First INTEGRAL and Swift observations of a giant outburst of A 0535+26

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Abstract.

The Be/X-ray binary A 0535+26 has shown three giant outbursts since 2005, after a long period of quiescence. The giant outbursts in 2005 (~5.2 Crab, 15-50 keV range) and 2009 (~5.6 Crab) could not be observed by most X-ray observatories due to Sun observing constraints. Finally, a giant outburst in February 2011, that reached a flux of ~3.8 Crab, was monitored with INTEGRAL and Swift TOO observations. We present first results these observations, with a special focus on the cyclotron lines present in the X-ray spectrum of the source.

Keywords: X-rays: binaries - stars: magnetic fields - stars: individual: A 0535+26

The Be/X-ray binary A 0535+26 was discovered by Ariel V during a giant outburst in 1975 [6]. At a distance of ~2 kpc, a $P_{\text{spin}} \sim 103$ s pulsar orbits the B0 IIIe star HDE 245770 [8] in an eccentric orbit ($e = 0.47$) of $P_{\text{orb}} \sim 111.1$ d [3]. A long quiescence period of more than 11 years ended with a giant outburst in 2005. Since then, several normal and giant outbursts have been observed, all of them around the periastron passage. The source presents cyclotron lines in its X-ray spectrum at ~46 keV, discovered during a giant outburst in 1989 with HEXE [4]. From the cyclotron lines, a magnetic field of $B \sim 4 \times 10^{12}$ G is inferred.

A 0535+26 underwent a giant outburst in February 2011, observed with INTEGRAL and Swift. The Swift-BAT light curve of the outburst and the times of the observations are shown in Fig. 1 (left). These observations provide for the first time the possibility to study the cyclotron line evolution of the source during a giant outburst.

We extracted phase averaged spectra for all the Swift and INTEGRAL observations, and fitted the broad band X-ray spectrum with a cutoff powerlaw plus a cyclotron line at ~46 keV, modeled with a Gaussian optical depth profile as in [2]. Preliminary results of the cyclotron line energy as a function of the luminosity are given in Fig. 1 (right). The INTEGRAL-ISGRI ancillary response file (ARF) is based on Crab observations. In
FIGURE 1. Left: Swift-BAT light curve of the February 2011 giant outburst of A 0535+26. The times of the INTEGRAL and Swift observations are shown. Right: cyclotron line energy evolution with the luminosity, from RXTE, INTEGRAL, and Suzaku observations of a normal outburst in 2005 [9, 1] and from the INTEGRAL observations of the 2011 giant outburst (preliminary).

most of our observations, A 0535+26 is significantly brighter than the Crab, and the ARF needs to be adjusted for these observations. For our preliminary analysis, we restricted the ISGRI analysis to energies below 80 keV.

Variations of the cyclotron line with the X-ray luminosity can be used to probe the change of the accretion structure and plasma properties with the mass accretion rate. Contrary to other sources (see, e.g., [5, 10, 7]), for A 0535+26 no significant variation of the cyclotron line energy with the X-ray luminosity was observed [9, 1]. The new INTEGRAL observations allow us to extend the studied luminosity range up to $L_{\text{X}}(3-50\text{keV}) \sim 3.4 \times 10^{37}\text{ergs}^{-1}$. As seen in Fig. 1 (right), one of the INTEGRAL measurements of the cyclotron line energy is significantly lower than the other ones. The other values remain rather stable in the luminosity range $0.037 - 3.4 \times 10^{37}\text{ergs}^{-1}$. A more in-depth analysis of the ISGRI data is ongoing to account for the current uncertainties in the response matrix in order to confirm these results.

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