THE FLUCTUATIONS OF THE COSMIC X-RAY BACKGROUND AS A SENSITIVE TOOL TO THE UNIVERSAL SOURCE DISTRIBUTION

P. Giommi* and G.F. Bignami
Istituto di Fisica Cosmica - CNR - Milano
*Istituto di Fisica Università - Milano

Recent experimental results (Giacconi et al,79, Tananbaum et al 79) ascribe an increasingly important role to the contribution of discrete sources to the low-energy (few Kev) cosmic X-ray background (CXB). While the astrophysical nature of the objects involved is not yet clear, distant and powerful emitters like QSO play probably an important role (e.g. Setti and Woltjer 1979, Field 1980). For them, often the number-flux curve (LogN-LogS) provides useful hints on such properties as space distribution and/or evolution. For the case of the X-ray sources, moreover, a definite relation exists between their LogN-LogS and the granularity of the sky emission as described by the fluctuations of the X-ray background (Cavaliere and Setti, 1976).
This relation refers to the case of a LogN-LogS graph characterized by a unique, continuous slope in the flux region of interest, the value of the slope bearing a precise relation to the distribution and/or evolution of the sources supposed to generate the fluctuations. It is appropriate now to consider the more general case of the impact on the percentage fluctuations of a LogN-LogS graph with one (or more) change(s) in slope, allowing for a greater variety of contributing populations and/or evolution models. Such assumption is suggested by (a) the recent Einstein Observatory data (see e.g. Maccacaro et al, 1979) (b) by the comparison of the Giacconi et al (1979) point at $\sim 3 \times 10^{-3}$ UEFU (UFU 1 - 3 Kev) with the 1 UFU point of Forman et al 1978), especially when considering that the latter point might include unidentified sources of galactic nature; (c) expected, or at least not unreasonable on theoretical grounds, from the recent blue object survey by Braccesi et al, 1980, Bonoli et al, 1980 as well as from the well known QSO-QSS distribution data (see e.g. Setti and Zamorani 1978).

Starting then from the results of Cavaliere et al, 1973, and of Cavaliere et al, 1979, assuming the differential LogN-LogS graph to steepen for weak fluxes from the "euclidean" -2.5 value to a slope $-\beta$ (β>2.5) the expression relating the fluctuations to the numbers and fluxes of sources will change into:

$$\delta S^2 = \Omega h / S_L^{\beta-3} \left\{ 1/(3-\beta) \left[(S_L/S_1)^{\beta-3} - 1 \right] + 2 (S_L/S_1)^{\beta-3} \left[(S_1/S_U)^{1/2} - 1 \right] \right\}$$

G. Setti, G. Spada, and A. W. Wolfendale (eds.), Origin of Cosmic Rays, 277–278.

where Ω is the field of view considered, h is the differential LogN-LogS normalization constant, S_U is the flux corresponding to the brightest unresolved source, S_L to the faintest source contributing to the CXB flux and S_1 is the flux value when the slope changes from -2.5 to $-\beta$

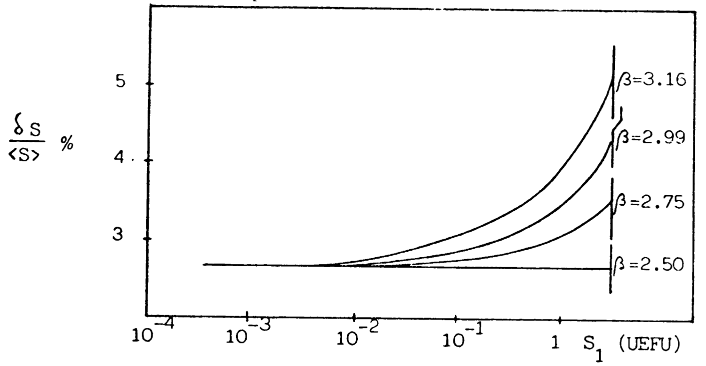

Fig. 1 shows the expected percentage fluctuations as a function of the S_1 flux value (in UEFU), for different β values. Note that for β = 2.5 the expected value (horizontal line) is $<$ 3% for a field of view of 100 sq. deg. It is seen that the change in slope of the LogN - LogS is reflected quantitatively on the percentage fluctuations, and that, at least in principle, an accurate measurement of the latter could determine β. Obviously, fig. 1 is computed for the case of the totality of the 1-3 Kev CXB (1.9 10^{-8} ergs/cm^{2}secsr.)being due to point sources. Since a significant fraction of it, however, could well be due to truly diffuse processes (see e.g. Field, 1980, Boldt, 1980), it is important to note that the present results still hold true because this is equivalent to truncate the LogN-LogS graph on the side of the very weak source which contribute very little to the fluctuations.

The conclusions of the present work are to some extent academic, if compared to the capabilities of the present generation X-ray detectors of measuring both very faint sources and low-level fluctuations of the CXB. It is hoped, however, that the nearly contemporary advent of very much improved, long-lived X-ray facilities (e.g. AXAF) and of the ST, will make it possible to investigate more completely on the various cosmological populations contributing to the (optical and) CXB.

References:

Boldt, E.A., 1980 NASA T.M. n° 80659
Bonoli, F. et al. 1980 preprint
Braccesi A. et al. 1980, A&A, 85, 80.
Cavaliere, A et al, 1973 Ap; J. 182, 405
Cavaliere A. and Setti G., 1976 A&A 46, 81
Cavaliere A. et al, 1979 A&A, 79, 169
Field, G.B., 1980 Ap. J. in press
Forman, W. et al. 1978 Ap. J. suppl. 38, 357
Giacconi R. et al 1979 Ap. J. 234, L1
Maccacaro T. et al. 1979 B.A.A.S. 11, 771
Setti G. and Zamorani G. 1978 A&A 66, 249
Setti G. and Woltjer L. 1979 A&A 76, L1
Tananbaum H. et al., 1979, Ap. J. 234, L9.

https://doi.org/10.1017/S007418090007474X Published online by Cambridge University Press