Data Analysis of Anomalous Luminous Phenomena in Hessdalen

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ABSTRACT. In the beginning of 1984 a group of norwegian researchers, supported by external physical scientists, carried out investigations on a luminous phenomenon which was occurring with strong recurrence in the area of Hessdalen in Norway. Such a phenomenon, which was monitored without interruption for 36 days, also by employing several types of instruments, allowed researchers to obtain a precious set of data. At the present time a new station, which has been installed in 1998 in the Hessdalen area and which is supplied with an automatic videocamera, is currently furnishing data in real time. The present paper is devoted to the presentation and discussion of the data analysis and interpretation which have been attempted in order to try to understand the nature of such a phenomenon. The following main results are presented: a) the luminous phenomenon, which appears mostly during the night time and during the winter season, shows a marked radar signature and occurs approximately in concomitance with some peculiar magnetic disturbances and sometimes with unexplained radio emission, b) magnetometric data, radar data and some components of radiometric data show some slight correlation with daily solar activity. The hypothesis regarding the formation of solar-driven plasmoids which acquire self-governing EM and magnetic fields, is ventured and discussed. The alternative possibility that solar activity is interfering with a still unknown EM behaviour due to the luminous phenomenon is further discussed.

1. INTRODUCTION

In the beginning of the eighties an anomalous luminous phenomenon suddenly appeared in the Hessdalen valley with a particular concentration of sightings in the years 1981, 1983 and 1984. The Hessdalen valley, which is about 15 km long and is inhabitated by about 200 persons, is situated in the center-south of Norway, south-east of Trondheim, and about 30 Km north-west of the town Røros. What happened in Hessdalen in the period 1981-1984, when it was possible to report sightings almost every day, can be ascribed to the general definition of “UFO flap” (refs. 5, 6, 8, 23) but, in this case, with a big concentration of events in a very restricted area of the world.

The phenomenon, which mostly tended to occur at very low altitude, showed a large variety of displays: it was possible to see multicolour (mostly white, but red and blue too) and multiform lights (mostly spheroidal, but of other shapes too), multiple cohexisting lights, pulsating and flashing lights, lights whose motion in the sky was erratic or fastly oscillating, fast-moving or fixed lights, lights which were turned on for over an hour, lights which were projecting beams towards the ground, clusters of lights which were moving by maintaining the same mutual distance. The apparent dimensions of these lights ranged from point-like or strongly illuminated Venus-like objects to very extended Moon-like objects, and their distance was very often calculated to be 1-3 Km, so that, from reference points (such as trees or houses) whose distance was known, it was possible to estimate an intrinsic diameter which was ranging from 1 to 10 meters and an intrinsic luminosity which was surely higher than 1 Kw. The existence of a very large number of witnesses convinced the norwegian Defence Department and some university physics departments that a serious investigation should be soon attempted. Therefore a research group, named “Project Hessdalen” (ref. 50), was quickly built up. Such a team of investigators was mainly composed of norwegian electronic engineers constituting a “working committee”, but it was also accompanied by an external “advisory committee” composed of physical scientists coming from norwegian and foreign universities.

The investigations in the Hessdalen area (refs. 22, 50), which were both visual and supported by instruments, started the 21-st of January 1984 and ended the 26-th of February of the same year. The following instruments were used: a seismograph, a radar, a radio spectrum analyzer, a magnetometer, a laser, a Geiger counter, an IR viewer, and several conventional cameras mounted with tripod some of which were also supplied with a diffraction grating for preliminary spectrographic analysis. Some of these instruments, with the exception of seismograph, gratings, Geiger counter and IR viewer, provided some meaningful data. All the instruments were installed in two stations placed inside the Hessdalen valley. A reasonably constant 24-hour presence of personnel inside the stations was warranted during the last two weeks of the observational operations. The duty of the personnel, in addition to supervising the operating instruments, consisted in preparing all the time accurate reports of the visual sightings and in evaluating the level of strangeness and quality of every sighting: a total of 188 sightings could be reported, of which at least 53 were judged to be totally unidentified. About 70 % of the most reliable reported luminous phenomena was moving along a North-South direction. In some occasions, when the laser beam was pointed towards pulsating lights, such lights seemed to “answer” by doubling their pulsation rate. Radar, radiometric and magnetometric measurements and laser-pointing tests showed a peculiar behaviour which couldn’t be explained, at that time, by the known laws of physics, geophysics and atmospheric physics.

After the 36-day field observations carried out by Project Hessdalen in 1984, the only reports of luminous phenomena came from simple witnesses and visual sightings consistently decreased in number but didn’t disappear at all (ref. 54).

Project Hessdalen started again its scientific activity in march 1994, when the leader of this group (Erling Strand) organized an international scientific workshop which was held just near Hessdalen (ref. 52). In that occasion physical scientists of several nations were collected in order to present and discuss possible theories on the luminous phenomenon and to decide future strategies for the rigorous measurement of the physical parameters of the phenomenon, while the engineers of Project Hessdalen presented the plans for new instruments. These instruments were developed and tested during the subsequent years at the Østfold College. In August 1998 a new observing station equipped with an automated videocamera, named *Interactive Hessdalen Observatory (HIO*), was finally installed by Project Hessdalen. This instrumental platform, which will be supplied with additional multi-wavelength sensors in the near future (such as a CCD camera, an optical spectrum analyzer, a multi-channel radio spectrum analyzer, a Lidar, a new radar and a new magnetometer), is constantly furnishing data at the present time.

This paper deals with an analysis of the available data of scientific relevance regarding the Hessdalen phenomenon, which has been attempted in order to try to determine precisely the time-variability of the phenomenon, to search for possible correlations between the various parameters obtained with different instruments and finally to verify if some explanation can be found in terms of natural causes such as solar activity. By now, this study can only take into account the phenomenon as a group of points in time. A physical analysis of every single sighted object is not yet possible as the photographic, video and spectrographic data which were obtained so far, don’t contain sufficient quantitative informations. Photographs are often of very good quality but the only possible analysis which can be applied to them is useful to demonstrate that a given luminous phenomenon is real and to measure some geometric parameters such as distance and intrinsic dimensions (refs. 22, 51, 66), but not to allow the investigation of its intrinsic physical nature. The obtained grating-spectra of the lights are very few and in most cases their signal-to-noise ratio is too low for allowing a meaningful analysis (refs. 50, 58). The study of the intrinsic nature of the lights will be hopefully the subject of future systematic instrumental investigations when some of the new planned sensors will be installed (refs. 3, 55).

2. EVALUATION OF THE OPTICAL PHENOMENON

The optical side of the phenomenon has been studied by using the following procedures:

1) critical evaluation of visual sightings (1984);
2) monitor by means of an automatic videocamera (1998-2001).
3) execution of photographs (1984);
4) execution of low-resolution spectra (1984);

Only from procedures 1) and 2), it has been possible to describe the phenomenon behaviour in a sufficiently systematic way. Procedure 3) can be considered just as an additional useful documentation in support of procedures 1) and 2). Procedure 4) didn't furnish meaningful quantitative results, but it suggested qualitatively that the luminous phenomenon may be the source of a continuum spectrum (ref. 58). Because of the very low spectral resolution furnished by the used diffraction gratings, it is possible that some lines (in absorption and/or in emission) in the spectrum passed unnoticed expecially if they were intrinsically weak. Therefore a definitive answer to the nature of the optical spectrum can be obtained only by using specific devices for light-dispersion which allow a higher resolution: this investigation will be possible when a new optical spectrum analyzer will be available (refs. 3, 55).

a) Evaluation of visual sightings: 21 January - 26 February 1984

The criterion which was used during the 1984 field investigations in order to evaluate the visual observations involved two parameters (refs. 23, 25, 50): the *Strangeness Index F* and the *Quality Index G*. F index indicates the probability of finding a natural explanation or an explanation due to a known artificial light: it ranges from value F1, corresponding to a 100% probability that the object is a known light, to value F10, corresponding to a zero probability. G index gives the details which can be furnished of every sighted object: it ranges from value G1, corresponding to a very low number of details, to value G10, corresponding to a very high number of details. Data have been selected with the following criterion: F1 cases are ascertained to be airplanes, F2 cases are considered doubtful cases, F5 to F10 cases are properly considered as "UFO". Values F3 and F4 have been considered as well, as it was expected that they could assume a stronger physical meaning in the course of correlation analyses.

After comparing together 92 data points having values of F equal or greater than F3, it has been ascertained that the strangeness index F and the quality index G are slightly correlated (correlation coefficient is C = 0.30). This means that a sighting with a high strangeness level tends to be recorded with a higher wealth of details than a sighting with a lower one. This result strengthens the general level of accuracy with which a sighting was evaluated during the observational campaign in Hessdalen.

Fig. 1 shows the number of unidentified events recorded during the observational campaign carried out in 1984. From these graphs it appears that the highest number of sightings was reported in the second half of February (11-26 February): the real reason of this is that from 21 January to 10 February only few persons were present at the observing stations so that the number of lights might have been underreported. Following a check of the times of sunrise and sunset at the Hessdalen latitude (ref. 46), it is easy to ascertain that the darkness time in January is greater than the one in February: this clearly means that if the same full number of observers was present in the first period too (21 January - 10 February) reported sightings might have been probably more numerous than in the second period (11-26 February).

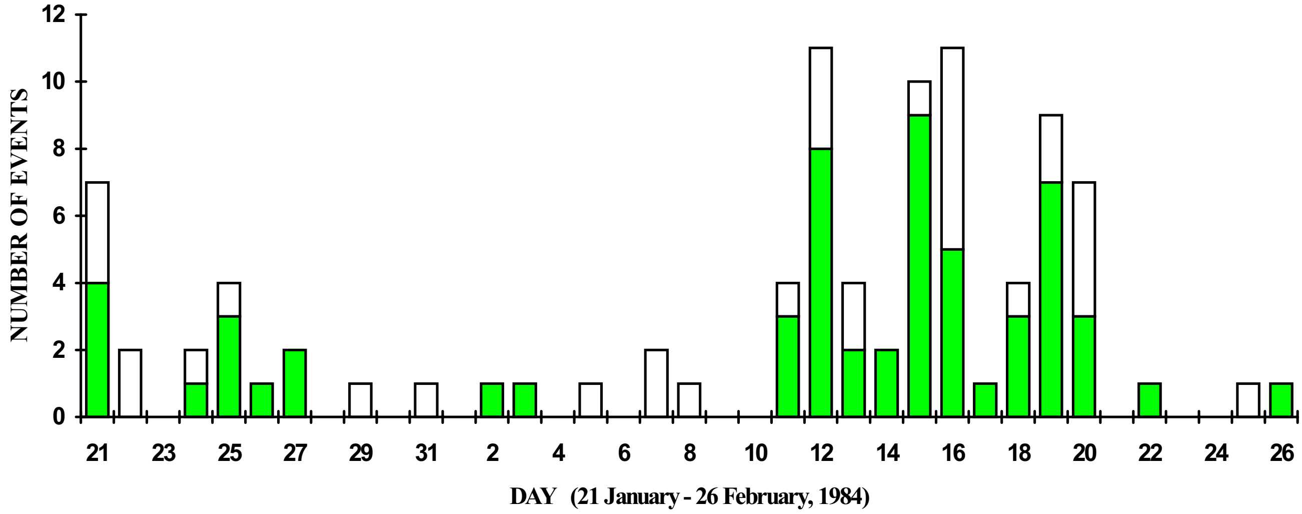

Figure 1. Daily number of luminous events in Hessdalen reported in the period 21 January - 26 February 1984 (lower dark bar: F5-F10 cases, upper clear bar: F3-F4 cases).

During the 1984 observations, sightings of luminous phenomena resulted to be sharply concentrated in the first hours of the evening: this is shown in Fig. 2, where it is possible to notice a primary peak due to the luminous phenomenon in the hour interval 19.00-20.00 UT (Universal Time) and two secondary peaks in the hour intervals 20.00-21.00 UT and 22.00-23.00 UT. By taking into account the times of sunrise and sunset during the winter season in Hessdalen (ref. 46), it is reasonable to assert that the low number of sightings registered in the range 17.00-18.00 UT might be due to the fact that, because of some residual post-sunset daylight, luminous phenomena might be still scarcely visible. In any fact, the almost total absence of sightings during the remaining night hours (from 24.00 up to 04.00 UT) and the generally decreasing trend after 19.30 UT cannot be explained as an effect due to scarce visibility. Therefore, from the 1984 data one is induced to suggest that the apparition of luminous phenomena is characterized by some kind of daily periodicity.

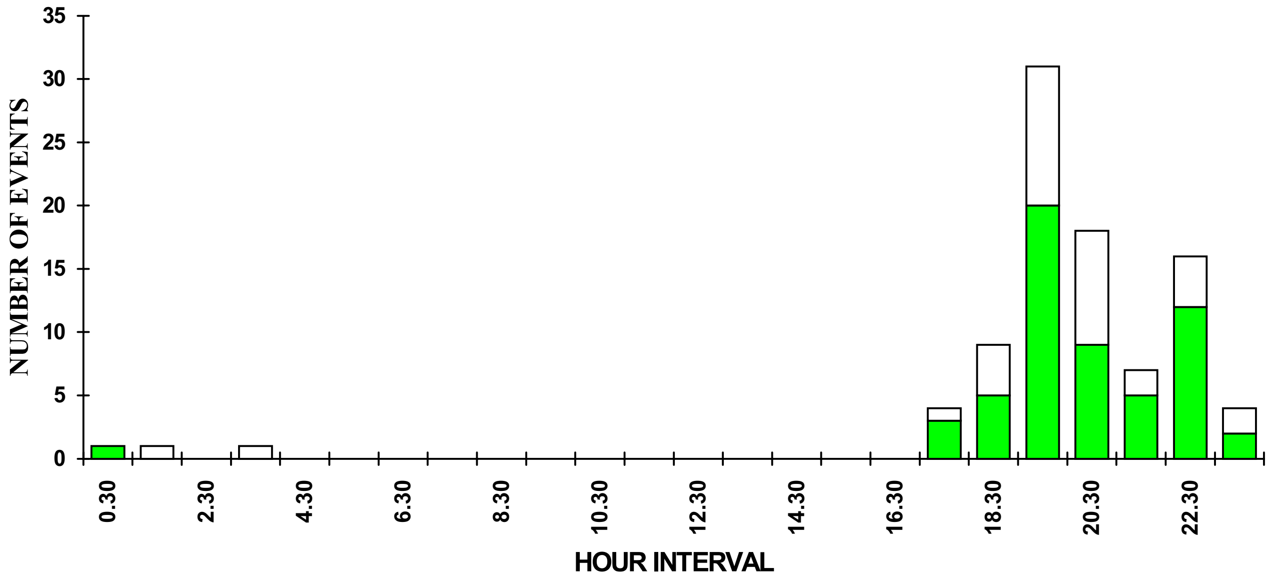

Figure 2. Hourly number of luminous events reported in the period 21 January - 26 February 1984 (lower dark bar: F5-F10 cases, upper clear bar: F3-F4 cases).

b) Evaluation of video frames: August 1998 - March 2001

Compared with the 1984 observational period, the monthly incidence of luminous phenomena in Hessdalen nowadays (1998-2001) has sensibly decreased (see Fig. 4). On the other hand, the possibility of a constant monitor by means of an automated video-camera, has highly increased the capability of recording the apparition of such phenomena all the time. A Panasonic solid-state videocamera supplied with a wide-angle lens, which is connected with a videorecorder and a Silicon Graphics Indy computer, is currently installed in the *Hessdalen Interactive Observatory* (ref. 56). Such a system is able to perform every second a complete survey of an accurately chosen area of the Hessdalen valley and to record any target whose luminosity is greater than a threshold value; the recorded frames are immediately made available to researchers through the Web site of Project Hessdalen. Each of the recorded phenomena is re-analyzed in a subsequent phase, in which case a selection of real "UFO cases" is done by carefully distinguishing such cases from identified objects (such as airplanes or celestial objects). Uncertain cases for which only a preliminary analysis has been done, are considered as well: a consistent number of such cases are possibly destined to be regarded as real UFO cases after a further analysis. The selected data furnished by the video-camera which have been obtained so far are shown in Fig. 3.

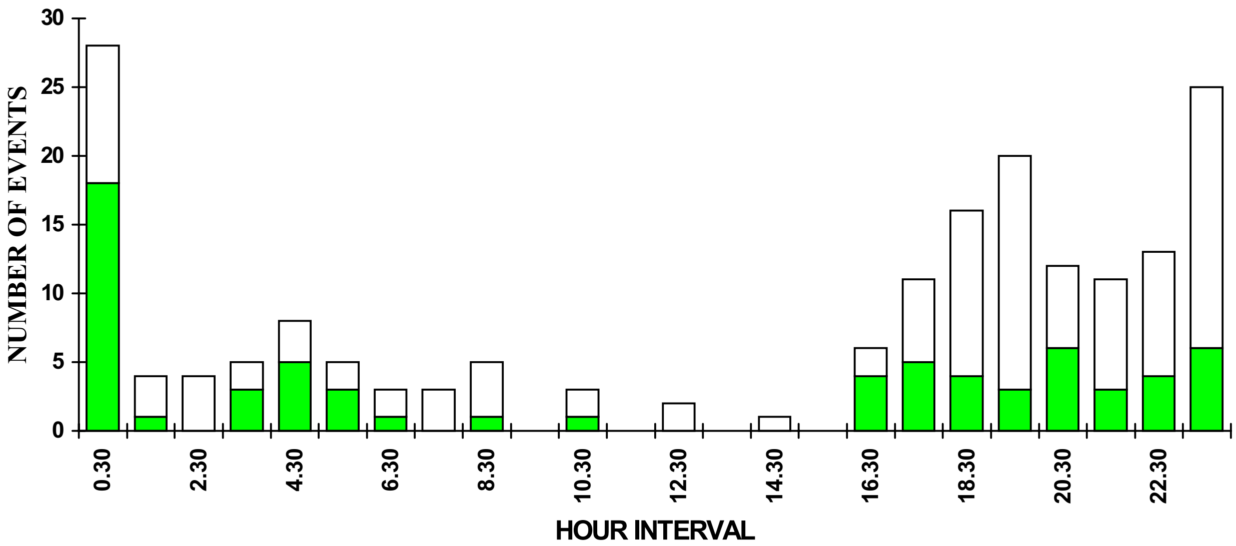

Figure 3. Hourly number of luminous events reported in the period August 1998 – April 2001 (lower dark bar: ascertained UFO cases, upper clear bar: still uncertain cases).

By comparing the graph in Fig. 3 (1998-2001 period) with the one in Fig. 2 (1984 period), one can notice that two main effects may be present:

1. A cumulative effect due to the much longer period of systematic observation (21 months vs. 36 days) makes so that the graph in Fig. 3 is overpopulated with data points; in fact in this case some events between 01.00 and 16.00 UT are now also recorded.
2. The higher ability of the *HIO* automatic videocamera to detect weakly luminous phenomena too, makes so that luminous events are recorded much more easily than in the case of eye witness.

If one compares the data obtained in Hessdalen regarding the distribution of the number of UFO sightings reported during a day (both Fig. 2 and Fig. 3) with previous statistical studies of "UFO flaps" occurred in other areas of the world (refs. 5, 6, 23, 43), it is surely possible to notice some qualitative similarity in the fact that the daily UFO number is approximately concentrated in the hour interval 18.00 - 24.00 UT. Nevertheless, such statistical studies show a more homogeneous and smoother distribution, while in the Hessdalen case discontinuities are more sharply marked. Data reported in other places of the world have been obtained exclusively by interviewing occasional witnesses and not by analysing full-time observations. Therefore it cannot be excluded that the well characterized multi-peaked distribution deduced from the Hessdalen data is much nearer the real UFO behaviour because of the highest employed precision, which is expected to increase after more data will be collected in the next years.

Since August 1998 the monthly incidence of the luminous phenomenon in Hessdalen can be carefully recorded. Also in this case, the resulting database (see Fig. 4) is very reliable because it is constructed just from an automated optical sensor which is able to monitor without interruption the Hessdalen area. Luminous events appear to be mostly concentrated during the winter and autumn seasons, probably because of the much longer night-time which allows a better phenomenon detection. Long-lasting luminous events whose duration ranges typically from 5 to 30 minutes have been mostly recorded during these seasons (ref. 59).

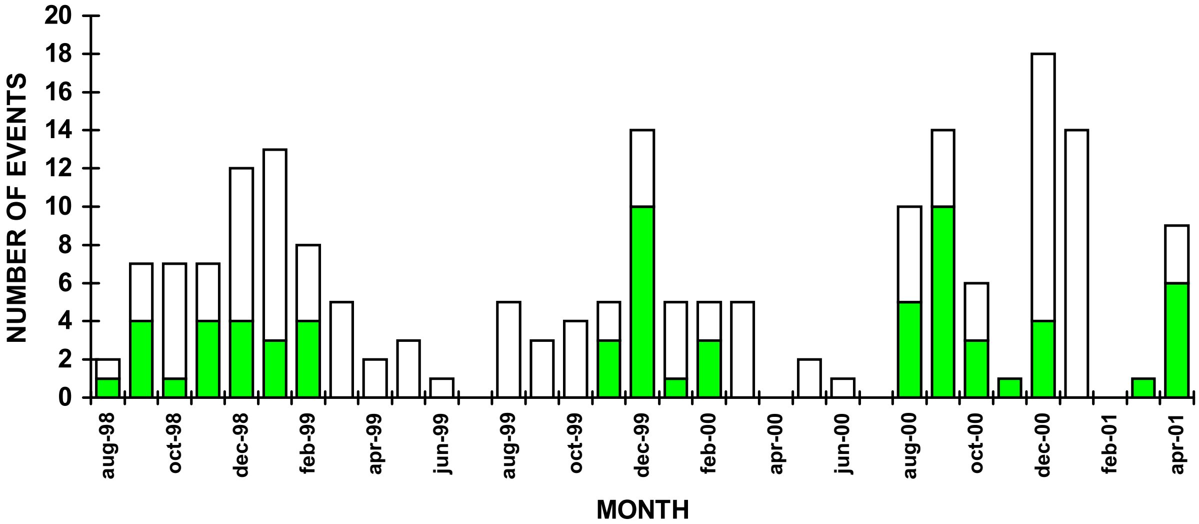

Figure 4. Monthly number of luminous events reported in the period August 1998 - April 2001 (lower dark bar: ascertained UFO cases, upper clear bar: still uncertain cases).

3. MEASUREMENTS WITH ELECTROMAGNETIC INSTRUMENTATION

There are good reasons to assert that the Hessdalen Phenomenon is not only optical but that visual sightings are often accompanied, and possibly related, with EM phenomena characterized by radar, magnetometric and radiometric recordings (ref. 50). This evidence was clearly demonstrated during the 1984 field monitor, and it will be further probed with more sophisticated instrumentation in the next years when funds will be available (refs. 1, 3, 13, 14, 55, 62, 64). The data reported in this section refer only to the 1984 period.

In order to derive an accurate timing of all the specific manifestations of such a multi-wavelength phenomenon, the Julian Date (JD) calendar has been used in some cases (refs. 38, 63 and Tables therein). The JD dating system, which is normally used in the astrophysical research in order to study celestial objects showing light variability, is a very precise and efficient system which allows a very straight confrontation of past and present data and facilitates the execution of correlation analyses. In the case of interest here, JD = 5701 corresponds to 1 January 1984 at 12 a.m.; each integer number added to the given JD corresponds to one more day and each decimal number added to it corresponds to more hours and/or minutes (which in this case are considered as a fraction of the day). In the illustrative case: 5700.0 is midday of 31 December, 5700.5 is midnight of 1 January, 5701.0 is midday of 1 January.

a) Radar recordings

The used radar, an Atlas 2000 (ref. 50), which operated at a wavelength of 3 cm with a maximum range of 33 Km, was adjusted in order to scan typical luminous targets whose distance was estimated to be not more than 5.5 Km. Even if the personnel was not monitoring all the time the radar screen, it was possible to record a consistent number of radar registrations, all of which gave a strong track on the radar screen. A total of 36 radar registrations were obtained in the period 21 January - 17 February 1984. Only 3 of them resulted to have a synchronous optical counterpart in form of a luminous phenomenon: such events occurred on 21 January at 17.50, on 25 January at 17.32 and on 27 January at 22.58; in the third case it was possible to measure a maximum velocity of about 30000 km/h. The fact that most radar registrations couldn't be identified with luminous phenomena in sight can be interpreted in two ways: a) most radar tracks were reported some hours before sunset and the alleged luminous counterparts were not visible because of the remaining sunlight (ref. 46); b) the luminous phenomena were intrinsically characterized by a very low light intensity or were radiating in the near IR (ref. 17). In one case in which the radar track was identified with a visible counterpart, such a track was intermittent while the corresponding light was constantly in sight. Moreover, in several other occasions it happened that when the luminous phenomenon was in sight, no radar track at all was detected. This behaviour (intermittence and/or absence of radar reflections) can be interpreted in the following alternative ways: a1) The luminous phenomenon, being always in sight, gave an intermittent radar reflection because it was quickly approaching and receding repeatedly along the line of sight, and consequently going in and out of the radar range; a2) The luminous phenomenon, being always in sight, didn't produce any radar reflection because it was stably situated at a distance which couldn't be reached at all by the used radar range; b) the radar cross-section of the luminous targets which were reachable by radar scanning, was intrinsically changing or disappearing for some unknown reasons.

Radar recordings coincident with optical UFOs have not been reported only by Project Hessdalen. Everywhere in the world radar tracks due to UFOs have been extensively and always accidentally reported by operators of airport control towers and by airplane pilots since over 50 years (refs. 8, 9, 21, 23, 39, 60, 69): also in such cases the radar behaviour appeared to be often anomalous. Anyway no specifically-oriented systematic radar monitor of UFOs in "hot areas" of the world, such as the one carried out by Project Hessdalen, has ever been carried out so far.

b) Magnetometric recordings

The employed magnetograph, a Fluxgate PM100 (ref. 50), which was operating with a two-channel mode consisting in magnetic field measurements at north-south and east-west directions, was able to record slow-varying magnetic fluctuations and magnetic fluctuations up to 0.5 Hz, and had a sensitivity $S = \pm 1\ \gamma$ ($1\ \gamma = 1$ nanoTesla). In the periods 11-14 and 25-26 February the magnetograph was also connected with a fast recorder, a TOA Electronic Polyrecorder, which was used to record high time-resolution phenomena such as magnetic pulsations.

Magnetometric registrations, which were obtained without interruptions only in the two cited periods, showed 3 main characteristics:

1. Pulsating magnetic fields with a pulsation rate of some seconds and with different amplitudes were recorded in both periods. In particular 4 types of readings were reported: very strong (over 10 γ), strong (10 γ), medium (2 γ) and weak (0.5 γ).
2. Slow-varying magnetic fluctuations of geophysical origin were continuously recorded.
3. Magnetic storms were recorded as well.

A subsequent analysis has furnished the following conclusive results:

A. During the period in which the magnetometer was used, luminous phenomena resulted to be always temporally related with magnetic pulsating events. However some fraction of the recorded magnetic events occurred separately - few hours before or after a given luminous phenomenon could be sighted - as if the original optical phenomenon had been replaced with an optically invisible form, which anyway couldn't be detected at all by the limited range and power of the employed IR viewer.

B. Magnetic pulsations were not correlated with slow-varying magnetic fluctuations of geophysical origin.

C. Magnetic pulsations were disturbed by magnetic storms, which occurred approximately during the same period (see Fig. 6 shown in Section 4).

The coincidence of luminous and magnetic pulsating events, together with the occurrence of magnetic pulsating events alone, undoubtedly are the most important and intriguing result which could be obtained during such a measurement campaign.

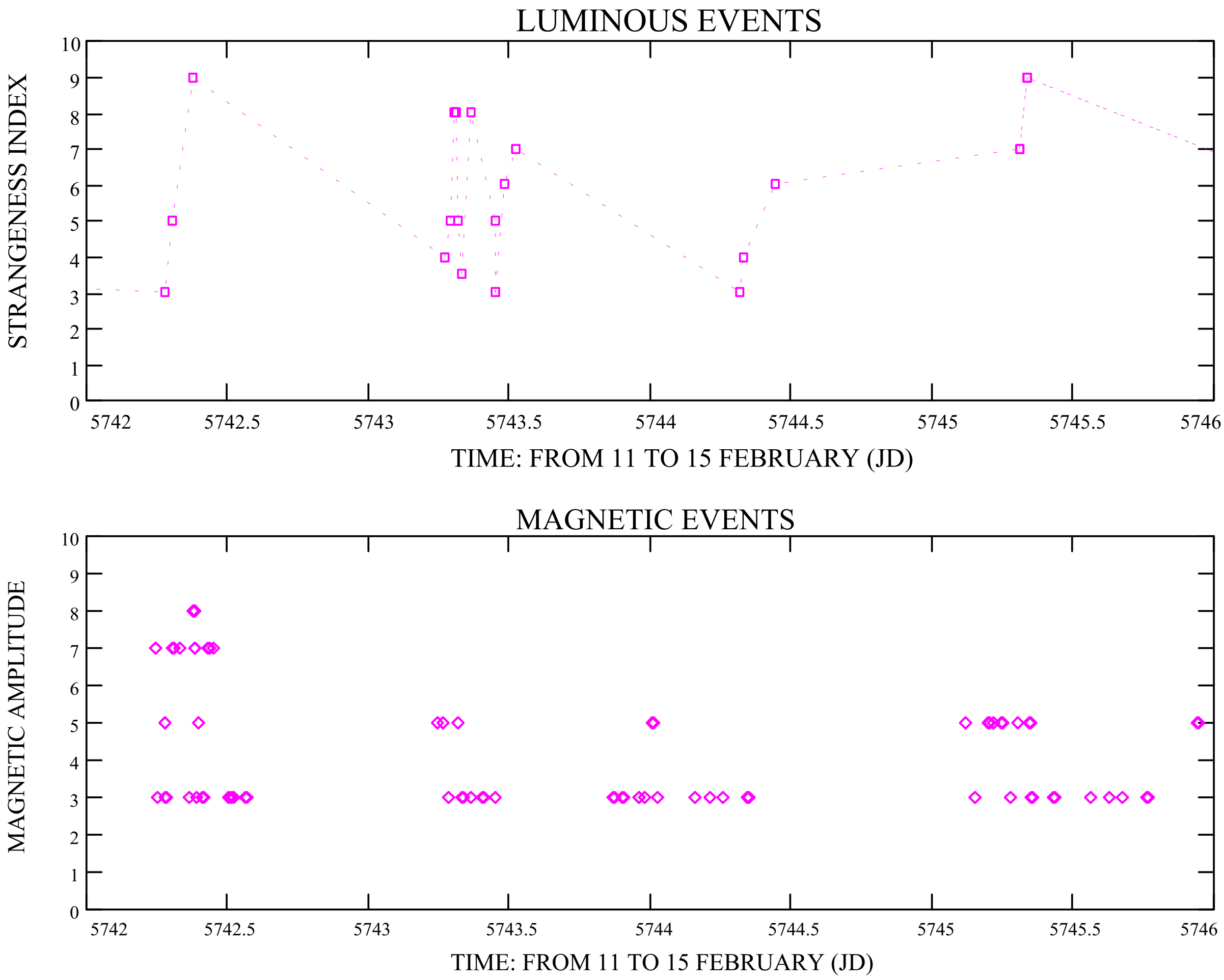

Figure 5. Detailed graph showing the time-variation of the amplitude of magnetic pulsations (126 data points) occurred in the period 11-15 February 1984 (below), compared with the time-variation of the strangeness index of the luminous phenomenon (above). The events occurred in the period 25-26 February showed a strictly similar behaviour. *Values of magnetic amplitude have been transformed into the following artificial values: 8 for reading $> 10\ \gamma$, 7 for reading $= 10\ \gamma$, 5 for reading $= 2\ \gamma$, 3 for reading $= 0.5\ \gamma$.*

Recordings of magnetic phenomena presumably coincident with UFOs in general, have never been attempted by previous researchers in a so systematic way as by Project Hessdalen. More recently (1996 and 1997) Project Hessdalen carried out analogous measurements also in other places of Earth, such as "Min-min" desert in Australia and Popocatepetl volcano in Mexico (ref. 53, 57), where recurrent luminous phenomena similar to the Hessdalen ones are often reported: in these two specific cases a systematic magnetometric monitor lasting some days, showed magnetic pulsating events with amplitudes which were a factor 10-100 higher than the ones measured in the Hessdalen valley in 1984. Also in the Min-min and Popocatepetl cases, magnetic and luminous events were apparently related in a similar manner as in the Hessdalen case. The fact that a great excursion of magnetic readings was reported by the researchers of Project Hessdalen may be due to differences of the distance at which the luminous phenomenon itself was situated, whose intrinsic magnetic intensity at zero distance is reasonably suspected to be much higher than the readings furnished by distant instruments.

c) Radio recordings

The apparatus which was used to detect radio-frequency signals (ref. 50) was composed of a Hewlett-Packard spectrum analyzer operating in the range 150 Khz-1250 Mhz, a Singer radio interference / EM field detector operating in the range 150 Khz-32 Mhz and a wide-band antenna.

Even if the spectrum analyzer was not running all the time and even if the screen was not constantly monitored, two types of recordings were reported in the period 29 January - 19 February 1984:

1. A signal characterized by a single component, whose frequency ranged from 130 to 1115 Mhz and whose amplitude ranged from 12.5 to 22.5 dB (4 events reported). Such a signal was characterized by a *spike*-like morphology whose amplitude was oscillating up and down: this kind of signal was called "Type 1".
2. A signal characterized by several simultaneous components represented by *spikes* having almost equal amplitude, which, being splitted by an 80 Hz interval, were displayed all over the frequency-band from 100 Khz to 1250 Mhz (12 events reported). The amplitude of such spikes was oscillating up and down, being about 5 dB over the noise in the down phase and 25-30 dB over the noise in the up phase. This kind of signal was called "Type 2".

Type 2 signals occurred few hours before or after the luminous phenomenon, while some of the Type 1 signals (at least two) occurred about to coincide with it. As in the case of radar data, the absence of an optical phenomenon in sight when some of the radio spike-like signals were recorded might be due to the fact that the phenomenon radiation might have shifted from the optical to the IR wavelength window.

Recordings of radio disturbances which are suspected to be related to UFOs have not been obtained only by Project Hessdalen. During a very long observational and partially instrumental field monitor carried out in the period 1973-1980 at Piedmont (USA) where a massive UFO flap was ongoing (ref. 45), physicist Harley Rutledge and his collaborators by using a spectrum analyzer was able to record similar *spike*-like radio events which were presumably associated with luminous phenomena. Anyway, even if a very good evaluation of distance and size of many luminous phenomena was done in that case, the number and the quality of the reported radiometric data at Piedmont were respectively lower and worse than the ones obtained in 1984 at Hessdalen. Astrophysicists George Smoot and Giovanni De Amici of the Lawrence Berkeley Laboratory (USA), using a small dish for radioastronomic research, recorded accidentally and repeatedly strong unexplained radio spikes during a mission in Antarctica (ref. 49) which was devoted to the measurement of the 2.7 °K background cosmic radiation; differently from the Hessdalen and Piedmont cases, in this specific case no luminous phenomenon was reported. One italian astrophysicist reported the accidental sighting of a huge ball of light during one of his research missions in Antarctica, but unfortunately no radio device was working at that time (ref. 40).

d) Seismic recordings

The employed seismograph, a MEQ-800, (ref. 50), was of portable type and had a sensitivity of 1.5 on the Richter scale. Such an instrument was constantly in function during the whole period in which observations were done in Hessdalen in 1984. 16 seismic registrations of several intensities were reported. Three out of 16 of the recorded events occurred about at the same time in which a luminous phenomenon was reported, while three of them occurred few hours before or after luminous phenomena. It was possible to ascertain that all such recordings were caused by seismic activity which was occurring many kilometers far from the Hessdalen area, therefore any relation between seismic recordings and luminous phenomena was excluded.

e) Instrument malfunction

During the period in which instruments were used (ref. 50), some black-outs or malfunctions happened just when luminous phenomena were passing very near the measurement stations. There are good reasons to suggest that such a phenomenon was able to induce a powerful EM interference, which was surely related to its capability to produce magnetic and radio emissions. Similar black-outs presumably caused by UFO incidents, have been amply documented in the technical UFO literature (refs. 23, 44).

4. DOES SOLAR ACTIVITY TRIGGER HESSDALEN PHENOMENA ?

Before venturing hypotheses which are aimed at explaining a given phenomenon by using blindly the obtained measurements, it is necessary to do basic checks which are sinthesized in the following three questions:

1. Is the EM radiation recorded by the various instruments (radar, magnetometer, radio spectrum analyzer) exclusively due to a precisely localized luminous phenomenon of unknown origin ?
2. Is the luminous phenomenon itself triggered by some prosaic natural mechanism ?
3. Is the recorded EM radiation due to a temporal overlap of EM emissions coming both from a prosaic natural mechanism and from a peculiar phenomenon localized in our atmosphere ?

These questions are not driven by personal choices regarding a preferential theory on the observed phenomenon, but constitute the prerequisites which are necessary in order to apply the scientific method. Before telling what is the phenomenon, it is important to separe the signal by the noise in order to establish a trustworthy “zero point” from which one can try to interpret objectively what is observed. Unfortunately the radiation which is produced by natural causes is not “silent” and is itself a prominent source of EM noise. Is that one only an overlapping noise or is it the cause of the luminous phenomenon? Certainly the Sun is the strongest source of natural radiation.

Some physicists suggest that solar activity can play a significant role in triggering luminous phenomena in our atmosphere (ref. 52). This mechanism is supposed to originate from high-energy particles which are produced by the Sun with amplified effects during active phases (refs. 28, 29, 48). According to this theory, an increase of solar high-energy particles could, in principle, trigger atmospheric ionization and consequently initiate the possible formation of luminous plasmoids. An attempt to explain how a coherent ball-like plasmoid can be formed in our atmosphere and maintained for a long life-time (up to 2 hours in the Hessdalen case) has been done in the ambit of some theories (refs. 47, 52, 70).

By taking into account the work hypothesis regarding plasmoids of solar origin, the simplest step to do consists in checking if any possible correlation exists between solar activity (in this case described by the *sunspot number*) and any useful parameter which is related with the multi-wavelength “Hessdalen phenomenon”.

a) Daily solar activity, monthly solar activity and luminous phenomenon

The following three main parameters describing the luminous phenomenon reported in Hessdalen have been related with daily solar activity (ref. 2): the daily UFO number, the UFO strangeness index and the duration of UFO sightings. Correlation analyses executed by interpolating solar data at the instants of UFO data, demonstrated that noone of these parameters is correlated with daily solar activity in the period 21 January - 26 February 1984. A similar negative result has been obtained by searching for correlations between the daily and monthly UFO number and the daily and montly solar activity (ref. 61) in the period August 1998 - March 2001. From these sole results, one would conclude that luminous phenomena in Hessdalen have nothing to do with solar activity.

b) Daily solar activity and magnetic phenomenon

Fig. 6 shows the trend of daily solar activity compared with the temporal trend of the magnetic phenomenon measured in Hessdalen. From the same figure one can notice that magnetic storms and magnetic pulsations are almost coincident. Fig. 7, where a correlation analysis between daily solar activity and amplitude of magnetic pulsations is presented, shows that a slight but significant correlation is present (correlation coefficient C = 0.42). What is interesting is that magnetic storms together with magnetic pulsating events occur just 1-2 days after a contingent maximum of solar activity. By knowing from solar physics that a solar sunspot maximum coincides approximately with strong optical and radio bursts and that typical geomagnetic storms occur with a phase shift of many hours after a solar burst (refs. 28, 29, 48), it is easy to deduce that the observed phase-shift of magnetic events (see Fig. 6) is just what is expected to occur as a consequence of solar activity.

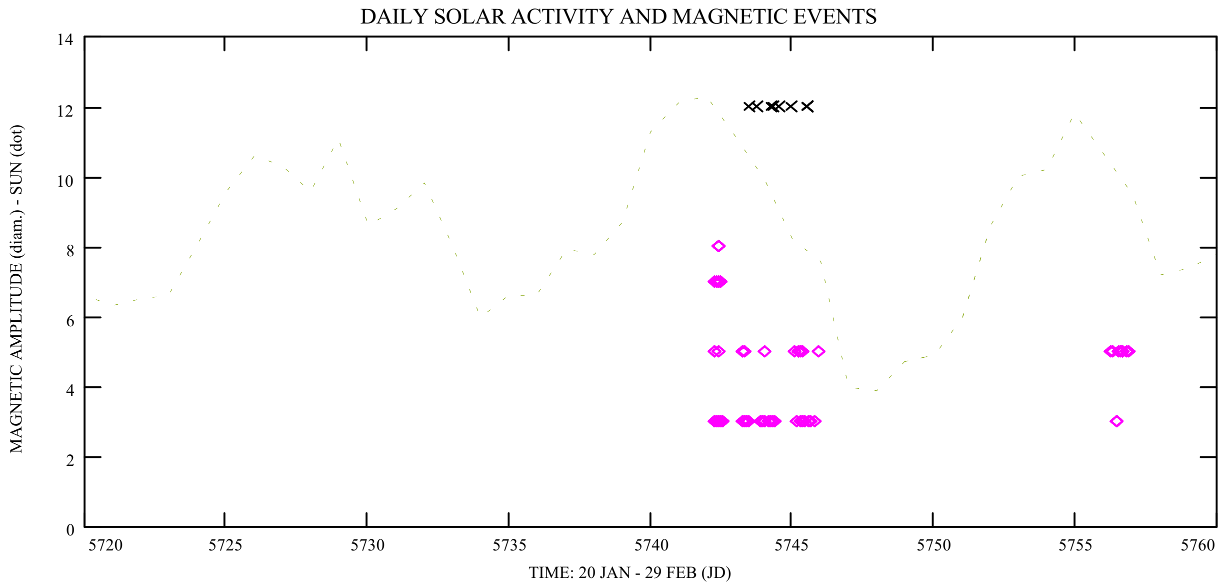

Figure 6. Time-variability of daily solar activity (dotted line), in comparison with time-variability of the amplitude of magnetic pulsations (diamonds - 126 data points) which were reported in the period 11-26 February 1984. Crosses represent magnetic storms. *In this graph the sunspot number has been artificially divided by a factor 10, while values of magnetic amplitude have been transformed into the following artificial values: 8 for reading > 10 γ, 7 for reading = 10 γ, 5 for reading = 2 γ, 3 for reading = 0.5 γ, 12 for magnetic storms.*

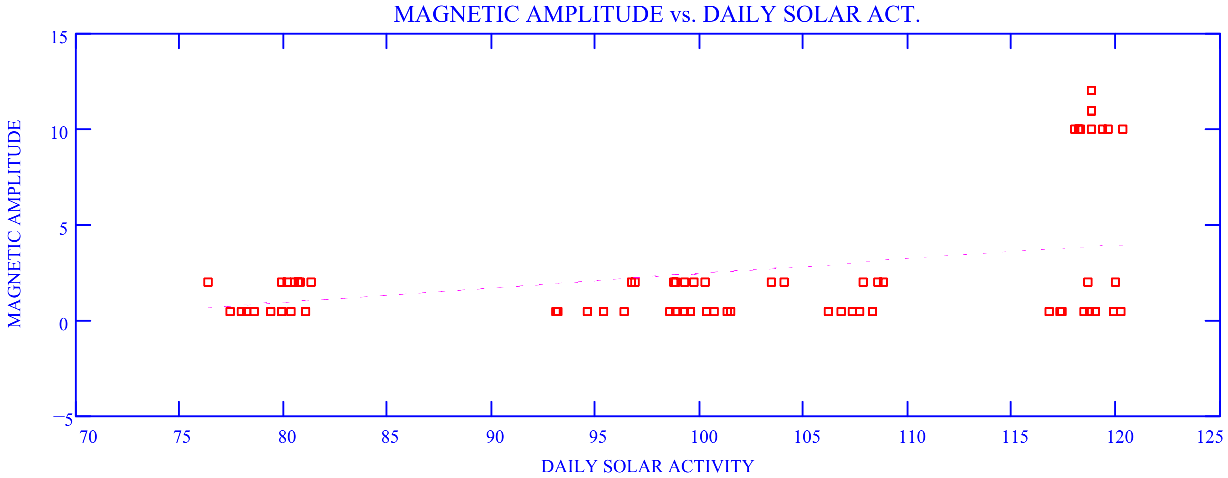

Figure 7. Amplitude of magnetic pulsations vs. daily solar activity. Solar data have been interpolated at the instants of magnetic events.

Nevertheless, an attempt to correlate daily solar activity with the duration of magnetic pulsating events reported in Hessdalen, produced a negative result: in this case no correlation exists at all. Moreover, the specific "pulsating mode" of magnetic events, is not typically reported during geomagnetic storms.

c) Daily solar activity and radar phenomenon

Fig. 8, in which correlation analysis between daily solar activity and the number of radar tracks per minute is presented, shows that a slight correlation is present (correlation coefficient C = 0.47). Some radar reflections may be due to optical and/or IR-emitting plasmoids, whose radar signature is predicted to be strong (refs. 9, 17, 50), which are triggered by solar activity.

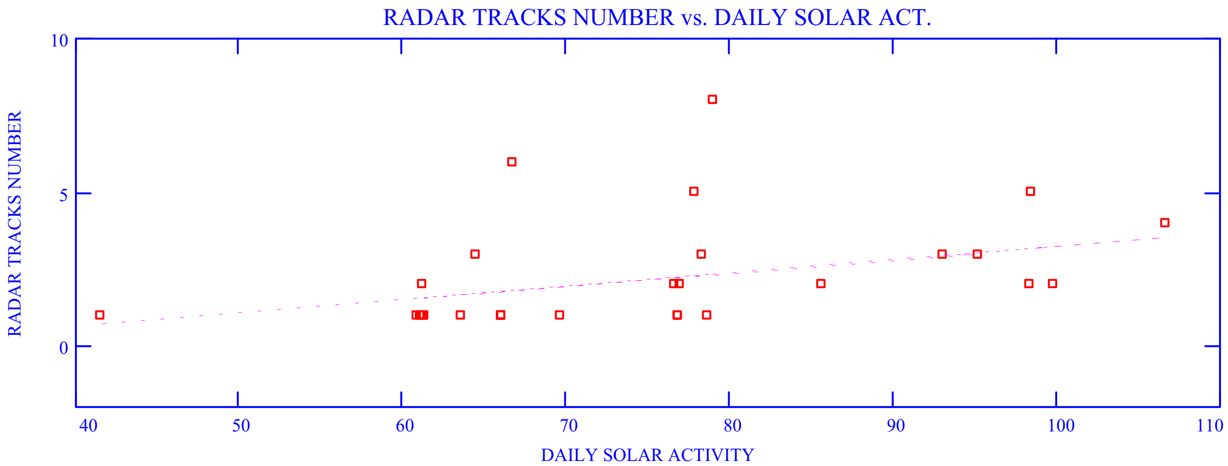

Figure 8. Number of radar tracks per minute (36 data points) vs. daily solar activity. Solar data have been interpolated at the instants of radar data.

d) Daily solar activity and radio phenomenon

Statistically significant correlation studies between daily solar activity and radiometric parameters (amplitude and duration of spike-like radio events) are not possible due to the few available data. Anyway it has been ascertained that 8 of the detected radio events (6 of the Type 2 ones and 2 of the Type 1 ones) occurred just to coincide with a high value of solar activity (ref. 63 and tables therein). Furthermore, two apparently peculiar radio features which were reported in Hessdalen may be due to solar activity as well: the radio *spike*-like morphology and the oscillating trend of radio spikes. A spike-like morphology is often reported during solar radio bursts (refs. 28, 29). The fast up and down amplitude oscillations of radio spikes, may be due to *radio pulsations*, which are often recorded during solar radio bursts and which are simultaneously present mostly in the 100-300 Mhz range but sometimes also above 700 MHz and below 28 MHz, with a pulsation rate of few seconds (ref. 48).

On the contrary, the evidence of further 8 radio disturbances (radio spikes of both types) which are temporally much distant from a sunspot maximum, suggests that some radio events may be due to some unidentified EM phenomenon. Three of these events are almost coincident with luminous phenomena in sight (see Section 3). These data suggest that some of the radio events could be directly produced by the sighted light-balls in Hessdalen, which are suspected to produce a self-contained electromagnetic field.

5. DISCUSSION

By using the data which are available up to now, it is not possible yet to furnish an one-sided and definitive interpretation of the multi-wavelength phenomena occurring in Hessdalen.

Some of the measurements show that solar activity at maximum may be the origin of many of the recorded EM data. This can be deduced from the following observational evidences:

a) The amplitude of magnetic pulsating events is slightly correlated with daily solar activity and it occurs approximately to coincide with magnetic storms.
b) The evidence of “oscillating radio spikes” is a morphologically recurrent aspect of solar radio bursts.
c) The number of the registered radar tracks is slightly correlated with daily solar activity and plasmoids of any nature (including the solar one) are able to give typically strong radar reflections indeed.

Nevertheless, some aspects of the problem which were analyzed in sufficient detail, present the following intriguing anomalous characteristics:

1. The timing of the luminous phenomenon (not considering its observational parameters such as daily number, strangeness index and duration) approximately coincides with the timing of magnetic disturbances (not considering their amplitude).
2. Magnetic disturbances are characterized by a peculiar pulsating mode which cannot be due to solar activity.
3. The timing of some radio events, mostly Type I ones, approximately coincides with the timing of the luminous phenomenon.

Two hypothetic alternative scenarios are proposed in order to explain all the reported data:

I. The luminous phenomenon is a by-product of the ionizing effect due to solar high-energy particles colliding with the Earth atmosphere, and is able to acquire an optical, radio and magnetic self-governing behaviour during and/or immediately after a maximum of solar activity. In such a case the EM field produced by such kind of plasmoids causes an apparent modulation of the normal radiation emitted by the sun, so that the EM radiation recorded by the instruments is just the result of an overlap of the standard solar EM emission during its active phases with some “extra EM field” produced by optical or IR-emitting sun-driven plasmoids that occasionally pass near the observer.
II. Something which is not triggered by solar activity at all is casually overlapping with radiation originating from the active sun. In such a case the observed luminous phenomenon as well as some EM performances might be due to an unknown cause. If this one is the real explanation, so during future observational field measurements of Hessdalen phenomena, the alleged

“solar interference” must be accurately evaluated by arranging specifically-oriented solar observations, and then removed from the rest of the data, being it a source of polluting noise. In such a case the source of *noise* (solar activity) could be eliminated: consequently one could be able to concentrate only on the study of the EM radiation which is due only to the multi-wavelength phenomenon (the main *signal*) occurring in Hessdalen.

Thus, if solar activity is not responsible for the Hessdalen lights but is only a source of interfering and overlapping noise, which one is the direct cause? Theories based on atmospheric electricity and related ionospheric phenomena (refs. 7, 9) and their applicability to the Hessdalen case require a deeper study, as they are not yet able to explain why luminous phenomena in Hessdalen occur at very low altitude. Theories based on *earthlights* or *tectonic strain* invoking the induction of piezo-electricity effects because of stress from the rocks (refs. 12, 31, 32, 42), could furnish a suitable explanation of the fact that most Hessdalen light phenomena are sighted quite near the ground: anyway the lack of recorded seismic activity in the Hessdalen surroundings is not favourable in this sense, even if it has not been demonstrated yet that stresses from rocks must be necessarily produced by earthquakes. Theories based on the possibility that the *zero point energy (ZPE)* can manifest itself as a quantum fluctuation of the vacuum state are well mathematically developed nowadays (refs. 19, 20): in the specific case discussed in this paper the problem consists in knowing the presumably spontaneous natural mechanism which is able to extract energy from the *ZPE* storage and release it in very specific areas of the world by producing spatially coherent and temporally transient structures such as light spheroids. Certainly, no theory or laboratory experiment is able to explain in a satisfactory way the typically very long duration of the Hessdalen luminous phenomenon, which is up to a factor 100 higher than the life-time of the *ball lightning* phenomenon (ref. 52); regarding this, two basic physical problems which still now are far from being understood (refs. 47, 52, 62) can be synthetized in the following question: why is a plasma object, which is characterized by a strong spatial coherence, which is presumably constituted of high-pressure incandescent atmospheric gas, and which has a luminosity of more than 1 Kw, characterized by such a long relaxation-time and which is the exact nature of the external energizer? The apparent capability of the luminous phenomenon to react to laser stimulation by doubling its pulsation rate, is one more unsolved problem: is it a still unknown form of photon-photon interaction?

Is the Hessdalen phenomenon, together with many similar phenomena in the world, a technological and/or energetic manifestation of *extraterrestrial intelligence*? Contrary to the superficial and unscientific arguments of some of the skeptics (ref. 36), such an hypothesis cannot be arbitrarily rejected: in fact it is currently studied by official science too (refs. 4, 10, 11, 15, 16, 18, 24, 26, 27, 30, 33, 34, 37, 41, 60, 65, 68) in the ambit of some specific sectors (such as SETA) of the SETI project, in the context of theoretical studies regarding new propulsion systems, and also by trying to analyze quantitatively UFO reports: but so far, solid and quantitative scientific proofs in this sense have not been produced yet (ref. 9, 39, 67). Surely, before venturing this hypothesis, it is of basic importance to exclude in a first phase any kind of natural cause and/or eliminate any source of bias in the data.

6. CONCLUSION

With this overall puzzling picture of the Hessdalen phenomenon in mind, it is necessary to encourage future improved and high-tech measurements. Intrinsic physical parameters of the luminous phenomenon can be precisely obtained by using radar-assisted astronomy-like photometers and spectrographs (refs. 60, 64): only such technical procedures for data acquisition could furnish a definitive answer in scientific terms to this enigma. Some new built-in sensors have been studied and partly tested by the engineers of Project Hessdalen (refs. 3, 56). Furthermore, wide-range scientific proposals which have been prepared for proving or disproving theories of any type (both canonical and non-canonical) have been developed and published (refs. 62, 65).

We are facing a source of energy of tremendous power which, if definitively understood, could be reproduced in a laboratory and subsequently bridled for our technological necessities such as, for instance, a new ecologically cleaner and more efficient form of propulsion. By now, a still enigmatic phenomenon is out there, sufficiently recurring to allow a systematic investigation, waiting and challenging all scientists who still like to be involved in adventures of the thought.

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