Short Term Scientific Mission whithin COST Action MP1304 - report

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STSM purpose

The purpose of my Short Term Scientific Mission to the CSIC-IEEC institute in Barcellona with Dr. Nanda Rea (from the 1^{st} to the 31^{th} of october, 2015) was to use three un-published XMM observations (P.I. N. Rea) to study the timing and spectral properties of the Soft Gamma Repeater SGR 0418+5729, famous for being the first "low-B" Magnetar discovered: the surface dipolar magnetic field of this source, inferred with the timing properties, is of about 6×10^{12} G, which is quite low for the usual Magnetar and even below that of some canonical pulsars (Rea et al. 2013). The discrepancy between the inferred field and the typical magnetar-like bursting activity led to the idea that the source is harboring a much stronger internal and/or multipolar field (Turolla et al. 2011, Rea et al. 2013). The existence of "low-B" magnetars (other two have been discovered: Swift J1822.3-1606 and 3XMMJ185246.6+003317, see Scholz et al. 2012, Rea et al. 2014) means that also "normal" pulsar, which have inferred dipolar fields up to 10^{13} G, could show magnetar-like activity.

Description of the work and main results

The first step of the analysis was to reduce the data from the XMM satellite, using `SAS` version 14 and applying standard data reduction criteria. The time resolution for the pn camera for all the observations was of $\sim$ 48 ms (Large Window mode) and for the MOS1 and 2 cameras of $\sim$ 0.9 s (Large Window mode). During observation 0741970301 (15 Aug. 2015) there was a drop in the telemetry for the pn camera, so the pn data from this observations were unfit for the timing analysis. The source photons were exctracted form a circular region of about 23 arcseconds centered on the source and the background from a similar region (far away from the source). For the spectral analysis only photons having FLAG=0 and PATTERN$\leq$4 for the EPIC-pn data and PATTERN$\leq$12 for the EPIC-MOS data were used.

The timing analysis was performed folding the data at the known source period ($\sim$ 9.1 s) and connecting the three new phase values to all the previous XMM

observations, obtaining a refined timing solution: fitting the data with the relation

$$\phi = \phi_0 + 2\pi\frac{(t-t_0)}{P} - \pi\frac{(t-t_0)^2\dot{P}}{P^2},$$

I found that the data were well fitted by a linear plus a quadratic term, meaning that it was possible to obtain a new value for the period and the period derivative. This new values led to a refined estimate of the surface dipolar magnetic field ($B_d \simeq 3.2 \times 10^{19}(P\dot{P})^{1/2}$) confirming that SGR0418+5729 is the magnetar with the lowest surface dipolar magnetic field known.

The spectral analysis (performed with `Xspec` version 12.8.2) was a bit challenging since the source is really faint and the background dominates the emission above 3 keVs. To obtain a spectrum with a good count rate I combined all the 9 data sets (three cameras for three observations, the problem with the telemetry doesn't affect the spectral analysis) using the `SAS` task `epicspeccombine`. The resulting spectrum was rebinned to have at least 15 counts per bin. The spectrum was well fitted with an absorbed blackbody (in the 0.5 - 3 keV range). From the unabsorbed flux I have estimated the luminosity (even if the source distance is not well known, see Rea et al. 2013) which is about an order of magnitude higher than the spin-down luminosity (the luminosity of a pure rotating magnetic dipole).
Due to the faintness of the source, it was impossible to perform a phase resolved spectral analysis (i.e: to divide the spectrum in phase interval to study the emission in function of the rotational phase).

Foreseen publications

We are currently working on an article about the work done during the STSM. The article should be submitted shortly to The Astrophysical Journal Letters.
Part of my Master's Thesis will be about the work done during my STSM (expected graduation in mid December 2015).