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.

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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 $P_{\rm spin} \sim 103$ s pulsar orbits the B0 IIIe star HDE 245770 [8] in an eccentric orbit ($e = 0.47$) of $P_{\rm orb}$ ∼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 and ∼ 100 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

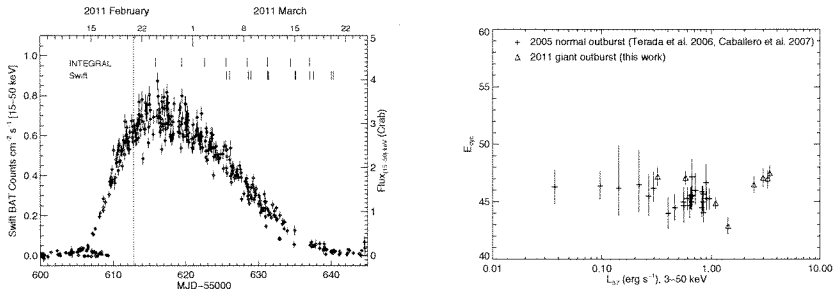

FIGURE 1. *Left: Swift*-BAT light curve of the February 2011 giant outburst of A 0535+26. The times of the *INTEGRAL* and *Swift* observations are shown. *Right:* cyclotron line energy evolution with the luminosity, from *RXTE*, *INTEGRAL*, and *Suzaku* observations of a normal outburst in 2005 [9, 1] 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 $L_{(3-50)\,\mathrm{keV}} \sim 3.4 \times 10^{37} \mathrm{erg\,s^{-1}}$. 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 $\sim 0.037 - 3.4 \times 10^{37} \mathrm{erg\,s^{-1}}$. A more in-depth analysis of the *ISGRI* data is ongoing to account for the current ucertanties in the response matrix in order to confirm these results.

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