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Altamirano, D.; Linares Alegret, M.; van der Klis, M.; Wijnands, R.; Kalamkar, M.; Casella, P.; Watts, A.L.; Patruno, A.; Armas Padilla, M.; Cavecchi, Y.; Degenaar, N.D.; Kaur, R.; Yang, Y.; Rea, N.

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## Discovery of 10 mHz quasi-periodic oscillations likely from IGR J17091-3624

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on 17 Mar 2011; 19:56 UT

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Subjects: X-ray, Black Hole, Neutron Star, Transient

Referred to by ATel #: [3229](#), [3230](#), [3266](#), [3299](#), [3913](#), [4773](#)

We report the discovery of  $\sim 10$  mHz quasi-periodic oscillations (QPOs) in a 3.5 ks RXTE observation of the black hole candidate IGR J17091-3624 (ATELs [#3144](#), [#3159](#), [#3167](#), [#3203](#)) on March 14th 2011 (MJD 55634.66). Only PCU2 was active, with an average 2-60 keV background-corrected count rate of 110 counts/s.

The QPO is visible by eye in the light curve during the first  $\sim 1000$  seconds and the last  $\sim 1500$  seconds, with an average 2-60 keV fractional rms amplitude of  $5.3 \pm 0.4\%$  and a mean frequency of  $\sim 10$  mHz. The fractional rms amplitude increases from  $\sim 3.5\%$  below 5 keV to a maximum of  $\sim 10\%$  in the 15-30 keV range. No oscillation is detected in the central  $\sim 1000$  seconds of the observation, with a 3 sigma upper limit on the fractional rms amplitude of 2.4%. In the same observation we find two QPOs at  $2.3 \pm 0.3$  Hz and  $8.0 \pm 0.3$  Hz, with fractional rms amplitudes of  $10.9 \pm 0.8\%$  and  $6.7 \pm 1.2\%$ , respectively.

IGR J17091-3624 is located in a crowded field, with the bright neutron-star system GX 349+2 and the black-hole candidate IGR J17098-3628 at a distance of  $\sim 41$  and  $\sim 9$  arcmin, respectively. An offset of 25' was applied during the observation described here, avoiding the contribution from GX 349+2 but including both the nominal target and IGR J17098-3628 in the 1 degree PCA field of view. IGR J17098-3628 is thought to be in quiescence (ATEL [#3148](#)), but we cannot exclude that it is active.

Both IGR J17091-3624 and IGR J17098-3628 have been tentatively identified as black-hole candidates (Lutovinov & Revnivtsev 2003, *AstL*, 29, 719; Capitanio et al 2009, *ApJ* 690, 1621). Similarly low-frequency oscillations have been seen in the BHC GRS 1915+105 (Morgan et al. 1997, *ApJ*, 482, 993). However, in that source the mHz QPO was seen together with strong ( $>20$

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%) 0.1-50 Hz broadband noise, which is not the case in our observation (<12%). The mHz QPO from IGR J17098-3628 has also different properties than the so-called Type C QPOs (e.g., Casella et al. 2005, ApJ, 629, 403), which are also observed together with strong broadband noise and at higher frequencies.

We note that mHz QPOs have been reported in 4 neutron star systems (Revnivtsev et al, 2001, A&A, 372, 138; Linares et al., 2010, ATEL #2958). However, the fractional rms amplitude of those oscillations typically decreases with energy, opposite to what we find in the present work.

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