IGR J17177-3656: a multi-wavelength campaign

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(Paizis et al., 2011, ApJ 738, 183)

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1. Multi-wavelength campaign of IGR J17177-3656

An overview of our multi-wavelength campaign is shown in Fig 1.

IGR J17177-3656 was discovered by *INTEGRAL* on 2011 March 15 (MJD 55635, Frankowski et al., 2011) and our *Chandra* ToO was performed on 2011 March 22.

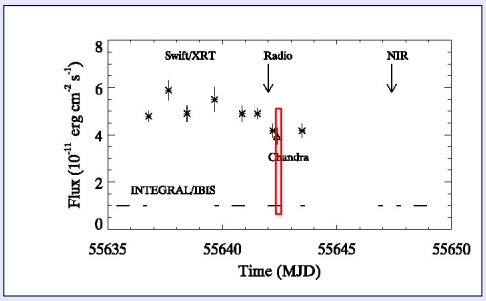

Fig 1. *Swift*/XRT and *Chandra*/HETGS (absorbed) flux evolution of IGRJ 17177-3656 in the 2-8 keV range. The *INTEGRAL*/IBIS coverage is marked as horizontal lines. Arrows indicate our NIR (IRIS telescope and HAWAII-1 detector, Chile) and radio (ATCA, Australia) follow-up observations.

2. X-ray results

We extracted the best available X-ray position and fit the simultaneous Chandra-INTEGRAL spectra with an absorbed power-law with a high and variable local column density, NH .

2.1 Position

We extracted the X-ray position from *Chandra* 0th-order:

α_{J2000}= 17^h 17^h 42^s.62

δ_{J2000}= -36° 56' 04".5

(0.6" at 90% uncertainty, Paizis et al, 2011a)

The *Swift* position we extracted is compatible with the *Chandra* one.

2.2 Spectra

The 1-8 keV spectra obtained from the *Swift*/XRT data show can be well described by an absorbed power-law (average spectral index 1.7±0.2, based on XRT data alone, <10 keV).

Above 20 keV (INTEGRAL/IBIS), the source could be detected in only three pointings out of the 121 analyzed and mosaicking of data was needed to extract a significant spectrum.

The simultaneous *Chandra-INTEGRAL* spectrum of IGR J17177-3656 is shown in Fig 2. *Chandra* data showed a clear variability (3 spectra) that could not be seen above 20 keV (1 average spectrum).

The spectra could be fit with a power-law with photon index Γ=1.36±0.15 and a variable *local* N_H, besides the interstellar column density fixed at 1.5 x 10^{22} cm^{-2}. The local neutral column density varies between (16.8±3.5) x 10^{22} cm^{-2} and (7±1) x 10^{22} cm^{-2} (absorption X-ray model by Wilms et al., 2000).

Un-absorbed (highest) flux:

$F_{(3\text{-}9keV)}$ =7.5 x 10^{-11} erg cm^{-2} s^{-1}

$F_{(3\text{-}200\ keV)}$=1.0 x 10^{-9} erg cm^{-2} s^{-1}

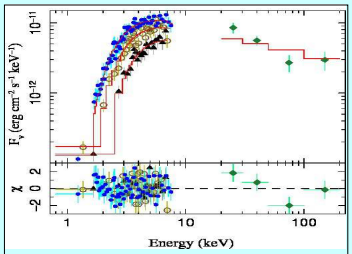

Fig 2. *Chandra*/*INTEGRAL* simultaneous spectra (marked in red in Fig. 1). From Paizis et al., 2011b.

3. Radio results

The radio observation revealed the presence of a ~0.20 and ~0.24 mJy source (9 and 5.5 GHz).

The radio source location accuracy is of 0.5", compatible with *Chandra*. The spectral index was poorly constrained α = -0.27 ± 0.79 (Corbel et al 2011, Paizis et al 2011b).

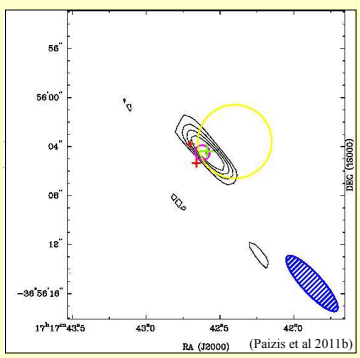

Fig 3. Radio map using the combined ATCA observations at 5.5 and 9GHz (from Paizis et al., 2011b). Green cross: fitted position of the ATCA counterpart; Purple circle: 0.6" *Chandra* error Yellow circle: 3" Swift error Red crosses: the two NIR candidates (Torres et al 2011, Rojas et al 2011) (Paizis et al 2011b)

4. Near Infrared results

No IR counterpart is visible either in the 0.6'' Chandra position or in the 0.5'' radio one down to K_s=16.3 mag.

The closest visible star is the blended doublet 2MASS J17174269-3656039 (Torres et al., 2011, Rojas et al., 2011, Fig4). It is present both in recent (March 2011) and past (April-October 2010) maps, but it is unlikely the NIR counterpart of IGR J17177-3656 due to:

(1) its positional offset from the *Chandra*/ ATCA source (0.9" and 1.05" away)

(2) its low E(J-K) color, not compatible with what expected given the large NH observed by *Chandra*, *Swift*, *INTEGRAL*.

Archival NIR maps taken in 2010 when IGR J17177-3656 was in quiescence show that no NIR source was detected within either the *Chandra* or the ATCA radio error circles down to K~18 (Rojas et al., 2011).

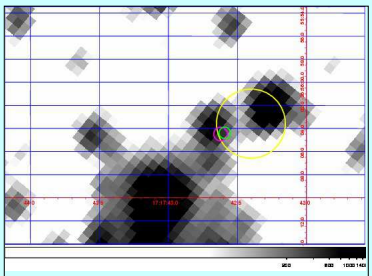

Fig 4. Final averaged Ks image of the field of view around IGR J17177-3656. The green circle represents the ATCA position, the purple one *Chandra*, the yellow one *Swift* (Paizis et al 2011b).

5. Discussion I – a LMXB

IGR J17177-3656 is located in the Galactic plane at (l,b)=(350°.1, 0°.51). Based on our multi-wavelength campaign, we propose that it is an LMXB.

5.1 Not an AGN

Applying our quasi simultaneous X-ray and radio fluxes to the "fundamental $L_{<10keV}$, L_{radio}, Mass plane" by Merloni et al. (2003), we see that we do not obtain typical values for AGNs: e.g., d=100Mpc results in $L_{(3\text{-}9\ keV)}$~10^{44} erg/s and M~4x10^4 $M_\odot$; d=1Gpc with $L_{(3\text{-}9\ keV)}$~10^{46} erg/s and M~5x10^5 $M_\odot$, unlikely for an AGN.

5.2 An X-ray binary

Considering an XRB at a distance of 8 kpc would result in an unabsorbed luminosity of $L_{(3\text{-}9\ keV)}$~5x10^{35} and $L_{(3\text{-}200\ keV)}$~7x10^{36}erg/s, compatible with a Galactic XRB.

5.2.1 Not an HMXB

The NIR limit of K~18 in quiescence together with the radio detection and high X-ray absorption pose quite stringent limits on the nature of the XRB most likely ruling out the HMXB scenario. Indeed:

• a typical supergiant Ib (B0.5) and the observed NH=7x10^{22} cm^{-2} would lead to an estimated observed K~13, that would have been detected in the maps by Rojas et al. (2011);

• a normal B0V star with K~18 would be nearly at 28 kpc, unlikely if compared to the furthest known candidate and BeXRBs in general (Zurita Heras & Chaty, 2008);

• direct accretion through stellar wind, common in HMXBs, should prevent the formation of steady jets; the radio detection suggests a LMXB nature, filling its Roche lobe and forming an accretion disk.

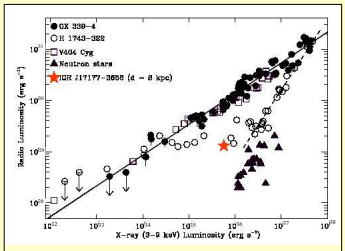

Fig 5. Radio to X-ray luminosity for a sample of black holes and neutron star LMXBs, including IGRJ17177-3656. Adapted from Coriat et al. (2011)

5.2.2 An LMXB

A main sequence K5 star at d=8 kpc would result in K~23, compatible with the non detection in Rojas et al. (2011), $L_{(3\text{-}9keV)}$~5x10^{35} erg/sec, $L_{(radio)}$~10^{29} erg/sec, all of which place IGR J17177-3656 in the black hole LMXB (X-to-radio) area (right in the pattern of the black hole H1743-322, see Fig. 5). Uncertainty on the distance does not alter the conclusions.

6. Discussion II – LMXB: geometry and compact object

The simultaneous Chandra-INTEGRAL spectra suggest that IGR J17177-3656 could be a high inclination Accretion Disc Corona (ADC) source. No clear indication is obtained for the nature of the compact object though the black hole scenario seems more likely.

• we obtain a column density up to about ten times more than the average expected Galactic value in the source direction. LMXBs do not have an important wind, but if seen at high inclination (>60°), they will appear heavily absorbed (dipping, eclipsing or coronal sources as e.g., X1822-377, EXO0748-676);

• the non-variability of the IBIS/ISGRI spectrum could suggest that the Comptonizing region (responsible for the emission above 20 keV) would be extended and wider than the blocking material, as in the ADC sources;

• if this is the case also for IGR J17177-3656, then the true X-ray flux could be higher than what reported and the source could place itself in the neutron star populated area of Fig 5.

References

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