X-ray variability of a polar-scattered Seyfert-1 galaxy Fairall 51

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Polar-scattered Seyfert 1 galaxies are characterised by an unusually large optical polarisation for the type-1 objects, and therefore represent a bridge between the un-obscured type-1 and obscured type-2 galaxies. Their X-ray spectra show complex and variable X-ray absorption. Here, we present our recent results on the Suzaku X-ray monitoring of Fairall 51 (Svoboda et al., 2015). The intrinsic X-ray spectrum is affected by at least three absorbers with different ionisations. We found that the least ionised absorber is variable on a week-long scale, from which we constrained its location in the Broad Line Region (BLR). Assuming an intermediate inclination of the source, this implies that the BLR clouds can reach relatively high altitudes above the equatorial plane.

Fairall 51

- type-1 galaxy
  - FWHM of $H_\beta \approx$ 3000km/s (Schmid et al.,01)
- degree of optical polarisation 5% (optical, 700nm) to 13% (UV)
- X-ray variable (Ricci et al.,10; Beuchert et al.,13)
- we performed a new X-ray monitoring programme

Table 1. List of new observations with Suzaku

Observation	ID	Date	Exposure [ks]
1	708046010	Sep 4, 2013	31.5
2	708046020	Sep 5, 2013	31.0
3	708046030	Sep 7, 2013	24.4
4	708046040	Sep 13, 2013	30.4

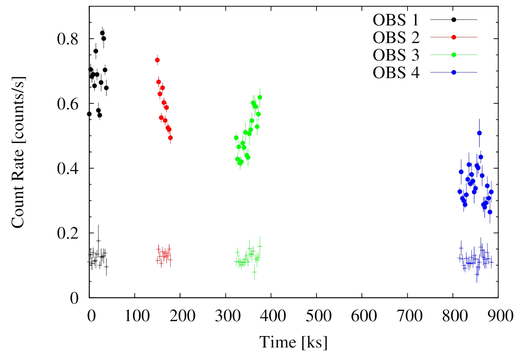

Figure 1. Suzaku XIS-0 (upper) and HXD/PIN (bottom) light curves.

X-ray spectroscopic results

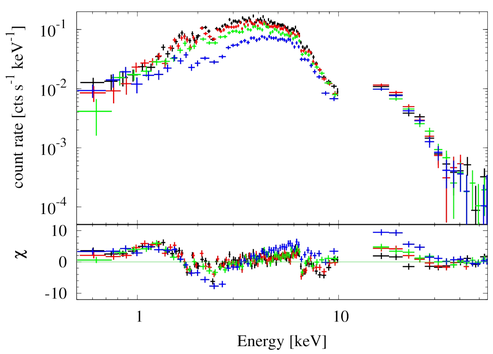

Figure 2. X-ray spectra of four Suzaku observations and the residuals against a simple absorbed power-law model.

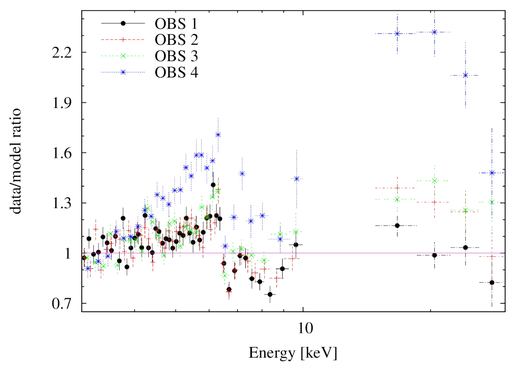

Figure 3. A detailed look at ratios around the iron line and Comtpon hump.

Spectral model components (*variable):

- power law
  - photon index $\Gamma = 2 \pm 0.2$
  - direct*
  - scattered
- absorption
  - low-ionised*
    - log ξ ≈ 1.2 erg cm s^{-1}
  - mid-ionised(*?)
    - log ξ ≈ 1.6 erg cm s^{-1}
  - high-ionised
    - log ξ ≈ 3.6 erg cm s^{-1}
- reflection
  - distant
  - relativistic*
    - spin a≈0.8
    - inclination i≈20deg
    - emissivity index q≈3.5

Origin of the X-ray variability

- most of the X-ray variability is due to changes of the column density of the low-ionised absorber and the power-law normalisation (Fig. 5)
  - their relation might be due to a gas-opacity effect?
- little evidence for variability of mid- (Fig. 6) and high-ionised absorbers
- the ionisation is not required to vary
  - → absorber not in photo-ionisation equilibrium?

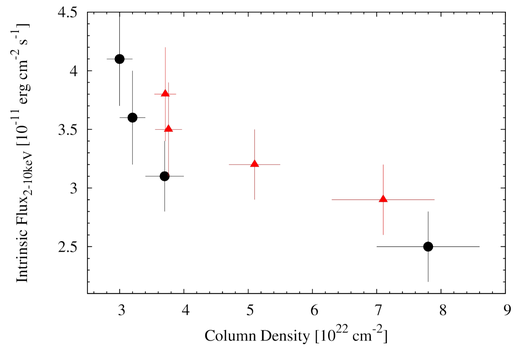

Figure 5. Relation between the intrinsic 2-10keV flux and the column density of the low-ionised absorber.

Location of the variable absorber

- assuming an obscuring cloud orbiting with Keplerian velocity, we get for the distance:

R ≈ 1.5 10^{17} cm ≈ 0.05 pc ≈ 60 light days

- corresponds to the Broad Line Region
  - an estimate from the luminosity - BLR radius relation by Bentz et al. (13) ≈ 40 light days

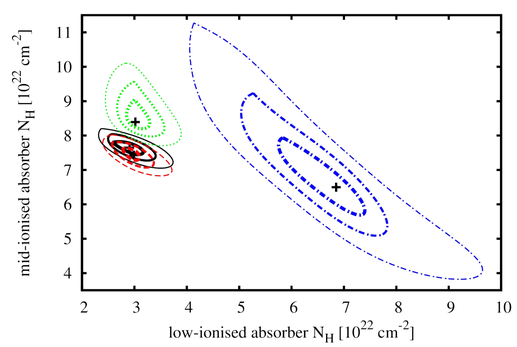

Figure 6. Contour plot between the column densities of the low and mid-ionised absorbers.

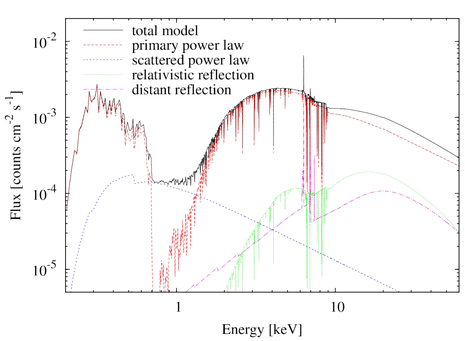

Figure 4. Components of the best-fit model.

Conclusions

- the X-ray monitoring programme by Suzaku satellite confirmed high spectral variability of Fairall 51
- the X-ray spectrum is characterised by a complex absorption (at least three different ionisations) and reflection (distant and relativistic)
- the spectral variability is due to the low-ionised absorber
  - its estimated distance from the week-scale variability corresponds to the Broad Line Region

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