Soft X-ray absorption in Parkes Quasars

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1. Introduction

Quasars from the Parkes Half-Jansky Flat Spectrum Sample (PHFS) (Drinkwater et al. 1997) are known to have a large dispersion in optical $(B-K)$ colours (Webster et al. 1995, Francis et al. 1999), with the reddest objects having $B-K>7$. As such, they are much redder than optically selected quasars.

There are two different theories to account for this large dispersion in $B-K$ colour: excess red emission (most likely synchrotron) is present that increases the K flux; or dust absorption takes place, reducing the B flux.

These two models have been explored by Whiting et al. (in preparation). We have found that there is an identifiable minority of quasars that are best fit with dust extinction, rather than synchrotron reddening. It is expected that, for these sources, there will be some degree of absorption of soft X-rays by gas associated with the dust. This possibility has been explored extensively by Masci et al. (1999) (M99) for quasars from the PHFS. We repeat their analysis for a subset of the PHFS, using the more appropriate values for the optical extinction gained from our model fitting.

2. Selection of dusty sources

To discriminate between the different types of sources present in the PHFS, we fitted different models to the photometry: a synchrotron + big blue bump model, a dust-reddened big blue bump model, and a pure big blue bump model. From this fitting we were able to pick out the sources that were clearly dust-reddened (rather than synchrotron reddened), by choosing the sources best fit by the dust model. This yielded a sample of 33 sources, or 28% of the total number considered.

We then plotted the extinction A_V gained from the dust fits against the optical – soft X-ray continuum slope, in the manner of M99. Our X-ray fluxes came from the ROSAT observations of the whole PHFS by Siebert et al. (1998), as did those used by M99.

3. Results and discussion

The predictions from M99 for the optical–X-ray slopes, as a function of A_V, are:

$\alpha_{\rm BX} = (1.3^{+0.3}_{-0.2}) - (0.13^{+0.03}_{-0.02})A_V$,

$\alpha_{\rm KX} = (1.0^{+0.3}_{-0.2}) + (0.05^{+0.04}_{-0.03})A_V$.

(See M99 for details). Our results, together with the predicted relationships, are shown in Fig 1.

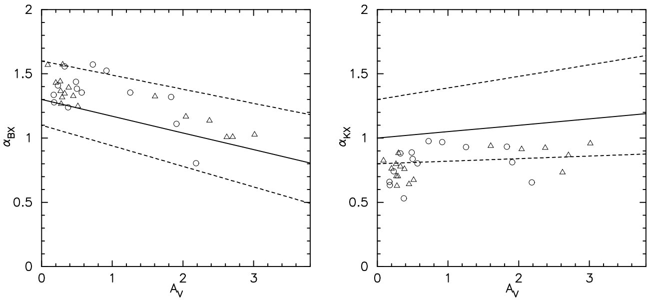

Fig. 1. Our results, for both optical– and NIR–Soft X-ray slopes. Lines show predictions from M99 (solid = predictions, dotted = limits). Circles are X-ray detections, and triangles are X-ray upper limits (lower limits to the index).

The best fit relationships to the data, found using the survival analysis package ASURV, are:

$\alpha_{\rm BX} = 1.54 - 0.14A_V, \quad \alpha_{\rm KX} = 0.82 + 0.07A_V$

These results are consistent with the simple hypothesis that dust is causing the absorption in the optical/NIR, and that the associated gas is causing absorption at soft X-ray energies. The fact that the slope of the best fit lines are within the error margins of the predictions indicates that the assumption of Galactic gas-to-dust ratios is valid for these sources.

The intrinsic values of the indices, given by the zero points on the graphs, are also consistent with the predictions. The value from $\alpha_{\rm KX}$ is at the low end of the predicted range, which perhaps indicates that radio-loud flat spectrum quasars have a flatter intrinsic slope than optically selected quasars (from which the prediction was taken).

These results give support to the assertion that at least a subset (and an identifiable subset at that) of the PHFS are affected by dust. This has important implications if radio-quiet quasars are similarly affected (see e.g. Webster et al. 1995). Indeed, our results here predict that about a quarter of quasars should exhibit signs of dust reddening, and this can be tested by multicolour surveys such as the Sloan Digital Sky Survey.

References

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