The reconstruction of the source and mechanism of the formation of the image on the Turin Shroud fabric: a hypothetical qualitative model*

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Introduction

It is well known that there are the face and the rear-view images of a man on the right side of the Turin Shroud. These are formed by dark products found in the cellulose of the fabric fibres.

One of the key problems with regard to the Turin Shroud is the reconstruction of the source that could have produced the said products. It is suggested that the source in question emerged in the course of the Resurrection of Jesus Christ after his crucifixion as a result of the events described in the New Testament.

At present no one can objectively evaluate if the image on the Shroud is due to certain miraculous processes unknowable by scientific methods, to the natural processes, or to a certain combination of both, so this question will be omitted in the present discussion.

I hold, however, that the final stage of the phenomenon under study, namely, ***the emergence of the image*** on the fabric had to do precisely with ***natural processes***. The formation of the image can therefore be studied by means of scientific methods and the specific traits of ***the source of impacts*** can be ***reconstructed***.

Up to now the reconstruction of the source in question has been purely arbitrary and has not been based on established traits of the formation of the human image on the fabric of the Shroud. Attempts at the reconstruction has consequently failed. The present paper envisages the possibility of such a reconstruction through ***the analysis of spatial distribution of dark products in microfibres (microfibrils) of flax fibres of the Turin Shroud fabric.***

The feasibility of the said analysis is based on the following experimentally ascertained data:

1. According to John Jackson's theory, ***the intensity of darkening in a given point of the image on the Shroud fabric,*** i.e., the content of dark products, ***varies directly with the distance from the point on the right side of the fabric to the corresponding point on the body of the man depicted***. Thus, the shorter is the distance from the fabric to the man's body the more intensive is the darkening in the corresponding point of the fabric.
2. To produce a clear image, the action on the fabric emanated by every point of a man's body should be collimated, i.e. shaped into a narrow vertical beam.

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3. Dark products have only been found in the upper microfibres of the Shroud fabric fibres.

1. Setting up the problem

The Shroud fabric, as any fabric, consists of two patterns of perpendicular threads of the warp and the weft. The threads consist of a bunch of twisted /spinned microfibres/microfibrils.

For the reconstruction of the properties of the source of impact I proceed from the following assumptions:

The first assumption is that a fabric is actually a hierarchically organized three-level system of transducers and/or detectors filled with cellulose, a biopolymer prone to oxidation, and air pockets;

- ***The first level*** is formed by flax microfibres in the threads of fabric. These microfibres are cylindrical transducers some 5-10 micrometres in diameter filled with cellulose, with a central cylindrical air channel.
- ***The second level*** is formed by fabric threads being beams of the above-mentioned parallel cylindrical transducers some 300-500 micrometres in diameter.
- ***The third level*** is the fabric as a whole being a two-dimensional system of beams of the above-described parallel cylindrical transducers. These beams form the *x* and *y* planes with regard to the Shroud surface in accordance with the pattern of the serge interlacing of the warp and the weft threads of the fabric.

The second assumption is that air pockets between microfibres in threads and between threads in the fabric play an important role in the above-mentioned three-level system of transducers, since they can intercept the influences emanating from human body at oblique angles. The dimensions of air pockets between microfibres vary from one to several micrometres, and these of air pockets between threads vary from 10 to 100 micrometres.

The impact on the fabric was fairly intensive but temporarily limited.

The third assumption is that the source of influence having produced the image on the fabric was in fact pulsatile.

The fourth assumption is that the influence of the source having produced the image first spread through the air layer between the man's body and the fabric, and then penetrated into the fabric, i.e., interacted with the system of the above-described cellulose transducers in the Shroud fabric.

The fifth assumption is that specific dark-coloured products emerge in the three-level transducer system under the influence of the source emanating from the face and the body of the man depicted. The spatial distribution of these products depends both on the nature and structure of the source and on the structure of the system of the above-described transducers in the fabric.

The sixth assumption is that the analysis of spatial distribution of dark products in microfibres, threads, and the fabric as a whole enables one to make certain important reconstructions of specific traits of the source of influence having emanated from the face and the body of the man represented on the fabric of the Turin Shroud, namely:

- ***to evaluate the nature of the source of influences***, if these influences were emanated by known sources capable of producing dark products in cellulose;
- ***to elucidate the possibility of collimation*** of point sources having produced a clear image on the Shroud fabric.
- ***to estimate the duration of the impulse*** that influenced the fabric;
- ***to reconstruct the configuration of the Shroud fabric*** with regard to the body of the man represented.

The present paper makes no claim to be a detailed analysis of the possibilities of reconstructing the source on the basis of the data on spatial distribution of dark products. I have only tried to make a purely qualitative demonstration of the potentialities of this method.

2. How can the data on spatial distribution of dark products be used for the reconstruction of the main features of the source of influences?

In this section various aspects of the formation of the image on the Shroud fabric are dwelt upon. Moreover, the correlation between possible influences emanating from the human body and the spatial distribution of dark products creating the image is qualitatively analyzed.

2.1. The sources of oxygen and its possible role

As Adler in his latest overview at the Turin conference in March 2000 has shown, the matters having produced the man's image are ***dark-coloured products of the oxidation of the cellulose present in flax fibres***. It is evident that, if Adler's hypothesis is true, the final stage of the formation of dark products was represented by the chemical process of oxidation of cellulose of flax fibres by oxygen.

Consequently, the oxygen concentration in the relevant areas of the zone of formation of dark oxidized cellulose products would be ***the limiting factor*** for the emergence of these products from their predecessors.

The molecules of oxygen (or its activated forms) on different levels of fabric organization could in principle come to the molecules of cellulose from ***the following main sources.***

In microfibres:

- from channels in flax microfibres;
- from the air;
- from micropockets between polymer molecules of cellulose in flax microfibres themselves.

In threads:

- from air pockets between microfibres in a thread;
- from air space between the right side of the fabric and the man.

In the fabric:

- from air pockets between threads;
- from air space between the right side of the fabric and the man.

It is evident that the oxygen must come to the molecules of cellulose ***through diffusion*** from all the above-mentioned sources. This means that the concentration of dark products of cellulose oxidation must correspond to the oxygen concentration gradient. Naturally, the content of oxygen would diminish away from the source ***according to the classical diffusion equation***, i.e. as the square root of the distance to the source.

Therefore the ***analysis of spatial distribution of dark products in microfibres***, threads, and the fabric as a whole would enable one to evaluate, which of the above-mentioned oxygen sources prevailed in the process of formation of the said products.

An additional zone with a ***high concentration of dark products*** exceeding their average concentration in the whole zone should be formed in flax microfibres at the sites of ***maximum oxygen concentration***, i.e.:

- near the **outer surface of microfibres** adjoining the right side of the fabric;
- ***around inner air channels***.

It is worth noting that the ***concentration of dark products both above and beneath the air channel*** in flax microfibres would depend on the radiation energy, if the latter is the source of formation of dark products (see beneath):

- for low ***energy radiations*** with a short path the content of dark products in the zone ***above the channel would be higher*** than in that ***beneath the channel***;
- for high energy radiations with a long path the content of dark products in the zones ***above and beneath the channel would be comparable***.

2.2. The likely nature of the processes having triggered the formation of dark products

To use the data on spatial distribution of dark products, let us consider possible variations of their distribution in "cellulose" transducers characteristic of influences of different nature. Let us analyze the plausible alternatives of spatial distribution of ***dark-coloured products of cellulose oxidation*** in microfibres and threads for various kinds of hypothetical influences that the body of the man represented on the Shroud could potentially emanate.

2.2.1. Chemical influence

Liquid and/or volatile compounds ***containing non-saturated double bonds***, for instance, ***terpene resins*** from fragrances and ***non-saturated fatty acids*** from liquid oils could have been the most plausible chemical agents capable of producing oxidized products in cellulose.

In this case the ***diffusion of possible chemical agents*** through the surface of microfibres and threads would be the ***limiting stage*** of dark products formation.

However, these presumed chemical agents could have produced sufficiently high local concentrations of dark oxidized cellulose products only under the following conditions:

- the ***concentration of agents*** has to be ***sufficiently high***;
- these agents should interact with the fabric ***for a long time;***

- ***oxygen*** is indispensable for the formation of dark-coloured products of cellulose oxidation; the ***speed of the oxygen diffusion*** at the sites of contact between these agents and cellulose should be ***fairly high*** and correlate with that of the diffusion of the chemical agents in cellulose at all the levels of the fabric organization.

It seems highly probable that ***these conditions were not met*** in the course of formation of the image on the Shroud fabric. Nevertheless, it can still be surmised that the image emerged with the aid of unknown chemical agents.

Spatial distribution of dark products in microfibres and threads under chemical influence would be ***typically diffusional,*** i.e. decreasing drastically with the penetration into the depth of fibres.

Given the necessity of a simultaneous oxygen diffusion, the decrease in distribution would be even more steeple.

2.2.2. Thermal influence

In theory such influence could have created the image owing ***to the processes of pyrolysis*** if a high temperature impulse emanated by the man's body were the source of influence. However, no ***clear image of a man*** can emerge as a result of the processes of pyrolysis ***in the course of a long time***, not pulsatile high temperature influence. With high-temperature influence, as with the influence of chemical agents, the ***diffusion of heat energy through the surface of microfibres*** and threads would become the ***limiting stage*** for the formation of oxidized cellulose dark products. Spatial distribution of dark products in microfibres and threads, as under chemical influence, would be typically diffusional, i.e. decreasing drastically with the penetration into the depth of fibres. If dark products would emerge not only owing to high-temperature carbonization but also with the participation of oxygen, the decrease in their spatial distribution would be even more steeple.

2.2.3. The influence of electromagnetic radiation of various energy

Cellulose is transparent for visible light and near ultra-violet radiation if its intensity is not too high. With intensive laser radiation processes of multi-quantum absorption can take place in these spectral regions.

Owing to classical monoquantum processes molecules of cellulose begin to absorb in far ultra-violet over the range of 200-220 nm and continue to absorb under the influence of X-rays and gamma-radiation. The ionization of cellulose molecules and the formation of free electrons take place under these radiations. Cellulose ions and free electrons are source components for multi-stage processes of photo- and radiation oxidation of cellulose, including those with the participation of oxygen and intermediate free radicals. Dark-coloured products of cellulose oxidation having produced the image on the Shroud fabric could have been a result of these processes.

If dark products emerged in the Shroud fabric owing to electromagnetic radiation, their spatial distribution would be characterized by the following peculiarities:

1. ***The depth of the dark products zone*** measured from the surface into the depth of microfibres would depend on the ***energy of radiation***. The ***weaker*** the energy, the ***greater*** the zone depth, and vice versa.

2. If the radiation energy would be ***sufficiently powerful***, dark products would almost ***completely fill the inner volume of the uppermost microfibre*** in a thread and would either completely or partially fill the inner volume of the second and the following microfibres aligned perpendicular to the flow of radiation emanated by human body. If, on the contrary, the ***radiation energy*** would ***be low***, ***dark products*** would emerge only in the ***upper part of the uppermost microfibre*** of the relevant threads. The other, lower microfibres would not be affected by them.

3. ***The concentration of dark products*** within this zone would depend on the energy and intensity of the source of radiation, on the concentration of oxygen in the inner volume of microfibres, and on the duration of impulse, if the radiation source would be pulsatile.

- The ***lower*** the radiation energy, the ***higher*** the concentration of dark products in the zone.
- The ***higher the intensity*** of radiation, the ***higher*** the concentration of dark products in the zone and vice versa.
- The higher the content of oxygen, the higher the concentration of dark products in the zone and vice versa.

2.2.4. The influence of charged particles

The ionizing effect of high-energy charged particles is comparable to that of ionizing electromagnetic radiation.

The effect of charged particles is characterized by the following traits:

- Owing to their more effective interaction with cellulose, ***charged particles*** have a ***considerably shorter path.*** This feature would determine the depth of penetration of these particles as well as the ***spatial distribution and the concentration of dark products*** in microfibres and threads of the fabric.
- ***The content of dark products*** in the zone of penetration of charged particles in microfibres and threads would be ***very high*** or, at least, higher than under the influence of electromagnetic radiation.

2.3. The fabric and its components as a possible collimator of spot influences

A rational explanation of the collimation of influences having produced a clear image of a man is one of the biggest problems of the scientific study of the Turin Shroud.

In this paper I propose a hypothesis concerning the origin of collimation of the influence emanated by every spot of human body. The ***three-level system of "cellulose cylindrical transducers" formed by microfibres, threads and the fabric*** of the Turin Shroud themselves can act ***as the collimator*** in question.

Let us assume that ***electromagnetic radiation with a relatively low energy***, for instance, ***the visible and/or ultra-violet light***, had become the source of influences that produced the image. ***The refractive index*** of these radiations for cellulose flax microfibres ***averages 1.5.***

Microfibres are nothing but cylindrical lenses with regard to such radiations projected on the surface of a fabric. Their focal distance and resolving power depend on the diameter of flax microfibres and average some 5-10 micrometres. ***Microfibres can therefore focus radiations*** perpendicular to the line running from a spot on the body towards the surface of the fabric.

At the same time, ***air pockets between microfibres*** would ***cut off rays*** spreading at other angles to the surface of the fabric! Thus, the three-level system ***of "transducers" and detectors of microfibres in a thread focusing radiation*** as well as that ***of air pockets between microfibres in threads cutting off radiations at oblique angles*** would in fact ***collimate influences*** emanated by every spot of human body! A ***collimated and focused image of human body*** can emerge, under certain conditions, within microfibres of the Shroud fabric. In this case threads and the fabric as a whole would become a ***two-dimensional system of spatially arranged and divided by air spaces lenses*** for rays ***spreading perpendicularly to the surface of the fabric***!

Therefore threads and the fabric as a whole can be considered as a specific ***analogue to the faceted eyes of the insects***! The image of real objects is formed in faceted eyes of the insects as an orderly mosaic of separate fragments of a given object in every facet of the eye! The man's image on the fabric could have been created on the model of ***"the mosaic of faceted images"*** with the aid of a ***"facet" consisting of microfibres*** arranged according to the above-described principle as a system of fibrous transducers.

It is evident that the ***possibility for a fabric to act as a "faceted eye" capable of producing a man's image*** would depend on the energy of radiation, if electromagnetic radiation was the source of influence emanated by the man. A prerequisite to the creation of the image on this model would be the ***relatively high refraction indexes*** of ***cellulose fibres for this kind of radiation.***

A fabric can also act as a "faceted eye" under the influence of fairly low-energy charged particles and the like. In this case the ***cellulose of microfibres*** would be a ***"detector" or "transducer"*** for ionizing particles while ***air spaces*** between microfibres would, as in the case of electromagnetic radiation, cut off particles spreading at other angles to the fabric surface and thus ***play the role of collimators***!

The analysis of the conditions to collimating and focusing the influences through the three-level system of "transducers" and "detectors" in the shape of microfibres in a thread and spaces between them will be carried out in subsequent papers.

Conclusion

The present paper offers a rational hypothetical model of the formation of the image on the Turin Shroud.

Various kinds of influences emanated by human body and capable of producing dark products of cellulose oxidation in flax fibres are dwelt upon.

In this model flax microfibres and fabric threads as well as air spaces between them are considered as the very device collimating different kinds of plausible influences and focusing them on the fabric. Collimated and focused influences, emanated by every spot of human body, can in principle create man's image on the Shroud fabric on the model of the "faceted eye" of the insects.

In the context of the model there exists a correlation between spatial distribution of dark products creating the image and the nature of possible influences that can be emanated by a human being.

The present paper is but a first, purely qualitative stage of application of the said model. Nevertheless, the analysis of spatial distribution of dark products within the framework of this model enables one to build the reconstruction of the source of influences on a rational scientific foundation.

Figure 1

The scheme of linen microfibre

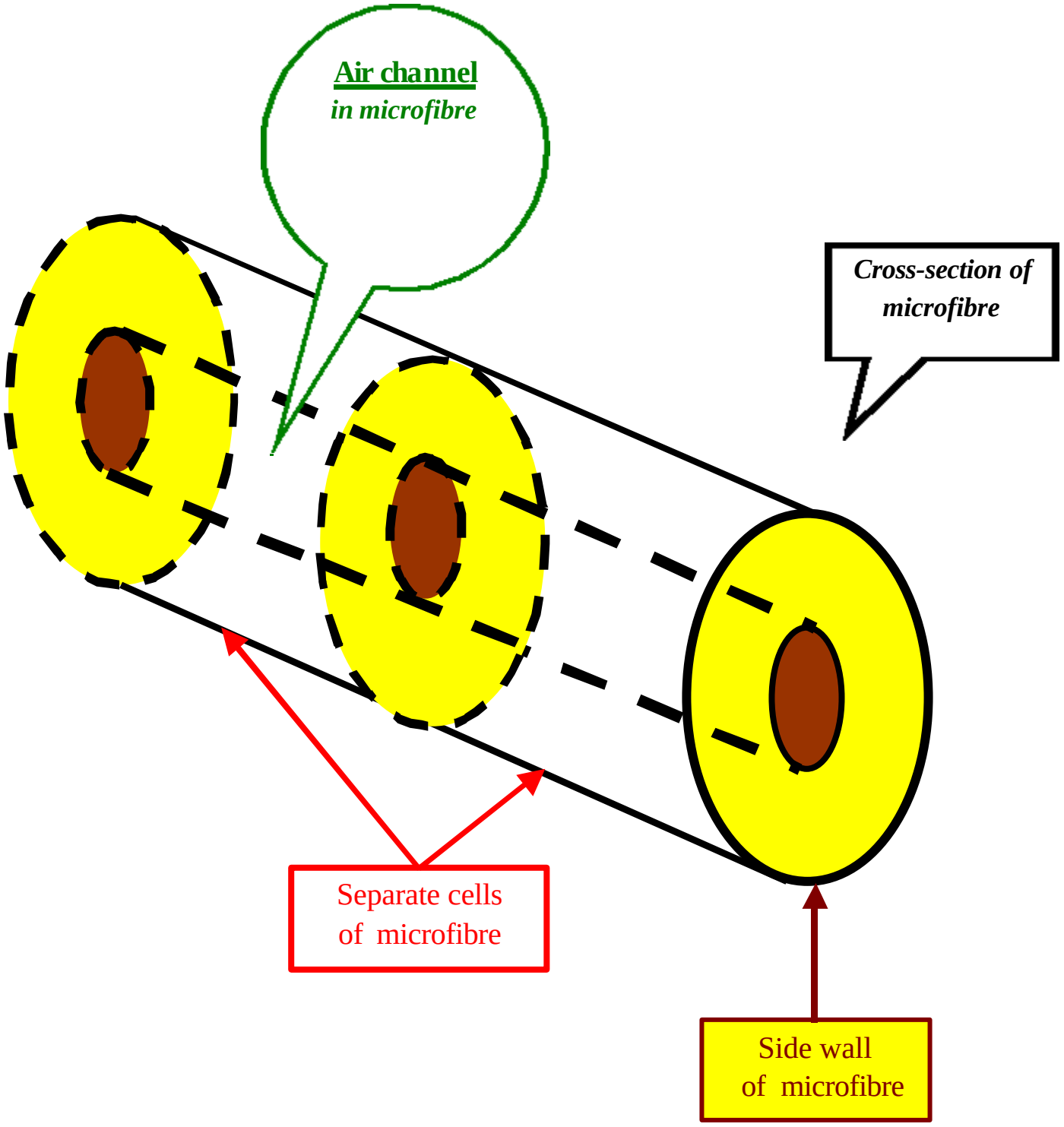

Figure 2

Sources of air in microfibre

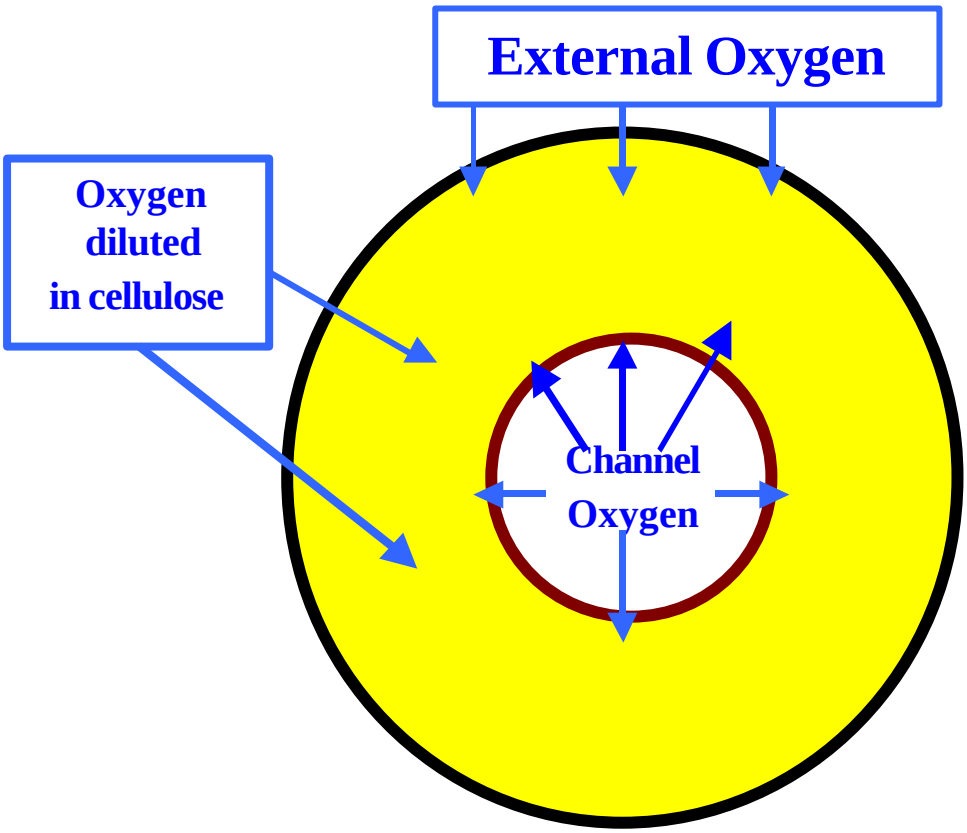

Figure 3

Zones of most dark product content in microfibres, connected with higest oxygen concentrations

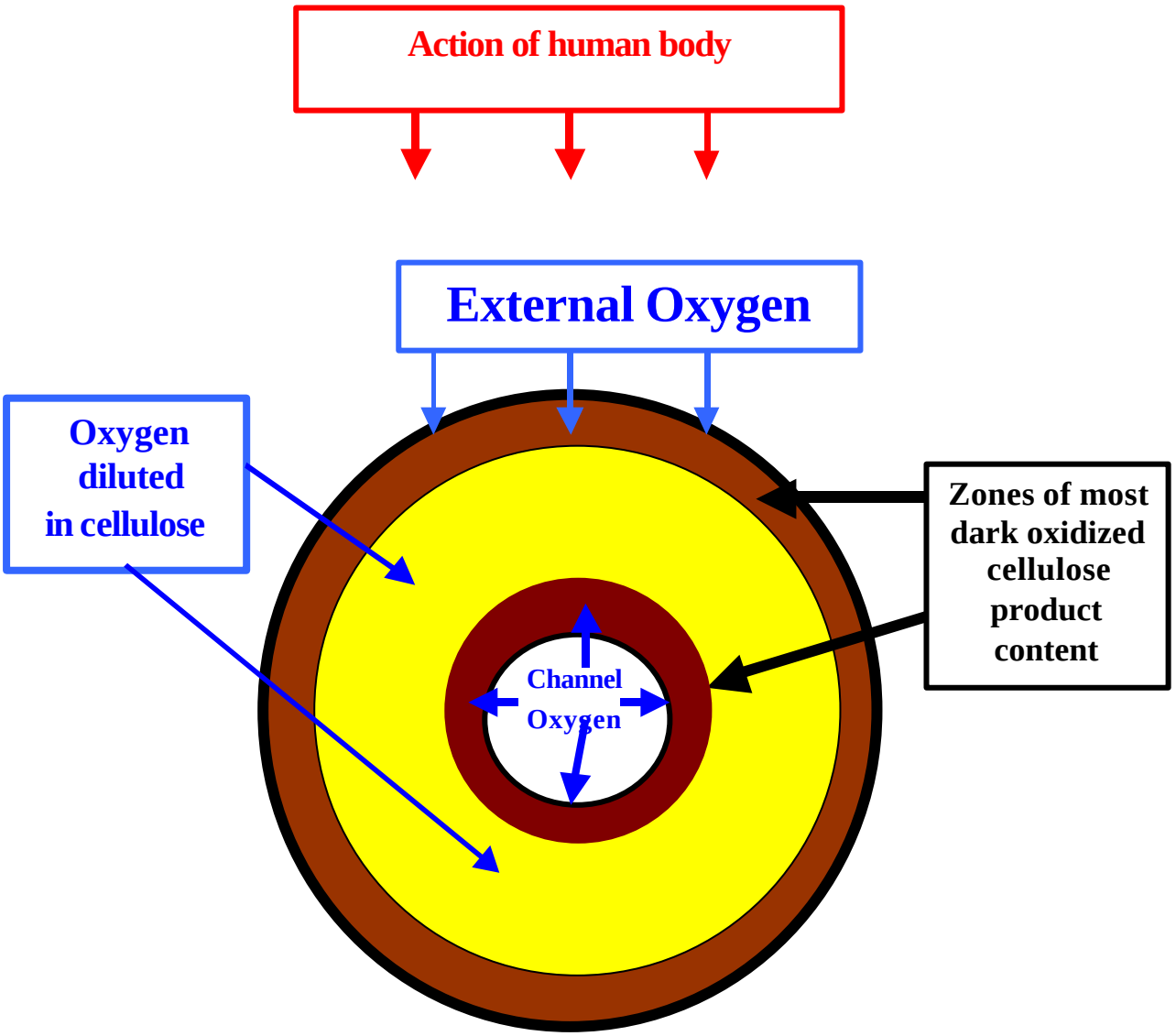

Figure 4

Hypothetical spatial distribution of dark oxydized cellulose products for chemical influence of human body

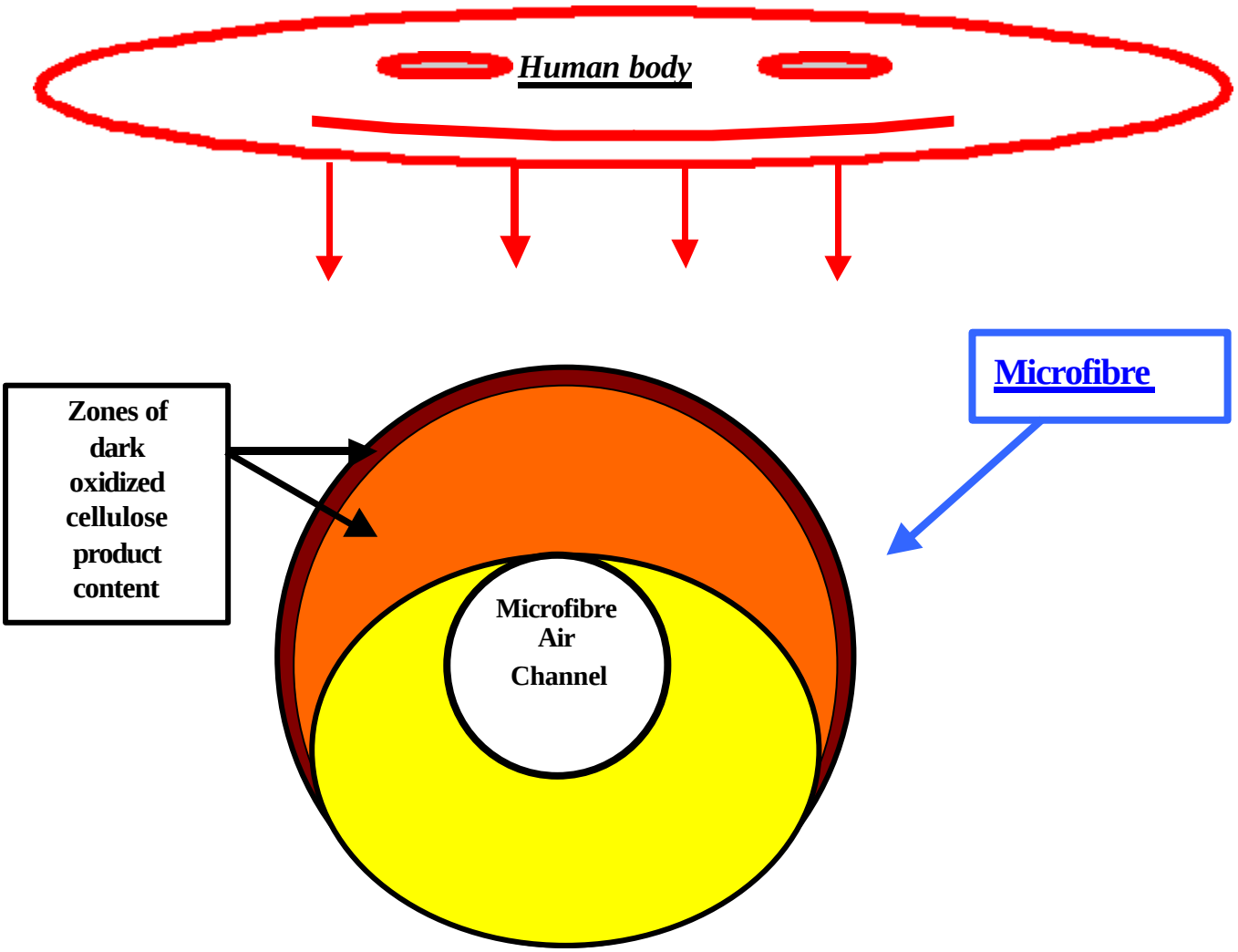

Figure 5

Hypothetical spatial distribution of dark oxydized cellulose products for thermical influence of human body

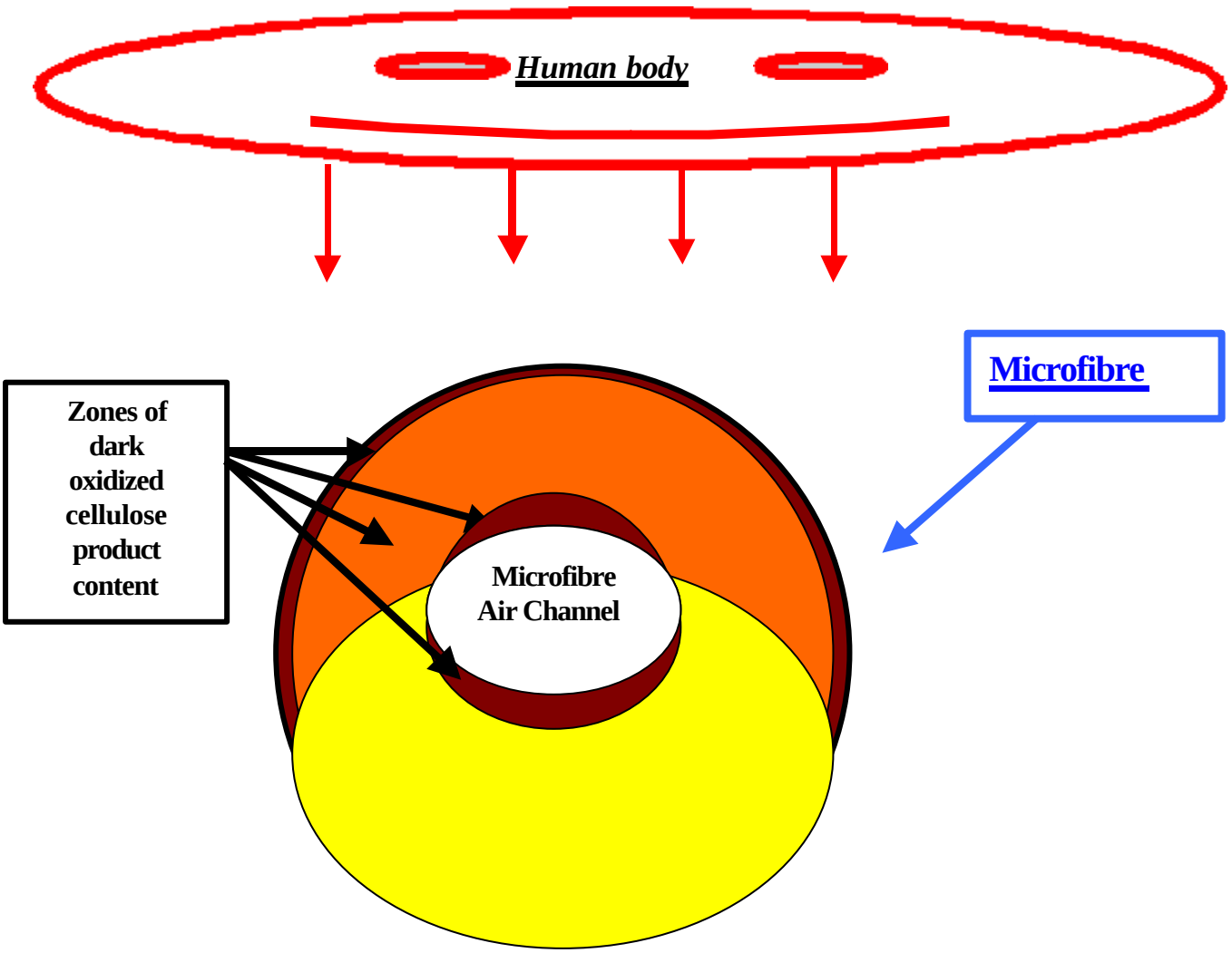

Figure 6

Hypothetical spatial distribution of dark oxydized cellulose products for ionizing charged particles of human body

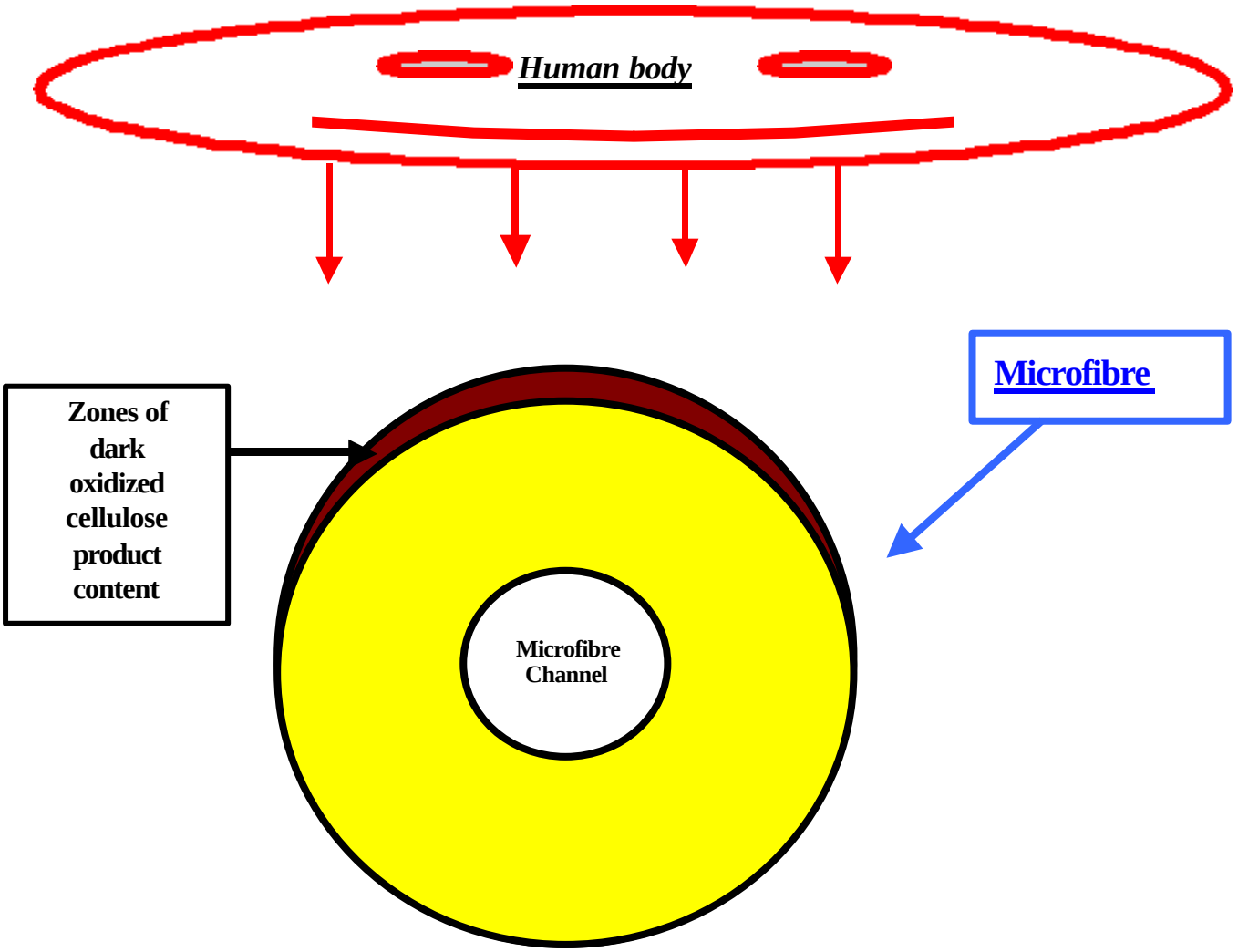

Figure 7

Hypothetical spatial distribution of dark oxydized cellulose products for ionizing irradiation of human body

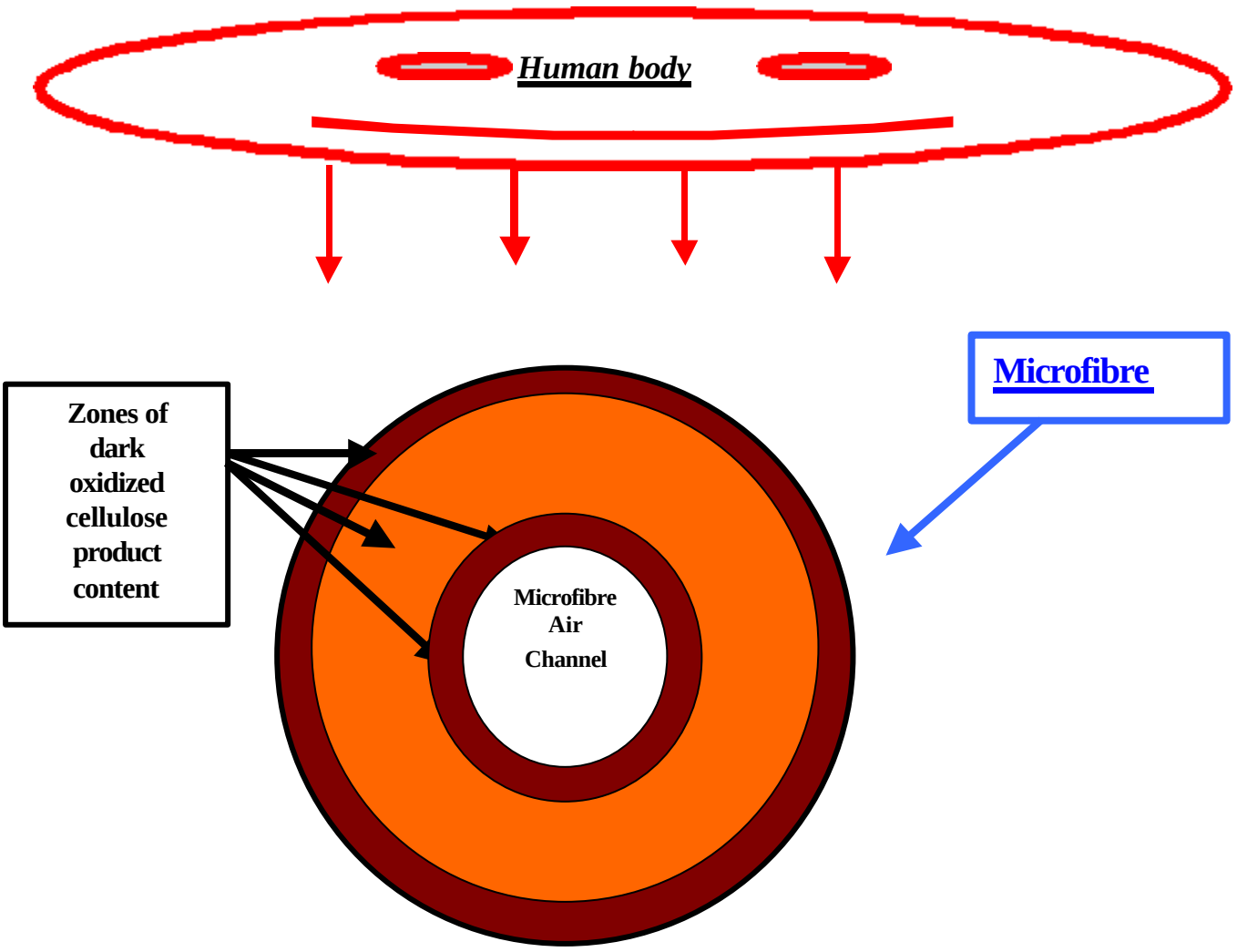

Figure 8

Microfibres and threads of the Turin Shroud tissue as collimator of human body influence