because of the likelihood of intra-uterine death. Though, as yet, no inherited disease characterized by a deficit in tryptophan peroxidase activity has been described, a case reported by Baron is suggestive (*7*).

ANDREW M. NEMETH
VIVIANNE T. NACHMIAS*
Department of Anatomy,
University of Pennsylvania,
Philadelphia

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* Postdoctoral fellow, U.S. Public Health Service.

29 May 1958

Psychological Brightness Reduction of Simulated Flashes from a Polyhedral Satellite

Abstract optical properties (such as brightness, frequency, and duration) of solar flash reflections to be expected from a polyhedral satellite have been discussed extensively elsewhere (*1*). However, since a leading advantage of such design for an artificial satellite would be the relative ease and certainty of visual observation of it, there remain to be studied further the human visual reactions which might result from such optical properties. In particular, one might ask how the apparent brightness or conspicuousness of the satellite would be affected by the reflected sunbeam's consisting of intermittent pulses having a frequency of perhaps 10 per second and a pulse duration of less than 0.001 second.

Visual response to intermittent illumination is generally described by two psychological theories (*2*). First, Talbot's law states that, for flash rates greater than the "critical flicker frequency," the fused image always appears fainter than a steady source, and of brightness equal to the time-mean brightness (*3*, p. 118). For example, if the image appeared fused at flash frequency of 10 per second, and the flash durations were 0.001 second, the image brightness would be 0.001/0.1, or 1/100 of its steady brightness—that is, it would be reduced by five stellar magnitudes.

But the proper applicability of Talbot's law depends on the flash rate's being above the critical frequency. This critical rate has been extensively measured for various colors and intensities of light. Curves plotted by Hecht (*4*) show that, for night (rod) vision, the critical flicker frequency is about 15 per second, while for fainter and redder sources it may decrease to 10 or below. Hence, although Talbot's law giving a time-mean brightness would hold for polyhedral satellites flashing more than 15 times per second, for lower flash rates it would not be strictly applicable.

It has been shown (*3*, p. 138) that for such flash rates below the fusion frequency the apparent brightness of the flickering light increases continuously with decreasing frequency. Indeed, for day (cone) vision and light-to-dark ratios of at least 1 to 1, the enhancement effect, discovered by Bartley, gives, for a frequency of about 9 per second an apparent brightness actually greater than the steady brightness, by a factor equal to the reciprocal of that given by Talbot's law. However, the Bartley effect for a light-to-dark ratio as low as the expected 1 to 100 of a polyhedral satellite seems not to have been investigated by the psychologists.

Nevertheless, it appears certain that, for frequencies below that of fusion, the brightness above the time-mean would generally increase with decreasing frequency, so that, for zero frequency, it would always equal the steady brightness. As an approximation hypothesis one might assume, for a constant light-to-dark ratio, a linear logarithmic increase of brightness with decrease of frequency—that is, a linear variation of apparent stellar magnitude in proportion to frequency below that of fusion. Thus, for the above example in which brightness at the fusion frequency of 10 per second was reduced by five magnitudes, the reduction at a frequency of 4 per

Table 1. Diminution of the intermittent image for three typical flash rates.

Star	Steady magnitude	Flashing magnitude	Dimming
Run No. 1 (frequency, 3.3/sec; duration, 0.00152 sec)			
Jupiter	−1.4	+1.2	+2.6
Vega	+0.1	+1.8	+1.7
Arcturus	+0.2	+1.2	+1.0
Saturn	+0.5	+2.7	+2.2
Altair	+0.9	+1.8	+0.9
Spica	+1.2	+3.8	+2.6
Mean dimming			+1.8 ± 0.2
Run No. 2 (frequency, 6.2/sec; duration, 0.00081 sec)			
Jupiter	−1.4	+0.7	+2.1
Arcturus	+0.2	+1.9	+1.7
Spica	+1.2	+3.4	+2.2
Mean dimming			+2.0 ± 0.1
Run No. 3 (frequency, 7.7/sec; duration, 0.00065 sec)			
Jupiter	+1.4	+1.4	+2.8
Arcturus	+0.2	+2.2	+2.0
Spica	+1.2	+3.3	+2.1
Mean dimming			+2.3 ± 0.2

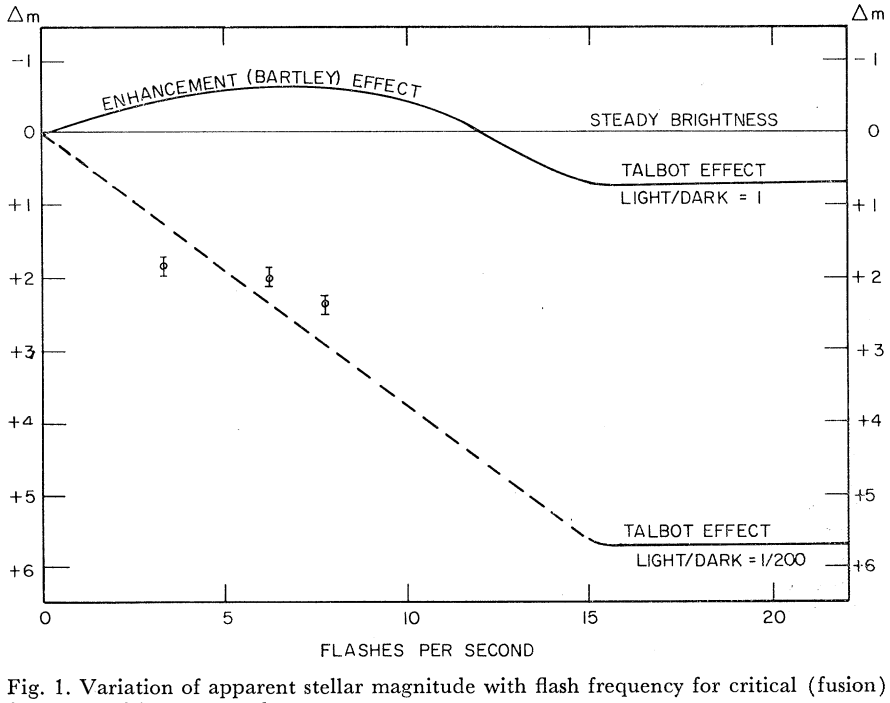

Fig. 1. Variation of apparent stellar magnitude with flash frequency for critical (fusion) frequency of 15 per second.

second might be expected to be about two stellar magnitudes.

Experimental measurement (*5*) of the actual reduction of apparent brightness under such conditions was carried out as follows. Intermittent solar reflections from the surface of a polyhedral satellite were simulated by viewing various planets and stars through the interception of a rotating metal disc of about 10-in. radius from which had been cut a sector ⅓ in. wide; this gave a clear opening effectively 1/200 the total area of the disc. The intercepted, flashing image of one star—say Arcturus—viewed with one eye was compared in brightness to the image of another—say Spica—viewed simultaneously, without interception, with the other eye. From the known magnitudes of each star the diminution of the intermittent image was estimated for three typical flash rates, with the results shown in Table 1. For this the flash frequencies and durations were derived from the rotational rate of the disc, as measured with a tachometer.

The graph (Fig. 1) shows these three values of brightness reduction compared to theoretical curves of such reduction for sources, like stars, for which the intermittent images would appear fused for frequencies 15 per second.

For a polyhedral satellite rotating once per second, the mean duration of a reflected sunbeam would be 0.0009 second, and this would vary inversely as the spin rate (*1*). If, also, the complete polyhedron had 856 faces, the mean frequency would be 2 per second, and this would vary directly with both the spin rate and the number of faces. Since a spherical reflector is optically equivalent, for solar reflection, to a polyhedron having about 200,000 faces (the number of angular solar areas on a sphere), the optical gain from use of the 856-face polyhedron would be about 250, or six stellar magnitudes. Since the present measures indicate a visual reduction, in this case, of only about one magnitude, the net visual gain from use of a polyhedral rather than a spherical satellite would be five stellar magnitudes.

RAYMOND H. WILSON, JR.
U.S. Naval Research Laboratory, Washington, D.C.

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24 June 1958

Physicochemical Study in Water of a Mucoprotein with Virus-Inhibiting Activity

Abstract. Human urinary mucoprotein precipitated with cetyltrimethylammonium bromide and suspended in distilled water has a light-scattering molecular weight of 2.8×10^6, an intrinsic viscosity of 225, a refractive index increment of 1.73×10^{-4}, and an absorption coefficient ($E^{1\%}_{1\,cm}$) of 11.4. The molecule is therefore smaller than that of the mucoprotein isolated by Tamm and Horsfall but retains its biological activity.

A mucoprotein derived from human urine which reacts with influenza, mumps, and Newcastle disease virus has been isolated and characterized physicochemically by Tamm and Horsfall (*1, 2*). This fibrous mucoprotein, soluble in distilled water and isolated as a single component in the ultracentrifuge, was found from ultracentrifuge and diffusion measurements (*2, 3*) to have the very large molecular weight of 7×10^6 and to be highly asymmetric.

A mucoprotein with similar antiviral properties and chemical analysis has been isolated by Di Ferrante (*4*), by a different method. In the ultracentrifuge this is a single component whose sedimentation constant in water suggests that its molecular weight is considerably smaller than that of the mucoprotein isolated by Tamm and Horsfall.

The work discussed in this report (*5*) is an attempt to characterize physicochemically the mucoprotein isolated by Di Ferrante and to indicate its relationship to that of Tamm and Horsfall. The large molecular weight, the high asymmetry, and the poor solubility in salt solution render light scattering the method of choice in the investigation of this mucoprotein.

The mucoprotein was prepared by the method of Di Ferrante (*4*) from the urine of two male diabetic patients. Ten grams of cetyltrimethylammonium bromide were added to 18 lit. of urine. After standing 3 days in the cold, the precipitate was removed in a continuous-flow refrigerated Sharples supercentrifuge and washed four times with ethyl alcohol saturated with sodium chloride. The precipitate was suspended in, and dialyzed against, distilled water and clarified by centrifugation. The supernatant was brought to 0.58*M* sodium chloride, and the new precipitate was removed, redissolved, and dialyzed in water. The dialysis was continued with frequent changes for 3 days, and then the precipitate was clarified by centrifugation. All investigations reported here were made on this distilled water solution.

Through the kindness of Igor Tamm, I investigated the biological activity of two samples of this mucoprotein in his laboratory at the Rockefeller Institute for Medical Research and found these to exhibit a hemagglutination-inhibiting activity of 0.013 μg for a fresh sample of mucoprotein and of 0.1 μg for a sample which has been standing at 4°C for several weeks. This activity is expressed as amount (in micrograms) of mucoprotein required for complete inhibition per hemagglutinating unit of heated Lee virus (56°C for 30 minutes).

The intensity of light of wavelength 436 mμ scattered from serial dilutions of mucoprotein in a cylindrical cell at angles of from 26° to 135° from the direction of the incident beam was measured in a Brice-Phoenix light-scattering photometer and recorded in the form of a Zimm plot. The Zimm plot is, of course, highly distorted (*6*) in the case of media of low ionic strength, and a dissymmetry of less than unity was observed at the highest concentrations used. The extrapolated curve of scattering at zero angle which determines the interaction constant, and the intercept of this curve with the axis of KC/R_θ, which yields the molecular weight independent of the shape of the molecule, are not distorted. The weight average molecular weight was determined by this method to be 2.8×10^6. The interaction constant B is $+0.88 \times 10^{-3}$, indicating that water is indeed a good solvent for the mucoprotein. The solution did not fluoresce at this wavelength and showed a small depolarization.

Viscosity data (Fig. 1) extrapolate linearly at low concentrations to an intrinsic viscosity of 225. The high intrinsic viscosity suggests a highly asymmetric molecule. In view of the electroviscous effect, it would be misleading to calculate an axial ratio from these data. The intrinsic viscosity of a sample of mucoprotein prepared by the method of Tamm and Horsfall was found to be 630.

The refractive index increment (Fig. 1) is 1.73×10^{-4} and remains constant, over the concentration range tested, from $0.6 + 10^{-3}$ to 2.0×10^{-3} g/ml. This is lower than the usual values for proteins but is in line with the values reported for mucoproteins.

The ultraviolet absorption spectrum (pH 5.7) has a single major peak at

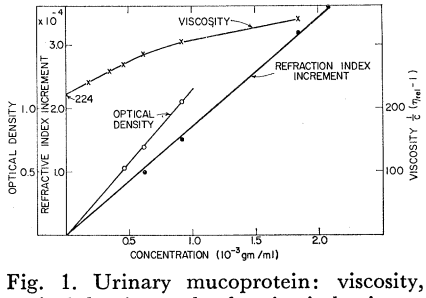

Fig. 1. Urinary mucoprotein: viscosity, optical density, and refractive index increment as a function of concentration.