# SOME SPECULATIONS CONCERNING THE PROCESS LEADING TO THE FORMATION OF THE IMAGE ON THE SHROUD OF TURIN

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Thorough investigations by the members of the Shroud of Turin Research Group have elucidated the basic physical and chemical nature of the Shroud image. The account of Heller [1] is a particularly convenient summary of a number of detailed studies of the image. While the issue of the authenticity of the Shroud can perhaps still be argued, the viewpoint adopted here is that the image on the Shroud is, in fact, that of a crucified man, created by some unknown "imaging" process, i.e., the notion of a forgery is dismissed. It is the purpose of this note to present some speculations on the nature of that process and to propose some experiments that might be undertaken to yield further information concerning the image formation process.

The salient facts about the image that appear to the author to be significant are:

1) The image consists of a yellow coloration on the crowns of the threads only, with no signs of capillary or diffusion action
2) The color on each fiber is the same; image density is related to the number of colored fibers per unit area
3) The color on a fiber is restricted to its surface and is the result of a chemical reaction (dehydrating acid oxydation)
4) "Imaged" fibers on which blood was found were clear in the areas under the blood
5) Where one fiber crossed another, there was a shielding effect, with the "shadowed" fiber remaining clear.

Heller comments that these characteristics of the image would appear to rule out liquid or gas phase chemical reactions. The author sees no reason to challenge this conclusion.* Instead, what these facts strongly suggest, particularly 4 and 5 above, is a photochemical reaction image process. Heller does comment that thermal radiation, presumably from the crucified body, would radiate in a diffuse manner and thus, would not lead to the formation of a spatially resolved three-dimensional image. On this point the author does differ and offers the following hypothesis for examination.

Suppose the crucified body, after being covered by the Shroud emitted optical radiation, i.e., electromagnetic radiation in the range of ultraviolet to infrared, of some reasonably coherent nature for some period of time. The wavelength of the radiation is left to be determined by the experiments suggested later, as is its time duration and character (single pulse, repetitive pulse, or continuous). By being coherent, i.e., "laser-like", the radiation field would preserve the geometrical characteristics of the source, though the essential details of the process remain to be determined. To be sure, laser radiation from a corpse is an unobserved process but, clearly, the Shroud is an unusual artifact. In any case, the process followed by Shroud researchers has been to formulate testable hypotheses and thus the remainder of this note consists of suggested measurements that could shed light (no pun intended) on

*It is to be noted that the discussion here is based entirely on a reading of the literature and not on direct personal observation of the Shroud fibers.

this proposed image formation process. In effect, the hypothesis proposed here has the linen providing a photosensitive surface recording the emission of radiation of a suitable wavelength (and hence energy) to cause a photochemical reaction in the surface layers of the fibers.

Several plausibility arguments can be advanced. The radiation penetrates the fibers to a depth determined by the fiber opacity at the wavelength of the radiation. The image thickness is derived from the subsequent reflection and absorption of the incident radiation (3 above). The image on the fibers is much like a photographic image, where the image density is related to the number of exposed photoreceptor "grains" per unit area (2 above), each exposed grain being identical to the others. The blood shielding is obvious, subject to the condition that the opacity of blood at the wavelength in question greatly exceeds that of fiber (4 above), and the geometric shadow is also obvious (5 above)

Such a mechanism is suggested by Wilson (2). It also was the subject of a discussion with Lynn (3) where ultraviolet radiation was suggested, in analogy to the process of yellowing newsprint when left in the sun. It is tempting to associate the hypothesized coherent radiation with the instant or period of resurrection though the theological association is not germane to this discussion of imaging processes.

How might this hypothesis be tested? A number of experiments suggest themselves. Some can presumably be done on available Shroud fibers; some require only recent linen fiber; others would require further Shroud fiber sampling, but with far more rigorous sampling protocols.

First, take the matter of radiation wavelength. In the case of the geometrical shadowing of one fiber by another, it is possible that careful microdensitometer examination of the shadow edge could reveal a Fresnel diffraction pattern that, with reasonable assumptions of the relative fiber geometry, could provide information concerning the wavelength of the diffracted radiation. On the other hand, if the radiation consisted of a range of wavelengths, that also might be revealed. The details of unscrambling the wavelength or bandwidth of the radiation would have to be suggested by working with shadow edge data. And since the fibers are cylindrical, azimuthal variations in the shadow density could provide some idea of the directional characteristics of the radiation field. This in turn, if it works, could be related to the geometry of the underlying body. Admittedly, all this is speculative. The point is simply that microdensitometer observations of the shadow edges could be an extremely fruitful source of information about the imaging radiation field. However, if the suggestions about relating the directional characteristics of the radiation to the crucified body are fruitful, the sampled fibers would have to be precisely related to image position and the relative position of the fibers would have to be preserved in the sampling process. And areas selected for sampling should cover a range of body/Shroud geometries.

Another approach to wavelength determination, and one that could yield radiation time-intensity information would be a series of laser radiation experiments on recent linen fibers. Here one would set up a series of tunable lasers covering a range of wavelength and power. One would expose linen fibers at various wavelengths for various time and intensity conditions, attempting to reproduce the observed yellowing of the Shroud image fibers. The suggestion here is that with enough testing, one might be able to narrow down the wavelength, time duration, and radiation intensity that caused the images. Or, if this were not the case, one ought to come up with a set of phenomenological wavelength-time duration -

intensity curves that would provide useful quantitative constraints on further theorizing.

Finally, one could attack the image formation process theoretically. Radiation transport theory in absorbing media is a well established field of study and is the basis for understanding stellar structure, nuclear weapon design, and radiation effects in materials. The issue here is what wavelengths match the observed image density in the surface layers of linen fibers and how do they relate to the experiments suggested in the two previous paragraphs.

It is not the purpose of this note to construct a complete mathematically-based theory of image formation by radiation on linen fibers. Rather, it is to suggest a new direction for Shroud image research. By a combination of careful studies of shadow edges, laser experiments to define the characteristics of the radiation producing the hypothesized photochemical reactions, and theoretical studies of radiation transport in the surface layers of linen fiber, it should be possible to characterize the imaging radiation field by wavelength, time, intensity, and spatial character, especially as it might be related to the geometry of the crucified body. While some of this can be done with available fibers, and other experiments can be done with non-Shroud linen fibers, definitive studies will require fibers whose geometrical relations to each other and to the Shroud image are preserved. This will either require other more sophisticated fiber sampling than current "sticky-tape" approaches, or it will demand more elaborate in situ fiber studies. On the other hand, it suggests that the finest details of the image formation process could conceivably be revealed by the most intense scrutiny and analysis of a very few strategically chosen fibers. In short, what is suggested is a new era of Shroud research, one building on our understanding of laser physics and photochemical reactions coupled with classical concepts of geometrical and physical optics. Potentially, whole new realms of understanding of Shroud phenomenology await discovery.

27 March 1984

References

1. John M. Heller, Report on the Shroud of Turin, Houghton Mifflin Company, Boston, 1983. See Chapters 10-14.

2. Ian Wilson, The Shroud of Turin, Doubleday and Company, New York, 1978. See Chapter XXIV.

3. Donald J. Lynn, private communication, Dec. 1983.