COST Action: MP1304
STSM title: Hunting for transitional millisecond pulsars
Reference : ECOST-STSM-MP1304-091215-
STSM dates: from 09-12-2015 to 20-12-2015

Report

I visited the Integral Science Data Center (ISDC) in Versoix (Switzerland) from December 9 to 20. There, I mainly collaborated with Dr. Enrico Bozzo, Dr. Carlo Ferrigno and Dr. L. Pavan. The visit was mainly aimed at discussing the results of a number of observations of X-ray transients performed by X-ray telescopes such as XMM-Newton, INTEGRAL and Swift. Details are given in the following.

IGR J17511-3057; This accreting millisecond pulsar went into a 4-weeks long outburst on 2015 March 23. We analysed a series of Swift XRT and INTEGRAL monitoring observations performed along the outburst, as well as a 76 ks XMM-Newton observation performed when the source was close to the peak of the accretion event. The spectra obtained by these instruments revealed a distribution dominated by inverse Comptonization of soft (<1keV) photons produced at the NS surface off an optically thin distribution of hot (>20 keV) electrons. The analysis of XMM-Newton data revealed also the presence of two thermal components, interpreted as the emission coming from the NS surface and the accretion disk, as well as the presence of a broad (~1 keV) emission line centered at 6,9+/0.2 keV, interpreted as reflection of the hard X-ray emission produced close to the NS surface by ionized Fe in the accretion disk. Such a spectral decomposition resulted remarkably similar to the one seen during the previous accretion event observed from IGR J17511-3057 in 2009, indicating how the physical and geometrical conditions at the accretion flow are unchanged from an outburst to another. We performed a timing analysis of the coherent signal emitted by the X-ray pulsar to discover that its spin frequency has decreased by (5.8+/-2.0)E-07 Hz during the time elapsed since the end of the 2009 outburst. This allowed us to estimate a spin down rate of (-3.3+/-1.2)E-15 Hz/s which translates into a magnetic field strength of ~3.5E8 G. The orbital ephemerides of the source were also used to analyse data taken at a high temporal resolution by the ISGRI on-board INREGRAL across the outburst, but no pulsations could be detected significantly. During the visit we have also finalized the analysis of the Swift (in collaboration with Dr. P. Romano of INAF-OA Palermo) and INTEGRAL observations (in collaboration with Dr. Celia Sanchez of ESAC Madrid). **A paper "The 2015 outburst of the accreting millisecond pulsar IGR J17511-3057 as seen by INTEGRAL, Swift and XMM-Newton", A. Papitto, E. Bozzo, C. Sanchez-Fernandexz, P. Romano, C. Ferrigno has been submitted to A&A**.

IGR J17451-3022; This X-ray transient was discovered in 2014 August. INTEGRAL, Swift and XMM-Newton observations were requested and performed. The monitoring observations provided by the JEM-X instruments on-board INTEGRAL and the Swift /XRT showed that the event lasted for about 9 months and that the emission of the source remained soft for the entire period. In the soft energy range (0.5–10 keV), the source emission was dominated by a thermal component, most likely produced by an accretion disk. At high energies (>10 keV), a power-law component is also detected and could originate either in a Comptonizing corona above the disk or in a neutron star accretion column. The XMM-Newton observation carried out during the outburst revealed the presence of multiple absorption features in the soft X-ray emission that could be associated to the presence of a disk wind, as observed in many high-inclination low mass X-ray binaries. The XMM-Newton data also revealed the presence of partial and rectangular X-ray eclipses (lasting about 820 s), together with dips. The latter can be associated with increases in the overall absorption column density in the direction of the source. The detection of two consecutive X-ray eclipses in the XMM-Newton data allowed us to estimate the source orbital period at Porb=22620.51(+2.02−1.83 s) (1σ c.l.). **A paper ("IGR J17451–3022: a dipping and eclipsing low mass X-ray binary", E: Bozzo,**

P. Pjanka, P. Romano, A. Papitto, C. Ferrigno et al.) had been submitted to A&A already before the visit, and a favorable review was received. During the visit the answer to the reviewer was discussed and edited. In particular, the results from a thorough spectral modelling with Cloudy, (in collaboration with S. Bianchi and G. Ponti) were discussed and inserted in the revised version of the paper, that is going to be submitted in early 2016.

EXO 1745-245; This NS binary system is hosted by the globular cluster Terzan 5, and went into outburst in 2015 March. An 80 ks-long XMM observation performed during the outburst revealed a spectrum dominated by a Comptonized component originated in a 3keV optically thick (tau~8) environment, presumably a boundary layer between the disk and the compact object. An evident complex of emission (and possibly) absorption features has been detected between 6 and 7 keV, at energies compatible with K-alpha transition of Fe. The emission component could be modelled with the sum of a narrow feature at 6.5 keV (compatible with neautral or weakly ionized Fe) and a broad feature at 6.9 keV (compatible with ionized Fe XXV or XXVI). The different broadness and ionization state of the lines indicate a different origin. While the broad, hotter component is compatible with coming from the inner regions of an accretion disk truncated at ~10 gravitational radii from the NS, the narrow line is possibly produced in a cloud located farther from the NS. Absorption features at 6.4 and 6.97 keV are detected at low (~3sigma) significance, and could possibly indicate absorption by a wind that crosses at least partly the line of sight. The physical interpretation of these observations were discussed during the visit, as well as the prospect of analysing the whole dataset of Swift observations of the source, to produce a detailed view of the magnitude and X-ray hardness evolution of the source during its outburst. To this end a collaboration with Dr. P. Romano (INAF OA-Palermo) was started. A timeline to finalize the observation analysis before the end of January 2016 and submit a paper before April 2016 has been agreed upon.

During the visit, we also discussed a revised version of the paper **“The accretion regimes of a highly magnetised NS: the unique case of NuSTAR J095551+6940.8”, S. Dall'Osso, R. Perna, A. Papitto, E. Bozzo, L. Stella, 2015, ApJ, submitted**. Such a version was then resubmitted to ApJ to take into account reviewer comments.

In addition, during the short stay at ISDC, I could also discuss and write observation proposal to perform a Target of Opportunity observation with NuSTAR in the hard 3-80 keV X-ray band, and ATCA at radio frequencies of 5,5 and 9 Ghz, should a candidate transitional ms pulsars go into outburst during the following years. These proposals were submitted on December 11 (**NuSTAR prop. no. 2145, PI: Papitto, “Hunting for transitional ms pulsars with NuSTAR”**) and December 14 (**ATCA prop. No C3007, PI: Papitto, “Coupling accretion and ejection in transitional millisecond pulsars**”).

Copies of the papers and observation proposals written during the STSM would be produced upon request. In any pubblication resulted from this short stay, the NewCompStar action was ackowledged by adding the following sentence “AP acknowledges partial support from “NewCompStar”, COST Action MP1304.”