

Physics of Atmospheric Luminous Anomalies A Sieve for SETI ?

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Abstract. Anomalous atmospheric light phenomena recur in many locations of Earth, some of which have become a laboratory area for a rigorous instrumented study of the involved physics. Three Italian missions to Hessdalen (Norway) furnished crucial multi-wavelength data, the analysis of which has recently permitted us to establish that the very most part of light phenomena are caused by a geophysical mechanism producing light balls whose structure and radiant characteristics are very similar to the ones of ball lightning. While most of light phenomena in Hessdalen and elsewhere can now be successfully explained within the framework of a natural mechanism, a residual of “locally overlapping data” remains presently unexplained. To investigate them also the ETV (Extraterrestrial Visitation) working hypothesis is taken into account. It is shown how the search for ETV (SETV), consistent with the assumption of interstellar and galactic diffusion, can be carried out only from a rigorous data screening coming originally from the study of natural phenomena.

A world-wide phenomenon

Strange light phenomena are recurrently seen in several locations of Earth, of which at least 35 are documented with photos and some scientific measurements (see Table 1). Such phenomena appear, both in the sky and close to the ground, like multicolor “light balls” characterized by irregular pulsation and erratic movements. The time correlation of light phenomena with oscillating magnetic fields is probably the most intriguing observational result which was obtained in some areas of Earth like Hessdalen in Norway (7), Minmin in Australia (7), Yakima in USA (2) and Popocatepetl in Mexico (7), thanks to professional researchers such as Erling Strand, David Akers and Marsha Adams (1). The light phenomenon which is reported in the Hessdalen valley in central Norway (7) is probably the most known in the world, due to the fact that since 20 years it is under scientific field study using several kinds of techniques such as magnetometry, radar scanning, radio and optical spectrometry, optical photography and video. Engineer Erling Strand, assistant professor of Østfold University College, has been the pioneer of this research since the late 1984. He and his staff of “Project Hessdalen” demonstrated that the Hessdalen area can be used as a laboratory for the study of this kind of atmospheric anomaly. For this reason they installed a permanent observatory in that area, from which since 1998 it is possible to acquire automatically and continuously video data and occasionally measurement data with electromagnetic instrumentation (7, 12). The rich statistics which we obtained from the data furnished by the Norwegian observatory, shows that the light phenomenon is spatially uniformly distributed and tends to appear more often in the winter season and in the hourly interval between 09.00 p.m. and 01.00 a.m. local time (12, 14). The light events do not show any correlation with solar activity.

As an Italian group of physicists and engineers of the Radioastronomy Institute in Bologna (Italy), we have been collaborating with Strand and his colleague Bjørn Gitle Hauge for several years, also by carrying out instrumented expeditions in 2000, 2001 and 2002 in the Hessdalen area which permitted us to obtain several crucial measurements (12, 15). Electronic engineers Stelio Montebugnoli, Jader Monari and Marco Poloni monitored constantly the Hessdalen valley by means of spectrometers operating in the frequency range 300 Hz - 20 KHz (ELF-VLF: Extra Low Frequency - Very Low Frequency) and of a UHF (Ultra High Frequency) pulse radar. Together with astronomer Simona Righini and physicist Gloria Nobili, I concentrated on the acquisition of photographs, videos and low-resolution spectra of the light phenomenon, and on the analysis of ELF-VLF data and the collection of ground samples (12, 15). Some portable instruments such as

IR-viewers, ultrasound and electric field detectors, and a high-speed optical radiometer, were used as well by all of us.

More recently I analysed photographs, video frames and spectra of light phenomena which recur or suddenly appeared in Australia (17) and Canada, after training scout observers to use diffraction gratings (*SpecNet* initiative). Joint field missions have been recently carried out in other world locations too, such as the Arizona desert, in collaboration with the IEA organization (1, 16) and the Sibillini mountains in Italy (14).

TABLE 1: Locations where anomalous light phenomena recur.

AREA	STATE	LATITUDE	LONGITUDE	INSTRUMENTED MONITOR
HESSDALEN	Norway	62° 49' 17" N	11° 12' 07" E	Magnetometry / Radio / Radar / Photo / Video / Spectra
YAKIMA	USA	46° 34' N	120° 32' W	Magnetometry / Photo / Video
BROWN MOUNTAINS	USA	30° 40' 05" N	104° 05' 30" W	Photo / Video
TAGISH LAKE	Canada	60.3° N	134.3° W	Photo
MARFA	USA	30° 18' 28" N	104° 01' 13" W	Magnetometry / Photo / Video
PINE BUSH	USA	41° 36' 29" N	74° 15' 00" W	Magnetometry / Photo Stereo
VICTORIA	Argentina	35° S	70° W	Photo
CERRO URITORCO	Argentina	30° S	64° W	Photo
PERM	Russia	56° N	60° E	Photo
POPOCATEPETL VOLCANO	Mexico	19° N	98° W	Magnetometry / Radio / Photo
PIEDMONT	USA	37° 09' 14" N	90° 41' 45" W	Magnetometry / Radio / Photo / Triangulation
MIN-MIN	Australia	22° S	139° E	Magnetometry / Radio / Photo
HARDIN	USA	40° 32' 20" N	83° 34' 31" W	Photo
LAKE ONTARIO	Canada	43° 06' 00" N	79° 04' 00" W	Video / Telescopic Photo / Spectra
SEDONA	USA	34° 50.92' N	111° 47.31' W	Photo
SASSALBO	Italy	44° N	10° E	Photo
CLUJ NAPOCA	Romania	46.78° N	23.62° E	Photo
TATRA MOUNTAINS	Poland	49° N	20° E	Photo
MUSINÉ MOUNTAIN	Italy	45° 06' 54" N	07° 27' 20" E	Photo
VALCONCA	Italy	44° N	12° E	Photo
SOLIGNANO	Italy	44.8° N	10.28° E	Photo
TWENTE	Holland	52° 26' N	06° 58° E	Photo
ARENDAL	Norway	58° N	8° E	Photo
SIBILLINI MOUNTAINS	Italy	42° N	13° E	Photo
BOYLE	Ireland	53.58° N	8.18° W	Video
BYRON BAY	Australia	28° 38' 15" S	153° 38' 14" E	Video
AVALON BEACH	Australia	38° 02' S	144° 29' E	Photo / Video / Spectra
SPOKANE	USA	47° N	117° W	Telescopic Photo
ARIZONA DESERT	USA	34° N	112° W	Video / Spectra / Radio / Triangulation / Geiger
DUNDEE	USA	43° 39' 19" N	88° 09' 52" W	Photo
WU TAI SHAN MOUNTAIN	China-Tibet	34°- 41° N	110°- 114° E	Photo
LONGDENDALE VALLEY	Great Britain	53° 26' 58" N	01° 56' 43" W	Photo / Video
MONTERREY	Mexico	25° 40' N	100° 18' W	Photo / Video
SASKATCHEWAN	Canada	50° 51' 00" N	101° 43' 00" W	Photo
SAGUENAY	Canada	48°22'59" N	70°45'00" W	Photo
NONG KHAI	Thailand	17.88° N	102.74° E	Photo

Scientific results of the Italian expeditions to Hessdalen

After eliminating a lot of man-made noise and spurious signals, we noticed that the ELF-VLF radio data showed very often unusual signals characterized by inclined lines with a marked Doppler feature (12, 15). From the measured frequency ν , by using the classic relation given by $\pm v = \pm c (\Delta\nu / \nu)$, we determined the velocity v of the emitting source, which was fastly changing within several seconds from 10,000 to 100,000 km/s. The inclination of the lines was almost periodically and gradually changed from negative (blue shift) to positive (red shift) in a lapse of few seconds, by showing that the source was alternately approaching and receding from the observer. Many cycles were occurring for a time interval as long as half an hour, by starting and finishing abruptly like if some transient electromagnetic phenomenon was turned on and off. In order to interpret this evidence I have proposed an ad-hoc empirical model, where high-energy particles are accelerated and collimated by a cylindrically symmetric magnetic field whose axis is misaligned in comparison with the rotation axis of a strongly rotating body. In this framework the observer is able to

register periodically blue and red-shifts. Very high energies for particles - presumably electrons - and very strong magnetic fields are necessary in order to produce the observed effect. This mechanism seems to be the small-scale version of the synchrotron radiation which is observed in fastly spinning objects such as the pulsars in astronomy. The Doppler phenomenology was recorded mostly when the light phenomenon was not in sight. After scanning the sky and the top of the hills with the IR-viewer we verified sometimes that a normally invisible light phenomenon was detectable in the near infrared.

Many times we were able to assist to the apparition of the light phenomena (12, 14, 15). Both visually and photographically we verified that the light phenomenon is always preceded by very short-lasting flashes of light which appear everywhere in the valley and which emit a power ranging from 10 to 300 W. Sometimes we recorded such flashes at a very short distance from us. The 3-D light-distribution of the illuminated surface of phenomena, which in optimal atmospheric conditions shows to be steep and rectilinear, is drastically different from the one - a Gaussian and exponential distribution - which is expected from a standard plasma. Luminosity is time-variable with a rate of one second or less, and a power up to 20 kW is produced in the phases of maximum. In most cases irregular or semi-regular pulsations are terminated in few cycles with an average event duration of 5 seconds, in other cases many cycles are continued for a period as long as several minutes or more. Luminosity increases in a drastic way because of the sudden apparition of many smaller light balls around a larger luminous core. Due to this the luminosity increase is only caused by the dimensional increase of the composite light surface which is formed by a cluster of light balls. Some of the secondary light balls are often ejected from the core. The phenomenon produces light by maintaining a constant color-temperature, by behaving like a lamp with "on" and "off" phases. The spectrum of a cluster of three light-balls colored in white, red and blue, shows three well-distinguished peaks which are about 500 Angstroms wide, anyone of which may resemble a light emission feature which is very similar to the one produced by LED (Light Emitting Diode) illumination systems. The color temperature derived from the spectra is consistent with the colors of the light balls as they were recorded in the obtained photograph.

Approximately 5% of the sightings reported and recorded during the three Italian missions were characterized by light-phenomena with a geometric or symmetric shape and sometimes by translucent or low-luminosity apparently structured objects (12, 14, 15).

The light phenomenon often shows strong radar tracks, which transiently appear and disappear, also when it is optically faint or almost invisible. In some cases in which it is visible, it shows no radar track. Velocities can reach values up to 100.000 km/h (E. Strand personal communication).

Some slightly radioactive powder was collected by us very close to a spot where the light phenomenon approached the ground; an analysis carried out at the SACMI Imola laboratories using plasma spectroscopy, X-ray diffraction and scanning electronic microscopy showed the evidence of sphere-like iron particles of micrometric dimensions (15).

This is all what came out from our three expeditions to Hessdalen in 2000, 2001 and 2002.

Natural phenomena vs. unknown phenomena in Hessdalen

The natural laboratory is just out there, inside our world, and is manifesting itself since a very long time. Physical science has at disposal a lot of sites which can be scientifically monitored by using highly sophisticated sensing instrumentation (14).

Several theories have been considered to explain the light phenomenon occurring in Hessdalen and the electromagnetic field which seems to be correlated to it. One theory was finally found, which is able to explain most of the data recorded by us (15): this theory is due to physical chemist David Turner. It consists of a thermo-chemical mechanism (21) producing and maintaining light balls whose structure and radiant characteristics are very similar to the ones of ball lightning. In a first phase, air can be ionised by tectonic stress causing simultaneously piezoelectricity and the emission of VLF and UHF waves (20). In a second phase, the formed plasma can bind with water and aerosols to create a hot sharp-edged light ball with a cool water-and-ion coat, in which electrical and thermo-chemical energy exchanges occur. Surface energy re-minimization can determine both ball clustering and ball ejection effects. The typical erratic motion and kinematic characteristics can be explained by asymmetries in the layer of droplets of the light balls, which can be caused by changes in either the chemical or electrical state. In the specific Hessdalen case or elsewhere, a possible spontaneous production of almost mono-disperse quantum dots might come from mould spores, as the main semi-conducting elements, decomposed by the central plasma of the light ball. This could explain successfully not only the recorded LED-like spectrum but also the existence of balls of

distinctly different colors. Therefore Turner's thermochemical model is able to explain as a natural phenomenon at least 80% of the data collected by us.

Other evidence we found in Hessdalen constitutes another anomaly inside the main anomaly (15). We cannot yet confirm that the lights really are associated with Doppler-like signals in the ELF-VLF range or with the deposition of metallic particles. Therefore a sound comparison of these findings with Turner's model is not yet possible. On the other hand, Turner's model is not able to explain the geometric shapes or structures that were recorded by us in a small minority of cases. It is not yet known whether these manifestations are different and rarer aspects of the same "standard" light phenomena or whether they are distinct phenomena that overlap with the standard one for some unknown reasons. A similar strange mixture of "standard earth-light phenomena" and very exotic features are reported in other locations of the Earth too. This uncomfortable side of the anomaly constitutes valuable observational evidence and must be investigated more deeply. Also, working hypotheses different from those covering natural "earth lights" should be followed up. This research must be conducted by considering how far standard physics can take us, but also with some parallel attention to those other anomalies whose possibly spurious relevance should be investigated. This means simply following one of the main prerequisites of science: methodological rigour.

The role of SETI

Methodological rigour can be applied to everything, including the possibility that Earth is being visited. By using appropriate diffusion equations it is possible to predict the interstellar expansion of galactic civilizations as a process which is expanding like a wave (4, 6, 18). The wave speed comes out at $\sim 10^{-3}$ light years per year. This implies that intelligent civilization could settle the entire galaxy in only 60 million years. Compared with the age of our galaxy ($\tau = 10^{10}$ yrs), this means that galactic post-migration colonization would occur during a time interval which is at least 150 times smaller. Earth itself may have been visited numerous times since the arrival of homo sapiens and much before. These are strong scientific reasons for the systematic search for proofs of extraterrestrial visitation both inside the solar system and on our planet.

In the general context of the SETI project a new branch named SETV (*Search for Extraterrestrial Visitation*) was officially born at the end of the nineties in the NASA ambients and has been very recently developed (3, 5, 8, 9, 10, 13, 20). The goal of this research, which is also called "Local SETI", is of studying the possible evidence of visitation of "exogenous probes" inside our solar system. The SETV strategy (8) is devoted to the monitoring of the entire solar system, including Earth, inside an ideal sphere with a radius of 50 astronomical units. This project involves the use in the very next future of space satellites equipped with specific detectors such as high-sensitivity infrared CCD cameras, and of ground-based stations such as radars and radiotelescopes connected with multichannel spectrum analyzers, wide-field and small-aperture optical telescopes (for search) and large-aperture optical telescopes (for analysis). These planned monitoring operations may allow researchers to search for the possible evidence of anomalous celestial objects associated with low-luminosity exogenous probes, including "Dyson spheres", which are presumably located, according to predictions, in energetically favourable zones such as the Earth-Moon libration points, the asteroidal belt, the Moon and the circumlunar and circumterrestrial orbits. On the basis of physical theories derived from general relativity it is also hypothesized that ET civilizations of superior level may be able to use space-time tunnels such as "wormholes", which would shorten a lot the time of travel.

Even if it is unanimously recognized that at present no scientific proofs exist that Earth has been visited, the SETV project considers also the possibility to monitor Earth with proper instrumentation (3, 8, 9, 13). The presence on Earth of explorative devices of possible exogenous origin, would appear necessarily like anomalies in our atmosphere. These anomalies might be eventually sighted as luminous phenomena in the skies of some areas of Earth. The existence of long-duration ET civilizations can be predicted by the theories of stellar evolution, especially when one considers the very long duration of a low-mass solar-type star. If the visiting probes (including also nano-probes) come from civilizations which are highly more evolved than ours the anomaly which they would be able to create in our atmosphere might be of a nature which cannot be predicted at all. What presumably comes from an highly evolved science might appear like magic even to the eyes of our present science. On the basis of this work-hypothesis a network of instrumented sensing stations (both automatic and not) is planned to be placed in the next future in specific areas of Earth where anomalous atmospheric events are reported very often. Instruments such as small telescopes of both photometric and spectroscopic type coupled with high quantum-efficiency CCD detectors, spectro-radiometers, sensors operating in the near infrared and near ultraviolet wavelength windows, detectors of high-energy events (X and Gamma), radio spectrum analyzers operating both in the ultra-low frequencies (ELF-ULF) and in the microwaves (UHF), magnetometers and radars for searching and tracking any target, are intended to be used as a basic instrumentation. A pilot project is already operational (3).

Therefore the assumptions which are based on the SETV Project are a possibility like another and must be seriously tested like all the others without any preference. An experiment carried out by Project Hessdalen during the 1984 campaign showed that when a laser was aimed towards a blinking light-ball, that light-ball punctually responded by changing its pulsation rate (7). Was such a reaction a natural consequence of some kind of "photon-photon interaction" or an artificial manifestation of alien intelligence? Very recently a preliminary analysis (17) of the spectrum of light phenomena recorded in Australia has clearly shown that the identified substance producing light cannot be produced by geophysical and/or atmospheric mechanisms and that a possible magnetic field is associated to these objects. The evaluation of videos of such phenomena shows sometimes sharp structures. We do not know yet where such structures come from and which is the physical mechanism producing the related emission of radiation, but we do know that our present physical science might furnish the answer to the specific anomalies which might be crucial for SETI.

Essential references

1. Adams, M. & Strand, E. P., *International Earthlight Alliance*, website, <http://www.earthlights.org/>
2. Akers, D., *The Willard J. Vogel Study*, website, <http://www.vogelstudy.org/>
3. Ansbro, E. (2001), New OSETI observatory to search for interstellar probes, *Proc. SPIE*, Vol. 4273, p. 246-253, "The Search for Extraterrestrial Intelligence (SETI) in the Optical Spectrum III", Stuart A. Kingsley; Ragbir Bhathal; Eds.
4. Betinis, E.J. (1978), On ETI Alien Probe Flux Density, *JBIS*, **31**, n. 2 pp. 217-221.
5. Cornet, B. & Stride, S. L. (2003), Solar System SETI Using Radio Telescope Array, Contact in Context, *NIDS*, <http://cic.setileague.org/cic/v1i2/s3eti-ata.pdf>
6. Jones, E. M. (1981), Discrete Calculations of Interstellar Migration and Settlement, *Icarus*, **46**, p. 328.
7. Strand, E.P., *Project Hessdalen*, website, <http://hessdalen.hiof.no>
8. Stride, S. L. (2001), An Instrument-Based Method to Search for Extraterrestrial Interstellar Robotic Probes, *JBIS*, **54**, No. 1/2, p. 2.
9. Teodorani, M. (2000), Physical data acquisition and analysis of possible flying extraterrestrial probes by using opto-electronic devices, *Extraterrestrial Physics Review*, **1**, n. 3, pp. 32-37.
10. Teodorani, M. (2001), Instrumented Search for Exogenous Robotic Probes on Earth, Conf. Proc. on "First European Workshop on Exo/Astrobiology", 21-23 May 2001, ESRIN, Frascati (Rome), Italy, *ESA SP-496*, pp. 379-381.
11. Teodorani, M. (2002), The physical study of atmospheric luminous anomalies and the SETV Hypothesis, *Open SETI*, http://www.zeitlin.net/OpenSETI/Docs/EuroSETI2002_OSI.htm
12. Teodorani, M. (2003), Anomalous Light Phenomena: 1994-2003 Research Papers, *CFI*, Anomalous Phenomena, http://www.freedomofinfo.org/current_research/anomalous-light-phenomena.pdf (and references therein).
13. Teodorani, M. (2003), SETV: An Extension of SETI?, *SETI Italia*, <http://www.seti-italia.cnr.it/Pagina%20Articoli/SETV.pdf>
14. Teodorani, M. (2003), *Fenomeni Luminosi: Investigazione Scientifica di Fenomeni Luminosi Anomali in Atmosfera*, M.I.R. Edizioni (Book, 159 pages).
15. Teodorani, M. (2004), A Long-Term Scientific Survey of the Hessdalen Phenomenon, *Journal of Scientific Exploration*, **18**, n. 2. In PRESS.
16. Teodorani, M., Optical Investigation of Anomalous Light Phenomena in the Arizona Desert (31 pages). To be published on the International Earthlight Alliance (IEA) Internet website: <http://www.earthlights.org/>
17. Teodorani, M. & Beacham, C., Analysis of optical spectra of unknown luminous objects in the sky of Avalon Beach. In Preparation.
18. The Scientific Search for Extraterrestrial Intelligence (2003), Astronomy Lectures, *Principia*, website, <http://www.gifford.co.uk/~principia/Lectures/SETILectures/index.htm>
19. Turner, D. J. (2003), The missing science of ball lightning, *Journal of Scientific Exploration*, **17**, n. 3, pp. 435-496.
20. Zeitlin, G., *Open SETI*, website, <http://www.zeitlin.net/OpenSETI/Opening.shtml>
21. Zou, You-Suo (1995), Some Physical Considerations for Unusual Atmospheric Lights Observed in Norway, *Physica Scripta*, **52**, pp. 726-730.

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