# LOCAL ELECTRON SPECTRUM ABOVE 100 MeV DERIVED FROM GAMMA-RAY EMISSIVITY SPECTRA

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## ABSTRACT

*Two new determinations of the local γ-ray emissivity spectrum are in good accord and have been used to derive constraints on the local electron spectrum. The requirement for an electron intensity above 1 GeV larger than previously believed is confirmed, and no low-energy upturn in the electron spectrum is then needed.*

**1. INTRODUCTION** The local γ-ray emissivity spectrum from 70-5000 MeV has recently been determined by two independent analyses of the COS-B data, first at intermediate latitudes (Strong et al., 1985) secondly at low latitudes ($|b| < 5.5^o$) in the longitude range $15^o < l < 165^o$ (Bloemen et al. 1985). The first method, using 21-cm and galaxy count data as gas tracers, refers only to the region within about 500 pc from the Sun; the second, using 21-cm and CO surveys with velocity information to estimate distances, gives large-scale average emissivities for various galactocentric distance ranges. To compare the two results, Table 1 uses the mean values for galacto- centric distances between 8 and 15 kpc from Bloemen et al.

**TABLE 1**: Local emissivity spectrum ($10^{-26} sr^{-1} s^{-1}$)

| *Energy range* | $10^o < \|b\| < 20^o$ | $\|b\| < 5.5^o$ |
|---|---|---|
| $70 - 150$ *MeV* | $1.1 \pm 0.1$ | $1.0 \pm 0.1$ |
| $150 - 300$ *MeV* | $0.76 \pm 0.06$ | $0.74 \pm 0.05$ |
| $300 - 5000$ *MeV* | $0.68 \pm 0.07$ | $0.62 \pm 0.04$ |

The agreement with the intermediate latitude values is excellent, and since the techniques used are quite different I conclude that the local emissivity spectrum is reliable and not subject to large systematic errors. The intermediate latitude results are improvements on earlier analyses (Lebrun et al. 1982, Strong 1982, 1985) owing partly to the increase amount of data now available and partly to improved analysis methods.

**2. RESULTS** The emissivity spectrum has been used to derive the local interstellar electron spectrum by the method of Gualandris and Strong (1984), in which a three-power-law representation is assumed and allowance is made for an uncertainty of up to 20% in each of the adopted emissivity values. The bremsstrahlung is treated using the formulae of Blumenthal and Gould (1970); the $\pi^o$ spectrum is taken from Stephens and Badhwar (1981), and the electron spectral shape above 300 MeV is assumed to be $E^{-2.4}$ as derived from radio spectral data (Webber 1983). As before a factor $f_p$ is introduced to allow for the uncertainty in the absolute level of the $\pi^o$ spectrum.

Fig 1 shows various spectra consistent with the intermediate latitude emissivities and includes the range of 'reasonable'solutions for $f_p = 1.0$ and 1.1. In fact with the present values such solutions are only obtained if the 300-5000 MeV emissivity is reduced by 10% or more, so Fig 1 shows families of solutions for reductions of 10% and 20% (i.e. within the allowed uncertainties). For comparison the 'local demodulated'values at 4 GeV given by Rockstroh and Webber (1980) and Webber (1983) are shown. The conclusion of Gualandris and Strong (1984) that the local spectrum is higher than that given by Rockstroh and Webber is reinforced by the present analysis; this conclusion depends on the 300-5000 MeV emissivity which is now higher than in previous analyses (e.g. Strong 1982). A factor 2-3 relative to Rockstroh and Webber (1980) is required, while the larger value given by Webber (1983) is consistent with the lower limit from the present analysis for $f_p = 1.1$. The comparison is summarized in Table 2.

**TABLE 2**: Electron intensity at 4 GeV (units of $10^{-2} cm^{-2} sr^{-1} s^{-1} GeV^{-1}$)

| | |
|---|---|
| *Rockstroh and Webber* (1980) | 3.0 |
| *Fig* 1 *of Webber* (1983) | 4.7 |
| *Fig* 6 *of Webber* (1983) | 4.1 |
| *present work* $f_p = 1.0$ | $7 - 10$ |
| *present work* $f_p = 1.1$ | $5 - 8$ |

The uncertainty in the electron spectrum below 100 MeV is still very large, a consequence of the fact that the bremsstrahlung from these electrons lies largely below the lowest COS-B energy band. The spectra are however consistent with the continuation of the $E^{-2.4}$ shape down to 100 MeV, as proposed by Webber (1983) provided the intensity $> 300$ MeV is in the range shown in Fig 1.

The present result is particularly important for estimates of the inverse-Compton component of the galactic emission (e.g. Bloemen 1984, Bloemen et al 1985, Strong 1985, Strong et al. 1985). These calculations have generally used the local demodulated spectrum; attempts to leave the intensity as a free parameter (Strong 1985, Strong et al.1985) indicate an intensity consistent with the present work.

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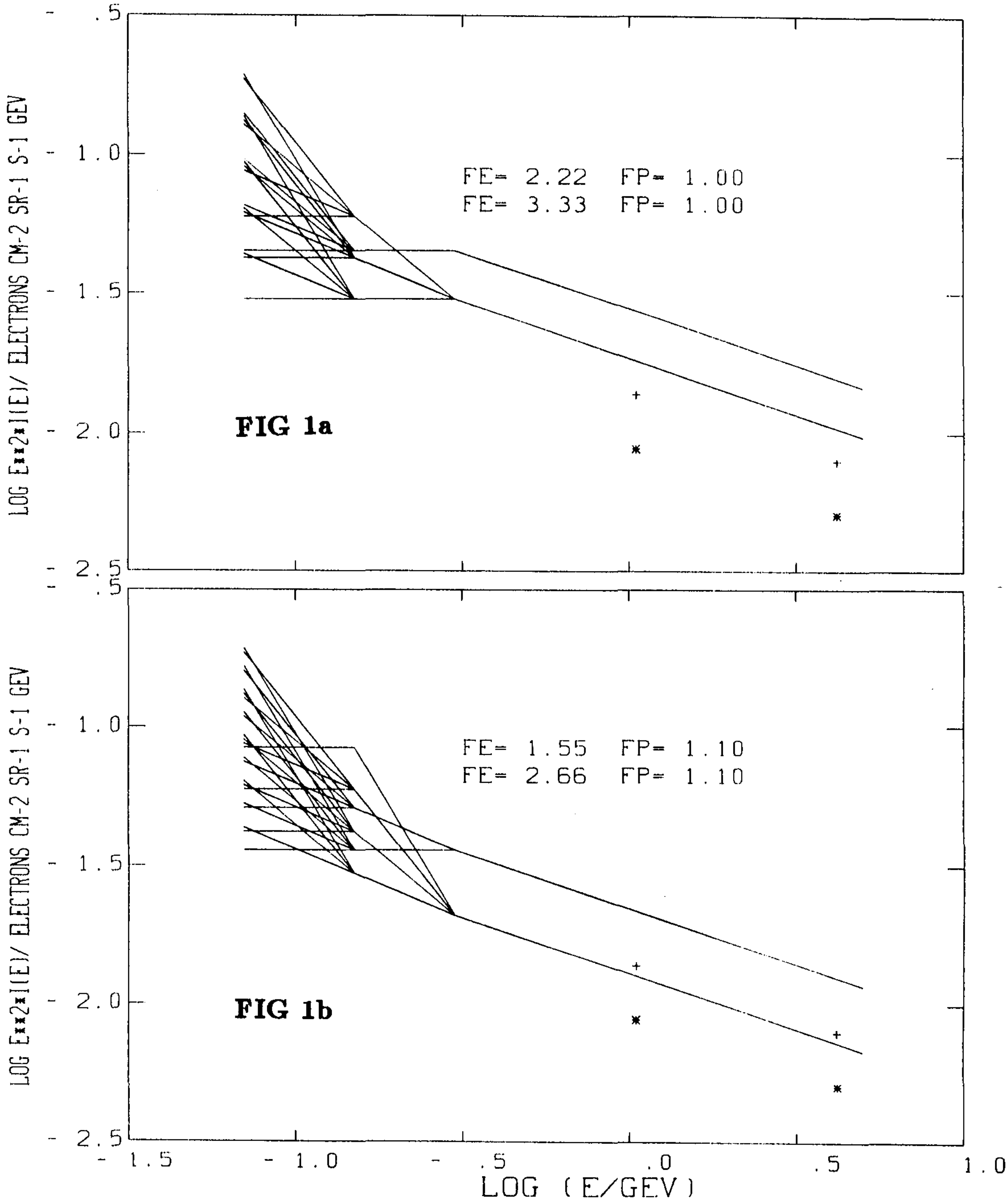


**FIG 1a** ***Electron spectra consistent with $\gamma$-ray emissivities derived at intermediate latitudes.*** The $\pi^o-$ spectrum factor $f_p$ is 1.0. Each family of connected spectra represents the range allowed by uncertainties of up to 20% in the 70-150 and 150-300 MeV emissivities. In the upper and lower sets the 300-5000 MeV emissivity is reduced by 10% and 20% respectively relative to Table 1. (Larger values of the 300-5000 MeV emissivity do no lead to reasonably-behaved spectra.) * ....Rockstroh and Webber (1980), +....Webber (1983)

**FIG 1b** ***As Fig 1a, but with*** $f_p = 1.1$