Magnetic Transitions in Alpha Hematite

Recently Smith and Fuller (*1*) discussed the stable magnetic remanence and memory behavior in alpha hematite (α-Fe_2O_3); they suggested from experimental evidence that the magnetization of α-Fe_2O_3 consists of a soft spin-canted moment and a hard defect moment. They noted that the former is observed between $-20°$ and 675°C, while the latter is maintained up to the Néel point of α-Fe_2O_3 at 725°C. Their conclusions appear to be based primarily upon the differential thermal analysis (DTA) work by Aharoni, Frei, and Schieber (*2*) who stated that the true Néel point of stoichiometric α-hematite is 725°C, approximately 50°C above the Curie point. Smith and Fuller have drawn upon certain magnetometer work (*3*) and other work (*4*) showing that apparently the absolute temperatures of these transitions depend on the impurity (especially Ti) content.

Our purpose is to point out that several investigations by various experimental techniques have shown that there exists only one transition of an order-disorder of second order in the region of 700°C. The DTA work by Lielmezs and Chaklader (*5*; single antiferromagnetic Curie point at $690° \pm 5°C$) and Schneider and Beaulieu (*6*; Curie and Néel points coincide at $685° \pm 5°C$), and dilatometric measurements (*7*) showed that there is only one phase transition—at $687° \pm 10°C$.

It is of interest to note that independent Mössbauer-effect studies (*8*, *9*) of α-Fe_2O_3 also reveal no difference between the Curie and Néel points. Moreover, our most recent DTA experiments (Fig. 1) on spectrographically pure α-Fe_2O_3 (*10*) show that there is only one phase transition, at $683° \pm 2°C$, which is also the Néel or the antiferromagnetic Curie point of α-Fe_2O_3, contrary to suggestions (*2*). Further experiments with standardized and precise thermocouples showed that the temperature of this order-disorder change is very close to 683°C. This observed temperature of the Néel point is the same as that (956°K) suggested by van der Woude (*8*) in his work on the Mössbauer effect in α-Fe_2O_3.

Regarding the comment (*1*), based on the work of Aharoni *et al.* (*2*), that the Néel temperature (as separated from the Curie point) for the stoichiometric α-Fe_2O_3 is 725°C, and that therefore one can explain the stable fraction of remanence, we feel that these statements are not substantiated by experimental observations. However, further study may clarify the effect of impurities such as Ti on the Néel and Curie points of α-Fe_2O_3.

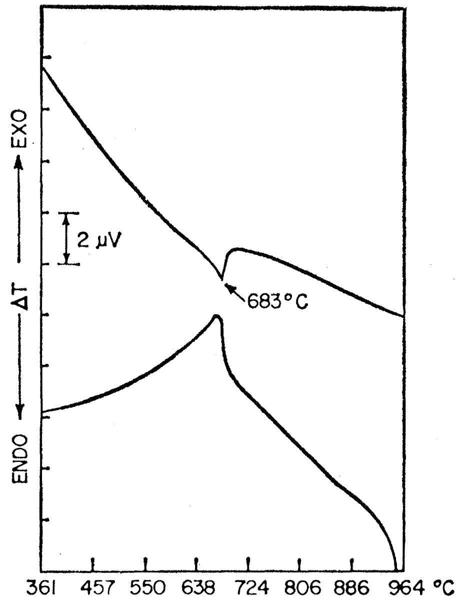

Fig. 1. Differential thermal analysis of α-Fe_2O_3 in air; heating rate, 10°C per minute.

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References and Notes

1. R. W. Smith and M. Fuller, *Science* **156**, 1130 (1967).
2. A. Aharoni, E. H. Frei, M. Schieber, *Phys. Rev.* **127**, 439 (1962).
3. K. Kobayashi and M. Fuller, *Procedures in Palaeomagnetism* (Elsevier, New York, 1967).
4. T. Nagata, *Rock Magnetism* (Plenum Press, New York, ed. 2, 1961).
5. J. Lielmezs and A. C. D. Chaklader, *J. Appl. Phys.* **36**, 866 (1965).
6. M. Schneider and C. E. Beaulieu, *Can. Met. Quart.* **6**, 1 (1967).
7. G. G. Robbrecht and R. J. Doclo, *Phys. Letters* **3**, 85 (1962); G. G. Robbrecht, *Bull. Soc. Belge Phys. Ser.* 3 **4**, 325 (1963); C. M. Iserentant, G. G. Robbrecht, R. J. Doclo, *Phys. Letters* **11**, 14 (1964). Robbrecht and Doclo, and Robbrecht, observed first transformation at 684°C (which they considered to be of the first order), while at 726°C they observed a transformation that they believed to be the Néel point. Later, however, Iserentant, Robbrecht, and Doclo modified this last observation, concluding that there is only one second-order transition at $687° \pm 10°C$. The experimental error is thought to reflect the temperature inhomogeneity across the sample [G. G. Robbrecht, personal communication to one of us (J.L.), 1966].
8. F. van der Woude, *Phys. Status Solidi* **17**, 417 (1966).
9. S. Frier, M. Greenspan, P. Hillman, H. Shechter, *Phys. Letters* **2**, 191 (1962); P. Gilad, M. Greenspan, P. Hillman, H. Shechter, *ibid.* **7**, 239 (1963).
10. Supplied by Johnson, Mathey and Co.
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Hypothalamic Releasing Factors: Distribution of Samples

It is usually difficult for qualified investigators to obtain milligram quantities of peptide hormones such as alpha- and beta-melanocyte-stimulating hormone (MSH), or even oxytocin and vasopressin, in spite of the fact that these peptide hormones can be purified from natural sources and made synthetically. Being an endocrinologist who is not averse to doing purification work, I have had the pleasure and privilege of supplying these peptide hormones, sometimes in sizable quantities, to colleagues near and far. The samples have been used wisely, as the literature attests. The purpose of my comment, however, is to relate my less happy experiences with requests for samples of the elusive and rare hypothalamic neurohumors controlling the secretion of anterior pituitary glands. The hypothalamic releasing factors have blossomed during the past few years into a family of seven well-established neurohumors (*1*) as well as a few of doubtful status. But even before they became accepted entities, the demand for them from researchers in many countries was considerable, prompted mainly (I want to think) by a desire to verify, for their own satisfaction, that these neurohumors really existed.

There are only nanogram amounts of these hormones in each hypothalamus. After securing tens or hundreds of thousands of hypothalami at no small monetary cost, and laboring over them for months, one emerges, if successful, with a few hundred micrograms of active material. This amount is hardly adequate for the determination of the chemical structure which, of course, must receive top priority. To receive two requests within a few hours for 25 to 50 mg of the "pure" factor, as I once did, sets one back a pace or two.

I once supplied a well-known investigator with 1 mg of a highly purified factor, corticotropin releasing factor (CRF), after taking care to emphasize to him that it was very unstable, as some of these hypothalamic factors are, and that it should be stored in a vacuum at $-60°C$. (Fortunately the storage requirements of other releasing factors are not nearly so exacting.) Some months later I was puzzled on hearing that the material was inactive. The mystery was solved when I discovered he had stored the sample in a desk drawer during the summer holidays. Such incidents, of which this is only one, gave the unfortunate and erroneous impression that hypothalamic releasing factors might not exist. Other researchers, who have actually experienced the pains of preparing as well as testing these materials, have undoubtedly had similar experiences.

Some investigators have intimated that they are ready to undertake clinical experiments with hypothalamic factors—"in the backyard," if necessary, since the toxicity of none of the factors has been worked out in man and none has been approved by the Food and Drug Administration (FDA) for clinical testing. Even if FDA should grant approval, experiments with the natural products would be so costly that they could be undertaken only by very few investigators.

I am writing this not to discourage the spirit of adventure, which has led to so many accidental discoveries, but to urge biologists to exercise some degree of moderation in their requests for these costly materials. Such a demand can be more fully satisfied only after the synthetic materials become available.

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References

1. A. V. Schally, C. Y. Bowers, A. Kuroshima, Y. Ishida, T. W. Redding, A. J. Kastin, Proc. 23rd Intern. Congr. Physiol. Sci., *Excerpta Medica* **87**, 275 (1965); A. V. Schally, A. J. Kastin, W. Locke, C. Y. Bowers, In *Hormones in Blood*, C. H. Gray and A. L. Bacharach, Eds. (Academic Press, London, ed. 2, 1967), p. 491; A. V. Schally, A. Arimura, C. Y. Bowers, A. J. Kastin, S. Sawano, T. W. Redding, in *Recent Progr. Hormone Res.*, in press; A. V. Schally, E. E. Muller, A. Arimura, C. Y. Bowers, T. Saito, T. W. Redding, S. Sawano, P. Pizzolato, *J. Clin. Endocrinol. Metab.* **27**, 755 (1967); R. Guillemin, *Recent Progr. Hormone Res.* **20**, 89 (1964); S. M. McCann and V. D. Ramirez, *ibid.*, p. 131; J. Meites and C. S. Nicoll, *Ann. Rev. Physiol.* **28**, 57, (1966).

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Cosmic Rays from Nearby Supernovae: Biological Effects

Terry and Tucker (*1*) have just speculated that cosmic radiation from exploding supernovae could have caused the extinction of many animals on earth in geologic times. They give an estimate that over a period of 6×10^8 years animals on the earth would have been exposed to a dose of 25,000 roentgens (r) (arriving in a few days or less) at least once, 1000 r at least four times, and so on. Such bursts of radiation could cause the extinction of many exposed animals without simultaneously extinguishing plant life. These calculations depend sensitively on the following major assumption which they made. "Since diffusion effects can be neglected for relativistic particles traveling over comparatively short interstellar distances, such as are of interest here, the relevant time interval is that for the release of the energy in the form of cosmic rays. . . . Therefore, it is safe to say that the dose D is received over a period of, at most, a few days."

This assumption conflicts seriously with most current theories of cosmic ray propagation within the galaxy, which describe cosmic ray particles as either diffusing through the interstellar medium or as moving along galactic magnetic field lines so twisted as to produce the remarkable degree of isotropy that experimentalists observe. In either case, the typical distance for straight-line propagation of cosmic ray particles from their source is taken to be approximately 3 light-years. As a result, cosmic rays reaching the earth even from the relatively nearby supernovae that Terry and Tucker refer to would travel tortuous paths en route. Instead of arriving in one sudden burst concentrated in a few days or less, their radiation would be spread over years. The biological effect described would therefore be appreciably smaller, and probably negligible.

To illustrate this we can consider the one supernova explosion in 6×10^8 years that Terry and Tucker describe, which produces the largest dose of 25,000 r. If this is due to a supernova that releases 10^{50} ergs in the form of cosmic rays, as they assume, it is approximately 10 light-years away. Cosmic rays diffusing to the earth would pass through more than three mean free paths en route. Standard diffusion model calculations (*2*) show that they would take approximately 40 years on the average to arrive. The peak radiation would be spread over a period of several years rather than several days.

Similarly, Terry and Tucker describe more distant supernovae that might occur once every 1.5×10^8 years and produce doses of 1000 r. These supernovae would average 50 light-years in distance, and their cosmic rays would arrive at the earth 1000 years afterward, with the peak radiation spread over hundreds of years. More distant supernovae would spread their doses over appreciably longer intervals, thereby reducing further their biological effect.

The above numbers are based on a diffusion model for propagation of cosmic rays with mean free paths of about 3 light-years. Other models would differ in detail but would share the characteristic of lengthening appreciably the period during which the total radiation described would impinge on animals.

Even if supernovae are assumed to release the far larger amount of cosmic ray energy, 10^{51} ergs, which Terry and Tucker refer to, the biological effects would be appreciably reduced for all but the very closest (and rarest) supernovae. Thus doses of 10,000 r might occur once every 50 million years, but each such dose would be spread over hundreds of years and would, therefore, produce much less damage to animal life than is assumed.

Physicists have long observed that nonsolar cosmic rays arrive at the earth steadily from all directions. This spatial and time isotropy probably is due to the tortuous paths cosmic rays follow in traversing the interstellar medium. The same characteristics of galactic space that produce this nonlinear motion would serve to spread appreciably in time the radiation dose produced by a nearby supernova. Only an explosion within several light-years of the earth would result in the catastrophic effects suggested by Terry and Tucker. Since very few stars of any kind are that close to us, nearby supernovae such as they require would be very rare indeed.

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References and Notes

1. K. D. Terry and W. H. Tucker, *Science* **159**, 421 (1968).
2. In the equation $t = R^2/\lambda v$, R is 10 light-years; λ, 3 light-years; and v, the speed of light. For a general discussion see, for example, P. Morrison, in *Handbuch der Physik*, S. Flügg, Ed. (Springer-Verlag, Berlin, 1961), vol. 46; or V. L. Ginsburg and S. I. Syrovatskii, *The Origin of Cosmic Rays*, H. S. H. Massey, translator (Pergamon Press, Oxford, 1964).
3. Supported in part by NASA grant NsG-58-60.

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Laster has argued that supernova explosions would not have the catastrophic effects we suggested (*1*), since the resultant radiation dose would be spread over a period of many years rather than several days. He maintains that the "spreading-out" of the dose would occur because cosmic ray particles do not