IGRJ17361-4441: a transient IMBH in the globular cluster NGC 6388?

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1. Introduction

IGRJ17361-4441 is a hard X-ray transient source first observed by (1) with the IBIS/ISGRI telescope (2) onboard the *INTEGRAL* satellite (3) and was quickly recognized to be hosted in the galactic globular cluster NGC 6388 (4).

The location of the transient (close to the globular cluster gravitational center, but see later) is of great importance since NGC 6388, among all the globular clusters in our Galaxy, is one of the best candidates (5) to host an intermediate mass black hole (hereafter IMBH). In particular, by using high resolution optical observations, (6) estimated the mass of the IMBH to be $\simeq 5700$ $M_\odot$. It would be natural for such an IMBH to emit significant radiation in the X-ray band due to the likely accretion of matter from its surroundings. In the context of the earliest observations of globular clusters, (7) and (8) were the first to suggest that the X-ray emission detected towards these clusters was due to IMBHs (in the mass range 20 $M_\odot$ – $10^6 M_\odot$) accreting from the intracluster medium. This issue was considered more recently in (9) who provided the census of the compact object and binary population in the globular cluster 47 Tuc and give an estimate of the mass (a few hundred solar masses) of the central IMBH.

Initial *XMM*-Newton and Chandra observations in this direction (10; 12)) showed that the core of NGC 6388 hosts several X-ray sources. Based on the correlation between the X-ray and radio flux from black holes (13), it was pointed out that the search for radio emission from faint black holes is useful to test the IMBH hypothesis in globular clusters and dwarf spheroidal galaxies (14). in particular, the central region of NGC 6388 was observed in the radio band (12) using the Australia Telescope Compact Array (ATCA) to search for radio signatures of the IMBH. The radio observation resulted in an upper limit to the IMBH mass of $\simeq 1500$ $M_\odot$.

The discovery of a transient source close to the NGC 6388 gravitational center could be related to the turning on of the putative globular cluster IMBH. However, as will become clear in the subsequent sections, the nature and spectral properties of the transient IGRJ17361-4441 are difficult to reconcile with the IMBH picture and rather favour an interpretation as a high mass X-ray binary (HMXB) or a low mass X-ray binary (LMXB). Several observational campaigns (in the X-rays as well as in the radio band) were organized in order to pinpoint IGRJ17361-4441 and draw firm conclusions on the NGC 6388 IMBH paradigm.

We briefly discuss the past X-ray observations of the NGC 6388 globular cluster (see (10), and (12)) and the discovery of the hard transient IGRJ17361-4441 by *INTEGRAL* (1) as well as the follow-up observations conducted by Chandra, Swift/XRT and RXTE observatories ((4) and (15)). Then we concentrate on the analsyis of two *XMM*-Newton slew observations of NGC 6388 conducted 15 days after the *INTEGRAL* discovery of the source. The two slew observations had $\simeq 7.6$ seconds and $\simeq 7.7$ seconds on source exposure time (see Figure 1 for a DSS view of NGC 6388 with X-ray contours superimposed and Figure 2 for the historical data of the transient).

However, if one believes that the transient is associated with the IMBH in NGC 6388, then it should be noted that at least three X-ray sources (those labeled as #12, #7 and #3 in (12)) are within the error box of Swift/XRT. In particular, the sources #12 and #7 have fluxes which differ at least by a factor 2 between them. If source #7 is associated with the IMBH, then the observed Chandra X-ray flux (see (10) and (12)) and the updated radio observation of **(author?)** (15) together with the fundamental plane relation give an upper limit of $\simeq 1200$ $M_\odot$.

In the IMBH hypothesis, the intrinsic luminosity of the source as determined by using the XMM-Newton slew data (i.e. $\simeq 9.3 \times 10^{35}$ erg s^{-1}) should be compared with that derived by using the 2005 Chandra data (and in particular for the source #12 in (12)) when the putative IMBH was in quiescent state. In this case, one finds that the source luminosity increased by at least a factor $\simeq 1000$. Moreover, the spectrum seems to follow a power law with photon index $\Gamma \simeq 0.96 - 1.63$.

Nevertheless, the refined source position given by the Chandra satellite (even if still in agreement with the Swift/XRT result) argues against the IMBH hypothesis in favor of a newly discovered source. In this case, the XMM-Newton intrinsic source luminosity should be compared with the upper limit for the quiescent state of the source. Based on the non-detection of the source in the 2005 Chandra observation, the flux upper limit was stimated to be $\simeq 10^{31}$erg s^{-1}. Thus, in this case the transient source has increased its luminosity by a factor close to 10^5.

Two other possibilities as far as the the nature of the transient source is concerned are that it is either a HMXB or a LMXB. The first possibility is actually unlikely since these systems involve companion stars with mass larger than $\simeq 10$ M$_\odot$, i.e. O/B stars which are not expected to exist in globular clusters. Note also that NGC 6388 was extensively observed by the HST instruments and the collected data did not show the presence of any O or B star in the globular cluster.

Hence, among the IMBH alternatives, the LMXB option is the most favorable. This is supported by the observed X-ray luminosity ($\simeq 9.3 \times 10^{35}$ erg s^{-1}) and by the soft spectrum ($\Gamma \simeq 0.93 - 1.63$) observed in the XMM-Newton slew observation which seems to be consistent with the typical characteristics of the LMXB class of objects. A long X-ray observation (sto allow a detailed timing and spectral analysis) may help in understanding the physics underlying this transient source. More details can be found in (11).

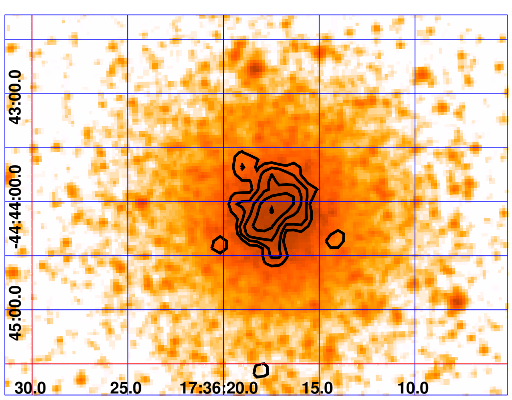

Figure 1. A DSS Image of NGC 6388 with X-ray contour levels superimposed.

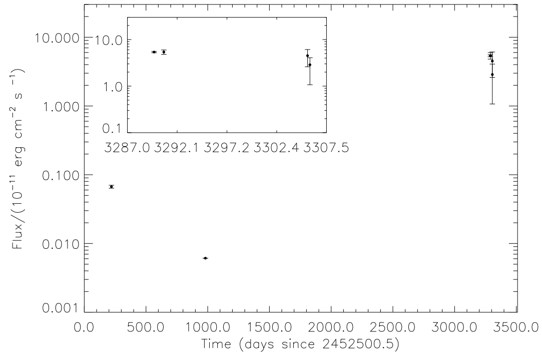

Figure 2. The historical high energy light curve of the possible IMBH in NGC 6388.

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