Post-glitch variability in the Anomalous X-ray Pulsar 1RXS J170849.0–400910

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ABSTRACT

Here we report on the first XMM–Newton observation of the Anomalous X-ray Pulsar 1RXS J170849.0–400910. The source was observed in 2003 August and was found at a flux level a factor of about two lower than previous observations. Moreover, a significant spectral evolution appears to be present, the source exhibiting a much softer spectrum than in the past. Comparison of the present properties of 1RXS J170849.0–400910 with those from archival data shows a clear correlation between the X-ray flux and the spectral hardness. In particular, the flux and the spectral hardness reached a maximum level close to the two glitches the source experienced in 1999 and in 2001, and successively decreased. Although the excellent XMM–Newton spectral resolution should in principle allow us to detect the absorption line reported in a phase-resolved spectrum with BeppoSAX, and interpreted as a cyclotron feature, we found no absorption features, neither in the phase averaged spectrum nor in the phase resolved spectra. We discuss in detail both the possibilities that the feature in the BeppoSAX data may have resulted from a spurious detection or that it is real and intrinsically variable. We then discuss a possible explanation for the glitches and for the softening of the source emission which followed the flux decrease, in the framework of the magnetar model.

Key words: stars: pulsars: individual: 1RXS J170849.0–400910 – stars: magnetic fields – stars: neutron – X-rays: stars

1 INTRODUCTION

Anomalous X-ray Pulsars (AXPs) and Soft γ-ray Repeaters (SGRs) are two peculiar groups of neutron stars (NSs) which stand apart from other known classes of X-ray sources. They are all radio-quiet, exhibit X-ray pulsations with spin periods in the \(\sim 5-12\) s range, a large spin-down rate \((\dot{P} \approx 10^{-10} - 10^{-12} \text{s}^{-1})\) and a rather high X-ray luminosity \((L_X \approx 10^{34} - 10^{36} \text{ergs}^{-1}; \) for a recent review see Woods & Thompson 2004). The nature of the X-ray emission from these sources has been intriguing all along. In fact, for both AXPs and SGRs, the X-ray luminosity is too high to be produced by the loss of rotational energy of the neutron star alone, as for more common isolated radio pulsars.

The magnetic fields of AXPs and SGRs, as estimated from the classical dipole braking formula \(B \sim 3.2 \times 10^{19} \sqrt{PP} \ G\), are all above the critical magnetic field at which quantum effects become important, \(B_{QED} \sim 4.4 \times 10^{15} \ G\). At the same time, the lack of observational signatures of a companion strongly argues against an accretion powered binary system, favoring instead scenarios involving isolated NSs. These findings led to the idea that these two classes of sources should be somehow linked together, and their X-ray emission related to their very high magnetic fields.

At present, the model which is most successful in explaining the peculiar observational properties of AXPs and...
SGRs is the “magnetar” model. In this scenario AXPs and SGRs are thought to be isolated NSs endowed with ultra-high magnetic fields ($B \sim 10^{14} - 10^{15}$ G) and their X-ray emission is powered by the magnetic field decay (Duncan & Thompson 1992; Thompson & Duncan 1993, 1995, 1996). Alternative scenarios, invoking accretion from a fossil disk remnant of the supernova explosion (van Paradijs, Taam & van den Heuvel 1995; Chatterjee, Hernquist & Narayan 2000; Alpar 2001), encounter increasing difficulties in explaining the data.

While SGRs were first identified through intense, repeated high-energy bursts observed in the X/$\gamma$-ray band, AXPs were revealed thanks to their persistent emission in the soft X-rays. For more than two decades, AXPs were thought to be steady, soft X-ray emitters and their X-ray spectrum was well modeled as the superposition of a blackbody at $kT \sim 0.4$ keV and a steep power-law with photon index $\Gamma \sim 2-4$. No counterparts had been detected at other wavelengths. Only in the past few years, mostly thanks to new generation observatories and to dedicated observational campaigns, our picture of AXPs has largely changed: 1) a few of them show definite long term X-ray flux variability on timescales of months (Woods et al. 2004; Mereghetti et al. 2004; Gavriil & Kaspi 2004), 2) large spectral variations with rotational phase were revealed (Israel et al. 2001; Rea et al. 2003; Tiengo et al. 2005), 3) bursting activity was detected (Kaspi et al. 2003; Gavriil, Kaspi & Woods 2002), 4) glitches were discovered (Kaspi, Lackey & Chakrabarty 2000, Dall’Osso et al. 2003; Kaspi & Gavriil 2003, Morii, Kawai & Shibazaki 2005), 5) high-energy tails requiring an additional spectral component were discovered (Kuiper, Hermsen & Méndez 2004) and 6) IR/Optical steady and variable emission was detected (Hulleman, van Kerkwijk & Kulkarni 2000; Kern & Martin 2002; Wang & Chakrabarty 2002; Israel et al. 2002).

1RXS J170849.0–400910 was discovered with ROSAT (Voges et al. 1996) and later on a $\sim 11$ s modulation was found in its X-ray flux with ASCA (Sugizaki et al. 1997). Early measurements suggested that it was a fairly stable rotator (Israel et al. 1999). However, in the last four years the source experienced two glitches, with different post-glitch recoveries (Kaspi, Lackey & Chakrabarty 2000, Dall’Osso et al. 2003, Kaspi & Gavriil 2003). Searches for optical/IR counterparts ruled out the presence of a massive companion (Israel et al. 1999), even though very recently an IR counterpart has been proposed (Israel et al. 2003; Safi-Harb & West 2005). A diffuse ($\sim 8$ s) radio emission at 1.4 GHz was recently reported, possibly associated with the supernova remnant G346.5–0.1 (Gaensler et al. 2000).

Pulse phase spectroscopy analysis of two BeppoSAX observations (Israel et al. 2001; Rea et al. 2003) revealed i) a large spectral variability with the spin-
phase, ii) a strong energy dependence of the pulse profile shape, and iii) shifts in the pulse phase between the low and the high energy profiles. High variability of the pulse shape with energy is now detected at even higher energies, up to \( \sim 220 \text{ keV} \), both with the HETE instrument on board of RXTE and the INTEGRAL satellite (Kuiper et al. 2005, in preparation).

By analyzing a BeppoSAX observation taken in 2001 (the longest pointing ever performed on this source), Rea et al. (2003) reported the presence of an absorption line at \( \sim 8 \text{ keV} \) in a phase-resolved spectrum. The line significance is \( \sim 4\sigma \). Interpreting the feature as a cyclotron line due to resonant scattering yields a neutron star magnetic field of either \( 9.2 \times 10^{11} \text{ G} \) or \( 1.6 \times 10^{15} \text{ G} \), in the case of electron or proton scattering, respectively.

In this paper we report on the first XMM–Newton observation of the AXP 1RXS J170849.0–400910. Timing and spectral data analysis are presented in §2. The Discussion is divided into two parts: in Section 3 we discuss the results, readdress the problem of the line significance in the BeppoSAX observation, and briefly report on the cyclotron line variabilities detected so far in other X-ray pulsars; Section 4 is instead a more theoretical part where we propose an interpretation of the results in the framework of the magnetar scenario. Conclusions follow in §5.

2 OBSERVATION AND DATA ANALYSIS

1RXS J170849.0–400910 was observed with XMM–Newton between 2003 August 28th and 29th, for \( \sim 50 \text{ ks} \). The XMM–Newton Observatory (Jansen et al. 2001) includes three 1500 cm\(^2\) X-ray telescopes with an EPIC instrument on each focus, a Grating Spectrometer (RGS; der Herder et al. 2001) and an Optical Monitor (Mason et al. 2001). Two of the EPIC imaging spectrometers use MOS CCDs (Turner et al. 2001) and one uses a PN CCD (Strüder et al. 2001). The MOS cameras were operated in Prime Partial Window Mode, while the PN camera was in Prime Small Window Mode, all with the medium optical photons blocking filter. The Optical Monitor was operating during the observation but the optical counterpart of 1RXS J170849.0–400910 was too faint to be detected. Data were processed using SAS version 5.4.1. We employed the most updated calibration files available at the time the reduction was performed (June 2004). Standard data screening criteria were applied in the extraction of scientific products. Since a higher background affected the last \( \sim 10 \text{ ks} \) of the observation, we used only the data during intervals in which the count rate above 10 keV was less than 0.35 counts s\(^{-1}\). The source events and spectra were extracted within a circular region of 27′′ centered on the peak of the point spread function of the source. This non standard radius was used because the source was located near the edge of the chip. The background was instead obtained from a source-free region of 27′′.

Thanks to the high timing and spectral PN resolution we have been able to perform timing and spectral analysis, as well as Pulse Phase Spectroscopy. Results are reported in the following subsections.
2.1 Timing Analysis

In order to determine the spin period of 1RXS J170849.0–400910 we first barycentered the events (using the SAS tool barycen) and performed a power spectrum (powspec) where we found a periodicity at ∼11 s (as expected from previous period determinations) composed of a fundamental and a second harmonic. In order to obtain a precise estimate of the pulse period, we carried out a period search around this value (efsearch). We obtained a best spin period of \( P_s = 11.00170 \pm 0.00004 \) s. The uncertainty was determined by dividing the observation in 8 intervals and performing a linear fit to the phase determined in each interval (phase-fitting technique).

The PN phase-folded light curve in different energy bands is shown in Fig.1 (right panel), together with that obtained in the past by BeppoSAX. We found that the pulsed fraction of the X-ray signal (defined as the amplitude of the best-fitting sine wave divided by the, background corrected, constant level of the emission) is energy-dependent, and it varies from 39.0 ± 0.5% in the 0.5–2.0 keV range to 29 ± 1.5% in the 6.0–10.0 keV range. These values are consistent with those reported for the pre-glitches BeppoSAX observation (Israel et al. 2001) while both are larger than those reported for the post-glitches BeppoSAX observation (Rea et al. 2003).

2.2 Spectral Analysis and Pulse Phase Spectroscopy

We generated the PN phase-averaged spectrum and 10 phase-resolved spectra. Phase zero was arbitrarily defined as the start of the observation (MJD = 52879.9115833) and the phase bins are equally spaced. The choice of the number of intervals was based on the comparison between the better quality of the XMM–Newton phase-averaged spectrum with respect to the BeppoSAX spectrum (for which 6 phase intervals were used) and it was made prior to the analysis, in order to keep the number of trials to a minimum in case evidence for a cyclotron line was present.

The phase-averaged spectrum in the range 0.5–10 keV is satisfactorily fitted by a model consisting of an absorbed blackbody plus a power law (\( \chi^2_{\text{red}} = 1.28 \) for 242 degree of freedom, with a 2% systematic error included; see Fig.2). The best fitting parameters are: hydrogen column density \( N_H = (1.48 \pm 0.04) \times 10^{22} \) cm\(^{-2} \), blackbody temperature \( kT_{\text{bb}} = 0.456 \pm 0.009 \) keV (with a blackbody radius of \( R_{\text{bb}} = 2.7 \pm 0.2 \) km at a distance of 5 kpc) and photon index \( \Gamma = 2.83 \pm 0.03 \) (all errors are at the 90% confidence level). The unabsorbed flux in the 0.5–10 keV range is \( 9.1 \times 10^{-11} \) erg cm\(^{-2}\) s\(^{-1}\) corresponding to a luminosity of \( 2.7 \times 10^{35} \) erg s\(^{-1}\) (again for a 5 kpc distance). In the 0.5–10 keV band, the blackbody component accounts for \( \sim 14.9% \) of the total unabsorbed flux. We found some deviations from the best fit model in the lower energy range (see Fig.2), however we believe these deviations are the result of mixing of spectral shapes, since those deviations are not present in the phase-resolved spectra and to calibration issues. Consistently with what has been done in the past for other AXPs,
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Figure 4. Residuals (σ) of the fits to the phase-resolved spectrum of 1RXS J170849.0–400910. Phase intervals are indicated in the lower-right of each panel. This figure shows the absence of any significant feature during the whole pulse period.

we tried to fit the spectrum of 1RXS J170849.0–400910 with two absorbed blackbodies but this resulted in a worse fit ($\chi^2_{\text{ dof}} \sim 2.2$).

The absorbed blackbody plus power law model provides excellent fits for all the ten pulse phase-resolved spectra, either when leaving $N_H$ free or when fixing it to the value obtained from the phase-average analysis. The resulting parameters (both for $N_H$ fixed and free) are shown in Fig. 3. We note that the lowest $\chi^2$ is observed when the blackbody flux is lowest, which might suggest that a simple blackbody is not a very realistic description of the thermal component. As we tested, by replacing the single temperature blackbody by a disk blackbody gives a lower $\chi^2_{\text{ dof}}$ (reduced by up to 0.06) in 9 out of the 10 phase-resolved spectra. Of course this does not imply much about a physical interpretation, but is suggestive of a thermal emission more complex than a single blackbody.

Note that all the phase-average spectral parameters, but the power-law photon index $\Gamma$, are consistent (within 1.5σ errors) with the last BeppoSAX observation. We then found here a clear softening in the spectrum correlated with a decrease of the soft X-ray flux by a factor of almost two.

As we can see from Fig. 4 there is no significant indication for an absorption line near 8.1 keV, as reported by Rea et al. (2003). In order to determine an upper limit to the strength of such a line, we concentrated on the phase intervals which coincide best with that in which the absorption line was found in the BeppoSAX data. From the re-analysis of the BeppoSAX data, we noticed that the phase interval in which the absorption line was strongest is incorrectly stated in the published version of Rea et al. (2003) (see also § 3.1). The correct value is 0.5–0.6 in their phase convention (phase zero corresponding to minimum of the 0.1–2 keV pulse profile) which corresponds best to phases 0.5–0.6 and 0.6–0.7 in our phase convention. Thus, it does not lie in the rising part of the pulse profile, but close to the minimum in the 0.1–2 keV range (which actually is the maximum in the 6–10 keV band; see Fig. 4). We then fitted the spectrum taken at these phases by adding to the best fitting continuum (with $N_H$ fixed) a cyclabs model (Mihara et al. 1990; Makishima et al. 1990) as that used by Rea et al. (2003). We fixed both line energy and width to 8.1 keV and 0.2 keV, respectively, finding no significant improvement in the $\chi^2$. We stepped through values of the dimensionless line depth while the continuum parameters were allowed to change, until a $\Delta \chi^2$ of 2.706 (90% uncertainty region for one parameter of interest) was reached. This occurred at a depth of 0.15 as a 95% upper limit to the line depth.

Hints for spectral lines could be found around ~7 keV in some phase-resolved spectra and around 1.8 keV and 2.8 keV in the phase-average spectrum (see Fig. 4 and Fig. 2) but in all cases the significance considering one single trial was less than 2σ, then highly not statistically significant. We believe them most probably due to systematic instrumental deviations.

3 DISCUSSION ON THE RESULTS

In this paper we analyzed the first XMM-Newton observation of the AXP 1RXS J170849.0–400910. We found the source at a flux level two times lower than that measured in a previous BeppoSAX observation (Rea et al. 2003) and with a significantly softer spectrum (see Fig. 2). The strong phase dependence of the spectrum, the large pulse shape variability and the shifts in phase of the

Note that the BeppoSAX flux reported in this plot is slightly lower than one reported in Rea et al. 2003, this is due to a different, more updated, arf matrix used here for the re-analysis of this data.
As discussed above, we have found no evidence in this XMM–Newton observation for an absorption line at $\sim 8$ keV neither in the phase-averaged nor in the phase-resolved spectra; the upper limit for the line depth is 0.15 at 95% confidence level. If we compare this with the value found by Rea et al. (2003; $0.8 \pm 0.4$ at 90% confidence level), there is only a very small chance that the two measurements are consistent. This leaves us with two options to be considered: i) the BeppoSAX detection is a spurious result, or ii) the absorption line is variable.

Before discussing the option of a variable absorption line (see §4), we undertook a careful re-analysis of the BeppoSAX data. This re-analysis resulted in the finding that the phases at which the absorption line was strongest were given incorrectly in the published version of Rea et al. (2003), as we noticed earlier: in particular, the line is strongest close to the pulse minimum in the 0.1-2 keV band (or the pulse maximum in the 6-10 keV band). We nevertheless found that the reported estimate of the significance is sound and not much influenced by different choices in the background subtraction (annular regions, circular regions far from the source or using blank field files) or by different extraction regions for the source. The re-analysis of the BeppoSAX data made varying the extraction radius, the criterion for the background subtraction and the spectral binning factor, results in basically the same line properties, which strengthens our confidence in the robustness of the result.

Using an F-test method and taking into account the six trials we made in the phase resolved spectra, we derive a confidence level for the absorption line of $\sim 4\sigma$. Note that even if we take into account all the possible energies at which the feature could lie in the LECS plus MECS energy range, the confidence level is still $\gtrsim 3.5\sigma$. We note that recent works pointed out that the F-test may be inappropriate in this circumstances (see Protassov et al. 2002), leading sometimes to incorrect estimates of the significance of a feature, although it has been (and still is) widely used to test the significance of spectral lines.

In order to further investigate on this issue, we ran a Monte Carlo simulation of 10000 spectra with only the continuum model (parameters reported in Rea et al. 2003) and the same number of photons of the phase resolved spectrum which showed the line in the 2001 BeppoSAX observation. The results of the simulation is shown in In Fig. Each circle represents the line depth found in each of the 10000 spectra, here plotted as a function of the line energy. From this simulation we found 32 spectra with depth $>0.8$ in 10000 points. We can then reliably say that the probability of the line being a fluctuation is $<0.32\%$. In summary, we confirm the detection of the 8.1 keV absorption line in the BeppoSAX data made by Rea et al. (2003) at 99.68% confidence level.

The interpretation of the absorption feature as a cyclotron scattering line proposed by Rea et al. (2003) was based on the following criteria: 1) a Gaussian line gives a bad fit and does not reproduce the asymmetrical shape of the observed feature; 2) the best fitting model is the XSPEC cyclabs model; 3) the line strength is highly phase dependent; 4) no atomic edges or absorption lines are known to lie around 8.1 keV (at least without assuming ad hoc shifts possibly due to the high gravitational redshift or to Zeeman effects in such strong magnetic field); 5) the relation between the line energy and width agrees with that of cyclotron scattering features discovered in other classes of sources (see Fig. in Rea et al. 2003); 6) the magnetic field inferred from the line energy, either in the case of an electron or proton cyclotron resonance, is reasonably consistent with what is
expected for a normal neutron star (∼ 10^{12} \text{G}) or for a magnetar (∼ 10^{15} \text{G}), both being still open possibilities. Then, if this feature is real, all the above points hint toward the cyclotron nature of the absorption feature at 8.1 keV.

Keeping always in mind the possibility that the absorption line in the BeppoSAX spectrum might be due to statistical fluctuations, in the following section we discuss a physical mechanisms which could be responsible for the appearance of a transient cyclotron line in this source in the context of the magnetar scenario.

### 3.2 Other cases of variability of cyclotron absorption features

We conclude this section by summarizing the current status of detections of variable resonant scattering cyclotron absorption features in X-ray pulsars, both in binary and in (probably) isolated systems.

Cyclotron resonant scattering features were first detected in accreting X-ray pulsators. Up to now more than ten pulsars in binary systems are known to exhibit an absorption line in their spectra. In all these cases, there is unanimous consensus about an interpretation of the feature in terms of resonant scattering by electrons (see e.g. Heindl et al. 2004 for a recent review). Variability in the line energy has been observed in some of these sources, and changes appear to correlate with the source flux. This behavior finds a quite natural explanation within the column accretion scenario, in which the height of the radiation shock depends on the luminosity. At larger fluxes the shock forms higher up in the column where the (dipole) field is weaker (Mihara, Makishima & Nagase 1997; Mihara, Makishima & Nagase 2004).

Cyclotron features have been reported so far in the spectra of some isolated neutron stars too: the soft γ-repeater SGR 1806-20, five X-ray dim isolated neutron stars (XDINs) and the radio-quiet neutron star 1E 1207.4-5209. With the exception of 1E 1207.4-5209 (Bigianni et al. 2003), the nature of the line (either electron or proton) is controversial as yet, and, at least for XDINs, a possible atomic origin can not be excluded.

The similarity of XDINs pulsational periods (∼ 3–10 s), together with the alleged high values of their magnetic field (∼ 10^{13}–10^{14} \text{G}), makes comparison with 1RXS J170849.0–400910 particularly interesting. Present data show that absorption features in XDINs are in all cases dependent on the spin phase. Until recently XDINs were believed to be steady (albeit some of them are pulsating) soft X-ray emitters. However, the brighter pulsating member of this class, RX J0720.4-3125, has been discovered to undergo rather conspicuous spectral changes over a timescale of a few years (De Vries et al. 2004; Vink et al. 2004; Haberl et al. 2004). Weather this spectral evolution is accompanied by significant changes in the absorption line properties is not completely clear as yet.

Perhaps the most convincing evidence of long-term variations of a cyclotron line comes from the SGR 1806-20. This source provided the first possible detection of an absorption feature in a magnetar candidate (Ibrahim et al. 2002; Ibrahim, Swank & Parke 2003). The feature has an equivalent width EW ∼ 0.5 keV, width σ ∼ 0.2 keV and an energy of ∼ 5 keV. The spectral feature appears to be transient and has been detected only in the spectrum of a number of quite energetic bursts. Moreover, recently a hint for a 4 keV feature has been found during bursts detected by XMM-Newton (Mereghetti et al. 2005). Despite intensive searches no evidence of any feature has ever been found in the persistent X-ray emission of this source. The feature appears to be almost certainly correlated with the onset of the bursting activity and with periods of increased X-ray luminosity and spectral hardening.

### 4 INTERPRETATION IN THE MAGNETAR SCENARIO

We discuss here the possibility that the onset of a twist in the magnetosphere might have been responsible for the two successive glitches, for the observed correlation between spectral hardening, luminosity and glitching activity, and, possibly, also for the transient behavior of the cyclotron feature.

Thompson, Lyutikov & Kulkarni (2002) recently proposed a scenario in which the magnetars (AXPs and SGRs) differ from standard radio pulsars since their magnetic field is globally twisted inside the star, up to a strength of about 10 times the external dipole and, at intervals, it can twist up the external field. The resulting stresses building up in the neutron star crust and the magnetic footprints movements can lead to crustal fractures, known to be responsible of the glitches activity of the pulsars (Ruderman 1991b; Ruderman, Zhu & Chen, 1998, Ruderman 2004). These fractures could in principle be violent enough to affect substantially the neutron star interior and in particular to unpin the crustal neutron superfuid vortex lines from the crustal lattice, causing the occurrence of a glitch (see Thompson & Duncan 1993).

In this picture the vortex lines become unpinned sequentially in small patches of the crust rather than in the whole crust as in the case proposed for radio pulsars (Ruderman 1991b). Because of the large discontinuities of the crustal field, the reconnection of the vortex unpinned lines could be suppressed at such discontinuities, driving a pure horizontal field evolution to a point where reconnection is possible. This, in turn, can cause a second and potentially more energetic rupture of the crust (Thompson & Duncan 1993). This scenario, therefore, can qualitatively explain the occurrence of the two successive glitches observed from 1RXS J170849.0–400910 between 1999 and 2001 (Kaspi, Lackey & Chakrabarty 2001; Dall’Osso et al. 2003; Kaspi & Gavriil 2003). We note that 1RXS J170849.0–400910 was not totally recovered from the second glitch at the time of the BeppoSAX observation (Rea et al. 2003), while it was at time of the XMM-Newton observation reported here.

More interestingly, the onset of a twist in the magnetosphere can in principle explain both the observed spectral variability in the AXP 1RXS J170849.0–400910
softening and a transient appearance of the cyclotron feature.

In fact, a key feature of twisted, force-free magnetospheres is that they support current flows. The presence of charged particle (electrons and ions) produce both a large resonant scattering depth and an extra heating of the star surface, the latter induced by returning currents. Because the electrons distribution is spatially extended and the resonant frequency depends on the local value of $B$, repeated scatterings could lead to the formation of a high-energy tail instead of a narrow line at the cyclotron frequency. In this model, both the scattering depth (which is strongly dependent on the magnetic latitude) and the luminosity released by particles hitting the surface increase with the twist angle. Therefore, since the spectral hardness increases with the depth, this implies a positive correlation between the source X-ray luminosity and the spectral hardening. This is indeed what the data reported in Fig. 6 indicate.

Moreover, the same model can provide a possible explanation for the transient appearance of a proton cyclotron feature during the epoch in which the twist was substantial. In fact, the charges present in the magnetosphere are also providing a large optical depth to resonant proton (ions) cyclotron scattering and the proton resonance occurs much closer to the star surface than the electron resonance. A transient absorption feature at the proton cyclotron frequency may arise then when a) the twist angle is large and b) the X-ray luminosity at the resonant frequency (evaluated at the star surface, $\omega_{B,p}$) is large enough to exceed the gravity pull on the protons, so that positive charges are efficiently confined in a thin layer close to the star surface (see again Thompson, Lyutikov & Kulkarni 2002).

Although not strictly compelling, the correlation between line appearance, glitching activity and flux enhancement is therefore intriguing and suggests that the conditions for line formation may have been met at the epoch of the BeppoSAX pointing.

5 CONCLUSION

Our present analysis of the XMM–Newton observation performed on 2003 August of 1RXS.J170849.0–400910 revealed that this source is variable in X-ray over a period of about five years. This provides further evidence that AXPs, which were believed to be steady sources for a long time, exhibit both flux and spectral changes. We pointed out the existence of a clear correlation between the source flux level and spectral hardening. An interesting possibility is that both the increased X-ray emission and the hardening are related to the occurrence of glitches.

The XMM–Newton pointing caught the source at a factor of two lower flux than that of the BeppoSAX observation, performed soon after the last glitch, and with a significantly softer spectrum. By comparing the evolution of 1RXS.J170849.0–400910 with that of the AXP 1E 2259+586, which followed a similar pattern, it is possible that 1RXS.J170849.0–400910 too had a transient period of bursting activity, missed in the RXTE monitoring.

We interpret both the occurrence of the glitches and the spectral softening accompanying the flux decay in the framework of the magnetar scenario, by the onset of a twist in the external magnetic field (Thompson, Lyutikov & Kulkarni 2002). Moreover, the occurrence of the twist could also account for the possible variability of the cyclotron line, which was detected only while the source had not entirely recovered from the last, and more powerful glitch event.
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