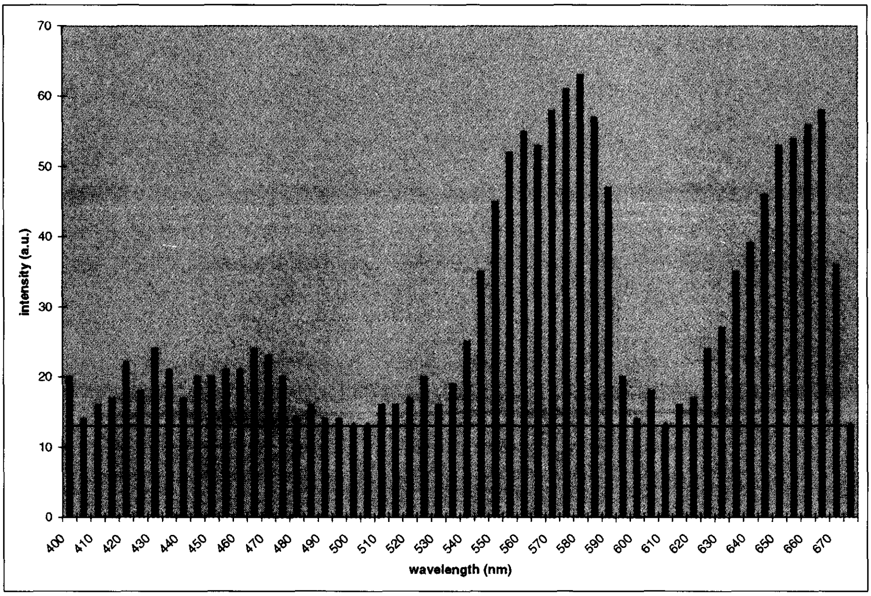

Fig. 4. EMBLA experimental spectrum. The blue line indicates the noise level.

QDDH68002, L3882, L-793SRC-E and QDDH66002; the peak at 5100 K is slightly red-shifted with respect to the one produced by an amber-yellow LED light of the types HLMP-DL32 and LY5436; and the (weak) peak at 6300 K [resembles] a blue LED light of the type HLMP-CB31. Under this interpretation, the Hessdalen lights may be the combination of three different LED-like lights" (Teodorani, 2004: 227–228).

This "hypothesis" immediately calls forth an obvious question: do we really need an ad-hoc choice of LED lights emitted by an alleged illuminated solid object to explain the spectrum collected by the EMBLA team?[v] Given the evidence discussed in the previous chapters, it is fair to carry out an analysis of the vehicle headlamps hypothesis, also in relation to the spectroscopic evidence.

In Figure 5, a typical spectrum of an incandescent lamp, i.e. the expected vehicle headlamp spectrum, is represented. As is evident, the spectral distribution of light from incandescent lamps is continuous and follows a blackbody distribution very closely. While there are no emission lines or bands, most of the emission in the range between 400 and 700 nm is at high wavelengths, in analogy with the spectrum obtained by the EMBLA team (Figure 4).

The relative intensity plotted in Figure 5 is expressed by the blackbody irradiance $E_{\lambda,T}$, according to the Planck law:

$$E_{\lambda,T} = \frac{2\pi hc^2}{\lambda^5} \frac{1}{\left(e^{\frac{hc}{\lambda kT}} - 1\right)} \tag{5}$$

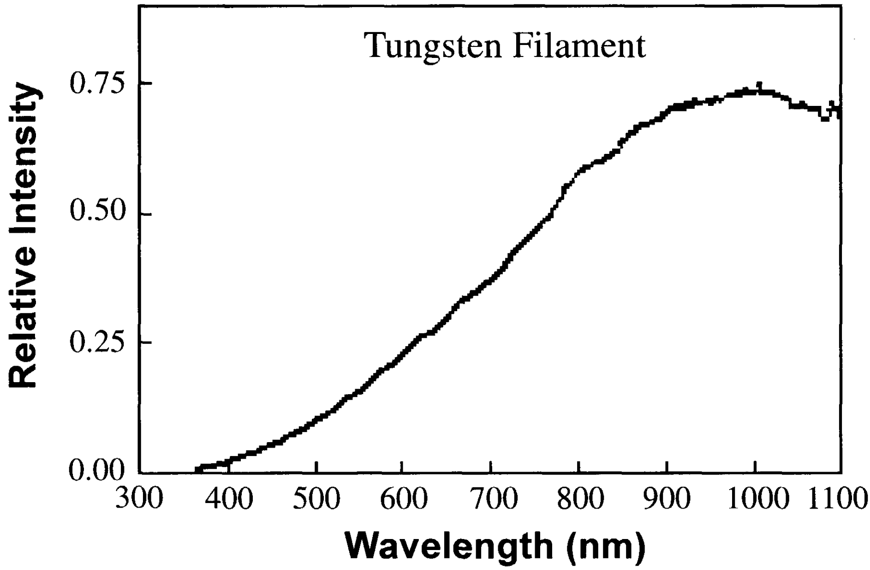

Fig. 5. Spectrum of a tungsten filament within a white light bulb (Rechtsteiner & Ganske, 1998).

where h is Planck's constant ($6.63 \cdot 10^{-34}$ J s), k is Boltzmann's constant ($1.38 \cdot 10^{-23}$ $J \cdot K^{-1}$), c is the speed of light ($3 \cdot 10^{8}$ $m \cdot s^{-1}$), λ is the wavelength and T is the absolute temperature. Thus, in the visual range the spectrum of a blackbody radiator at 3200 K—corresponding to a typical halogen headlamp (OSRAM Sylvania, 2000)—is roughly rectilinear (see Figure 5 in the 400–700 nm interval).

Although the high wavelength emission of a headlamps-like incandescent source of light agrees with the general spectroscopic result of the EMBLA optical survey, the "anomalous" issue of the "peaks" at 660, 575 and 450 nm is yet to be settled. This issue requires us to consider both the source of light and the measurement system, i.e. the photographic film. The reflex camera used to take the Hessdalen spectrum indeed used a film (Kodak Ektachrome 100) whose curve of spectral sensitivity, far from being flat in the range between 400 and 700 nm, has three spectral sensitivity curves—one each for the red-sensitive (cyan-dye forming), the green-sensitive (magenta-dye forming) and the blue-sensitive (yellow-dye forming) emulsion layers (Figure 6).[vi]

In order to establish if the light witnessed by the EMBLA team was actually emitted by vehicle headlamps (as experienced by this author, in agreement with the topographical and photometrical data) it is necessary to compute the effective power per unit area collected by the photographic film under this hypothesis. The power per unit area is obtained by multiplying the blackbody irradiance values of a typical 3200 K halogen headlamp light (through Planck's

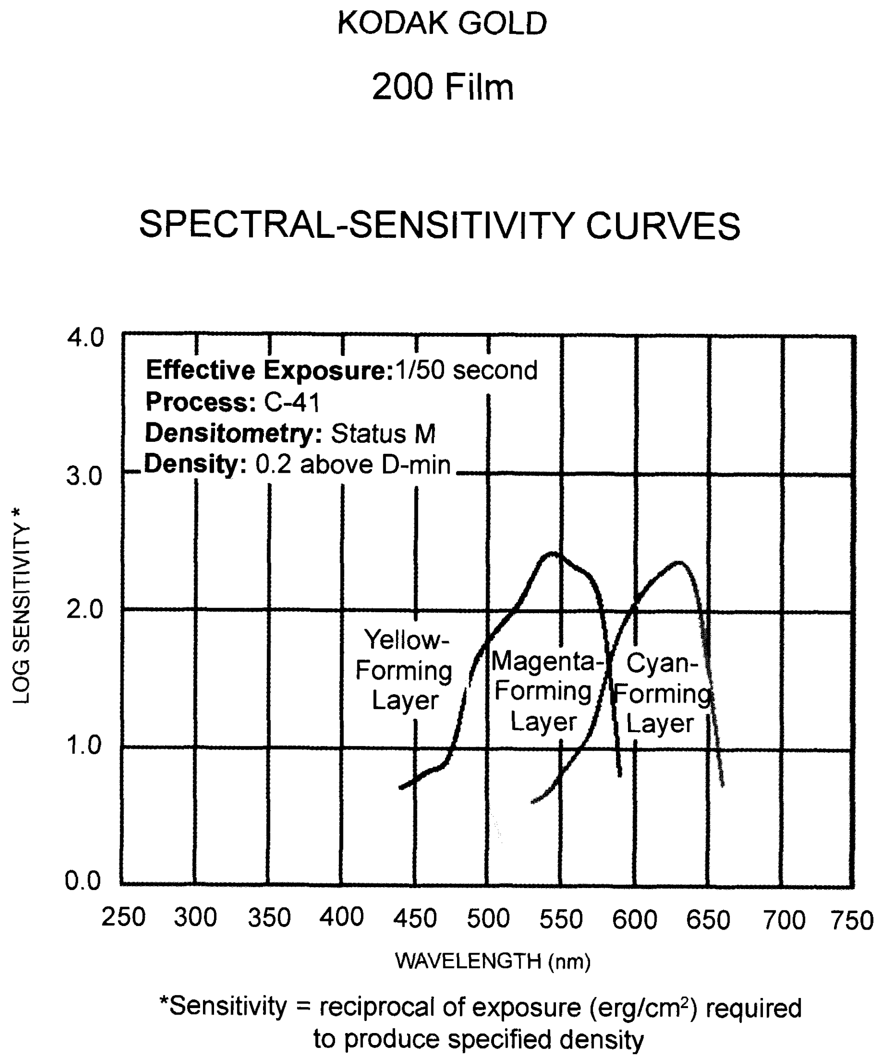

Fig. 6. Spectral-sensibility curves of the color film used by the EMBLA team (source: KODAK EKTACHROME 100 Professional Film, 2002). The data are derived by exposing the film to calibrated bands of radiation 10 nm wide throughout the spectrum, and the sensitivity is expressed as the reciprocal of the exposure (erg/cm^2) required to produce a specified density. The radiation expressed in nm is plotted on the horizontal axis, and the logarithm of sensitivity is plotted on the vertical axis to produce a spectral-sensitivity curve (Eastman Kodak, 1997).

law) and the spectral sensitivities of the yellow, magenta and cyan forming layers of the Ektachrome 100 film.

In Figure 7 are plotted the theoretical spectrum, under the vehicle headlamp hypothesis, and the experimental spectrum collected by Teodorani

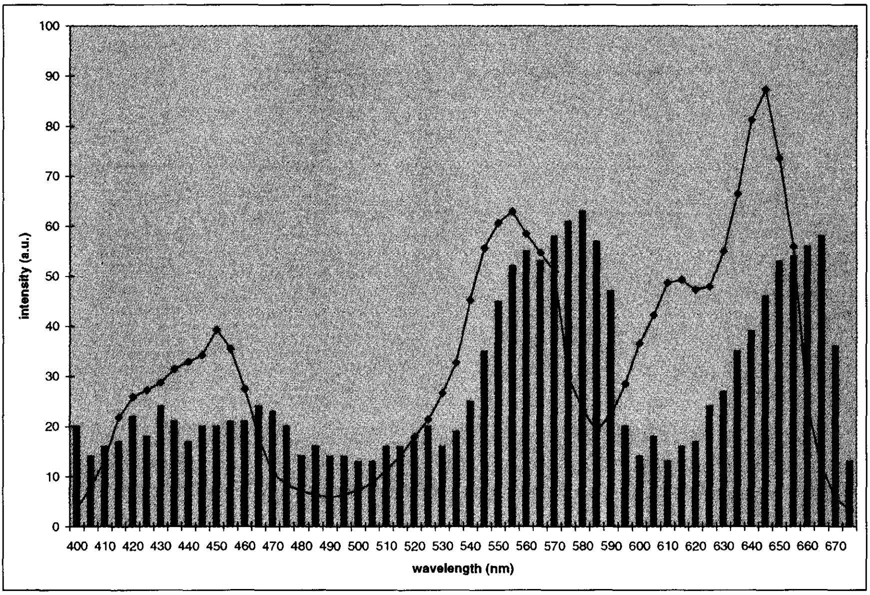

Fig. 7. EMBLA experimental spectrum (histogram) vs. theoretical spectrum (line).

(2004: 226). As is evident, the theoretical spectrum closely matches the experimental one.[vii]

In order to quantitatively test the car headlamps explanation, this author attempted a first statistical analysis of the EMBLA experimental spectrum vs. the theoretical one through an estimate of the nonparametric Spearman rank correlation coefficient (Galeotti, 1983; Siegel & Castellan, 1992).

Since no raw data were available, linear measurements of EMBLA spectrum intensity and Kodak film sensitivity plots were carried out at 5 nm intervals (as shown in Figure 7). The EMBLA values were multiplied by the reverse of the film spectral sensitivity. This step was necessary in order to get two *independent* spectra: the theoretical one emitted by a halogen light (Figure 5) and the experimental one emitted by the Hessdalen light. Each intensity value of both spectra was ranked from 1 to n according to its magnitude (where n is the sample size, i.e. the number of classes in which the spectrum was divided). As a final step, the Spearman correlation coefficient r between the two spectra was computed:

$$r = 1 - \frac{6\sum d^2}{n(n^2 - 1)} \tag{6}$$

where d is the difference in rank. This parameter is calculated as a difference between a couple of ranks at each wavelength value (Holl, 1990; Siegel & Castellan, 1992).

The correlation between the EMBLA experimental spectrum and the expected headlamp theoretical spectrum was significant at the .01 level ($r = 0.383$; sample size = 50). However, Figure 7 shows that the spectroscopic data collected by Teodorani are very close to the noise level in several ranges of wavelength (λ < 415 nm; 480 nm < λ < 535 nm; 600 nm < λ < 620 nm). Should only the classes out of these ranges be considered, the rank coefficient would be significant at the .001 level ($r = 0.730$; sample size = 33). These results show a fairly strong relationship between the data series (for full details see Leone, 2003b).

Further support for the headlamp hypothesis might come from a reliable explanation of an anomaly observed in the EMBLA experimental data, i.e. the apparent 20 nm wavelength shift toward the red edge (Figure 7). This anomaly is presently being studied by the CIPH consultants (e.g. Moroni, 2004); however, no unequivocal explanation has surfaced so far. This outcome is partly rooted in the unclear experimental choices by the EMBLA physics team. As an example, according to the Kodak Ektachrome 100 technical sheet concerning the adjustments for long and short exposures, significant color shifts and contrast mismatch are possible consequences of exposure longer than 1 second (KODAK EKTACHROME 100 Professional Film, 2002). In spite of Kodak's advice, the EMBLA physics team made use of alleged average exposures close to 5 seconds.

The Case against Hessdalen Lights

In the section "Observational evidence, possible interpretations, and open questions", Teodorani (2004) states having ascertained some phenomenological features of the Hessdalen phenomenon by "combining the data acquired in the first phase (Norwegian measurements) with those from the second phase (the three EMBLA investigations)". This "combining" procedure is legitimate provided that it is beyond doubt that the two sets of data concern the same phenomenon and can therefore be summed up. This assumption is accepted by Teodorani (2004: 240–241) without a proper discussion.

The quantitative data obtained through the EMBLA surveys would be as follows: appearance of the lights "several tens of meters over the top of the hills" (Teodorani, 2004: 240); shape of the light intensity different from what is "expected from a standard plasma" (Ibid.: 241); 19 kW maximum optical power (Ibid.: 241); appearance of a "cluster of light balls" (Ibid.: 242); "constant color-temperature" (Ibid.: 242); spectrum showing "three well-distinguished peaks about 500 Å [editor's note: i.e. 50 nm] wide" (Ibid.: 242). Further quantitative data concerns the analysis of a ground sample and alleged infrared signature and recording in the HF and VLF ranges of dubious relevance to the optical phenomenology.

The preceding sections show that the above conclusions are the outcome of both experimental and theoretical faults on the part of the EMBLA team.

Among the experimental shortcomings, a few are worth addressing here:

- No recording of the actual time/date of each sighting; no recording of reliable angular coordinates; no attempts at photographing the southerly placed blinking light (i.e. the only light confirmed to be due to the Hessdalen phenomenon by the EMBLA 2002 team) at closer range during the 3-year-long survey in spite of its constancy in angular position, its daily basis appearance, its evening-time behaviour, and an alleged triangulation.
- Bad choice of film: Kodak Ektachrome 100, whose three-peak sensitivity shape and color balance shift at long exposure times prevent the convenient collection of alleged anomalous light spectra. As is well known, an ordinary camera equipped with a transmission diffraction grating or a prism can be used to photograph a wide range of spectra. However, the collection of photographic spectra requires care in the choice of the film. As regards the astronomical spectra (i.e. point-like source of light, like the "Hessdalen lights"), "colour film is not worth the effort since the dominant spectral features in the image are due to the colour filters within the film: you don't get a smooth gradation in colour. Even with B&W film, you have to be careful with the rather rapid changes of sensitivity with wavelength *which show up as broad bands in the spectrum*" (Fosbury, 1999).
- Conspicuous lack of adequate observational tools (namely, a portable telescope) and measurement tools (like a theodolite for angular measurements).

The theoretical shortcomings are serious as well:

- Assumption of the three-peaks spectrum, without a discussion, as the actual spectrum of the Hessdalen lights rather than as an artifact of the measurement system; neglected role of the photographic film; ad-hoc choice of a three-LED source of light.
- Unsupported isotropic radiator assumption.
- Wrong inference from a constancy of spectral detected color-temperature (as expected under a vehicle headlamps hypothesis) and an almost linear counts-size relationship to an alleged "self-regulating mechanism" involving clusters of "satellite spheres" (Teodorani, 2004: 230). On this issue see Leone (2003a: 15).

The Case for Hessdalen Lights

As shown in the preceding sections, the answers given by the 3-year-long scientific survey carried out by the EMBLA Project are far from satisfying. When closely analysed, the whole of the optical evidence amounts to a single blinking light whose topographic, photometric and spectroscopic data are consistent with a vehicle headlamps explanation. This hypothesis is supported by the personal visual experience of this author. Does this outcome close the issue of the Hessdalen lights? Does questioning the hasty answers given by Teodorani (2004) authorize us to explain away the whole of the Hessdalen phenomena? To both of these questions my answers will be a firm and resounding "No!"

As a matter of fact, the argument for an unidentified aerial phenomenon in the Hessdalen valley rests on different kinds of evidence, like eyewitness testimony, photos and videos by the AMS and non-optical instrumental records. While a comprehensive review of the evidence collected so far is outside the aims of this paper, a brief discussion will follow.

Eyewitness Testimony

Though Teodorani is firmly convinced that the phenomena called "unidentified flying objects" are so elusive that a scientific analysis is impossible (e.g. Teodorani & Nobili, 2002: 16), the "Case Studies" of the "*Scientific Study of Unidentified Flying Objects*" conducted by the University of Colorado under research contract with the U.S. Air Force demonstrate that quite the opposite is true and that *eyewitness* sightings about unidentified phenomena are amenable to scientific research (Condon & Gillmor, 1969).

In summing up what constitutes scientific evidence, during a symposium on unidentified flying objects sponsored by the American Association for the Advancement of Science, MIT physicist Philip Morrison (1972) remarked that the "absence of humans in the data link is [not] the criterion for good evidence". While submitting that there are such criteria, he added that "from the point of view of drawing inferences about events, a witness is simply an extraordinary subtle and complex instrument of observation".

Unidentified flying object reports have been showed to pose a scientific problem for decades. A number of astronomers and physicists were able to expose this to the scientific community: among them are the astronomer and former U.S. Air Force "Project Blue Book" consultant J.A. Hynek (1969, 1972); the astrophysicist and computer scientist J.F. Vallee (1965, 1966); the atmospheric physicist J.E. McDonald (1967, 1972); and the CNES engineers C. Poher and A. Esterle (CNES, 1979–1983). This problem has to do with both psychology and physical science.

As regards the psychological side, it is well known that problems in perceiving events, retaining information in memory and retrieving information from memory are deeply rooted in eyewitness testimony (Loftus, 1979). Notwithstanding this, a number of phenomena of potential scientific interest, like transient luminous phenomena in the low atmosphere, are so unpredictable in their occurrence that the only sources of evidence are involuntary witnesses (Corliss, 1982). With the aim of treating the involuntary human observer as a source of scientific data, specific techniques have been developed by several psychologists with long-standing interest in the methodological problems of studying unidentified flying object reports (Haines, 1976, 1979, 1980; Shepard, 1968, 1979).

During the August 2002 on-site survey in the Hessdalen valley, the author of this paper and Flavio Gori had been collecting several sightings about unidentified lights and objects witnessed by valley inhabitants. While the body of anecdotal evidence collected so far by this author does not point at any specific constant of the alleged "Hessdalen phenomenon" as a whole, some eyewitness reports by the Hessdalen inhabitants still defy conventional explanation and require further in-depth analyses. To make use of the acronym coined by E.J. Ruppelt, former chief of U.S. Air Force's *Project Blue Book*, the reported phenomena are UFOs in the literal sense, i.e. Unidentified Flying Objects (Ruppelt, 1956).[viii] These investigations will be reported in a separate article.

Automatic Measurement Station

On September 30–October 3, 1997, a workshop was convened at the Pocantico Conference Center in Tarrytown, New York, in which a scientific review panel, composed of nine scientists of diverse expertise and interests, met with several investigators on UFO reports (Sturrock, 1999; Sturrock et al., 1998). The purpose of this four-day workshop was to review purported physical evidence associated with UFO reports, with a view to assessing whether the further acquisition and investigation of such evidence is likely to help solve the UFO problem, namely the determination of the cause or causes of these reports. The panel concluded that "it would be valuable to carefully evaluate UFO reports since, whenever there are unexplained observations, there is the possibility that scientists will learn something new by studying these observations" (Sturrock, 1999; Sturrock et al., 1998). During the workshop there was in addition a presentation (by Erling Strand) of investigations into recurrent phenomena that occur in the Hessdalen valley. As a result of this presentation, the panel concluded that there would be merit to designing and deploying a not-too-complicated set of instruments. These should be operated according to a strict protocol in regions where the probability of significant sightings appears to be reasonably high. It was recommended that, as a first step, a set of two separate video recorders be equipped with identical wide-angle objectives and installed on two distant fixed tripods to help eliminate the possibility that some of the apparent motions detected by video recorders were due to the operators' hand movements or ground vibrations. It would also be useful to set up two identical cameras, one of which is fitted with a grating. However, experience so far at Hessdalen indicates that a grating may not be adequate for obtaining spectroscopic information. In view of the great importance of spectroscopic data, it would be highly desirable that special equipment be developed and deployed for obtaining high-resolution spectroscopic data from transient moving sources. This may be a nontrivial problem (Sturrock, 1999: 80).

Following the Pocantico workshop, an automatic measurement station was installed in Hessdalen. As discussed in the Introduction, this station was developed and prepared by Erling Strand and Bjørn Gitle Hauge at Østfold College, which is the present base of Project Hessdalen. This station includes a wide-angle B/W CCD-type camera in the visible region (the output from the CCD-camera is fed automatically to a computer that triggers a video recorder) and a set of two color CCD-cameras aimed at triangulating the phenomenon (Strand, 2002). Whenever a sudden light shows up in the view of the CCD-camera, an alarm-picture is sent to the Project Hessdalen web site and the videorecorder is started and run for 15 seconds. Although the large body of alarms is due to easily identifiable sources of light, a few optical stimuli remain unexplained and deserve further attention (Strand, 2002).

These systems are an important step toward the full application of the Pocantico workshop recommendations. Special equipment for automatically collecting spectroscopic data from transient moving sources remains to be developed. This problem could be faced by importing methods and equipments from the field of "meteor spectroscopy" (Majden, 1998; Majden & Borovicka, 1998).

Non-Optical Instrumental Records

During the 1984 Project Hessdalen's field operations, a number of high-strangeness–high-probability[ix] visual sightings were corroborated by instrumental records (Strand, 1985). On February 12, the observers directed a laser beam (633 nm; power $= 0.4 \div 0.76$ mW) on passing lights. Out of a total of nine times, the light responded all but once in a curious way: according to the witnesses a slow-moving, regularly flashing light "changed its flashing sequence from a regular flashing light to a regular double flashing light" (Strand, 1985: 20). On February 27, a bright light was radar-tracked moving at 8500 m/s (the radar was an "Atlas 2000", $\lambda = 3$ cm). On another occasion an unidentified light under constant visual observation showed up on radar only on every second sweep of the radar dish. "But in most instances—33 in all—when radar showed something, the eye could see nothing, nor could the camera" (Clark, 1998: 485). Now and then "spike-like signals" in the radar range were detected by the researchers; however, "we did not see anything on the spectrum analyser at the same time we saw the lights" (Strand, 1985: 17).

So far most of the non-optical evidence collected during the EMBLA missions is uncorrelated with the alleged luminous phenomenon. As regards the "spike-like" signals, "no luminous phenomena could be reported while the personnel was controlling the monitors of the radio spectrometers" (Teodorani et al., 2000: 6). Concerning the radar recordings, an unidentified echo was detected in 2002; however, "it wasn't possible to see anything in the same point on the sky with binoculars and portable telescopes" (Montebugnoli et al., 2002: 29). Other interesting readings in the VLF range were carried out by Gori (2002). These recordings, also, were not correlated with visual sightings.

Conclusions

This analysis shows that the whole of the optical evidence reported by Teodorani (2004) is consistent with the car headlamps explanation. Several different pieces of evidence point to this conclusion: the "blinking light", upon observation through a portable refractor telescope by the author of this paper, turned out to be due to a pair of car headlights; the luminous phenomenon appeared in close proximity to a country road, whose angular coordinates (azimuth and angular elevation) from the observation's point agree with the "blinking light" coordinates; the light's luminous power output was consistent with the luminous emission by a hypothetical car moving on the above-mentioned country road; the light's spectrum was consistent with the spectrum emitted by a car headlight. This hypothesis is easily verifiable (or falsifiable) through a controlled experiment by means of a pair of car headlights.

It has been the intent of this paper to show that the EMBLA Project optical survey in Hessdalen was lacking both in the methodology of data collection and in the evaluation of the evidence. Notwithstanding this, the subject of the luminous phenomena observed in the Hessdalen valley deserves further attention. However, a continued effort into this subject is not likely to get reliable results unless a program of collection of eyewitness testimony and of intensive scientific surveillance for appearance of the alleged luminous phenomenon is set up. The information recorded during the 1984 field mission is suggestive but not conclusive, and researchers in the field of anomalous aerial phenomena need better phenomenological foundations. These foundations require a careful attention to both the methodology of collection of eyewitness testimony and the issue of "objective" evidence. As regards the first issue, it is absolutely necessary to follow some minimal guidelines to avoid the risks of leading the witness, misunderstanding his words, making wrong inferences from his testimony and so on. For several years, such guidelines have been followed by the most serious civilian groups[x] devoted to the study of unidentified flying object reports (Fowler, 1983; Randles, 1976; Russo, 1993; SOBEPS, 1979). The optical data collected by the Østfold College's AMS are a helpful contribution to the second issue, i.e. the intensive scientific surveillance of the valley. While the collected data still require an in-depth analysis to identify conventional stimuli, Strand and Hauge's station is an important step in the correct direction (Strand, 2002). As remarked at the Pocantico workshop, "this automatic station will hopefully prove to be but a first step in the development of a network of stations" (Sturrock, 1999: 80). The methodologies and tools employed by the EMBLA engineering team (Montebugnoli et al., 2002) could lead to interesting results as well, provided that the optical counterpart does not lead astray the focus of EMBLA missions as it has occurred in the questionable 2002 optical survey.

We have no answers to offer on the nature of the anomalous Hessdalen phenomena still defying a conventional explanation. Our only contribution confines itself to questioning—*à la Haisch*—some of the answers concerning an allegedly monolithic and indistinct "Hessdalen phenomenon". As shown above, these answers (optical power output, spectral fingerprint, etc.) were mostly based on wrong inferences from mundane stimuli. Most of the work concerning the *kernel*, the unexplained residue of Hessdalen phenomena, is still to be done.

The Italian Committee for Project Hessdalen is available to support further theoretical and/or experimental research projects on Hessdalen and Hessdalen-like phenomena. In order to support these projects, the committee requires both ideas and money. Scientists and technicians wishing to contribute to this enterprise are therefore welcomed to send to the committee papers on field/laboratory experimental works, theoretical models or speculative ideas of relevance to this subject. On the other side, the committee appeals to firms, banks, institutions and other generous patrons of scientific research of anomalous phenomena. Who is going to accept the challenge?

Notes

[i] November 1981 marks the beginning of the first "wave" of sightings in the Hessdalen valley. However, the first actual sighting of an unidentified phenomenon in Hessdalen dates back to September 19, 1980, when A.H. (name withheld) allegedly witnessed "three disc-shaped objects just above him" during a daylight hunting-party (Strand, 2000).

[ii] The EMBLA 2002 report is lacking in basic information about date/time of occurrence of this phenomenon. It is not easy to understand the reasons leading the EMBLA team to not record parameters (like date/time) that could help an independent corroboration (or falsification) of their data, should other witnesses have seen the light phenomena, or should the AMS station have filmed a light. By not taking note of this basic piece of information, the EMBLA researchers prevented themselves from obtaining an eventual triangulation of the phenomenon.

[iii] This author is grateful to Nicolosi and Ricchetti (2003) for having checked and corrected this author's former estimate of the light's angular elevation (Leone, 2003a).

[iv] Other, less likely candidate roads exist. For a full analysis see Leone (2003b).

[v] Moreover, this hypothesis is self-contradictory since the three values of temperature (6300, 5100 and 4400 K) were obtained "by arbitrarily assuming that the spectrum is due to some kind of ionised and/or excited gas of ions and electrons in thermodynamic equilibrium" (Teodorani & Nobili, 2002: 12).

[vi] This film replicates colors as seen by the human eye: our eyes have three sets of sensors (cones) with peak sensitivities at light frequencies that we call red (580 nm), green (540 nm) and blue (450 nm). Light at any wavelength in the visual spectrum range from 400 to 700 nm will excite one or more of these three types of sensors.

[vii] Independently of this author, R. Levin (personal communication, January 31, 2003)—an OSRAM Sylvania corporate scientist—has evaluated the spectrum collected by the EMBLA physics team. In his judgement this spectrum is an artifact of the measurement system. This conclusion agrees with the evidence discussed in this section. According to the OSRAM scientist, "the light is an incandescent headlamp and the structure [...] is an artifact of the measurement system. [...] The spectral picture at the top of [the] spectrum suggests that the light source spectrum is spectrally spread across the film [...]. Color film does not have a flat response curve. Rather, there are three relatively narrow responses, one for each color channel. I don't have curves for Ektachrome immediately available, but I will use a standardized typical response for colored film (ANSI Ph3.37-1969 developed for evaluating selective transmission of photographic lenses). When I multiply this by a incandescent headlamp spectrum, the results are quite similar to [the Hessdalen] spectrum. I don't know what specific film [was] used, so I didn't balance the relative response between the three bands, but I think that this demonstrates the problem. A panchromatic B/W film could record that actual spectrum".

[viii] "In many instances it has been positively proved that people have reported balloons, airplanes, stars, and many other common objects as UFOs. The people who make such reports don't recognize these common objects because something in their surroundings temporarily assumes an unfamiliar appearance. [...] In determining the identity of a UFO, the project based its method of operation on a well-known psychological premise. This premise is that to get a reaction from one of the senses there must be a stimulus. If you think you see a UFO you must have seen something. Pure hallucinations are extremely rare" (Ruppelt, 1956: 15, 17). Although most Hessdalen light sightings are caused by easily recognizable conventional stimuli, a few unexplained sightings are left.

[ix] An operative definition of strangeness/probability indexes was suggested by Hynek (1972).

[x] In Italy, the most serious civilian organization devoted to the collection and study of UFO reports is the Italian Center for UFO Studies (CISU): http://www.cisu.org.

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Anyone who believes they have had sightings of unidentified flying objects, Hessdalen-like lights or other anomalous aerial phenomena is welcome to write to the author. All correspondence will be treated in the strictest confidence.

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Hessdalen Research: A Few Non-Questioning Answers

M. Leone ("Questioning Answers on the Hessdalen Phenomenon", this issue) is convinced that the best way to make progress in Hessdalen research is to "*question the hasty answers given so far*". This is correct in principle, but his questioning is based on wrong information, assumptions, and data analysis. (Incidentally, the EMBLA 2002 mission (Teodorani, 2004a) has never been funded—even partly—by the CIPH association, but only by the SACMI Imola industry.)

Leone's claimed observation of a light-phenomenon caused by car headlights on a hill is no more than a personal anecdote since his telescope was not equipped with a camera. My collaborators and I could distinguish car headlights from the true phenomenon as a result of expertise acquired during 2 months of non-stop sky-watching at several spots in the area in 1994, 2000, 2001 and 2002. The road in the area was well known to me, thanks to prompt and precise information from our Norwegian collaborators (Teodorani, 2004a). Leone's observing experience in the area was limited to a few hours over several days, and he may well have confused the lights of a car with the true phenomenon that, by chance, was close in direction though not in distance. Therefore, his data analysis and interpretation are not well grounded.

Leone suggests that my research was limited to the specific light that he arbitrarily interpreted as car headlights. Not so; the many other phenomena that I investigated and recorded in the Hessdalen area, and that were seen in different directions, are described in my paper (Teodorani, 2004b).

That the stationary light was an isotropic radiator is not a conjecture; the conclusion is based on the documented clustering behavior of the phenomenon itself (Teodorani, 2004a,b). Clustering implies an approximately spherical symmetry and not a two-dimensional effect occurring on a plane orthogonal to the observer.

Concerning spectra, the LED hypothesis is simply that, an hypothesis. Though the best one so far proposed (Teodorani, 2004a,b), it must be checked by further measurements; but it is not an "ad hoc" assumption. The three-peaked spectrum