forbidden. Three of the five transitions listed in Table II for these target nuclei were characterized as being "paired"; as expected, all were observed to be weak in the corresponding (d, α) reactions ($\leq 8\%$ of the strongest transition).

The usefulness of the experimental method as a general spectroscopic tool is certainly not limited to the mass region discussed here. The approximations are widely applicable and, although Eqs. (4) and (5) indicate that R decreases with increasing T, the percentage difference between "paired" and "unpaired" transfer becomes greater. Thus with larger A (and T) the sensitivity of the method will be increased. The striking results already obtained provide useful restrictions for future model calculations, and invite more general and detailed experimental investigations.

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POSSIBLE ORIGIN OF THE DIFFUSE COMPONENT OF COSMIC X RAYS

R. F. O'Connell and S. D. Verma
Department of Physics and Astronomy, Louisiana State University, Baton Rouge, Louisiana 70803
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We show that if one assumes (following Cowsik and Pal and Shen in their explanation of the flux of galactic gamma rays) that the recently measured far-infrared radiation is galactic, then one must also accept the existence of the x-ray flux, with a magnitude in agreement with observations but with a large anisotropy, in sharp disagreement with the measured isotropy.

Far-infrared radiation, with an equivalent blackbody temperature T of 8.3°K, has recently been discovered.[1] Assuming that this radiation is at least galactic, Cowsik and Pal[2] and Shen[3] have pointed out that inverse Compton scattering of this radiation on cosmic-ray electrons can produce the observed flux of galactic gamma rays. It is our purpose here to point out that if one accepts this explanation of the gamma-ray flux then one must also accept the existence of an x-ray flux, with a magnitude in agreement with observations but with a large anisotropy, in sharp disagreement with the measured isotropy.

Production of x rays by (1) synchroton radiation of ultrahigh-energy electrons,[4] (2) decay of π^0 mesons[5] generated in cosmic-ray interactions, and (3) metagalactic proton-antiproton annihilation[6] results in an intensity orders of magnitude below the observational results. The x rays produced by the scattering of cosmic-ray electrons on the universal 3°K distribution are also insufficient to explain the observations,[7] even when cosmological effects[8] are taken into account, unless one makes some rather ad hoc assumptions. However, several extragalactic models[9] have been proposed which are capable of explaining the data.

Following Cowsik and Pal[2] and Shen,[3] we assume that the far-infrared radiation[1] is galactic with an equivalent blackbody temperature of 8.3°K and we calculate the flux of x rays produced by scattering of this radiation on the cosmic-ray electrons. Now the flux of diffuse x rays produced is given by[10,11]

$$I_\gamma(E_\gamma) = \tfrac{1}{2} n_{\rm ph} L \sigma_{\rm T} (mc^2)^{1-\gamma} (4\bar{\epsilon}/3)^{(\gamma-1)/2} \times K_e E_\gamma^{-(\gamma+1)/2}, \qquad (1)$$

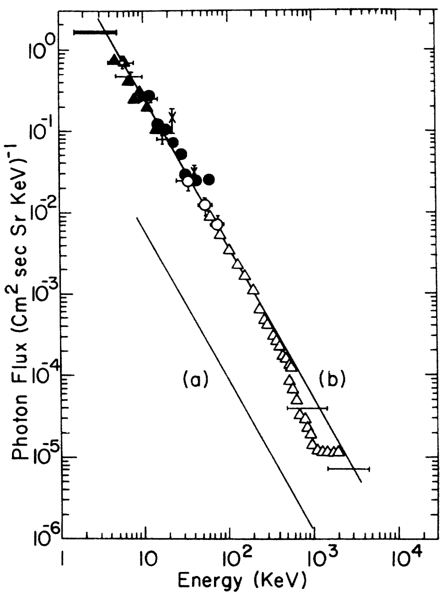

FIG. 1. The flux and energy spectrum of diffuse x rays. Solid and open symbols represent measurements (Ref. 15) of diffuse x rays: open triangles, Metzger et al.; open circles, Bleeker et al.; crosses, Hayakawa, Matsuoka, and Yamashita; open square, Fisher et al.; X's, Rothenflug, Rocchia, and Koch; solid bar, Bowyer et al.; light bars, Peterson; solid triangles and circles, proportional counter and scintillation counter data, respectively (Seward et al., Fig. 3). Curves (*a*) and (*b*) represent the theoretical results for galactic-blackbody radiation distributions corresponding to 3 and 8.3°K, respectively.

where E_γ, ϵ, and E are the energies of hard photons, thermal photons, and electrons, respectively; $n_{\rm ph}$ is the number of microwave photons per cm³; L is the integration path length in cm; $\sigma_{\rm T}$ is the Thomson-scattering cross section; $\bar{\epsilon} = 2.7kT$ is the average microwave photon energy; and the electon energy spectrum is given by $I_e(E) = K_e E^{-\gamma}$.

Microwave photons, corresponding to $T = 8.3$°K, become x rays in the 10- to 1000-keV region after scattering[11] from electrons with energies from 1 to 10 BeV.[12] A significant feature of Eq. (1) is that I_γ is proportional to T to the (relatively large) power of $3+(\gamma-1)/2$, which for a γ of 2.62 is equal to 3.81. Now the nonthermal radio background is consistent[4,13] with the presence of electrons in the halo and disk region having an energy spectrum[14]

$$I_e(E) = 126E^{-2.62}\ (\text{cm}^2\ \text{sec sr BeV})^{-1}. \qquad (2)$$

Taking an average $L \simeq 3\times10^{22}$ cm (the radius of the halo) and[7] $T = 3$°K, we obtain $I_\gamma(E_\gamma)$, which we display as curve (*a*) in Fig. 1.[4,7] A comparison with the experimental results[15] shows that the 3°K scattered photons make an insignificant contribution to the x-ray intensity. The corresponding curve for $T = 8.3$°K is shown as curve (*b*) in Fig. 1, in very good agreement with experimental data.[16]

However, L in fact varies[13] from about 1.25×10^{22} cm to 6.25×10^{22} cm, leading to an expected anisotropy in the plane of the galaxy of about 60%. This presents a puzzle because the observations indicate that the flux is isotropic[15] within about 10%.

In summary, we wish to emphasize that if one accepts the Shen-Cowsik-Pal interpretation of the galactic gamma flux,[2,3] then it follows unequivocally that one must also accept the existence of an anisotropic x-ray flux. As indicated above, this may prove to be somewhat of a mixed blessing. Perhaps the most reasonable interpretation is that the submillimeter flux[1] is strictly of local origin and that the problems of the origin of both the diffuse x-ray and the gamma-ray flux must be reconsidered.

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SEARCH FOR A GRAVITY SHIFT IN THE PROTON LARMOR FREQUENCY

B. Arlen Young
Varian Associates, Palo Alto, California 94303
(Received 23 May 1969)

An experiment was performed which placed an upper limit of 0.3 Hz on the gravity shift of the proton Larmor frequency rather than 31 ± 10 Hz as reported in the literature.

In a paper entitled "Searches for the Gravitational Moment of the Proton,"[1] Velyukhov examined the conditions under which eight independent measurements of the proton gyromagnetic ratio were made, and in addition he reported several NMR experiments and stated the following conclusions: A proton in a magnetic field precesses 31 ± 10 Hz faster when the field is parallel or antiparallel to the gravitational field than when perpendicular to it; within the experimental error this shift is independent of magnetic-field intensity. (Measurements were made from 64 to 170 G.) It was suggested that this shift could be the result of the gravitational moment of the proton precessing in the gravitational field, the rate of which would not depend on the magnetic field intensity.

A gravity shift of the reported magnitude would have a profound consequence in the mapping of the earth's magnetic field with a proton magnetometer. Mappings are frequently made to a precision of $\pm 1\ \gamma$ ($1\ \gamma = 10^{-5}$ G) and would be in error by roughly 730 γ when comparing polar and equatorial field measurements. The experiment described below was performed to check if such a magnitude of field-direction dependence actually exists for low fields. The result was that it does not. Measurements made using a vertical field orientation were found to agree, within the experimental error, with those made using a horizontal field orientation. The experimental error of these measurements was about a factor of 50 less than the error quoted by Velyukhov.

The experiment consisted of comparing the readings of a free-precession proton magnetometer (Varian model V4931DR) for nearly vertical and nearly horizontal fields having intensities of about 0.72 G. The proton sensor consisted of two small rectangular solenoids mounted one above the other in a noise-canceling configuration and filled with JP-4 jet fuel as a proton source. The protons were polarized with a 100-G pulse produced by the coils perpendicular to the external field and were then allowed to precess freely about the external field. The frequency of the emf induced across the coils was measured and translated to field intensity.

The external magnetic field was created by adding vectorially to the earth's field a field generated by a 7-ft-square pair of coils separated axially by 42 in. The coil axis was located perpendicular to the earth's magnetic-field direction (which was 61° off the horizontal) and in a vertical plane parallel to the earth's flux lines. By adjusting the current in the coil, a resultant field with 1.4 times the earth's field intensity was produced having a direction of 74° or 16° with respect to the vertical depending on the direction of current flow.

A cesium-vapor magnetometer (Varian model X4969) was used as a reference to measure the small field-intensity difference between the two field orientations. The dependence of the cesium magnetometer readings on magnetic-field direc-