0.40 degree (0.28 cm^{-1}) for δ/k. With this value of δ the salt should exhibit a maximum in the specific heat, C, in the region of 0.16°K while in the "high" temperature region, where $C \propto T^{-2}$, C/R is about twice that of chrome alum. Since, moreover, the molar volume is some 2.5 times smaller than that of chrome alum,[7] the heat capacity *per unit volume* (which is the important quantity from the more practical point of view) is 5 times greater.

The theory of Hebb and Purcell[8] as developed for the alums when applied to this salt describes the observed behavior only approximately (as might be expected). The fit is good down to $T^* = 0.4°$, below which the entropy falls off more and more rapidly than is predicted by the theory. It is interesting to note, however, that no maximum in the susceptibility was observed down to the lowest entropy obtained in these experiments ($S/R = 0.3$).

This work will be continued and extended to other members of the isomorphous series, e.g., $(NH_4)_3FeF_6$, K_3FeF_6, etc. The authors are indebted to Dr. L. S. Singer, then at the Naval Research Laboratory, for originally arousing their interest in the ammonium salt described above and for communicating his paramagnetic resonance results to them prior to publication.

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[7] The structure of this salt is described by R. W. C. Wyckoff, *Crystal Structures* (Interscience Publishers, Inc., New York, 1948), Chap. IX. The chromic ions are situated on a face-centered cubic lattice, $a_0 = 9.0$ A. In the alums the magnetic ions are similarly placed, with $a_0 = 12.2$ A. The contribution to the entropy reduction due to dipole-dipole coupling is conveniently expressed in terms of a parameter τ [see J. H. Van Vleck, J. Chem. Phys. 5, 320 (1937), Eqs. (18), (20), and (35)]; we find $\tau = 0.05$. The possibility of a significant exchange interaction was discounted for the reason that the salt obeyed the simple Curie Law very closely in the liquid He region.
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Ionospheric Effects Produced by Solar Flare Radiation

VAUGHN AGY

National Bureau of Standards, Boulder, Colorado

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WITH reference to a recent paper by Sedra and Hazzaa,[1] there is now overwhelming evidence that ultraviolet radiation from solar flares does not affect the ionic density of the E and $F1$ layers to any marked extent except perhaps in extremely rare cases.[2]

The "ion cloud," if such a term may be used, produced by the ultraviolet radiation from a solar flare extends over the entire sunlit hemisphere, and is at a height less than 100 km—not at 200 km as suggested by the authors. The 1929 Maris and Hulburt paper referred to was written at a time when the heights of the ionospheric layers, as well as their ion densities, were not regularly measured, and the solar flare effects on the ionosphere could only be guessed at.

The authors' illustration of a geomagnetic crochet is not typical. The interpretation of the ionospheric record shown in the paper is puzzling in that the "cloud" appearing at a virtual height of 200 km is either transparent (allowing reflections from the $F2$ layer to reach the receiver), or what is more likely, it is a sporadic E cloud located off the zenith at a height of about 100 km giving a recorded slant range of 200 km. In either case, it is probably not possible to determine a critical frequency (or an ion density) for such a "cloud."

Although the paper deals with solar flare radiation, solar observational data are not given. So far as can be determined (it is not clear whether the times listed are local or Greenwich), no solar flares were observed anywhere else on the dates and near the times listed. Further, no magnetic crochets (solar flare effects) are given in the IATME Bulletins[3] for the dates and times listed.

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Paramagnetic Resonance in As-Doped Silicon

A. HONIG,* *Ecole Normale Superiéure, Paris, France*

AND

J. COMBRISSON, *Commissariat à l'Energie Atomique, Saclay, France*

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EXPERIMENTS involving long relaxation times in As-doped Si have been previously reported.[1] The experiments had been interpreted as suggesting a large spin polarization of the As donor nuclei. Further studies carried out on an equipment similar to the first, and on the same silicon sample containing 1.3×10^{17} As/cm^3, lead us to believe that most of the effects previously observed, as well as some new effects, can be more satisfactorily explained on the basis of a long electronic relaxation time and accompanying adiabatic rapid passage behavior.

One way in which it was directly established that the 16-second relaxation time, previously attributed to the

As nuclei, was of electronic origin, was as follows: the magnetic field was left at zero field for several minutes. It was then switched on to a value near the electronic resonance field, and subsequently swept through the resonance field. The signal observed was very small, since one had not allowed sufficient time (i.e., several electronic T_1's) for the Boltzmann difference in population of the electron spin states to be established. It was possible to observe the growth of the Boltzmann population difference by looking at the amplitude of the resonance signal as a function of the time that the magnetic field was left on near the resonance field.

This long relaxation time, very unusual for an *electronic* time, is frequently encountered among nuclear spins. Hence, some of the fast-passage features of the resonance signal have been seen in nuclear resonance experiments.[2,3] However, in the present case, the behavior is further complicated by the inhomogeneous broadening[4] of the resonances, brought about by the magnetic Si^{29} nuclei contained within the electron's orbit and by the small amplitude magnetic field modulation at 600 cycles, used for greater sensitivity.

The intensity and form of the resonance signal, as well as the final state of the magnetization immediately after passage through resonance, depend on the value the sweep speed has in comparison with T_1 and T_2.[5] This dependence arises as a consequence of the inhomogeneous broadening of the resonances and the situation that even in the fast-passage case, the signal intensity at any point is made up largely of contributions from the wings of distant spin packets. One can either turn around by 180° the net magnetization M belonging to a particular spin packet by sweeping through the packet in a time *short* compared with T_2, or reduce the M nearly to zero via the T_2 relaxation if one sweeps through the packet in a time *long* compared with T_2. After having been thus reduced near to zero, or turned 180°, the M then recovers its original magnitude and and orientation via T_1 relaxation. Thus, since the signal intensity at a point on the over-all resonance curve depends partly on the state of the magnetization of the packets behind it, and since the state of the magnetization of the packets depends on the rate at which they were swept through resonance and on the amount of time elapsed afterwards, we get a fairly complicated dependence of signal intensity on sweep rate. We will not discuss here all of the possible cases that can arise.

The purpose of the present note is primarily to call attention to the unusually long electronic relaxation time. This and associated effects now explain most of the phenomena which previously were attributed to a very large nuclear polarization.

We would like to thank several people for having made possible this work. The experiments were performed in the laboratory of Professor A. Kastler, whose kindness and help is greatly acknowledged. The support for the work came from the magnetic resonance group

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* Now at Syracuse University, Syracuse, New York.
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Narrow Electron Spin Resonance in Charred Dextrose*

Ricardo C. Pastor,† John A. Weil,‡ Thomas H. Brown, and John Turkevich

Frick Chemical Laboratory, Princeton University, Princeton, New Jersey

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A STRONG electron spin resonance, with full width at half-height of at most 1.1 gauss, was found for charcoal prepared in the following way: Anhydrous dextrose, charred preliminarily in air at approximately 300°C, was heated at various higher temperatures in vacuum. A minimum in width, with the above value, was found for evacuated samples heated to 570°C and measured at room temperature. Samples of this type should be useful since they are more easily obtained than DPPH and have narrower, almost as intense (about 10^{20} spins/cm³), resonances.

The resonance, at $g = 2.003$, was studied at 9400 Mc sec^{-1} using a standard microwave spectrometer, with a $723A/B$ klystron and a rectangular transmission cavity, and using a dc magnetic field modulated at 37 cps. The absorption signals were amplified and displayed on an oscilloscope. The narrowest widths were probably limited by the homogeneity of our magnetic field, even though samples in capillary tubes were used and gave widths at the minimum somewhat less than 1 gauss. The resonance was also observed at 51.7 Mc/sec, using a Hopkins oscillator,[1] with the dc magnetic field supplied by Helmholtz coils and modulated at 60 cps. The samples showed a minimum width of 1.1 ± 0.1 gauss occurring at 570 ± 5°C. This width was not limited by field inhomogeneity, as indicated by the fact that n-picryl-9-aminocarbazyl[2] showed a width of about 0.63 gauss.