CONSTRAINTS ON THE COSMOLOGICAL EVOLUTION OF AGNs FROM X-RAY DATA *

L. Danese , G. De Zotti , G. Fasano , A. Franceschini
Istituto di Astronomia
Vicolo dell'Osservatorio, 5
I-35122 Padova
Italy

1. THE DATA

Both the soft (Maccacaro et al., 1982; Gioia et al., 1984; Giacconi et al., 1979; Griffiths et al., 1983) and the hard (Piccinotti et al., 1982) X-ray surveys provide crucial information on the evolution of AGNs in the X-ray band. Before combining the two data sets, however, the consistency of the two flux scales must be checked. To this end we have compared the soft (SX) and the hard (HX) X-ray luminosities of all powerful (log(SX)>43.5) AGNs for which both IPC and hard X-ray fluxes are available in the literature (lower luminosity objects frequently exhibit large intrinsic, luminosity dependent, absorbing columns which cannot be accurately accounted for). We find

$$\langle \log(HX)/(SX) \rangle = 0.17 \pm 0.06 ,$$

to be compared with the expected value $\langle \log(HX)/(SX) \rangle \simeq 0$ for a typical X-ray energy index $\alpha_x \simeq 0.7$. Thus, an average correction factor of $\simeq 1.5$ needs to be applied to the IPC fluxes to bring them into the hard X-ray flux scale.

Strong additional constraints on evolution models come from the observed properties of the X-ray background (XRB). Its intensity implies, anyway, a fast convergence of the counts of faint AGNs (Setti and Woltjer, 1979). Moreover, as shown by De Zotti et al. (1982), its spectral shape requires that the dominant contributors have a rather narrow range of spectral indices centered around $\alpha_x = 0.4 \div 0.5$; also, the remarkable smoothness of its spectrum (Marshall et al., 1980) strongly argues against a $\geqslant 30\%$ contribution from sources with "wrong" spectra, such as active galaxies which apparently have a "universal" slope $\alpha_x \simeq 0.7$. If indeed QSOs have similarly steep or even steeper slopes and/or a broad range of spectral indices, as suggested by several recent studies (see, e.g., Wilkes and Elvis, 1985) , tight constraints on the evolution properties of AGNs ensue.

2. THE EVOLUTION MODELS

The following evolution models were tested against these data.

* Discussion on p.513

G. Swarup and V. K. Kapahi (eds.), Quasars, 489–490 .

1) Luminosity Dependent Density Evolution (LDDE) models, as proposed by Wall et al. (1980) and by Schmidt & Green (1983). The evolution time scales are in this case proportional to log L_x .
2) Pure Luminosity Evolution (PLE) models.
3) Luminosity Dependent Luminosity Evolution (LDLE) models, of the kind proposed by Cavaliere et al. (1985), which allow only high luminosity sources to undergo strong luminosity evolution.

3. RESULTS

Various statistical techniques were applied to contrast the model predictions with the data. Minimum χ^2 and Maximum Likelihood methods were used as parameter point and interval estimators; a 2D Kolmogorov-Smirnov test (Peacock, 1983; Fasano and Franceschini, 1985) was also applied to further check the goodness of fit.

The main conclusions can be summarized as follows.

If the X-ray spectra of AGNs are significantly steeper than that of the 2-10 keV XRB (as current data suggest), a faster convergence of their counts is implied than can be achieved with the simplest LDDE models. Luminosity evolution models can meet the XRB constraints on the condition that only high luminosity sources (log $L_x \geqslant 43.5$) are allowed to evolve. Consideration of the Einstein Medium Sensitivity Survey luminosity distribution, on the other hand, suggests that the transition between non-evolving and evolving sources occurs just close to log $L_x \simeq 43.5$.

Further details can be found in Danese et al. (1986).

We acknowledge helpful exchanges with A. Cavaliere, E. Giallongo and T. Maccacaro. Work supported by CNR (through GNA and PSN) and MPI.

4. REFERENCES

Cavaliere A., Giallongo E., Vagnetti F., 1985, Ap. J. **296**, 402.
Danese L., De Zotti G., Fasano G., Franceschini A., 1986, Astron. Astroph. in press.
De Zotti G., et al., 1982, Ap. J. **253**, 47.
Fasano G., Franceschini A., 1985, submitted to Monthly Notices Roy. Astron. Soc.
Giacconi R., et al., 1979, Ap. J. **230**, 540.
Gioia I.M., et al., 1984, Ap. J. **283**, 495.
Griffiths R.E., et al., 1983, Ap. J. **269**, 375.
Maccacaro T., Gioia I.M., Stocke J.T., 1984, Ap. J. **283**, 486.
Peacock J.A., 1983, MNRAS **202**, 615.
Piccinotti G., et al., 1982, Ap. J. **253**, 485.
Schmidt M., Green R.F., 1983, Ap. J. **269**, 352.
Setti G., Woltjer L., 1979, Astron. Astroph. **76**, L1.
Wall J.V., Pearson T.J., Longair M.S., 1980, Monthly Notices Roy. Astron. Soc. **193**, 683.
Wilkes B., Elvis M., 1986, these Proceedings, p.261 .