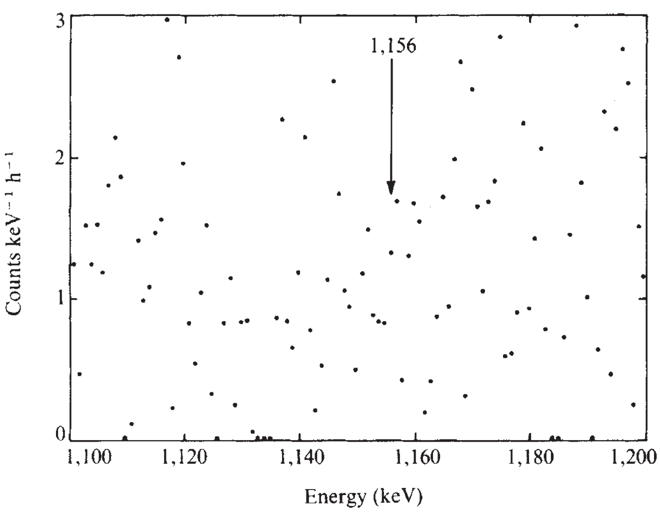
Search for the 1.2 MeV γ-ray line of Walraven and Haymes

WALRAVEN AND HAYMES[1] have reported the possible detection of a $\sim$1.16 MeV γ-ray line at a flux level of $(3.4 \pm 1.5) \times 10^{-3}$ photons $cm^{-2}\ s^{-1}$ from a point in the galactic plane ($l = 345°$, $b = 5°$). If correct this could be an enormously important result constituting the first direct confirmation of theories of explosive nucleosynthesis (ref. 2 and refs therein). Clayton *et al.*[3,4] have predicted that the most intense γ-ray line to be emitted from the radioactive debris of a typical supernova after $\sim$3 yr will be the 1.156 MeV line from the decay of ^{44}Ti ($\tau_{1/2} = 48$ yr). However, the reported detection was at a marginal level of statistical significance (2.6σ). It was mainly the "remarkable double coincidence that just the theoretically-predicted spectral anomaly occurred" when the telescope was pointed at a region of the galactic plane believed to contain young supernova remnants, that encouraged these workers to report this result. Clearly an independent attempt to confirm this observation with a telescope of finer energy resolution is called for. Here we report the result of such an attempt. Our conclusion is that the reported positive detection was probably a statistical fluctuation.

A balloon-borne high-resolution (3.2 keV FWHM at 1.156 MeV) γ-ray telescope was flown on 11 November 1977 from Alice Springs, Australia. The instrument was essentially the same as that previously described[5,6], but an important modification made for this flight was the replacement of the central Ge(Li) detector with a large volume, $\sim$130 cm^3 high-purity germanium detector. This necessitated an increase of the effective entrance aperture in the 400 lb NaI anticoincidence shield to 16° FWHM at 1.156 MeV. The direction ($l = 345°$, $b = 5°$) was tracked for 1 h starting at 23.51 UT with the balloon at an atmospheric depth of 3.0 g cm^{-2}. The search for the 1.156 MeV line was terminated when our quick-look data revealed that no indication of the feature at the reported flux level was evident.

In Fig. 1 we show the sum of all our data in the vicinity of 1.16 MeV. Only corrections for drifts in the energy calibration with time have been made. No astrophysical γ-ray line is apparent in these data nor in any of our data within hundreds of keV of 1.156 MeV. These data can be used to set a 1.156 MeV γ-ray line flux limit. Using the known detector efficiency, instrumental dead time and atmospheric attenuation we find a 2σ limit of less than $2.8 \times 10^{-4}\ \sqrt{\text{width (in keV)}}$ photons $cm^{-2}\ s^{-1}$. Since the linewidth is expected to be $\sim$40 keV (FWHM) (ref. 7) this corresponds to a 2σ limit of less than 1.8×10^{-3} photons $cm^{-2}\ s^{-1}$ which is a factor of two less than the reported intensity. Thus the reported positive detection seems likely to be a statistical fluctuation.

Fig. 1 Energy spectra in the vicinity of 1.156 MeV. Raw data corrected only for drifts in the energy calibration. Each point represents a 1-keV wide energy bin.



We thank P. E. Havey, G. C. Hauser, A. F. Huters and J. J. Lochtefeld for technical support and the staff of the Australian Balloon Launching Service (led by P. Oates) and the US National Center for Atmospheric Research (led by H. Woody and R. Collett) who ensured a successful balloon flight.

M. LEVENTHAL

Bell Laboratories, Murray Hill, New Jersey 07974

C. J. MACCALLUM
P. D. STANG

Sandia Laboratories, Albuquerque, New Mexico 87115

Received 26 June; accepted 2 August 1978.

1. Walraven, G. D. & Haymes, R. C. *Nature* **264**, 42 (1976).
2. Schramm, D. N. & Arnett, W. D. (eds) *Explosive Nucleosynthesis* (University of Texas Press, Austin, 1973).
3. Clayton, D. D., Colgate, S. A. & Fishman, G. J. *Astrophys. J.* **155**, 75 (1969).
4. Clayton, D. D. in *Explosive Nucleosynthesis* 264 (University of Texas Press, Austin, 1973).
5. Leventhal, M., MacCallum, C. J. & Watts, A. C. *Nature* **266**, 696 (1977).
6. Leventhal, M., MacCallum, C. J. & Watts, A. C. *Astrophys. J.* **216**, 491 (1977).
7. Ramaty, R. & Lingenfelter, R. E. *Astrophys. J. Lett.* **213**, L5 (1977).

Does the troposphere respond to day-to-day changes in solar magnetic field?

WILCOX ET AL.[1] have reported a statistical correlation between the solar magnetic sector structure and the vorticity area index (VAI) during the period 1964–70. Characteristically, the VAI reached a minimum 1 day after the passage of a solar magnetic sector boundary (SSB), with the response being greatest in winter and at 500 and 300 mbar. This result has been the basis of many subsequent studies; in particular Wilcox *et al.*[2] strengthened their previous results by extending the period of analysis to the 11 year interval 1963–73. We have examined the period 1974–77 and find that this characteristic response is now no longer evident.

Williams has recently[3] analysed the four components of the Lorenz energy cycle in an attempt to clarify the physical processes involved in the apparent solar modulation of the VAI. Although no statistically significant solar effects were discovered, some similarity was found in the behaviour of the eddy kinetic energy (KE) and the VAI. However, the KE exhibited a greater averaged response to the passage of an SSB (as obtained using a superposed epoch analysis) during the 1960s than the 1970s. Consequently, if there is a correlation between the KE and the VAI we might expect the effect of an SSB crossing on the VAI to also be weaker during the more recent years. This prompted us to extend the analysis to the period 1974–77 to determine whether or not the characteristic response of the VAI still existed during these years.

The VAI was calculated by the method described previously[1] using the National Meteorological Center data available at the National Center for Atmospheric Research. The VAI, at a particular pressure level, is defined to be that area of the Northern Hemisphere north of 20°N in which the absolute vorticity exceeds $24 \times 10^{-5}\ s^{-1}$ plus that area in which it exceeds $20 \times 10^{-5}\ s^{-1}$. This is a modification of the original index defined by Roberts and Olson[4]. In order to match the previous work, a superimposed epoch analysis was performed using the VAI and SSBs[5] during the winter months 1 November–31 March. However, we required that all the VAI data be in this interval

0028–0836/78/0275—0200$01.00