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Balls of Light: The Questionable Science of Crop Circles

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Abstract—Three papers published by W. C. Levengood (1994), W. C. Levengood and N. P. Talbott (1999) and by E. H. Haselhoff (2001) suggested the involvement of some kind of electromagnetic radiation during the creation of crop circles. Here we discuss the methods and conclusions of the three articles, pointing out the misrepresentation of the experimental protocols, the misleading application of statistical procedures, the arbitrary discarding of unwanted results and the weakness of the proposed physical model to the suggested hypothesis. In particular, we show that Haselhoff's conclusions are unsubstantiated and do not prove the involvement of an electromagnetic radiation source in the creation event.

Keywords: crop circles—balls of light—electromagnetic radiation—statistical models—stem node elongation

The official history of mysterious circular patterns appearing in crop fields began in 1980 when Dr. Terence Meaden's attention was drawn to a formation in a field of oats near Bratton (England) beneath the steep grassy slopes upon which the famous White Horse of Westbury is cut into the underlying chalk (Meaden, 1991).

These "first" circles were called "mystery circles" or simply "rings", but since circa 1988 they became identified all over the world as "crop circles". Crop circles consist of geometrical crop regions, in which the plants (primarily cereals crops) are flattened in a horizontal position.

Over the years, crop circles rapidly gained media attention, evolved from simple circular shapes to more and more complex patterns, and their number increased from dozens at the beginning of their documented appearance to hundreds only some years later. During the 1980s and 1990s, for example, the

number of circles appearing in Britain grew rapidly from only a handful per year in the early 1980s to dozens by the end of the decade and to several hundred in the U.K. alone in 1991.

Many people during the years admitted they had made the circles themselves, but in spite of these confessions, the "believers" continued to deny claims of human involvement as the only origin of the whole phenomenon. Many alternative theories proliferated attempting to explain the possible non-human mechanisms for the circles' creation. Most of the claims about circles were nothing but mere hypotheses that never gained sufficient reliability to hold up upon examination by a peer-reviewed scientific journal. Only three studies were published in a scientific journal: the first one was authored by W. C. Levengood (1994), the second one by W. C. Levengood and N. P. Talbott (1999), and the last one by E. H. Haselhoff (2001). All three papers suggested the involvement of some kind of electromagnetic radiation during the circles' formation. However, in those three papers a list of sufficient conditions (or at least necessary conditions) was not provided in order to establish without any doubt if a geometric formation has or has not been made by man.

Levengood (1994) asserted he had found anatomical alterations (the so-called anomalies) in crop formations which could not be accounted for by assuming a man-made origin of the circles. Among other anomalies that we are not discussing here, he observed an allegedly "anomalous" expansion of the stem nodes of the plants lying inside the crop circles when compared to those outside them (this was the so-called alpha-test, i.e. the ratio of the stem length to node length).

Levengood concluded that these alterations were probably caused by a thermo-mechanical effect due to a thermal expansion of the cell walls directly related to an absorption of electromagnetic energy. During an experiment carried out in Maryland in 1997, Levengood and Talbott (1999) made, by themselves, a crop circle, claiming that the gravitropic response of the flattened plants was no more than about 10% in the three days since the circle creation, too little to explain the elongations observed in the alleged "genuine" formations. We will discuss this assumption later in this paper.

In 1999 Levengood and Talbott (1999) published the results of the monitoring carried out on three simple circular formations at Devizes (England, 1993), Chehalis (Washington, USA, 1994) and Sussex (England, 1994). A fourth case is reported, analysing a more complex spiral formation which appeared in a barley field in Beckhampton (England) in 1995.

It is very important to highlight that two of the three crop circles appeared in areas where numerous known circlemakers live and have been creating crop circles for over a decade. The Devizes formation appeared in an area near Beckhampton, Wiltshire, close to where the first major crop circle hoax occurred at Bratton in July 1990 ("Operation Blackbird"), where an earlier hoax sponsored by national newspapers took place in 1983, where a major group of circlemakers called the "United Bureau of Investigation" lived and made circles

TABLE 1
Experimental Data Measured at Devizes, Chehalis and Sussex Formations. Distance (d) From the Circle Centre and Average Node Length (N_L) Are Reported. The Apex [c] Indicates Data Measured at Standing Central Tufts; Data Indicated With the Apex [e] Are Exterior to the Circle Diameter

Devizes		Chehalis		Sussex	
d (m)	N_L (mm)	d (m)	N_L (mm)	d (m)	N_L (mm)
0.303	6.0	1.110	4.1[c]	0.315	4.6[c]
1.510	4.4	1.825	3.7	1.558	3.5
1.529	5.5	4.543	3.5	4.476	3.3
2.812	4.4	9.109	3.3	4.830	3.4
2.897	4.3			12.224	2.8[e]
3.300	3.3[e]			19.775	2.4[e]
control	3.2	control	2.9	control	2.4

from 1990 to 1991, and where the Wessex Skeptics made formations to test crop circle researchers in the early 1990s. The Sussex formation appeared in an area where the evidence for crop circle hoaxing was less overwhelming than at Beckhampton but where a number of possible circlemakers live. Samples were taken from an area where even the most paranormally inclined crop circle researchers have subsequently admitted that crop circle hoaxing is rife. These samples are also close to the two areas where Doug Bower and Dave Chorley allegedly began making crop circles in the 1980s (South Wiltshire, Alfriston, East Sussex). Both areas appear to have attracted considerable copy-cat hoaxing of the original Doug and Dave circles.

Levengood and Talbott collected groups of 10–15 plants at each sampling location, defined by the distance from the centre of the circle, and averaged their stem node lengths. By plotting the distance from the centre of the circle against the logarithm of the group averages of the stem node lengths they found a linear relationship between the two variables. Thus, the node lengths seemed to decrease from the centre to the edges of the flattened areas following a negative exponential trend (Table 1). The authors suggested that this behaviour agreed with an electromagnetic energy absorption caused by plane wave fronts propagating in the air, according to the Beer-Lambert law, and striking the plants. They described the relationship between the node lengths and the radiation intensity as:

$$N_L = b(I/I_0) = b(e^{-\alpha cd})$$

where N_L is the node length, b a proportionality constant, α the absorption coefficient of the air, c the concentration of absorbing molecules, I_0 the radiation source intensity and I the radiation intensity at distance d from the source.

Two years later, Haselhoff (Haselhoff, 2001) criticised this paper, pointing at two major flaws: the normal node length was assumed to be zero and energy spreading with distance was not taken into account. He then suggested correcting

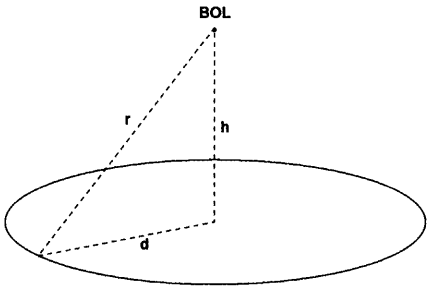

Fig. 1. Geometric representation of the BOL coordinates.

the first error by subtracting a term N_0, representing the average node length of undisturbed (control) plants outside the formations. He implicitly accepted both the questionable sampling strategy of the Levengood and Talbott experiments and the thermo-mechanical hypothesis explaining the node elongation.

Haselhoff's paper focussed on a new model for the electromagnetic radiation allegedly involved in the circles' creation. Analysing the data of the first three above-mentioned formations, Haselhoff identified a reciprocal quadratic trend for the stems' elongation with radial distance. Therefore, he proposed an electromagnetic point source model, assuming it as a "Ball Of Light" (BOL) irradiating the underlying crop field. In order to support his hypothesis he reported, as a counter-proof, the results of a study carried out on a surely man-made formation in Nieuwerkerk in 1997, in which the same reciprocal quadratic trend seemed not to be evident.

The BOL hypothesis consisted of a model describing the decrease with distance of the intensity of a spherical electromagnetic wave front centred at a point source located at a finite height, h, above the field (Figure 1). Though not reported in the article, the model equation can be obtained by simple physical considerations, assuming a $1/r^2$ decrease of the field intensity multiplied by a proportionality constant:

$$N_L - N_0 = b/r^2$$

where b is the proportionality constant and $r^2 = d^2 + h^2$, where d is the distance on the ground from the centre of the circle and h the height of the hypothetical source from the centre of the circle. For each formation the parameter h was optimised to best fit the data to a $1/r^2$ decrease. Scaling the x axis as $1/r^2$ and putting $N_L - N_0$ as the ordinates, if the BOL hypothesis is correct, a high coefficient of multiple determination (R^2) is expected.

Discussion

Because of the sensational scientific contents of this finding and the great impact exerted on world-wide public opinion, a more exhaustive inspection of