TESTING THE JACKSON "THEORY" OF IMAGE FORMATION

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John Jackson has claimed that the only way all of the features observed on the Shroud of Turin could have been formed would involve the body becoming "mechanically transparent" concomitant with the appearance of a flux of vacuum-ultraviolet photons. The photons would produce the image as the cloth fell through the volume previously occupied by the body. This would explain the appearance of image on the back side of the cloth and the appearance of bones and teeth in the image. The "theory" is offered as proof of a miraculous resurrection. Unfortunately, the "theory" completely ignores some important contradictions and some important laws of nature.

Introduction

The primary postulates of Jackson's "theory" are the following: 1) The body becomes "mechanically transparent [at the instant of resurrection], and the cloth falls into the body." 2) "Jesus' body became 'a body of light.' The light only penetrates air a millimeter or two ("if at all"); i.e., the air is opaque to the radiation." 3) "The cloth falling into the body is a transitional event, not instantaneous." 4) "Only the fibers on the cloth that were fully exposed in the energy field were imaged ... Deeper fibers were protected from the energy field by the fiber lying on top of them and therefore not imaged." 5) "When the cloth has fallen completely through the energy field, the fibers on the other side become exposed and are imaged by the energy field, except where they are protected or shaded by other fibers." 6) "The dorsal image is a contact image."

Jackson's postulates should be discussed one at a time, and much could be said about each; however, I will discuss only those for which I have first-hand observational information and evidence.

Robert L. Feller has written one of the best books on the factors that affect textiles [Robert L. Feller, <u>Accelerated aging : photochemical and thermal aspects</u>, The J. Paul Getty Trust, 1994, 292 pages]. He makes the following statement about the interactions between radiant energy (photons) and organic materials like linen: "…the primary step in photochemistry is the absorption of radiation followed by the dissipation of that energy through heat, emission of radiation (fluorescence or phosphorescence), transfer of the energy to another molecular entity, or the direct breaking of bonds." The primary question to ask about Jackson's "theory" is which photon-induced reactions are responsible for the image? If ultraviolet photons caused the color of the image, one of these mechanisms had to be responsible.

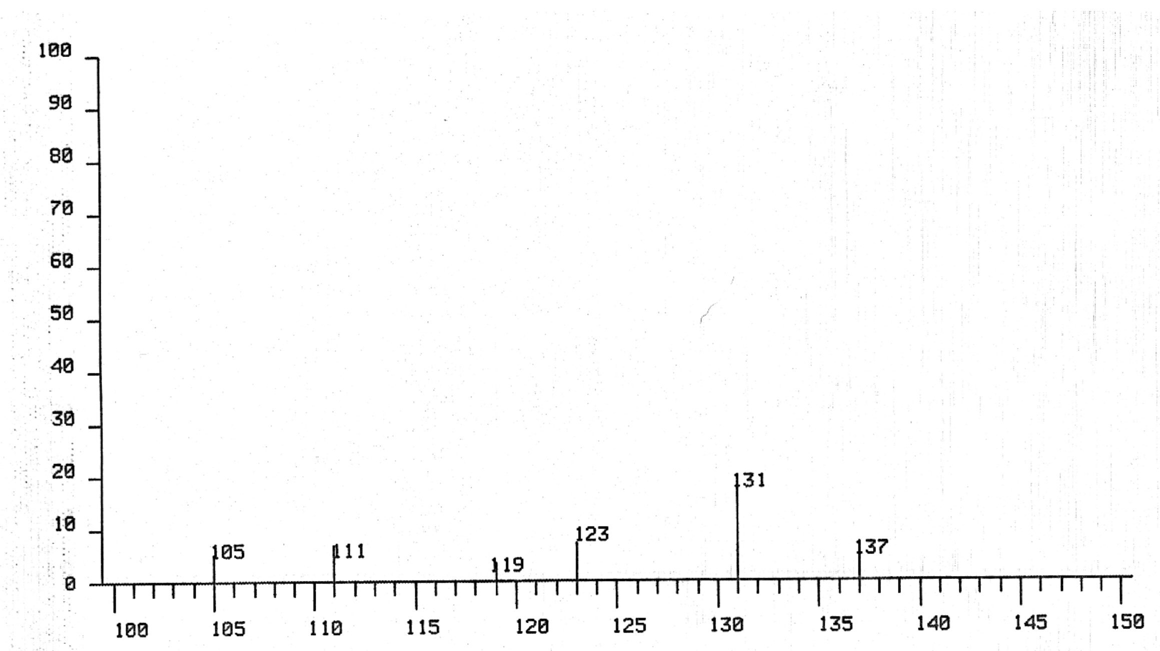
Our eyes see color as the result of three phenomena: the interactions of chemical structures with light, interference effects involving light in thin transparent films, and diffraction or refraction of light by gratings or prisms. Only colors produced by chemical structures can be considered in the context of the image. This means that the Jackson "theory" requires chemical changes in the materials of the Shroud that result in the color we see.

Visible/ultraviolet reflectance spectra were measured directly from the surface of the Shroud in 1978 [R. Gilbert Jr. and M Gilbert,. "Ultraviolet-visible reflectance and fluorescence spectra of the Shroud of Turin," *Applied Optics* **19**, 1930-1936 (1980), and S. F. Pellicori, "Spectral properties of the Shroud of Turin," *Applied Optics*, **19** (1980), pp. 1913-1920]. The color our eyes see is a result of the production of a chaotic system of conjugated carbon-carbon double bonds. Such structures are commonly produced by dehydrating carbohydrates. Flax fibers, starches, and sugars are carbohydrates. They are usually colored by heating; although there are well-known dehydration processes that involve catalysts.

Ultraviolet light is usually used to bleach materials; however, it might be possible for Jackson to find conditions involving both irradiation and heating that could produce color on a cloth. Jackson had to postulate vacuum ultraviolet radiation (very energetic photons that interact with air), because it would explain his perception of image resolution. Jackson has not reported any experiments with vacuum ultraviolet to confirm his "theory." His experiments used only normal ultraviolet frequencies for which air is transparent. However, assuming a flux of high-energy ultraviolet photons, the question becomes, what other effects would the color-producing process cause?

That question leads to the following questions: 1) Blood is not stable to heating. Was the blood affected by the intense flux of vacuum uv? 2) Can significant differences be observed between image areas and non-image areas as a result of radiation effects? 3) Why is there no color in the pores of the cloth?

1) The stability of the blood on the Shroud:
Blood contains many different proteins. When animal proteins are heated, a major pyrolysis



product is 4-hydroxyproline. We had pyrolysis/mass-spectrometry analyses run in 1980 on a wide range of Shroud samples, including several fibers that were coated with blood. The hydroxyproline molecule has a mass of 131. Molecules of this mass appeared very early in the pyrolysis of all of the samples that showed distinct red spots on the fibers. Indeed m/e 131 was the major organic pyrolysis product detected between masses 100 and 150 at the lowest temperature that gave any detectable pyrolysis products. The graph shows the spectrum that was taken at the lowest temperature that gave detectable products from a blood-spotted Zina thread. Hydroxyproline gave the distinct m/e 131 peak.

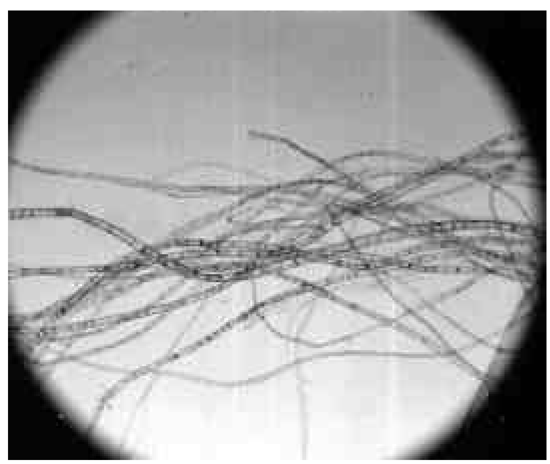
None of the image fibers, control fibers, or Raes fibers showed mass 131 at low temperatures. Proteins are much less stable than most other natural products. The appearance of a low-temperature emission of hydroxyproline sets a definite upper limit on the temperatures that could have been seen by the blood after it appeared on the cloth.

The primary result of irradiation of cloth with energetic photons is heat. The blood was never heated to a temperature concordant with an intense flux of vacuum ultraviolet photons.

The blood could be removed with proteolytic enzymes. The blood had not been crosslinked by irradiation.

It is extremely unlikely that any form of radiation interacted with the cloth.

2) Can significant differences be observed between image areas and non-image areas as a result of radiation effects during image formation?

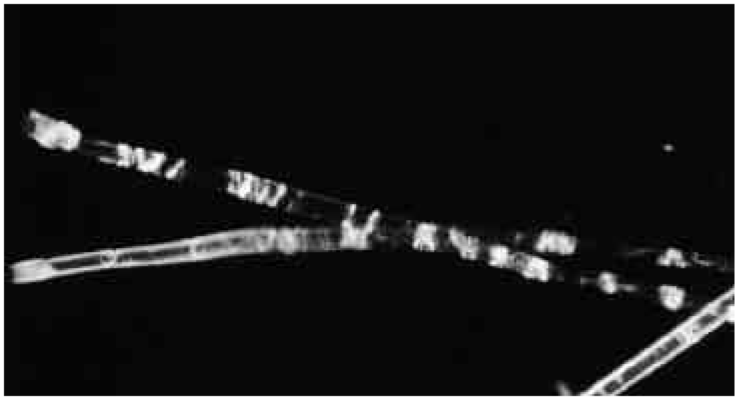


Freshly prepared flax fibers have very specific optical properties that can be observed and measured with a petrographic microscope. The photomicrograph shows flax fibers that had been retted and prepared by the methods in use before about AD 1200, the methods that would have been used to prepare a linen cloth in Palestine a few millennia ago. The photomicrograph was taken at 400X in 1.515 immersion oil.

The fibers look like microscopic pieces of bamboo, but notice that the sections of the fibers between the growth nodes are clear and colorless.

The next photomicrograph shows the fibers between the crossed polarizing filters of a petrographic microscope. The photomicrograph was taken at 800X in 1.515 oil.

The very bright features are the growth nodes of the flax fibers. They have a different crystal structure than the main length of the fibers, and they show "birefringence." The length of the fibers is oriented with the plane of polarization of the microscope such that its crystals are "at extinction." They look perfectly black. The crystals are all the same, and they are all pointing in the same crystallographic direction, parallel to the length.

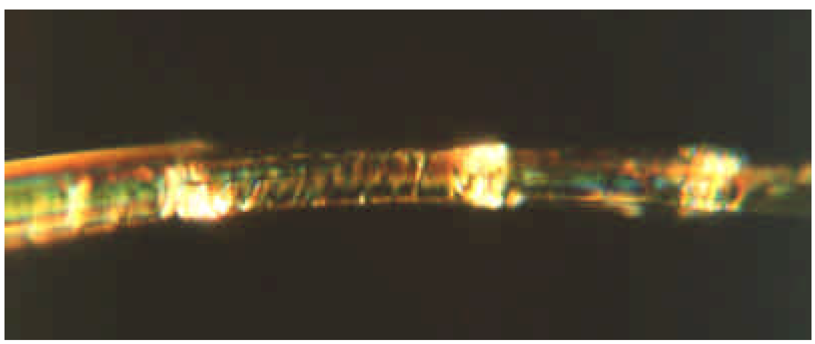


Any changes in the chemistry of the flax fibers will change the crystals: you will see differences in birefringence. Differences in birefringence *prove* changes in the fibers.

Significant amounts of radiation of any kind will change the chemical composition and crystal structure of flax fibers.

Even low-energy infrared radiation can ultimately heat the fibers sufficiently to scorch (dehydrate) them.

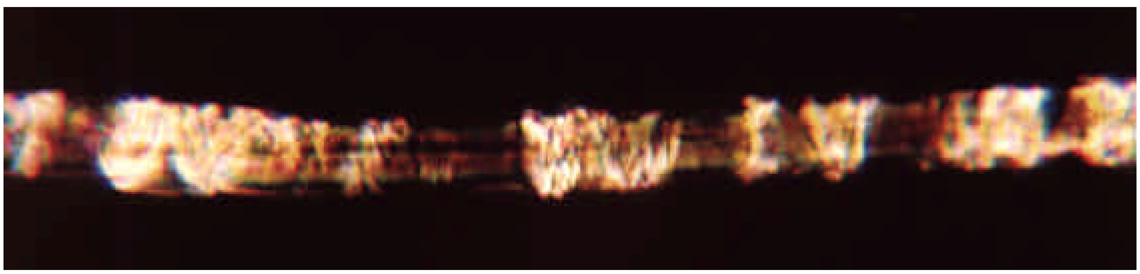
Energetic particle radiation such as protons (a common product of cosmic-ray cascades) ionize the fibers as they pass through. The resulting ion tracks are shown in the photomicrograph below.



The crystal structure of the flax has been damaged by the passage of the ionizing particles, the protons.

Neutrons are not ionizing particles; however, their mass is almost exactly the same as a proton. When they hit a proton, the result is much like a very small game of billiards: the proton is bounced away from its location. The proton does have a charge, and it is an ionizing particle. The effects of recoil protons in neutron-irradiated flax can be seen, as shown below. Look for the short, dim, white tracks between the large, birefringent growth nodes. Also notice a slight fog or haze in the background. The fog is the effect of gamma photons from the reactor that was the neutron source. Gamma, x-ray, and ultraviolet photons cause diffuse changes in the crystal structure of flax.

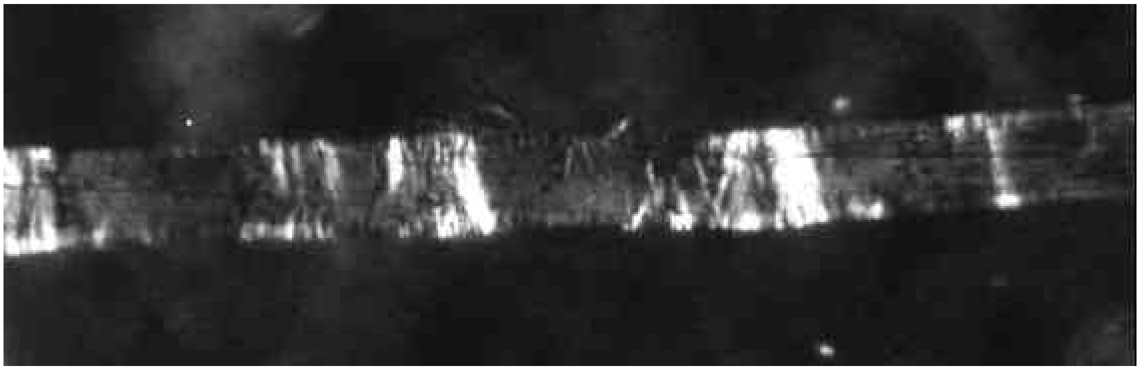
Kate Edgerton bleached some flax by laying it out in the sun for an entire summer. The effects of solar ultraviolet radiation can be seen in the next photomicrograph. There is an easily visible haze between growth nodes.



If Jackson were correct, and energetic photons caused the image color, the image areas should show significantly different amounts of diffuse radiation damage than the non-image areas. They do not.

The next photomicrograph shows STURP sample 3BF, a control sample that was taken in a non-image area to the left of the hand image. The photomicrograph was taken at 800X between crossed polarizers. There is a general light birefringence visible between growth nodes. This birefringence is a result of long-term, radiation-induced changes in the crystallinity of the cellulose. Because this is not an image area, the radiation had nothing to do with image formation.

The last photomicrograph is a view of an image fiber from the top of the wrist. The same kind of



light birefringence can be seen in it as is seen in the control sample. Many additional photomicrographs demonstrate this same fact. There is no significant difference in crystal perfection between image and non-image fibers. The image was not produced by radiation.

3) Why is there no image color inside the pores of the cloth?

Jackson postulated that Jesus' body became "a body of light" and that "the light only penetrates air a millimeter or two ("if at all"); i.e., the air is opaque to the radiation." This sets rigid limits on the kind of "light" that can be considered.

Light that does not penetrate air is energetic enough to ionize or excite (raise to a more energetic molecular quantum state) oxygen and nitrogen; therefore, it is energetic enough to break all bonds in cellulose, blood, and serum. It erodes the surface. Excited oxygen (e.g., the triplet state) oxidize all organic compounds, including cellulose, very quickly. It is used in a process called "cold oxidation." None of these effects can be observed in the Shroud.

Intense radiation exerts pressure as in a nuclear weapon. Radiation pressure coupled with ablation (the sudden appearance of hot gas, which gives the same propulsive effect as rocket exhaust) of the cloth by intense radiation should have thrown the cloth a considerable distance and probably would have torn it to shreds. Experiments we did with pulsed ultraviolet lasers on linen resulted in ablation and destructive shock waves. Samples often were converted into a little amorphous powder and gas.

If, as Jackson claims, the body becomes "mechanically transparent and the cloth falls into the body," all of the cloth would be subjected to an environment that can completely decompose the cellulose. If the cloth fell through (was immersed in) an energy field, all of the pores in the cloth should have been filled with and subjected to the energy. There is no image color or erosion inside the pores of the cloth.

Jackson said: "The cloth falling into the body is a transitional event, not instantaneous." This means that the more time the cloth spent in the "energy field" the more extensive would be destruction to the cloth. There is absolutely no evidence for destruction in any of the image fibers: other than possessing a colored coating, they are identical to non-image fibers. If the image were produced by radiation, image and non-image fibers should be much different.

According to Jackson, "Only the fibers on the cloth that were fully exposed in the energy field were imaged ... Deeper fibers were protected from the energy field by the fiber lying on top of them and therefore not imaged." Not even all of the fibers that would have been facing the "energy field" are colored. The distribution of image color on the surface of the cloth is discontinuous. This can easily be seen in macrophotographs of image areas.

Fibers hit by intense, energetic radiation vaporize; fibers hit by energetic radiation change crystal structure. A light shining on an irregular surface illuminates the entire surface. The entire facing surface should be affected by radiation hitting it. The surface of the Shroud does not show the effects of radiation. Figures 4, 23, and 24 of http://www.shroud.com/pdfs/rogers2.pdf illustrate the observation.

Jackson said: "Now, when the cloth has fallen completely through the energy field, the fibers on the other side become exposed and are imaged by the energy field, except where they are protected or shaded by other fibers." How did the "energy field" pass through the pores of the cloth without having any effect on the fibers surrounding the pores?

Conclusions:
If any kind of radiation had caused the image, the characteristic effects of the radiation would be clearly visible in the flax fibers of the Shroud. In addition to that fact, more damage should be observed in image areas than in non-image areas. Such a situation is not observed.

As any material ages, it is subjected to bombardment by cascades of particles caused by cosmic rays in the upper atmosphere. Most of the particles reaching the surface of the earth are muons (about 100 per square meter per second), but they have very little effect on materials. The more important radiation comes from natural sources. A good example is radon (Rn). Calculations indicate that every square mile of soil to a depth of six inches contains about 1 gram of radon-emitting radium, and radon makes up more than half of the normal background radioactivity in the environment. Rn is a product of the decay of radium, thorium, and actinium, all of which appear in the soil, bricks, and stone. Radon provides a health hazard in many kinds of structures, especially adobe buildings. Radon is an alpha emitter, and alpha particles are very effective ionizing particles, much more than gamma rays and protons. Some of the very intense but short ion tracks seen in old flax fibers may have been made by alpha particles (helium nuclei).

Radon is a very heavy gas, and it will permeate anything in its vicinity. A piece of cloth that is several thousands of years old will show radiation damage to an extent that depends on how and where it was stored. Deep burial and massive stone buildings will protect objects from cosmic rays, but they will probably increase exposure to Rn. However, all parts of a cloth will show the same radiation damage, unless there has been specific radiation in limited areas. Image areas do not show any evidence for excess radiation.

Jackson's "theory" can not be supported by the observations that have been made on the Shroud of Turin or the masses of information available on radiation effects.