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THE ABSORBED ENERGY IN THE SHROUD BODY IMAGE FORMATION APPEARS AS CONTRIBUTED BY DISCRETE VALUES

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ABSTRACT. Starting from the optical density distribution in the Shroud body image and without any assumption on the mechanism that acts at a distance, we deduce that the absorbed energy by the Linen of Turin, related to the human body shape presence, is due to the contribution of discrete energy values.

The scientific investigation on the Shroud, performed in Turin in the October of the 1978 [1] by members of the STURP (Shroud of Turin Research Project), has obtained interesting results about the spectral properties of the Linen of Turin [2–5].

Nowadays, we know that the optical density or the intensity of image of the sheet in the region where the Shroud body image lies is due to two contributions: the first depends on the natural degradation of the cellulose and interests all the linen ($\sim 345\mu m$ thick); the second one (uneven and related to human body shape presence) is added to the former for the depth of a few tens of μm (the thickness of 2 or 3 fibrils) [6].

The present paper is devoted to the analysis of the optical density distribution in the region where the image lies with a resolution of the order of the dimensions of one linen fibril that is about $(10 \div 15)\mu m$.

A macroscopic observation, using a microdensitometer in 13 different locations of the front part of the body image, shows a correlation between the intensity I of the image and the estimated body-sheet distance z [7], well represented by a linear regression:

$$I(z) = I_M(1 - z/R_0) + I_b \tag{1}$$

where $I_M + I_b$ is the image intensity in the contact areas (at $z = 0$) and R_0 the body-sheet distance that makes $I(z) = I_b$, the average background value due to the natural absorption of light and/or heat. Obviously, the first part of the right-hand side $(I_M(1 - z/R_0))$ of equation (1) is related to the human body shape presence contribution, while the distance z can vary in the interval $0 \leq z \leq R_0$.

We think that an analogous $I(z)$ regression line exists also for the back part of the body image. This occurs because the back and front parts of the above image have the same physical and chemical characteristics. Nothing contradicts this hypothesis. The VP-8 analysis [7] shows, in fact, in the body-sheet contact areas is: $(I_M)_{back} \approx (I_M)_{front}$.

Up to now, a mechanism capable to explain the Shroud body image formation is unknown. In any case, we think that two mechanisms [8] have to take into account that the bloodstains on the Shroud occurred before the body image formation [9]. The first (known) mechanism is at contact and determines the resolution power value, the second one (unknown) acts at a distance and yields the above-mentioned $I(z)$ correlation.

In analogy to equation (1), for the absorbed energy per unit area of the linen, we can write a linear function type:

$$E(z) = E_0(1 - z/R_0) + E_b \tag{2}$$

where E_0+E_b is the energy absorbed per unit of surface, in the body-sheet contact regions, E_b is the average value of the energy that the linen receives naturally and z is the distance between the body shape and the center of area. Here, so as for equation (1), the term $(E_0(1 - z/R_0))$ is related to the human body shape presence while E_0/R_0 represents the absorbed energy per unit of volume in the space between the human body shape and the sheet.

With this state of affairs, that shows that the optical density decreases with the body-sheet distance, one expects that the yellowing of fibrils decreases as z increases. On the contrary, a work performed by Pellicori and Evans points out that the yellowed fibrils forming the image have all the same optical density, independently from the distance z [9]. Practically, increasing the body-sheet distance decreases the number of the yellowed fibrils, in agreement with a lower availability of energy because in part it has been absorbed between the human body shape and the sheet.

Therefore, an observation with a resolution of about $(10 \div 15)\mu m$, in the region where there is the body image, shows (independently from the z distance) fibrils with only two possible values of optical density: the one of the background and the other observed by Pellicori and Evans.

As, already, affirmed the $E(z)$ is the energy that has reached the unitary surface placed to z distance. This area contains many fibrils that only in part are yellowed and yield the body image. So, labeling with n_M the number of yellowed fibrils for unitary surface in the body-sheet contact areas, we can write:

$$n(z) = n_M(1 - z/R_0) \tag{3}$$

where R_0 is the distance compatible with the fibril areas that have the average optical density value produced only by the natural action of light and/or heat. This R_0 value coincides, obviously, with the ones of equations (1) and (2).

Moreover, from the ratio between the $E(z)$ and $n(z)$, we obtain $(E - E_b)/n = E_0/n_M$ with $E_0/n_M = \epsilon$, the energy necessary to yellow one fibril. Therefore:

$$E = E_b + n \times \epsilon \tag{4}$$

where n is a discrete variable that assumes only integer values.

This result means that the optical density distribution (not due to the natural degradation of the linen) can not be attributed at the absorbed energy, described in the framework of the classical physics model. It is, in fact, necessary to hypothesize a absorption by discrete values of the energy where the "quantum" is equal to the one necessary to yellow one fibril.

In conclusion, also without assuming any hypothesis for the formation mechanism of the body image, we can state that the absorbed energy is due to the: i) interaction with the e.m. radiation (represented by E_b value), ii) human body shape presence with a $n \times \epsilon$ discrete contribution.

In memory to Raymond N. Rogers (Los Alamos National Laboratory, University of California), member of the STURP. His articles have contributed to the knowledge of the Turin Linen.

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