Optical spectrum analysis of the Hessdalen phenomenon. Preliminary report June 2007

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ABSTRACT: Identification of the unexplained luminous phenomenon in Hessdalen has always been difficult to do, since these phenomena's often is mixed up with artificial and natural lights as cars, aeroplanes, meteors, planets etc. Although the Hessdalen phenomena has some spectacular manifestations, like; *"huge blinking and spiralling lightball*", these manifestations are rare, and in most of the cases it shows itself in a more modest manifestation, often mistaken as a natural source of light. The latest development in digital SLR cameras, and the use of transmission gratings to obtain optical spectra, has made it possible to identify the Hessdalen phenomenon, and to find the chemical elements which the phenomenon is made of.



Pic.1 Optical spectra of lights in Hessdalen

Background

The author has been involved in the study of the Hessdalen Phenomenon since 1994, and developed together with Dr. Stelio Montebugnoli at the Italian radiotelescope in Medicina, the EMBLA program in 1999. The main objective of this program was to study the electromagnetic signature/spectrum of the Hessdalen Phenomenon in both the electrical and optical field (Ref.1). Almost every year since 2000, Italian and Norwegian researchers, has carried out field investigations in Hessdalen, the last one in June 2007. During these campaigns pictures of optical spectra's from the Hessdalen Phenomena was obtained and analysis was carried out (Ref. 2 & 3). To further increase the observing time of the sky in Hessdalen, the author launched the "Science Camp" program for students and primary school pupils in 2002. Through this program, base camps were established in the mountains of "Rogne", "Finså" and at the Øyungen Lake. These research stations in the mountains were manned all night long for at least one week in September every year since 2002 (Ref.4). During these campaigns, vital experience about how to obtain optical spectra from the Hessdalen Phenomena was obtained. Different cameras and techniques were tested, and in 2004, pictures of the spectrum from different light sources inn Hessdalen was obtained with good quality, se Pic.1. This picture is taken from the "Finså" mountain towards east, and the "Rogne" mountain is seen in the background. All of these spectra's is produced by artificial light sources, and the type of elements burning can be identified (Ref.5). The rightmost dotted spectrum is coming from a high pressure mercury streetlight, the three in the middle is common light-bulbs with carbon tread and the two at left is most possible neon-xenon lamps. Identification of the type of lightsource was resolved by using optical spectral analysis, and with the introduction of digital SLR cameras in 2006, identification could be done instantaneously, sine no developing of film was necessary.

Observation sites

Experiences from the EMBLA program in 2000 - 2002 made it evident that better visibility and more observation time was needed to obtain necessary data. Traditionally observations has been done down in the valley, at Aspåskjølen and at the BlueBox (marked with blue dots). The Science Camp program carried out mountain expeditions and picked out tree new bases up in the mountains with great visibility and high altitude. These were: 1) Rogne, 2) Finså, 3) Øyungen See picture 2.



Pic.2 Map of the Hessdalen valley with observation sites

These new mountain bases were not easily accessible, and all instrumentations, food, power and housing (tents) had to be carried up by "manpower". The base at Rogne Mountain, the one with the best visibility, was almost 1hr away, climbing, from the nearest road. Se picture 3. Despite the effort of establishing these mountain bases, we gained intensively in data collection.



Pic.3 Wiev towards south from the base at Rogne mountain

Equipment and calibration

The mountain bases was equipped with, Geiger counters, ULF receivers (NASA Inspire), radio spectrum analysers (1kHz - 3GHz), night vision binoculars, astronomical telescopes (Meade ETX 90), video cameras and SLR cameras with optical grating, se picture 4. Two types of SLR



cameras was used, Canon A1 with 800 ASA film and Nikon D70 digital camera with 1600 ASA sensitivity. Processing of the pictures was done by IRIS software (Ref. 6), and "Visual Spec" software (Ref. 7) was used to process and analyze the optical spectra. The optical spectra shown in this report are obtained with Canon A1 equipped with a lens of 50mm f-1.8. Exposure time was always 30 seconds with maximum aperture f-1,8. The film used was Fujicolor Superia X-Tra 800. After developing, the film was scanned at a laboratory with a QSS-30 scanner, format JPEG, resolution 3,47 Mbit. The wavelength sensitivity of the Canon A1 camera & scanner is at this time not known. Two campaigns in Hessdalen this year failed to obtain a reference spectrum of Vega. A spectrum of the star Vega,

obtained with the Canon A1 & scanner, can be used to calibrate the wavelength sensitivity, since the "Visula Spec" software contains intensity calibrated spectra's of Vega and different other stars. The calibrated spectrum is divided with the original spectrum, and a transfer function is obtained. This transfer function is used to multiply all spectrums that are obtained with this particular equipment. The need for intensity calibration can clearly be seen in fig.1. These spectra's is obtained from the web pages of Christian Buil, ref.6.



Fig. 1 Vega spectrum, uncalibrated and calibrated (ref.6 Christian Buil)

Combination of traditional film developing and scanning is impossible to do in "realtime", and is the main reason that old film based SLR cameras is replaced with digital SLR cameras, like the Nikon D70, for spectral analyses in Hessdalen. Since optical spectral analysis of the Hessdalen phenomenon is the only way for proper identification, all other instrumentation in use must wait for this identification. With digital SLR cameras, results can be obtained momentarily in the field, and calibration of intensity is quickly done when calibration of wavelength is carried out. The sensitivity of the CCD in the digital SLR cameras is weak in the blue (>4000Å) and red region (<7000Å), and intensity calibration must always be carried out. The spectra's shown in this report has been filtered 2 times, first by the transfer function of the 800 ASA film, and next the transfer function of the CCD in the QSS-30 scanner. It is suspected that the sensitivity in the blue and in the red area is heavily distorted. Thanks to the work of Christian Buil, (Ref.6), relative spectral response, or "spectral sensitivity", for different digital SLR cameras can be obtained from his web pages. Fig.2 shows the spectral sensitivity for Canon 10D and Nikon D70 digital SLR cameras. We can clearly see how poor the sensitivity are in the red and blue region, and that both of them also suppresses intensity in the yellow area around 5700Å.



Fig. 2 CCD spectral sensitivity for two digital SLR cameras

The Rogne data 2006

The data presented here was obtained during the Science Camp 2006 campaign in Hessdalen. This campaign involved near 30 students and teachers from the period of Monday 18 September to Friday 22 September. Two mountain bases was used, the Øyungen base and the Rogne base. The pictures presented here were shot from the Rogne Mountain towards south. All of the observations were seen inside the dotted oval red circle in pic.1. The visibility towards south from the Rogne base is blocked by the "Skarvan" mountain, and the "Øyungen" lake can not be seen from here. This makes it possible to estimate the distance towards lights that is under the horizon of the Skarvan Mountain. The distance from the Rogne base towards the highest point at Skarvan Mountain is 9000m. The pictures from Rogne is listed in table 1.

Picture #	Picture	HP	HP	Bearing	Distance	HP	Spectre	HP	Comments
	quality	Type	Altitude	Approx	Approx.	Intensity	quality	Lifetime	
28760005	Low	Single	Low	215	3600m	Medium	None	Max 10s	
28760006	Low	Single	Low	215	3600m	Low	None	?	
28760007	Low	Single	Low	215	3600m	Low	None	?	
28760008	Low	Pair	High	215	2500m?	Medium	None	Max 10s	
28760009	Good	Single	Low	240	3000m	High	Weak	Max 20s	
28760010	Very good	Doublet	Low	230	3200m	High	Very good	Min 30s	
28760011	Low	Pair	High	210	2500m?	High	Good	Min 30s	
28760012	Low	-	-	-	-	-	-	-	No spectra
28760013	Good	Doublet	High	200	4000m?	High	Good	Min 30s	Same pos. as 14
28760014	Good	Doublet	High	200	5000m?	High	Good	Min 30s	Same pos. as 13
28760015	Good	Doublet	High	160	6000m?	High	Weak	Max 20s	
28760016	Very good	Doublet	Low	240	3000m	High	Good	Max 25s	
28760017	Good	Doublet	High	200	5000m?	High	Very good	Min 30s	Same pos. as 14
28760018	Very good	Doublet	High	200	5000m?	High	Very good	Min 30s	Same pos. as 14
28760019	Very good	Doublet	High	200	5000m?	High	Very good	Min 30s	Same pos. as 14
28760020	Very good	Doublet	High	200	5000m?	High	Very good	Min 30s	Same pos. as 14
28760021	Very good	Doublet	High	200	5000m?	High	Very good	Min 30s	Same pos. as 14
28760022	Very good	Single	High	200	5000m?	High	Very good	Min 30s	Same pos. as 14
28760023	Very good	Doublet	High	200	5000m?	High	Very good	Min 30s	Same pos. as 14
28760024	Very good	Doublet	High	200	5000m?	High	Very good	Min 30s	Same pos. as 14

Table 1. Pictures shot from Rogne towards south 18-22 September 2006

The Rogne base was equipped with a Canon A1 camera and a grating as described before. The Øyungen base was equipped with a Nikon D70 camera with grating. Picture 4 shows the view of the valley at daytime. The sun symbol marks the church, where a powerful searchlight is turned on by nightfall.



Pic.4 Daytime view from base camp Rogne towards south



Pic.5 Optical spectra obtained from base camp Rogne, same view as pic.4, exposuretime 30 sec.

Picture 5 shows a picture with different spectra's obtained during night-time from the base camp at the Rogne mountain. The Hessdalen phenomenon appears in the middle of the blue star, with its two spectra's marked "spectrum 1" and "spectrum 2". The distance towards the Phenomenon is approximately 3200m. The altitude of the Phenomenon is very low, possible a few tenth of meters over the tree tops. Investigation of the area in June 2007 showed no signs of burned trees ore other marks in the area. Enlargement of the phenomenon shows the classical "doublet lights" as reported in the EMBLA 2001 campaign by M.Teodorani (Ref. 2).

During the four nights of observing from the Rogne Mountain in September 2006, 18 pictures of the Hessdalen phenomenon was obtained, and 6 more from the Øyungen base. The last 6 from Øyungen will not be presented here. During these four days it was possible to obtain 24 pictures of the Hessdalen Phenomenon, and 20 of them with good optical spectra. 10 of these pictures was shot at tree different times, groups of 2 - 4 - 4, and surprisingly showed the phenomenon at approximately the same position in high altitude over the valley, se picture 6. This point is marked "Meeting point" in the picture.



Pic.6 The Hessdalen Phenomenon observed in high altitude over the valley, same position in 10 pictures

At tree different times, the Hessdalen phenomenon shows up at almost exactly the same place in the sky. 8 of these pictures may have been shot in a sequence, 4 - 4, indicating a lifetime of over 4 minutes! Both the high altitude phenomenon and the low altitude phenomenon have the same "doublet" appearance.

The intensity of the spectrum in picture 5 & 6 is high, and is characterized by the lack of yellow and low intensity in the blue region, se picture 7 & 8.



Pic 8 Spectrum 3 of HP in pic.6 700 x 50 pix resolution

15 of the pictures obtained from the Rogne Mountain shows a spectrum of the Hessdalen Phenomenon with the same characteristics, the major intensity is in the red and green band of the optical window. These characteristics are comparable with the findings in 2001 (Ref. 2). It must be stressed that none of these spectra's has been intensity calibrated as a function of the wavelength.

Intensity plot

Picture 7 and 8 was converted into FIT's format by using IRIS software. This format could then be processed by the "Visual Spec" software seen in picture 9. In the upper window the black and white FIT's format picture is displayed with a red "binning area" around. Intensity counting's of every pixel is summed vertically, each row at the time from left to right, restricted by the zone inside the red "binning area". The result of the binning gives an intensity plot shown in the lowest window. The horizontal axis shows pixel number.



Pic. 9 Intensity plot of spectrum 3 calculated by Visual Spec software

After using the same process for two of the best pictures obtained, regards to the spectrum intensity and signal-noise relationship, intensity plots of spectra's in picture 5 & 6 was obtained. This is shown in picture 10 and 11. The plots are displaced 20 pixels horizontally.



Pic.11 Intensity plot of spectrum 3

Wavelength calibration using reference spectrum

Calibration of the intensity plot regards to the wavelength was done by identifying emission lines in known spectra's in picture 5. The reference light to the left in picture 5 was identified as a high pressure mercury streetlight, possible Osram HQA, or a similar mercury xenon lamp. These lamps have very distinct emission lines, and were identified thanks to the web pages of I.N.Galidakis, ref.5. Spectra of Osram HQA 80W obtained by I.N.Galidakis is shown in pic.12.



Pic.12 Spectrum of Osram HQA 80w by I.N.Galdiakis, ref.5

The Osram HQA spectrum was used to identify the lines in the reference spectrum in pic.5. The reference spectrum is shown in picture 13 together with the lightsource at the right side.



Pic.13 Reference spectrum of streetligth in Hessdalen

The "Visual Spec" software calibrates the intensity plot as long as only two emission lines is known. In picture 14 the identification of the emission lines of 4050Å and 4920Å is shown.



Pic.14 Wavelength calibration with emission lines 4050Å and 4920Å

Wavelength calibrated spectrum

The reference spectrum, and the calibration of the picture with this, gave us the resolution of 11,09 Å/pixel. This information is used to calibrate any other spectrum in the picture as long as only one position is known. In this case, the lightsource act as the common point for all spectra's, and the reference spectra and the spectra of the Hessdalen phenomenon is adjusted regards to the position of the lightsource in both spectra's, this is shown in picture 15.



Pic.15 Adjusting reference and HP spectra regards to wavelength

When the adjusting is done, the program can apply the same horizontal axes for both intensity plots, and the wavelength calibration of the reference spectrum is applied to the HP spectrum. This gives the wavelength calibrated spectrum of the Hessdalen phenomena, shown in pic.16



Pic. 16 Wavelength calibrated spectrum of the Hessdalen phenomena

Identification of emission lines

The "Visual Spec" software has an automatic line identifying software package which links the wavelength of the emission line to chemical elements in the periodic table, their relative intensity and ionisation level. This package also adjusts for the resolution 11Å/pix and the digital sampling error, and gives suggestion of different elements inside the "error range" This is shown in pic.17 for the dominant emission line at 5281Å.



Pic.17 Automatic line identification with error range

A lot of the elements suggested by the program have a very low relative intensity, and the dominant line at 5281Å can hardly be created by intensities under 100. A list of the elements with relative intensity over 100 is shown in table 2.

Element	Line (Å)	Intensity
AL2	5280,2	150
N1	5281,2	185
TI1	5283,4	140
AL2	5283,7	290
SC1	5285,76	210
AL2	5285,8	150

Table 2. Elements inside the error range for the dominant line at 5281Å

As seen in table 2, nitrogen, at ionisation level 1, N1, is direct in the middle of the emission line at 5281,7Å, with an error of only 5Å. Inside the error range, both AL and SC has higher intensity than N, and may also contribute to this line. Since it has been impossible to calibrate the intensity of the spectrum at this time, the intensity values must be regarded with outmost care, taken in mind that the lines in the blue and red area is heavily distorted and suppressed.

Using the line identification program on all of the dominant lines in the spectrum, and only take into account lines with relative intensity over 100, gives us a preliminary suggestion of what the Hessdalen phenomenon is composed of. The error range is large, and the resolution is low, but it gives us a clue of what kind of elements that "burns" inside the Hessdalen phenomenon. The most dominant lines inside the error range suggest that the Hessdalen phenomena is composed of the elements listed in table 3. This also correlates with findings by M.Teodorani in 2001, ref.2.

Element	Emission lines (Å)					
N1	5281	5674	5829			
N2	5535	5927	5932			
N3	5314					
01	5435	5436	5958			
O3	5592					
SC1	5349	5414	5724			
SC2	5657					
HE1	5875					
FE1	5405 ?	5616				
SI2	5405 ?	5466	5469?			

Table 3. Preliminary suggestion of elements burning inside the Hessdalen phenomena

Since we have identified emission lines, at least the Hessdalen Phenomena must be made of a gas and not a solid. This is also suggested by a 3D intensity plot of the Hessdalen "doublet" light source as seen in picture 18, which also correlates with findings in 2001 by M.Teodorani., ref.11.



Pic 18, 3D intensity plot of the "Doublet"

Discussion

This is only a preliminary report, and more detailed analysis of the data must be done. The findings are based on data which is not intensity calibrated, and the wavelength calibration gives us a very low resolution of only 11Å/pixel. This preliminary work gives us some new hypothesis that must be supplied with new data of better resolution. The preliminary findings suggest the following hypothesis:

- The Hessdalen phenomena is composed of ionized gas, not a solid.
- The dominant chemical elements is O and N, suggesting that this is "burning" air.
- Other elements like SI, sand, and some metals FE, SC, TI suggest dust from the valley.
- The occurrence of SC, Scandium, a rare Norwegian metal, suggest why the phenomenon is only located in Hessdalen, a valley known for its metal mines.
- Scandium, SC, reacts vigorously with acid and air, and may be the ignition mechanism.
- TI, titan, is the only element that burns in nitrogen and may explain the long living time.
- Titan is used in fireworks, and makes spectacular fires.

This hypothesis suggests that the Hessdalen phenomenon is made up of dust from the valley, which ignites due to the fact that Scandium reacts rapidly with acids and air (ref.9+10). The dustcloud burns, rises in the air, and hovers in the same position, or guided by the wind, until the fuel, titan, iron and scandium is burnt out.

Scandium is a rare metal, and was first found in Norway, in the mineral "Thotveitit". This hypothesis suggests that Hessdalen like phenomena is localized to areas where this mineral can be found, and is why the phenomena seems to be localized in certain areas and not others.

The use of high resolution spectrographs is of high importance in the future research of Hessdalen like phenomena. The use of these spectrographs will give insight into the elements which these phenomena's are composed of. At least this report shows that it is possible to obtain optical spectra's of the Hessdalen phenomena, and to start a discussion of what it is made up of and why it burns for so long.

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